FILE COPY

HUMAN HEALTH RISK ASSESSMENT

FOR THE FORMER GULF STATES CREOSOTING FACILITY,

HATTIESBURG, MISSISSIPPI

May 2, 2001

Prepared for:

KERR-MCGEE CHEMICAL LLC
123 Robert S. Kerr Avenue
P.O. Box 25861
Oklahoma City, OK 73125-0861

Prepared by:

ENVIRONMENTAL STANDARDS, INC.
1140 Valley Forge Road
P.O. Box 810
Valley Forge, PA 19482-0810

FILE COPY

HUMAN HEALTH RISK ASSESSMENT
FOR THE FORMER GULF STATES CREOSOTING FACILITY,
HATTIESBURG, MISSISSIPPI

May 2, 2001

Prepared for:

KERR-MCGEE CHEMICAL LLC
123 Robert S. Kerr Avenue
P.O. Box 25861
Oklahoma City, OK 73125-0861

Prepared by:

ENVIRONMENTAL STANDARDS, INC.
1140 Valley Forge Road
P.O. Box 810
Valley Forge, PA 19482-0810

Table of Contents

Table of Contents (Cont.)

Executive Summary

A baseline human health risk assessment (HHRA) was conducted for the Former Gulf States Creosoting facility in Hattiesburg, Mississippi. The HHRA was performed in accordance with: Mississippi Commission on Environmental Quality's (MCEQ's) *Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi* (1999); US EPA's *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* (1989); US EPA Region 4 guidance entitled *Technical Services Supplemental Guidance to RAGS, Region 4 Bulletins* (1995); and other relevant US EPA guidance documents.

Creosoting constituents of potential health concern include polycyclic aromatic hydrocarbons (PAHs), of which benzo(a)pyrene is the predominant contributor to potential risks. Much of the former creosoting process area is currently covered with asphalt or large building structures. Potential future exposure scenarios included a construction worker, a maintenance worker, an infrequent Site visitor, and off-Site residents. Media of concern included soils, sediment, and surface water.

Hazards posed by chemical constituents in soils, sediment, and surface water for health effects other than an increased risk of cancer were well below a threshold of possible concern for each receptor evaluated in this risk assessment. Cancer risks for all exposure scenarios were within or below the US EPA's acceptable target risk range of 1×10^{-6} to 1×10^{-4} (*i.e.*, one in one million to one in ten thousand) with the exception of maintenance worker exposure to soils in EU4 and off-site resident exposure to sediments in EU6. The added lifetime cancer risk conservatively estimated for a maintenance worker was 4×10^{-4} for the entire Site, while that for the off-site resident was 2×10^{-4} for the entire Site. The potential risk for a construction worker was estimated to be 5×10^{-5} for the entire Site. The estimated potential risk for an adolescent Site visitor was 9×10^{-5} for the entire Site. For the Site visitor, maintenance worker, and construction worker scenarios, oral contact with carcinogenic PAHs in sediment and soils drove the cancer risk level. For the off-Site resident scenario, oral contact with carcinogenic PAHs in sediment drove the cancer risk level.

Risk levels are mainly attributable to residual concentrations of carcinogenic polycyclic aromatic hydrocarbons (cPAH) in EUs 4, 5, and 6. Remedial actions currently planned for these areas, including deed restrictions, will result in incomplete exposure pathways thereby resulting in acceptable levels of risks to potential receptors. Proposed remediation activities to address impacted media in EUs 4, 5, and 6 include the following:

- Conduct in-situ biological treatment of impacted soils in the unpaved area between the former Process Area and the Southern railroad tracks (EU4);
- Attempt to recover free product from targeted areas within the former Process Area to address continuing sources (EU5);

- Remove impacted sediments from the northeast drainage ditch and install a culvert to provide for surface drainage (EU6);
- Establish deed restrictions limiting the use of property to non-residential (i.e., "restricted") purposes (EU4 and EU5); and
- Include in the deed restrictions provisions for maintaining pavement to preclude contact with impacted media left in place (EU5).

Constituent concentrations in surface soils at two isolated locations within EU2 also resulted in maintenance worker risk levels slightly greater than 1×10^{-6}. Because these locations are within a densely wooded area where no maintenance activities currently occur and remediation would require significant clearing, no remediation activities are planned to address surface soils at these locations. *Deed restrictions limiting the use of properties within EU2 to non-residential purposes will be established.*

1.0 Introduction

Environmental Standards, Inc. (Environmental Standards) was retained by Kerr-McGee Chemical Corporation (Kerr-McGee) to perform a human health risk assessment (HHRA) to evaluate hazards and risks potentially posed by residual levels of chemicals present at the Former Gulf States Creosoting facility (Site). The Site, located near the intersection of US Highways 49 and 11 in Hattiesburg, Mississippi, was formerly a wood treating facility that operated between the early 1900s and 1960. In the early 1960s, the Site was redeveloped for commercial and light industrial uses (Michael Pisani & Assoc., 1997). The land on which the Site is located is a portion of the Sixteenth Section land owned by the Hattiesburg Public School District and leased to the current tenants under a 99-year lease, granted on July 7, 1947. At the time of this report, the Site, with the exception of the grassy and wooded areas in the south and southwest, respectively, was primarily used for automobile dealerships. There are no residential or institutional (*i.e.*, schools) uses of the Site (Michael Pisani & Assoc., 1997).

Operations at the Site consisted of a small-scale wood preserving process using creosote. The creosoting process was primarily confined to a 2.5-acre area in the northeast corner of the Site; this is known as the former Process Area and is currently occupied by Courtesy Ford. During the redevelopment of the Site in the early 1960s, construction debris (*e.g.*, broken concrete, asphalt, etc.) appears to have been relocated to the southwestern corner of the Site along Gordon's Creek. This area is known as the Fill Area and currently remains undeveloped.

This assessment has been conducted as a result of an agreement between Kerr-McGee, the Mississippi Department of Environmental Quality (MDEQ), and the Mississippi Commission on Environmental Quality (MCEQ) pursuant to the Uncontrolled Site Voluntary Evaluation Program. The MDEQ Office of Pollution Control, Uncontrolled Sites Section has been providing oversight and review of investigations and reports relating to the former Gulf States Creosoting facility.

This report will address the potential for on-Site exposures to human receptors and off-Site exposures to humans along the northeast drainage ditch.

The primary guidance used to develop this risk assessment was the MCEQ *Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi* (1999). US EPA Region 4's *Technical Services Supplemental Guidance to RAGS: Region 4 Bulletins* (1995) were also referred to for guidance. Additional US EPA guidance documents cited herein include:

- *Guidance for Remediation of Uncontrolled Hazardous Substance Sites in Mississippi (MDEQ, 1990);*
- *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual/ Part A (RAGS/Part A)* (US EPA, 1989);
- *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (US EPA, 1991);
- *Exposure Factors Handbook* (US EPA, 1997);
- *Guidelines for Exposure Assessment* (US EPA 1992);
- *Dermal Exposure Assessment: Principles and Applications* (US EPA, 1992);

These documents are not listed in a hierarchical manner; other US EPA guidance documents and peer-reviewed technical papers may have also been referenced in this risk assessment report.

2.0 Hazard Identification and Conceptual Site Model

As a result of the historical wood preservation process, residual levels of creosote-related chemicals are present in soils in the former Process Area. Sediment and surface water in a drainage ditch along the southeast border of the former Process Area also contain chemical residuals. These Site-related chemicals, mostly polycyclic aromatic hydrocarbons (PAHs) are also present in the Fill Area. Residual levels of PAHs have been found in soil in the Fill Area and in Gordon's Creek surface water and sediment.

PAH residuals have also been detected in shallow groundwater underlying the Site. Currently, there are no private water wells located on-Site that access this shallow groundwater for potable purposes. The results of a door-to-door survey conducted by Michael Pisani and Associates on October 3, 2000 indicated no private uses of shallow groundwater downgradient of the Site. For these reasons, the groundwater exposure pathway, both on- and off-Site, was considered incomplete and not evaluated in this assessment.

A conceptual site model (CSM) was developed for the Site to aid in determining the potential receptors and exposure units to be evaluated under current and future potential land use (Figure 1). These receptors were identified as infrequent Site visitors, maintenance workers, construction workers, and off-Site residents.

Under current land use assumptions, Site visitors may potentially contact residual chemicals in Gordon's Creek surface water and sediment, and/or surface soils in the Fill Area and surrounding woods, the grassy field southeast of the Fill Area, and/or the drainage ditch along side of the former Process Area. Visitors may also potentially contact surface soil, surface water, and sediment along the former Process Area drainage ditch. The remaining affected areas of the Site are covered with either buildings or pavement precluding casual direct contact with surface soils. As a conservative measure, however, visitor exposure to soils from these paved areas was also assessed.

Under both current and future land use assumptions, a maintenance worker may contact surface soils in the Fill Area and surrounding woods, the grassy field southeast of the Fill Area, and/or the former Process Area and surrounding affected areas, including the drainage ditch located to the southeast of the former Process Area. Although most of the former Process Area and vicinity are paved, maintenance activities may involve some shallow digging; therefore, direct contact with shallow soils in this area was assessed. As a conservative measure, exposure to surface water and sediment in Gordon's Creek was assessed. The remainder of the Site was relatively unaffected by historical creosoting activities.

Although there are currently no major construction activities at the Site, these types of activities may occur at some time in the future. As with the maintenance worker scenario, construction activities could potentially occur in the Fill Area and vicinity, the grassy field southeast of the Fill Area, and the former Process Area and vicinity. Construction workers may be exposed to both surface and subsurface soils (down to the water table). Construction worker exposure to surface water and sediment in Gordon's Creek was assessed as a conservative measure. The remainder of the Site was relatively unaffected by historical creosoting activities.

Areas of the Site affected by historical creosoting activities will be deed restricted prohibiting future residential development. Off-Site areas along the northeast Drainage Ditch, currently a residential neighborhood, were assessed for residential exposures to soil, sediment, and surface water.

3.0 Data Evaluation

To characterize potential exposures to Site-related chemicals, the former Gulf States Creosoting facility was divided into six exposure units (EUs). Each exposure unit outlines potentially affected areas of the Site and adjacent on-Site locales that may be frequented by individuals accessing the Site for recreational or occupational purposes. The use of EUs is encouraged by the US EPA Region 4 (1995), which defines an EU as "an areal extent of a receptor's movements during a single day...." Each of these exposure units is depicted on Figure 2 and is discussed below.

A sixth EU was created for off-Site residential exposures to surface water and sediment along the northeast Drainage Ditch. This EU is delineated on Figure 3.

3.1 Exposure Unit Delineation

The following EUs were delineated based upon the presence of residual chemicals and the potential for receptors to contact those chemicals. Areas of the Site most affected were included in at least one of the five EUs while areas with relatively low or non-detectable concentrations of residuals were not included in an EU. By limiting Site-wide exposures to the EUs most affected by historical activities at the Site, worst-case scenarios were created.

3.1.1 Exposure Unit 1

EU1 outlines the on-Site areas in, adjacent to, and downstream of the Fill Area along Gordon's Creek (Figure 2). EU1 includes exposures to surface water and sediment by an infrequent Site visitor, future maintenance worker, and future construction worker. Although US EPA Region IV guidance indicates that "In most cases it is unnecessary to evaluate human exposures to sediments covered by surface water," (US EPA, 1995) dermal and oral surface water exposures were conservatively assessed herein at the request of the MDEQ (2000). Sediment samples included in EU 1 were SD07 and SD08. Surface water samples included in were SW-07 and SW-08.

Soil samples from this area were considered part of EU2 and exposures were assessed accordingly.

3.1.2 Exposure Unit 2

EU2 delineates the upland areas of the Fill Area and adjacent woody and grassy areas (Figure 2). Surface soils from zero to one foot and zero to six feet below ground surface [bgs] in this area were evaluated for potential visitor and future hypothetical maintenance worker scenarios, respectively. Surface and subsurface soils were also evaluated for a hypothetical future construction worker scenario. Available data for subsurface soils for a construction scenario were evaluated from the surface to the water table (approximately 10 feet bgs) as recommended by the MDEQ (2000). Soil samples included in EU2 are presented in the table below:

Soils (0-1' bgs)	GEO-13/0-1'	SS-1	SS-2	SS-3	SS-4
	SS-5	SS-6	SS-7	SS-8	SS-9
	SS-10	SS-11	SS-12	SS-13	
Soils (0-6' bgs)	GEO-03/2-3'	GEO-03/5-6"	GEO-10/2-3	GEO-10/5-6	GEO-13/0-1'
	GEO-13/2-3'	GEO-13/5-6'	GEO-44/5-6'	SS-1	SS-2
	SS-3	SS-4	SS-5	SS-6	SS-7
	SS-8	SS-9	SS-10	SS-11	SS-12
	SS-13				
Soils (0-10' bgs)	GEO-03/2-3'	GEO-03/5-6'	GEO-10/2-3	GEO-10/5-6'	GEO-13/0-1'
	GEO-13/2-3'	GEO-13/5-6'	GEO-43/7-8'	GEO-44/5-6'	GEO-45/7-8'
	SB-03/8-9.3	SB-05/4-9	SB-07/5-7	SS-1	SS-2
	SS-3	SS-4	SS-5	SS-6	SS-7
	SS-8	SS-9	SS-10	SS-11	SS-12
	SS-13				

3.1.3 Exposure Unit 3

In the southwest corner of the Site there exists a grassy field east of West Pine Street between Henson Auto Sales and Eagan Cars and Trucks. This grassy area has been defined as EU3 for

purposes of this risk assessment (Figure 2). Similar to EU2, surface soil from zero to one foot and zero to six feet bgs were evaluated in EU2 for visitor and hypothetical future maintenance worker scenarios, respectively. Surface and subsurface soils in this EU were evaluated for a hypothetical future construction worker scenario. Available data for subsurface soils for a construction scenario were evaluated from the surface to the water table(approximately 20 feet bgs) as recommended by the MDEQ (2000). Soil samples included in EU3 are presented in the table below:

Soils (0-1' bgs)	SS-15	SS-16	SS-17		
Soils (0-6' and 0-20' bgs)	GEO-16/2-3'	GEO-16/5-6'	GEO-17/2-3'	GEO-17/5-6'	SS-15
	SS-16	SS-17			

3.1.4 Exposure Unit 4

EU 4 encompasses the grassy drainage ditch area along the fenceline behind Courtesy Ford in the northeast corner of the Site and continues parallel to the railroad tracks, and west through EU 3 and EU 2 (Figure 2). EU 4, along the southeast side of the former Process Area, has been widened to include soil data from that area. Receptors associated with EU 4 included Site visitor exposures via casual contact with surface soil, sediment, and surface water. Maintenance worker and construction worker scenarios were also evaluated for exposures to surface water and sediment in EU 4 as well as soils in EU 4 near the former Process Area. Soils down to six feet bgs were evaluated for maintenance workers while soils down to the water table (approximately20 feet bgs) were evaluated for construction workers in this EU as requested by the MDEQ (2000). Sediment, surface water, and soil samples included in EU4 are presented in the following table:

Sediment	SD-02	SD-12	SD-18	SD-19	SD-20
	SD-21	SD-22	SD-23		
Surface Water	SW-02				
Soils (0-1' bgs)	GEO-19/0-1'	GEO-20/0-1'	GEO-21/0-1'	GEO-46/0-1'	GEO-47/0-1'
	GEO-48/0-1'				
Soils (0-6' bgs)	GEO-19/0-1'	GEO-19/2-3'	GEO-19/5-6'	GEO-20/0-1'	GEO-20/2-3'
	GEO-20/5-6'	GEO-21/0-1'	GEO-21/2-3'	GEO-21/5-6'	GEO-46/0-1'
	GEO-46/2-3'	GEO-46/5-6'	GEO-47/0-1'	GEO-47/2-3'	GEO-47/5-6'
	GEO-48/0-1'	GEO-48/2-3'	GEO-48/5-6'		
Soils (0-20' bgs)	GEO-19/0-1'	GEO-19/2-3'	GEO-19/5-6'	GEO-20/0-1'	GEO-20/2-3'
	GEO-20/5-6'	GEO-20/9-10'	GEO-21/0-1'	GEO-21/2-3'	GEO-21/5-6'
	GEO-21/9-10'	GEO-46/0-1'	GEO-46/2-3'	GEO-46/5-6'	GEO-47/0-1'
	GEO-47/2-3'	GEO-47/5-6'	GEO-47/7-8'	GEO-48/0-1'	GEO-48/2-3'
	GEO-48/5-6'				

3.1.5 Exposure Unit 5

EU5 outlines the former Process Area and the historical drip track and treated wood storage areas of the former Gulf States Creosoting facility (Figure 2). Surface soils from zero to six feet bgs were evaluated in EU5 for a hypothetical maintenance worker scenario. Available data for soils down to the water table (approximately 20 feet bgs) were evaluated in EU5 for a hypothetical future construction worker scenario. Soil samples included in EU5 are presented in the table below:

Soils (0-1' bgs)	GEO-28/0-1'	GEO-29/0-1'	GEO-30/0-1'	GEO-31/0-1'	GEO-32/0-1'
	GEO-33/0-1'	GEO-59/0-1'	GEO-60/0-1'		
Soils (0-6' bgs)	GEO-28/0-1'	GEO-28/2-3'	GEO-28/5-6'	GEO-29/0-1'	GEO-29/2-3'
	GEO-29/5-6'	GEO-30/0-1'	GEO-30/2-3'	GEO-30/5-6'	GEO-31/0-1'
	GEO-31/2-3'	GEO-31/5-6'	GEO-32/0-1'	GEO-32/2-3'	GEO-32/5-6'
	GEO-33/0-1'	GEO-33/2-3'	GEO-33/5-6'	GEO-59/0-1'	GEO-59/2-3'
	GEO-59/5-6'	GEO-60/0-1'	GEO-60/2-3'	GEO-60/5-6'	
Soils (0-20' bgs)	GEO-28/0-1'	GEO-28/2-3'	GEO-28/5-6'	GEO-29/0-1'	GEO-29/2-3'
	GEO-29/5-6'	GEO-30/0-1'	GEO-30/2-3'	GEO-30/5-6'	GEO-31/0-1'
	GEO-31/2-3'	GEO-31/5-6'	GEO-32/0-1'	GEO-32/2-3'	GEO-32/5-6'
	GEO-33/0-1'	GEO-33/2-3'	GEO-33/5-6'	GEO-59/0-1'	GEO-59/2-3'
	GEO-59/5-6'	GEO-60/0-1'	GEO-60/2-3'	GEO-60/5-6'	GEO-60/7-8'
	SB-01/8-10	SB-02/9-11	SB-05/10.5-12.5	SB-06/6-10	SB-07/14-16

3.1.6 Exposure Unit 6

EU6 outlines a stretch (approximately 2700 feet in length) of the northeast drainage ditch that leads from the Site into the neighboring residential area. EU6 exposures include oral and dermal exposures by off-Site residents to sediment and surface water along the northeast drainage ditch. Soil exposures were not assessed in this area for lack of soil data. Also, it was anticipated that sediment exposures in this area represent a more conservative estimate of exposure in that chemical concentrations in the exposed sediment along the drainage ditch are likely to be greater than concentrations in the surrounding soils. Sediment and surface water samples included in EU6 are presented in the table below:

Sediment	SD-03	SD-04	SD-05	SD-13
	SD-14	SD-15	SD-16	SD-17
Surface Water	SW-03	SW-04		

3.2 Statistical Evaluation

Environmental samples undergo laboratory analyses that are designed to quantitate the concentrations of constituents in the various environmental media. As a result of the analytical procedures, a constituent may be detected and its concentration measured, detected but not able to be quantitated, or not detected at all in a sample. The data set for the Site contains a number of nondetections for some chemicals of potential concern (COPCs) in various samples. Assuming that the COPC is present in these samples at the achieved detection limit is biased because the chemical may be absent altogether. Assuming a concentration of zero is also flawed because the chemical could be present at a level below laboratory capabilities to detect and quantify the concentration. Consequently, in the event that an analyte identified at least once in a given medium was not detected in a given sample, it was conservatively assumed for the risk assessment purposes to be present at a concentration equivalent to one-half of the sample quantitation limit (SQL). In addition, samples labeled with an "R" (rejected) qualifier were not included in the data analysis because those data were deemed unreliable and, therefore, unusable. Constituents that were not detected in any sample from a particular medium were eliminated from further consideration in accordance with US EPA guidelines (1989).

Site analytical data used in this assessment were collected during the Phase I (1997) and Phase II (1998) remedial investigations as well as the additional investigation conducted in 2000 at the request of the MDEQ. These data were fully validated by qualified technical professionals using standard data validation protocols, as required by the MCEQ (1999).

Previous investigations at the Site have been conducted since 1990. These investigations included the following:

- 1990 soil gas and soil sampling by Roy F. Weston
- 1991 MDEQ Site inspections and Phase II report
- 1994 Phase II Site investigation by Environmental Protection Systems (EPS)
- 1994 Site investigation by Bonner Analytical Testing Company (BATCO)
- 1994 preliminary subsurface investigation by BATCO

- 1995 three-dimension resistivity surveys by American Remediation Technology
- 1996 investigation by McLaren/Hart
- 1996 investigation by Kerr McGee Chemical Corporation

Data acquired from these historical (pre-1997) investigatory activities were not used in this assessment as they were not validated by qualified chemists and sampling locations for some of the data could not be accurately established. These historical data were not considered valid and were, therefore, not appropriate to use in this assessment of risks. Only validated data that were considered to be representative of Site conditions with a reasonable level of confidence were used for this assessment.

The validated laboratory data from 1997, 1998, and 2000 investigations were compiled into data sets representing areas of potential exposure (EUs) for each potential receptor. Each data set was analyzed statistically using SiteStat®, a commercially available software package, to calculate the minimum, maximum, arithmetic mean, logarithmic mean, standard error of the mean, and the 95% upper confidence limit of the mean concentration (95% UCL) for each constituent based on distributional analysis of the data (*i.e.*, utilizing goodness-of-fit statistical tests to determine whether the data are distributed normally or lognormally). The data qualifier associated with the minimum and maximum detected concentrations as well as the location of the maximum detected concentration for each EU were also determined. Results of the quantitative and statistical analyses for each of the EUs discussed above are presented in Tables 1 through 18.

Standard sampling protocol requires the collection of duplicate field samples used to ensure the quality of a laboratory analysis (i.e., to ensure that analytical results can be replicated). As such, duplicate sample results were provided as part of the database for the Hattiesburg Site. In accordance with US EPA guidance (1989), duplicate sample results were averaged (for any sample containing duplicates) and the average concentration was used as a single concentration for that sample in the calculation of summary statistics as discussed below.

Soils down to one foot deep were assumed to be representative of surface soils at the Site for infrequent visitor exposures. A depth of 0 to 6 feet was used to define surface soils for maintenance worker exposures. These assumptions were recommended by the MDEQ (2000). The groundwater table was considered the extent of subsurface soils as recommended by MDEQ (2000). This value (depth-to-groundwater) varies significantly across the Site and, as such, the extent of subsurface soil was EU-specific as follows:

EU2 – soils down to 10 feet
EU3 – soils down to 20 feet
EU4 – soils down to 20 feet
EU5 – soils down to 20 feet

This risk assessment focuses mainly on environmental data collected from the former Process and Fill Areas and any other portions of the Site that were affected by former creosoting operations. Virtually unaffected areas (e.g., the developed area north of West Pine Street) as delineated using historical data were not considered to contribute significantly to risk levels and, therefore, were excluded from this risk assessment.

3.3 Determination of Exposure-Point Concentrations

Exposure-point concentrations were determined to be the 95% UCL or the maximum concentration of a COPC in an EU, whichever was lower. This methodology is in accordance with US EPA guidance (1989). If the distribution of the concentration data was determined to be lognormal, then the lognormal 95% UCL was compared to the maximum concentration to determine the exposure-point concentration. In the event that the distribution of a chemical in any given medium could not be confidently labeled as normal or lognormal, it is termed either "unknown" or "normal/lognormal." In these cases, the lognormal 95% UCL was compared to maximum concentration when determining the exposure-point concentration. It should be noted, however, that in cases where the distribution is "unknown," the normal and lognormal 95% UCLs could not be reliably predicted. Assuming a lognormal distribution of the data increases

the uncertainty associated with this step of the risk assessment process; however, hazard and risk estimates are likely to be less uncertain than if the maximum concentrations were used.

Exposure-point concentrations are provided on the statistical summary tables, Tables 1 through 18.

3.4 COPC Selection

Soils (both surface and subsurface) were screened according to MCEQ (1999) guidance. The first tier of the screening process compared maximum concentrations of a constituent in an EU with the Restricted Tier 1 target remediation goal (TRG) for maintenance worker and construction worker scenarios. Restricted TRGs were used because the Site is not currently used for residential purposes and the current commercial/industrial land-use is anticipated to remain into the future as a result of the implementation of deed restrictions on the impacted areas of the Site. If a maximum concentration of a constituent was less than the Restricted Tier 1 TRG, then that constituent was eliminated from further quantitative assessment.

Surface soil data (zero to one foot bgs) for the visitor scenario was screened using Unrestricted Tier 1 TRGs at the request of MDEQ (2000). If a maximum concentration of a constituent was less than the Unrestricted Tier 1 TRG, then that constituent was eliminated from further quantitative assessment. Conversely, if the maximum concentration of a constituent exceeded the Tier 1 TRG, that constituent was retained for quantitative analysis.

If the maximum concentration of a constituent in an EU exceeded the Tier 1 TRG, then the 95% UCL of the constituent was compared to the Tier 1 TRG (Restricted or Unrestricted, depending on the exposure scenarios as described above) as part of the Tier II screening process. In the event that the concentrations of a chemical were distributed lognormally, the lognormal 95% UCL of that constituent was compared to the Tier 1 TRG. If the distribution of data of a chemical could not be positively identified as either normal or lognormal, the lognormal 95% UCL was used in the screening process. In these cases, either the maximum concentration or the lognormal 95% UCL can be conservatively used. The US EPA, however, justifies the use of an

average concentration as the exposure-point concentration by explaining that toxicity criteria for both carcinogenic and non-carcinogenic effects are based on lifetime average exposures and that the "average concentration is most representative of the concentration that would be contacted at a site over time" (*Supplemental Guidance to RAGS: Calculating the Concentration Term*, 1992). Other US EPA guidance states that "...in most situations, assuming long-term contact with the maximum concentration is not reasonable" (*Risk Assessment Guidance for Superfund, Part A*, 1989). US EPA Region 4 also states that, generally, it is reasonable to assume that soil data are distributed lognormally (1995). In keeping with these guidances, the lognormal 95% UCL was considered in the screening process where the data distribution for a compound could not be defined as specifically normal or lognormal.

If the 95% UCL (or lognormal 95% UCL where appropriate) of a constituent was less than the Tier 1 TRG, then that constituent was eliminated from further quantitative analysis. If the 95% UCL (or lognormal 95% UCL where appropriate) of a constituent in soil exceeded the Tier 1 TRG, then that constituent was retained for quantitative analysis in the Site-specific risk assessment (Tier III).

MCEQ guidance (1999) does not specify screening levels for constituents in sediment or surface water; therefore, Region 4 was referred to for guidance (1995). Sediment is only found on the Site in drainage ditches that contain little to no water most of the time. US EPA Region 4 guidance states that sediments in an intermittent stream (or ditch) should be considered as surface soil for the portion of the year the stream is without water. Based on these factors and comments provided by the MDEQ (2000), the maximum detected constituent concentrations in sediment was compared to MCEQ unrestricted Tier 1 TRGs. The screening process then followed the same procedure as mentioned above for other soils.

For surface water, the maximum detected concentration of a constituent in an EU was compared to the US EPA Human Health Water Quality Standard (WQS) for consumption of water and organisms in accordance with US EPA Region 4 guidance (1995). If the maximum

concentration of a constituent in surface water was less than the WQS, then that constituent was eliminated from quantitative analysis. If the maximum concentration of a constituent in surface water exceeded the WQS, then that constituent was retained for quantitative analysis.

At the request of MDEQ (2000), if any single carcinogenic polycyclic aromatic hydrocarbon (cPAH) was retained as a COPC in a medium, then all cPAHs were also retained as COPCs in that medium. This guidance refers to the following chemicals: benzo(a)anthracene, benzo(b)fluoroanthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. To establish an exposure point concentration for undetected cPAHs retained as COPCs in an EU, one-half the maximum detection limit was used.

The results of the screening process are presented on the statistical summary tables, Tables 1 through 18. The screening process eliminated detected constituents from the subsurface soil dataset down to 20 feet bgs and surface soil dataset down to 6 feet bgs in EU3 For this reason, construction worker and maintenance worker exposures to soils in EU3 were not evaluated quantitatively in this assessment.

4.0 Exposure Assessment

Currently, a majority of the Site is used for commercial and light industrial purposes and is paved for roads and parking lots. Unpaved areas are limited to Gordon's Creek (EU 1), the wooded portion in and around the Fill Area (EU2) and the grassy field outlined by EU 3, and the drainage ditches and surrounding area delineated by EU 4 (Figure 2). Since the developed and undeveloped areas of the Site vary considerably with respect to both residual chemical concentrations and land use, the Site was divided into five EUs for the exposure assessment. A sixth EU was created to assess off-Site residential exposures. Chemical data from each EU were combined with EU-specific exposure parameter values and receptor scenarios to determine the chemical intake for each receptor potentially accessing an EU for occupational, recreational, or residential purposes.

4.1 Receptor Identification

The following exposures pathways (indicated with an "X") have been selected for this risk assessment as reasonable and realistic scenarios under current and future land-use assumptions:

EU/Media:	EU1		EU2	EU3	EU4			EU5	EU6	
Receptor/Route:	Sed.	Surf. Water	Soil	Soil	Soil	Sed.	Surf. Water	Soil	Sed.	Surf. Water
Visitor										
Dermal	X	X	X	X	X	X	X	X		
Oral	X	X	X	X	X	X	X	X		
Inhalation										
Maint. Worker										
Dermal	X	X	X	X	X	X	X	X		
Oral	X	X	X	X	X	X	X	X		
Inhalation										
Const. Worker										
Dermal	X	X	X	X	X	X	X	X		
Oral	X	X	X	X	X	X	X	X		
Inhalation			X	X	X			X		

EU/Media:	EU1		EU2	EU3	EU4			EU5	EU6	
Receptor/Route:	Sed.	Surf. Water	Soil	Soil	Soil	Sed.	Surf. Water	Soil	Sed.	Surf. Water
Off-Site Resident										
Dermal									X	X
Oral										X
Inhalation										

Surface water present on-Site is either ephemeral or very shallow and is conducive only to wading-type activities. Ingestion of Site surface water was considered an insignificant exposure pathway since on-Site drainage ditches "contain little or no water most of the time" (MDEQ, 2000). In addition, US EPA IV guidance indicates that "In most cases, it is unnecessary to evaluate human exposures to sediments covered by surface water" (1995). At the request of MDEQ (2000), however, dermal and oral exposures to surface water were assessed for visitors, maintenance workers, and construction workers in EUs 1 and 4. Surface water exposures were also assessed for residents in off-Site EU 6.

Each of the potential receptors is discussed below.

4.1.1 Infrequent Site Visitor

Since the Site is not currently fenced or guarded, the general public has access to most areas of the Site at any given time. It is possible, though unlikely, that an individual may use some areas of the Site, such as EU1, EU2, or EU3, for recreational purposes. For this reason, sediment and surface water exposures to visitors in EU1, and surface soil exposures in EU2 and EU3 were assessed for the visitor scenario. The vast majority of the remainder of the Site (EU5) is covered with either buildings or pavement, precluding direct contact with surface soils; however, a small exposed area encompassing a drainage ditch exists along side of the former Process Area (EU4). Although this area is not attractive for recreational purposes, it is possible that an individual traversing the Site may contact surface soils, sediment, or surface water in this EU; therefore, these potential exposures were assessed. Sediment exposures in EU1 and EU4 were addressed in accordance with US EPA Region 4 guidance that recommends evaluating sediment exposures in intermittent streams. At the request of MDEQ (2000), soil exposures were assessed for visitors

in EU5 regardless of the existence of buildings and pavements precluding almost all potential direct contact with soils in this area.

4.1.2 Maintenance Worker

Currently, maintenance activities are most likely limited to the developed portions of the Site. Of these, the former Process Area and adjacent former drip track and treated wood storage areas (EU5) were most affected by historical wood preserving processes. Although these areas are mostly paved or built upon, it is possible that maintenance activities may require some shallow digging in unpaved areas; therefore, exposures to surface soils in EU5 were assessed. As a conservative measure, surface soil data from sample locations located in paved areas were evaluated in conjunction with surface soil data from exposed areas in EU5. If the currently undeveloped portions of the Site (EU2 and EU3) become developed in the future, similar maintenance activities may be required and, therefore, exposures to surface soils in EU2 and EU3 were also assessed. The drainage ditch encompassed by EU4 requires periodic maintenance; therefore, exposures to soil, sediment, and surface water in this area were assessed. At the request of MDEQ (2000), maintenance worker exposures to surface water and sediment in EU 1 were also assessed.

4.1.3 Construction Worker

Although there are currently no major construction activities at the Site, such activities may hypothetically occur in the future. Thus, exposures to surface water and sediment in EUs 1 and 4, and exposures to soil in EUs 2 through 5 were assessed herein. Construction workers may be exposed to both surface and subsurface soils during activities such as excavating. Subsurface soils, for purposes of this assessment, were defined as those soils at the water table and shallower. Since the depth to the water varies significantly across the Site, so does the definition of "subsurface" soils. Accordingly, subsurface soils were evaluated down to 10 feet for EU2 and 20 feet for EUs 3, 4, and 5.

4.1.4 Future On-Site Residents

The affected areas of the Property (the Site) are currently zoned for industrial or light-commercial use, and, at the time of this report, there were no plans to develop the Site for residential housing. In fact, deed restrictions preventing residential development are in the process of being implemented for the impacted areas on Site. Because of these deed restrictions, it is reasonable and realistic to assume that the Site will remain commercial/industrial in the future; therefore, on-Site residential exposures were not addressed in this risk assessment.

4.1.5 Off-Site Residential Exposures

The northeast drainage ditch extends from the former Process Area to the northeast into a nearby residential community. Surface water and sediment data from areas along the northeast drainage ditch (EU6, Figure 3) were evaluated for off-Site residential exposures. For purposes of exposure assessment, a child resident between the ages of 1 and 6 years and an adolescent/adult resident between the ages of 7 and 30 years were evaluated. Hazards and risks for these two receptors were then combined (summed) to reflect the exposures incurred by a single individual living off-Site in the vicinity of the northeast drainage ditch for 30 years.

4.2 General Intake Equation

Chemical exposure/intake is expressed as the amount of the agent at the exchange boundaries of an organism (*i.e.*, skin, lungs, gut) that is available for systemic absorption. An applied dose is defined as the amount of a chemical at the absorption barriers such as skin, lung, digestive tract, available for absorption and is (usually expressed in milligrams, or mg) absorbed per unit of body weight of the receptor (usually expressed in units of kilogram, or kg). Absorbed dose can be defined as the amount of chemical that penetrates the exchange boundaries. If the exposure occurs over time, the total exposure can be divided by the time period of interest to obtain an average exposure rate (*e.g.*, mg/kg-day). The general equation, as defined by US EPA, for estimating a time-weighted average intake is:

$$\text{Intake (mg/kg-day)} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$ **[Equation 1]**

where:

C	=	chemical concentration at the exposure point (*e.g.*, mg/m^3 air);
IR	=	intake rate (*e.g.*, m^3/hr);
EF	=	exposure frequency (days/year);
ED	=	exposure duration (years);
BW	=	body weight of exposed individual (kg); and
AT	=	averaging time (period over which exposure is averaged, usually measured in days).

Additional parameters (*e.g.*, skin surface area) were incorporated into the above general equation to evaluate the different potential exposure routes (dermal, oral, inhalation).

Table 19 presents the general and pathway-specific exposure parameters utilized for the intake equations in this assessment.

4.2.1 General Exposure Parameters

Although some of the parameters used to calculate potential exposure are pathway- or route-specific, exposure frequency (EF), exposure duration (ED), averaging time (AT; determined separately for carcinogenic and non-carcinogenic exposures), and body weight (BW) are present in each intake model. These general parameters remain consistent throughout the intake calculations for each specific receptor.

4.2.1.1 Exposure Frequency

The exposure frequency (EF) describes the number of times per year an event is likely to occur. It is most often expressed in units of days/year or events/year, depending on the scenario. Variables such as weather, vacations, sick days, and institutional controls often aid in determining reasonable and realistic exposure frequencies.

The EF for an adolescent visitor was extracted from US EPA *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) Interim Final* (1989). This EF value of 12 days/year per EU is a reasonable estimate that assumes an adolescent would most likely be engaged in outdoor activity on the unpaved areas of the Site for one day a week during

the three warmest months of the year. This value was used for soil, sediment, and surface water exposures.

Typical construction projects, especially at industrial complexes, generally involve several phases of activity prior to completion. The EF parameter used for oral exposure in construction workers, therefore, was subdivided into two exposure events. The first event hypothetically lasts for 10 days (used in relevant exposure model calculations under "Exposure Level A") and would involve earth-moving activities such as foundation. The second exposure event to the same individual hypothetically lasts for 70 days (for a total of 80 days at the Site for an individual; this value was used in relevant exposure model calculations under "Exposure Level B") and included remaining construction activities such as building framing, plumbing installation, electrical installation, and roofing. Generally, to complete each of these phases, a different team of specialized contractors is employed to perform the tasks for which they are most qualified. As a result, an individual may only remain at the construction site for a few days or weeks until his/her task has been completed and the next phase has begun. This is especially true for those activities involving direct contact with soil such as excavating and foundation pouring. Individuals performing these tasks are not usually qualified or employed to continue with the actual building processes. For dermal and inhalation exposures, however, an 80-day EF was used and accounted for an individual to be involved in construction activities for four entire months of the year (assuming five-day work weeks).

For surface water and sediment exposures to construction workers, an EF value of 8 days/year was used. This value represents 1/10th of the time a worker may be on-Site for construction-type activities and is conservative in that it is unlikely that construction workers would be exposed at all to Site surface water or sediment.

The EF value used for the maintenance worker scenario was 150 days/year for surface soil exposures in EUs 2, 3, and 5. This is also a conservative assumption in that the currently developed areas of the Site are covered with buildings or pavement. Maintenance activities in

these areas would require little contact with the obscured surface soils. The undeveloped areas of the Site currently require little or no maintenance as they are only occasionally mowed or allowed to grow naturally. Should these areas become developed, they will most likely take on the appearance of the remainder of the Site, including industrial/commercial buildings and paved roads or parking lots. Once again, extensive direct contact with surface soils would be minimal for a maintenance worker.

For maintenance worker sediment and surface water exposures in EUs 1 and 4 and surface soil exposures in EU 4, an EF value of 30 days/year was used. Historically, the northeast drainage ditch has been maintained on an as-needed basis (less than annually). Maintenance worker exposures to sediment and surface water in these areas were assessed at the request of the MDEQ (2000). An EF value of 30 days/year is amply conservative in that both Gordon's Creek (EU 1) and the northeast drainage ditch (EU 4) are currently maintained less than annually.

For residential soil exposures, an exposure frequency of 350 days/year was used in accordance with Region IV guidance. This value assumes that 15 days/year are spent away from home (US EPA, 1991).

Sediments along the bank of the northeast drainage ditch are not comparable to surface soils comprising a yard with respect to exposure. Typically, yard soils include relatively large areas where children frequently play and where surface soils are tracked into the home to become part of the household dust that can be ingested, particularly by crawling infants, on a daily basis. These are the assumptions that underlie the standard residential soil exposure algorithm and parameter values. However, it is not realistic to assume that infants, children, or adults will directly contact a relatively small area of sediments on the banks of a drainage ditch on a daily basis. A more realistic exposure scenario for this unique area under an assumption of residential land use is for a resident child to play on occasion in the drainage ditch that traverses the residential property. An exposure frequency of 40 days/year, two hours per exploring event, is conservatively plausible.

4.2.1.2 Exposure Duration

The ED parameter represents the number of years during which an event is likely to occur. Factors affecting this parameter include variables such as age of receptor, population mobility, and occupational mobility. Exposure durations of less than seven years typically correspond to subchronic exposures while those greater than seven years are typically considered chronic exposures (US EPA, 1989). Toxicity indices are selected based on subchronic or chronic exposure durations.

The future construction worker scenario used an ED of one year because it is highly unlikely that a future construction worker would remain on one site for more than a year. Often, two months is considered the maximum amount of time a construction worker may reasonably remain at the same site.

The future maintenance worker ED, on the other hand, is based on occupational mobility studies. The ED of 25 years was obtained from US EPA (1991) which recommends a 95th percentile value of 25 years based on a study by the Bureau of Labor Statistics as of 1987. US EPA Region 4 also recommends a default value of 25 years for worker scenarios (1995).

The adolescent visitor scenario used an ED of 10 years. An adolescent was defined in this assessment as an individual aged seven to 16 years in accordance with US EPA Region 4 (1995); therefore, an exposure duration of 10 years was most appropriate.

An ED of 30 years (US EPA Region 4, 1995) was used for off-Site residents. This value assumes an individual spends 6 years as a child and 24 years as an adolescent/adult in the same location.

4.2.1.3 Averaging Time

The averaging time (AT) parameter is the time period over which exposure is averaged. For human health cancer risk calculations, the AT_c value prorates a total cumulative dose over a

lifetime. As a conservative approach, the AT_c value for each receptor is the product of a 365-day year and a 70-year life span, equaling 25,550 days.

The AT_n used for non-carcinogenic effects is the product of a 365-day year and the exposure duration (*i.e.*, $AT_n = 365 \text{ days} \times ED$). Because the ED parameter changes for each receptor, the AT_n changes as well. The AT_n values used for each receptor are summarized below:

Future Construction Worker - 365 days
Maintenance Worker - 9125 days
Adolescent Visitor - 3650 days
Off-Site Child Resident – 2,190 days
Off-Site Adult Resident – 8,760 days

4.2.1.4 Body Weight

The body weight used for the adult exposures (future construction worker and maintenance worker) analyzed in this assessment was the current US EPA default value of 70 kg (US EPA, 1989; US EPA Region 4, 1995). This value was also used for the adolescent/adult off-Site resident scenario. The adolescent body weight used for the visitor scenarios was 45 kg. This value was extracted from US EPA Region 4 guidance (1995). For the child resident scenario, a body weight of 15 kg was used as recommended by US EPA (1991).

4.2.2 Route-Specific Exposure Parameters

The general intake equation discussed above (Equation 1) was modified by including route-specific exposure parameters in order to calculate route-specific intake values. For dermal exposures, skin surface area, adherence factor, exposure time (surface water exposures only), and absorption factor parameters were included in the intake equation. For ingestion exposures, an ingestion rate and a matrix effect were included in the intake calculation. For inhalation exposures, an inhalation rate and a retention factor for fugitive dusts were included in the intake equation. Also, for inhalation exposures, an additional paradigm was necessary to convert soil concentrations to concentrations in air available for intake.

4.2.2.1 Dermal Exposure Parameters

Skin Surface Area

The total skin surface area used for adult receptors in this assessment was 20,000 cm^2. This is a US EPA default value extracted from the *Exposure Factors Handbook* (1997). For adolescent exposures, a value of 12,768.3 cm^2 was used for total skin surface area. This was a mean value calculated based on the distributions of total skin surface areas for males and females between the ages of 7 and 16 as presented in *Exposure Factors Handbook* (1997). For the off-Site child resident scenario, a skin surface area of 7,213 cm^2 was used. This value was based on skin surface area data for male and female children provided in *Exposure Factors Handbook* (1997).

For purposes of exposure, it was assumed that only portions of the body would be exposed to the affected media on the Site. For the construction worker scenario, it was assumed that the hands, forearms, lower legs, and face would be exposed to Site soils. These body parts comprise 27.8% of the total skin surface area, or 5560 cm^2.

For maintenance worker exposures to Site soils, it was assumed that the hands, forearms, and face would be exposed. These body parts comprise 15 percent of the total skin surface area, or 3000 cm^2.

For surface water and sediment exposures, exposed body parts for construction and maintenance workers included hands, forearms, and face or 3000 cm^2 (15% of the total skin surface area).

The visitor and off-Site resident scenarios assumed that the hands, forearms, and lower legs would be exposed for contact with Site soils. These body parts comprise 23.9% of the total skin surface area, or 3052 cm^2 for adolescent visitors, 1724 cm^2 for child residents, and 4780 cm^2 for adult residents. For exposures to surface water and sediment, hands, forearms, lower legs, and feet were assumed exposed for adolescent visitor and off-Site resident scenarios. These body parts comprise 30.9 % of the total skin surface area or 3945 cm^2 for adolescent visitors, 2229 cm^2 for child residents, and 6180 cm^2 for adult residents.

Soil Adherence Factor

Until recently, the US EPA-recommended default for soil adherence on skin ranged from 0.2 to 1.0 mg/cm^2 for the entire exposed surface area, without consideration of the type of activity (US EPA, 1992). However, the data from which that range was derived were primarily the result of indirect measurements, artificial activities, and sampling of hands only. A more recent study has presented the results of direct measurement of soil loading on skin surfaces before and after normal occupational and recreational activities that might result in soil contact (Kissel *et al.*, 1996). A five-order of magnitude range (roughly 10^{-3} to 10^{+2} mg/cm^2) was reported for observed activity-related hand loadings. That report indicated that hand loadings within the range of 0.2 to 1.0 mg/cm^2 were produced by activities in which there was vigorous soil contact (*e.g.*, rugby, farming); but for activities in which there was less soil contact (*e.g.*, soccer, professional grounds maintenance), loadings substantially less than 0.2 mg/cm^2 were found on hands and other body parts. Kissel *et al.* (1996) concluded that, because non-hand loadings attributable to higher contact activities exceeded hand loadings resulting from lower contact activities, hand data from limited activities cannot be used as a conservative predictor of loadings that might occur on other body surfaces without regard to activity. Furthermore, because exposures are activity-dependent, dermal exposure to soil should be quantified using data describing human behavior (*e.g.*, type of activity, frequency, duration, including interval before bathing, clothing worn, etc.).

The most recent version of the *Exposure Factors Handbook* (1997) states:

> In consideration, of these general observations and the recent data from Kissel *et al.* (1996, 1997), this document recommends a new approach for estimating soil adherence to skin. First use Table 6-12 [Summary of Field Studies, Kissel *et al.*, 1996a] to select the activity which best approximates the exposure scenario of concern. Next, use Table 6-13 [Mean Soil Adherence by Activity and Body Region, Kissel *et al.*, 1996a] to select soil loadings on exposed skin surfaces which correspond to the activity of interest. This table contains soil loading estimates for various body parts. The estimates were derived from soil adherence measurements of body parts of individuals engaged in specific activities described in Table 6-12. These results provide the best estimate of central loadings, but are

based on limited data. Therefore, they have a high degree of uncertainty such that considerable judgment must be used when selecting them for an assessment.

In another study that assessed the percentage of skin coverage in several soil contact trials in a greenhouse and an irrigation pipe laying trial, Kissel *et al.* (1996) concluded that adjusted loadings may be two to three orders of magnitude larger than average loadings if average loadings are small.

The activity-specific soil adherence factor for exposures to a maintenance worker was calculated based on data presented by Kissel *et al.* (1996) for grounds keepers, as presented below:

		Soil Adherence Factor by Body Part (mg/cm²)			
Receptor	**Representative Activity**	**Hands**	**Arms**	**Lower Legs**	**Face**
Maintenance Worker	Grounds Keepers	0.030 - 0.15	0.0021 - 0.023	0.0008 - 0.0012	0.0021 - 0.01

Data for the grounds keepers were used for the maintenance worker estimates because the activities of a grounds keeper best mimic those of a maintenance worker.

Soil adherence factors were calculated by normalizing each body part-specific soil adherence value (using the mid-points of the ranges tabulated above) with regard to the percentage of total body surface area represented by the respective body part (extracted from the US EPA *Dermal Exposure Assessment: Principles and Applications* [US EPA, 1992]). The maintenance worker adherence factor for soil was calculated based upon exposure to the hands, forearms and face. Surface area percentages for the hands, forearms, and face are 5.2, 5.9, and 3.9 percent, respectively (US EPA, 1997). Those body parts comprise 15 percent of the total body surface area. The normalized values for all body parts of interest were added, and the sum was divided by the total percentage of body surface area occupied by the parts. For example, the soil and sediment adherence factors for maintenance worker soil exposures (0.038 mg/cm^2) were calculated as follows:

$$AF\ (mg/cm^2) = \frac{(0.09 \times 0.052) + (0.0126 \times 0.059) + (0.006 \times 0.039)}{0.15} = 0.038$$

The construction worker adherence factor was also calculated in this fashion. This exposure scenario assumed that the hands, forearms, lower legs, and face would be exposed to Site soils. Soil loadings for the upper torso (chest and back) were not measured by Kissel *et al.* (1996) for construction workers because this body area is generally covered. However, to account for exposure to the upper torso during the very hot months of the year, the total area of the forearms, legs, hands, and face were assumed to be completely exposed. The hands, forearms, legs, and face comprise 5.2%, 5.9%, 12.8%, and 3.9% of the total skin surface area, respectively (with the face comprising one-third the surface area of the head), for a total of 27.8% exposed surface area. The construction worker soil adherence factor was based on data from Kissel *et al.* (1996) for construction workers as follows:

		Soil Adherence Factor by Body Part (mg/cm^2)			
Receptor	**Representative Activity**	**Hands**	**Arms**	**Lower Legs**	**Face**
Construction Worker	Construction Worker	0.24	0.098	0.066	0.029

The soil adherence factor for the construction worker scenario was calculated as follows:

$$AF\ (mg/cm^2) = \frac{(0.24 \times 0.052) + (0.098 \times 0.059) + (0.066 \times 0.128) + (0.029 \times 0.039)}{0.278} = 0.1$$

For sediment exposures, the soil adherence factor was calculated for the construction worker scenario using adherence data from Kissel *et al.* (1996) for construction workers (as tabulated above) for the hands, forearms, and face. The hands, forearms, and face comprise 5.2, 5.9, and

3.9 percent of the total skin surface area, respectively (totaling 15 percent). Thus, the adherence factor for construction workers exposed to sediment (0.13 mg /cm^2) was calculated as follows:

$$AF\ (mg/cm^2) = \frac{(0.24 \times 0.052) + (0.098 \times 0.059) + (0.029 \times 0.039)}{0.15} = 0.13$$

The adherence factor for visitor and off-Site resident exposures to soil assumed that the forearms, hands, and lower legs would be exposed to soil or sediment. The data used in these calculation were based on data by Kissel *et al.* (1996) for soccer players (exposed to a playing field of roughly one-half grass and one-half bare earth in a light mist) as presented below:

		Soil Adherence Factor by Body Part (mg/cm^2)		
Receptor	**Representative Activity**	**Arms**	**Hands**	**Lower Legs**
Visitor and Off-Site Resident	Soccer Players	0.0029 – 0.011	0.019 – 0.11	0.0081 – 0.031

The forearms, hands, and lower legs comprise 5.9%, 5.2%, and 12.8% of the total skin surface area, respectively, for a total of 23.9% (US EPA *Exposure Factors Handbook*, 1997). The adherence factor was then calculated for visitor and off-Site resident dermal exposures to soil as follows:

$$AF\ (mg/cm^2) = \frac{(0.00695 \times 0.059) + (0.0645 \times 0.052) + (0.0196 \times 0.128)}{0.239} = 0.026$$

A value of 0.026 mg/cm^2 was used as the soil adherence factor for visitors to the Site and off-Site residents.

Soil adherence factors for sediment exposures to Site visitors and off-Site residents were calculated using adherence data for the hands, forearms, lower legs, and feet. Adherence data for

reed gatherers were used for these exposures to best mimic activities that may incur sediment exposures. The reed gatherers studied by Kissel *et al.* (1996) periodically visited tidal flats to collect raw materials for basket weaving. The data from Kissel *et al.* (1996) presented in *Exposure Factors Handbook* (US EPA, 1997) were as follows:

		Soil Adherence Factor by Body Part (mg/cm^2)			
Receptor	**Representative Activity**	**Hands**	**Arms**	**Lower Legs**	**Feet**
Visitors and Off-Site Residents	Reed Gatherers	0.66	0.036	0.128	0.63

The hands, forearms, lower legs, and feet comprises 5.2, 5.9, 12.8 and 7.0 percent of the total skin surface area, respectively (totaling 30.9 percent). Thus, the adherence factor for visitors and off-Site residents exposed to sediment (0.33 mg /cm^2) was calculated as follows:

$$AF\ (mg/cm^2) = \frac{(0.66 \times 0.052) + (0.036 \times 0.059) + (0.16 \times 0.128) + (0.63 \times 0.07)}{0.309} = 0.33$$

Exposure Time

To estimate intakes as a result of dermal exposure to surface water, an exposure time (ET) parameter was included in the intake formula for Site visitors and off-Site residents. The parameter value of 1.0 hour/day was estimated using best professional judgement. This value represents the amount of time a Site visitor or off-Site resident may spend exposed to surface water in any one EU.

Dermal Permeability Constant

The permeability constant, Kp, accounts for the movement of a constituent dissolved in water through the skin, across the stratum corneum, and into the blood stream. Kp values for the constituents examined in this assessment for surface water exposures were obtained from US EPA *Dermal Exposure Assessment: Principles and Applications* (1992). For values not available in

US EPA *Dermal Exposure Assessment* (1992), the Kp value were calculated using the equations provided by the US EPA in the same document.

Dermal Absorption Factor

The final parameter included in the dermal intake paradigm was a dermal absorption factor. In general, the skin provides an effective barrier to environmental toxins. For example, certain hair-coloring formulations which are vigorously rubbed onto the scalp on a daily basis contain lead acetate at concentrations up to 200,000 ppm, yet lead toxicity does not appear to result. Moore *et al.* (1980) determined that the rate of lead absorption from 203^{Pb} labeled lead acetate in cosmetic preparations containing six mmol Pb acetate/L in male volunteers over 12 hours was 0.06% during normal use of such preparations. For most inorganic salts, percutaneous (skin) absorption is considered insignificant relative to incidental ingestion (for example, US EPA, 1986). On the other hand, some drugs (*e.g.*, nicotine) are effectively administered and absorbed into the blood stream from dermal "patches."

Most dermal bioavailability data for impacted soil have been obtained in laboratory animals or in vitro test systems. This introduces a significant source of uncertainty for predicting the human response. Safety factors have sometimes been applied to dermal absorption data obtained in animals to conservatively estimate the upper-bound of likely human percutaneous uptake of a certain constituent from skin exposure. This is usually unnecessary because human skin has generally been shown, for a diverse group of constituents, to be about 10-fold less permeable than the skin of typical animal species, such as rabbits and rats (Bartek and LaBudde, 1975; Shu *et al.*, 1988).

US EPA Region III evaluated available data concerning the dermal absorption of specific constituents and classes of constituents and provided several recommendations (US EPA Region 3, 1995). For semivolatile compounds, such as *bis*(2-ethylhexyl)phthalate, the US EPA recommends a range of 1% to 10% (US EPA, 1995). Kao *et al.* (1985) reported 2.7 percent for absorption of topically applied pure benzo(a)pyrene by human skin *in vitro*. The US EPA

Region 3 recommends using 10% as a conservative assumption based on the Ryan *et al.* study (1987). In addition, US EPA Region 4 guidance (1995) states that a soil dermal absorption factor "of 1.0% for organics and 0.1% for inorganics should be used as defaults in determining the uptake associated with dermal exposure" (see the Dermal Contact subsection of Exposure Assessment section of the 1995 guidance). For the purpose of this risk assessment, an ABS of 3% for cPAHs and of 10% for other SVOCs were conservatively assumed for dermal absorption, in keeping with US EPA Region 3's and MDEQ's recommendations.

4.2.2.2 Ingestion Exposure Parameters

Ingestion Rate

US EPA's *Exposure Factors Handbook* (1997) discusses three adult soil ingestion studies with results ranging from 10 mg/day to 480 mg/day. Hawley's (1985) value of 480 mg/day (as recommended by the MDEQ) was "derived from assumptions about soil/dust levels on hands and mouthing behavior" (US EPA, 1997). Since no supporting measurements were made for Hawley's study, the US EPA states that Hawley's estimate "must be considered conjectural" (1997). As such, the US EPA goes on to suggest adult soil ingestion rates of 50 mg/day for industrial settings and 100 mg/day for residential and agricultural settings, although "50 mg/day still represents a reasonable central estimate of adult soil ingestion and is the recommended value..." (1997). Accordingly, a value of 100 mg/day for the maintenance worker and adult off-Site resident is amply conservative and was used in this assessment. In conjunction with the use of a two-tiered EF to reflect the different stages of potential future construction activities (see Section 4.2.1.1), the soil ingestion s for the construction worker scenario was also divided into two exposure levels for a single individual. A highly conservative ingestion rate of 480 mg/day (used in relevant exposure model calculations under "Exposure Level A") was used for construction workers for the first 10 days of exposure to address direct contact with soil during earth-moving activities such as foundation excavating. A soil ingestion rate of 100 mg/day (used in relevant exposure model calculations under "Exposure Level B") was used for the remainder of the construction worker exposure (70 days). Risks were then summed for both exposure levels to estimate the total potential risk posed to an individual construction worker

The ingestion rate used for the adolescent visitor scenario was 100 mg/day. The US EPA Region IV (1995) recommends a value of 200 mg/day as a mean ingestion rate for children under six years of age. This value was conservatively used in this assessment to estimate soil and sediment ingestion exposures for an off-Site resident child aged one to six years.

Gastrointestinal Matrix Effects of Soil

Incidental ingestion incorporates the matrix effect (ME; sometimes called the absorption adjustment factor [AAF]) into the general intake equation. When constituents are administered in solid vehicles such as food and soil, only a fraction of the ingested dose is extracted from the vehicle and subsequently absorbed through the gastrointestinal tract (US EPA *Estimated Exposure to Dioxin-like Compounds*, 1992). Gastrointestinal absorption of constituents sorbed onto such a medium is inhibited by physical-constituent bonding to the matrix (Hawley, 1985). This phenomenon is referred to as the gastrointestinal matrix effect of soil. Several studies referenced in the US EPA's *Estimated Exposure to Dioxin-like Compounds* (1992) have been performed to estimate the oral absorption factors of constituents from soil. At the request of MDEQ (2001), however, a gastrointestinal matrix effect of 1.0 was used in accordance with US EPA Region IV guidance (1995), although this approach is highly conservative and does not account for scientific studies that indicate the absorption of chemical constituents through the gastrointestinal tract is less than 100%.

4.2.2.3 Inhalation Exposure Parameters and Paradigms

Inhalation Rate

The inhalation rate used for the construction worker scenario was 20 m^3/day. This is a common US EPA default value and was recommended by US EPA Region 4 (1995).

Retention Factor

According to the International Commission on Radiological Protection (ICRP), 75 percent of respirable dust particles (PM_{10}, or particles less than 10 microns in aerodynamic diameter) are retained when inhaled, the vast majority of which is potentially subsequently swallowed (ICRP,

1968). This 75% was included in the inhalation intake equation as the retention factor parameter (RF). This parameter applies only to non-VOC constituents entrained onto dust particles.

Concentration in Air

To estimate airborne dust levels during hypothetical construction activities, an emission rate of suspendible particles of less than 15 microns in aerodynamic diameter (PM_{15}) was calculated (grams/second); particles less than 10 microns were considered to be respirable. Considering particles of 15 microns or less in diameter in the emission rate calculation is a conservative assumption, inasmuch as only particles with an aerodynamic diameter of less than five to seven microns are inhaled into the lung.

The two types of construction activities at the Site that have the potential to emit fugitive dusts are vehicular movement over bare (unpaved or unvegetated) surfaces and the excavation of soil. Estimation of fugitive dust emissions caused by each activity were examined separately, as follows, and were derived from existing estimates of general construction exposure. The sum of the emissions from these two activities was multiplied by the concentration of constituent in the soil (Cs) in order to derive the total emission rate (Ei) for non-VOCs as follows:

$$Ei = C_s \times (PERv + PERe) \qquad \textbf{[Equation 2]}$$

where:

Ei	=	Emission rate (mg/sec);
C_s	=	Concentration in soil (mg/kg);
PERv	=	Particulate emission rate for vehicular movement (lb/vehicle mile); and
PERe	=	Particulate emission rate for excavation (lb/vehicle mile).

The following empirical expression (US EPA, 1988) was used to estimate the fugitive dust generated by vehicles during construction activities:

$$\text{PERv (lbs/vehicle mile)} = k \times 5.9 \times (s/12)(S/30) \times (mvw/3)^{0.7} \times (ww/4)^{0.5} \times ((365 - p)/365)$$

[Equation 3]

where:

PERv	=	Vehicle particle emission rate (lb/vehicle mile traveled);
s	=	Percent silt content (unitless);
k	=	Particle size multiplier (unitless);
S	=	Mean vehicle speed (mph);
mvw	=	Mean vehicle weight (ton);
ww	=	Mean number of wheels per vehicle (unitless); and
p	=	Mean number of days with ≥ 0.01 inches of precipitation per year (unitless).

It was assumed that the vehicle travels during 40% of the 80-day exposure duration and 0.5 miles per day. The result is a value of 16 miles per construction event. Percent silt content was estimated to have a mean value of 50%, based on geotechnical data provided in the *Remedial Investigation Report* (Pisani & Assoc., 1997). US EPA default values were utilized and referenced for all other parameters. The particle size multiplier was assumed to be 0.50, corresponding to particles less than 15 microns (US EPA, 1996). Vehicle characteristics consist of the following: mean vehicle speed was assumed to be 15 mph, with mean vehicle weight assumed to be approximately 12.5 tons, for 8-wheeled vehicles (US EPA, 1988). The estimated mean number of days with precipitation equal to or greater than 0.01 inches per year is 110 (US EPA, 1988). Total resultant dust emissions for constituents during vehicular movement activities were estimated to be approximately 16.5 lbs/vehicle mile traveled, or 0.0001 kg/sec. Calculations are summarized in Table 20.

Future excavation may be performed by bulldozers, a backhoe, or other heavy construction equipment. The following estimate of particulate emissions, less than 15 µm in diameter resulting from bulldozing activity, was based on the approach described in the US EPA *Compilation of Air Pollution Emission Factors* (1996), as developed from studies of emissions from uncontrolled open dust sources resulting from bulldozing at western surface coal mines.

$$\text{PERe (lb/hour)} = \frac{1.0 \times s^{1.5}}{M^{1.4}} \qquad \textbf{[Equation 4]}$$

where:

PERe	=	Excavation particle emission rate (lb/hr);
s	=	Percent silt content (unitless); and
M	=	Soil moisture content (unitless).

Percent soil moisture content was assumed to be 15.1%, an average of Site-specific soil moisture data and percent silt content 50%, as described above.

The resultant fugitive dust emission rate during excavation activities was 7.9 lbs/hr or 0.001 kg/sec. Table 20 summarizes these calculations.

Once the emission rate (Ei in Equation 2) was calculated, it was converted to a concentration in ambient air. Gaussian models are conventionally used to determine downwind ambient air concentrations, Ca, from the emission rate, Ei, estimated. However, in this scenario, such models have limited applicability when the receptor(s) is at or very near the source of emission. In this case, a bulldozer operator, for example, is situated directly within the area of ground emissions of vapors and dusts. Average ambient air concentrations in this circumstance are best estimated by use of a near-field box model (US EPA, 1988).

The near-field box model assumes uniform wind speed and uniform mixing throughout the box. The release and mixing of VOCs or respirable dusts in ambient air is estimated as follows:

$$\text{Ca (mg/m}^3\text{)} = \frac{Ei}{W_b \times H_b \times V} \qquad \textbf{[Equation 5]}$$

where:

Ca	=	Concentration of constituent in ambient air (mg/m^3);
Ei	=	Emission rate of constituent (mg/sec);
W_b	=	Width of box in crosswind dimension within the area of residual constituent in soil (m);
H_b	=	Downwind height of box (m); and
V	=	Average wind speed through the box (m/sec).

The value of H_b in this calculation is determined by the downwind distance and the atmospheric turbulence at ground level, which determines the trajectory of a release from the upwind edge of the source of vapor or dust emissions. For neutral atmospheric conditions, the height at the downwind boundary (H_b) may be expressed by the following function (Pasquill 1975, Horst 1979):

$$z = 6.25\ r\ [H_b/r \times \ln (H_b/r) - 1.58\ H_b/r + 1.58]$$ **[Equation 6]**

where:

H_b	=	Downwind height of box (m);
z	=	Downwind distance to boundary (m); and
r	=	A terrain-dependent roughness height (m)

H_b (defined in Equation 5) is adjusted until the z parameter is equal to W_b (defined in Equation 5). The resulting H_b value is the height of the box. On any given workday, it is estimated that grading or excavation activities occur over the entire "workable" Site area (exposure unit) from which dusts are generated. This area is estimated to be 2,500 m^2, with length of the box estimated to be 50 meters (downwind distance) and the width of the box (W) estimated to be 50 meters. The greater the roughness height, the greater the wind turbulence and constituent dilution (*i.e.*, the height of the box increases). For the purposes of this risk assessment, it is conservatively assumed that the roughness height is 0.20 meters, which corresponds to a terrain with grass, some small bushes, and occasional trees (US EPA *Rapid Assessment of Exposure to Particulate Emission from Surface Contamination Sites,* 1985). This

assumption is appropriate for the actual Site conditions. An annual average wind speed (4.69 m/sec) is obtained from the STAR data set, accessed through the Personal Computer Graphical Exposure Modeling System (PCGEMS), for STAR station 03940, Jackson/Thompson, MS for the period 1974-1978 (Table 21).

5.0 Toxicity Assessment

The toxicity assessment involves the evaluation of available toxicity information to be utilized in the risk assessment process. Toxicity values derived from a dose-response relationship can be used to estimate the potential for the occurrence of adverse effects in individuals exposed to various constituent levels.

Exposure to a constituent does not necessarily result in adverse effects. The relationship between dose and response defines the quantitative indices of toxicity required to evaluate the potential health risks associated with a given level of exposure. If the nature of the dose-response relationship is such that no effects can be demonstrated below a certain level of exposure, a threshold can be defined and an acceptable exposure level derived. Humans are routinely exposed to naturally-occurring constituents and man-made constituents through the typical diet, air, and water, with no apparent adverse effects. However, the potential for adverse effects may occur if the exposure level exceeds the threshold in a variably sensitive population. This threshold applies primarily to constituents which produce non-carcinogenic (systemic) effects, although there is a growing body of scientific evidence which suggests that exposure thresholds may exist for certain carcinogenic constituents as well.

Adverse effects can be caused by acute exposure, which is a single or short-term exposure to a toxic substance, or by chronic exposure on a continuous or repeated basis over an extended period of time. "Acceptable" acute or chronic levels of exposure are considered to be without any anticipated adverse effects. Such exposure levels are commonly expressed as reference doses (RfDs), health advisories, etc. An acceptable exposure level is calculated to provide an "adequate margin of safety."

Chronic RfDs, which have been derived by the US EPA for a large number of constituents, were utilized to evaluate exposures lasting seven to 70 years (US EPA, 1989). Activities involving exposures of shorter duration to COPCs at the Site are anticipated to result in hazard and risk estimates that are lower than those associated with the long-term exposures. Identification of

subchronic toxicity values corresponding to shorter-term exposure scenarios (*i.e.*, less than seven years) are included in the risk assessment to ensure that both short-term and long-term risks can be addressed.

Currently, the US EPA has not developed toxicity values to be utilized in dermal exposure scenarios; however, the US EPA does provide the following guidance for dermal exposure:

> No RfDs or slope factors are available for the dermal route of exposure. In some cases, however, non-carcinogenic or carcinogenic risks associated with dermal exposure can be evaluated using an oral RfD or oral slope factor, respectively. (US EPA, 1989).

Provisional dermal toxicity values were developed and utilized in the dermal exposure pathways considered in the human health risk assessment to provide a more accurate Site-specific risk assessment. These dermal RfD values were developed by multiplying the published oral RfD for a given constituent by the fraction of that constituent that can be absorbed through the gastrointestinal tract (stomach/intestine lining). The absorption fraction utilized was 50% for semivolatiles as extracted from US EPA Region 4 guidance (1995).

A number of sources of toxicity information exists, and these sources vary with regard to the availability and strength of supporting evidence. The following protocol has been established for the determination of toxicity indices; it defines a hierarchy of sources to be consulted and the methodology for the determination of toxicity values. This protocol has been developed in accordance with current US EPA methodology. Toxicity values for the COPCs at the Site were obtained with reference to the following hierarchy of sources developed in accordance with MCEQ guidance (1999):

1) Toxicity values were obtained from the *Integrated Risk Information System* (IRIS, 1999) database. This database contains the RfDs and Cancer Slope Factors (CSFs), which have been verified by the US EPA's RfD and Carcinogen Risk Assessment Verification Endeavor (CRAVE) workgroups, and is, thus, the

agency's preferred source for toxicity values. IRIS supersedes all other information sources.

2) For toxicity values which are unavailable on IRIS, the most current source of information is the Health Effects Assessment Summary Tables (HEAST, US EPA, 1997), published by the US EPA. HEAST contains interim, as well as verified RfDs and CSFs. Supporting toxicity information for verified values is provided in an extensive reference section of HEAST.

3) In cases where IRIS or HEAST could not provide toxicity values, US EPA Region III's Risk-Based Concentration (RBC) Tables were visited. These tables often provide toxicity values generated by reliable sources other than IRIS or HEAST. For example, in response to specific requests from risk assessors, the US EPA National Center for Environmental Assessment (NCEA) develops provisional RfDs or CSFs for chemicals not listed in IRIS or HEAST. Region III's RBC tables will list such provisional values. Also, RfDs or CSFs that have since been withdrawn from IRIS or HEAST may still be listed on the Region III RBC tables, although they are flagged with a "W." These toxicity values were no longer agreed upon by US EPA scientists; however, the Region III RBC tables continue to publish such values because risk assessors still need to quantify exposures to these chemicals. Lastly, the Region III RBC tables will list toxicity indices found in "other" US EPA documents. These values are flagged with an "O" on the tables.

The US EPA has derived carcinogenic slope factors for both oral and inhalation pathways, and these are utilized to quantitatively estimate risks. In the first step of the US EPA's evaluation, the available data are analyzed to determine the likelihood that the agent is a human carcinogen. The evidence is characterized separately for human studies and animal studies as sufficient, limited, inadequate, no data, or evidence of no effect. The characterizations of these two types of data are combined, and based on the extent to which the agent has been shown to be a carcinogen in experimental animals or humans, or both, the agent is given a provisional weight-of-evidence classification. The US EPA scientists then adjust the provisional classification upward or downward, based on other supporting evidence of carcinogenicity (see Section 7.1.3, US EPA, 1989). For a further description of the role of supporting evidence, see the US EPA guidelines (US EPA, 1986).

The US EPA classification system for weight of evidence is shown in the table below. This system is adapted from the approach taken by the International Agency for Research on Cancer.

US EPA WEIGHT-OF-EVIDENCE CLASSIFICATION SYSTEM FOR CARCINOGENICITY

Group	Description
A	Human carcinogen
B1 or B2	Probable human carcinogen B1 indicates that limited human data are available B2 indicates sufficient evidence in animals and inadequate or no evidence in humans
C	Possible human carcinogen
D	Not classifiable as to human carcinogenicity
E	Evidence of non-carcinogenicity for humans

(US EPA, 1989)

Table 22 summarizes the available toxicity values for the identified COPCs. COPCs lacking published toxicity values were not able to be quantitatively evaluated in this assessment in accordance with MCEQ guidance (1999). The MCEQ limits the use of toxicity values to those that have been published in IRIS, HEAST, ATSDR toxicity profiles, or other peer-reviewed reference sources or literature approved by the MCEQ (1999). The MDEQ (2001), however, requested that risks from dermal exposure to cPAHs be estimated using the oral cancer slope factor for benzo(a)pyrene, applying benzo(a)pyrene relative potency factors, and accounting for an absorption efficiency of 50%. This methodology was used accordingly.

6.0 Risk Characterization

The objective of the risk characterization is to determine potential risk to receptors by combining the results of the exposure and toxicity assessments. Non-carcinogenic effects and carcinogenic risks are summarized in Table 23. Tables 24 through 78 provide algorithms and parameters for each pathway.

The estimated intakes calculated for each exposure pathway considered and each COPC were compared to RfDs for non-carcinogenic effects. The following formula was used to estimate the potential for non-carcinogenic health effects for each COPC.

$$HQ = ADI/RfD \qquad \textbf{[Equation 7]}$$

where:

HQ	=	Hazard quotient - potential for noncancer health effects (unitless);
ADI	=	Average daily intake of COPC (mg/kg-day); and
RfD	=	Reference dose (mg/kg-day).

RfDs have been developed by the US EPA for chronic (*e.g.*, lifetime) and/or subchronic exposure to constituents based on the most sensitive non-carcinogenic effects. The chronic RfD for a constituent is an estimate of a lifetime daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects. The potential for noncancer health effects was evaluated by comparing the Site-specific exposure level with the RfD derived by the US EPA for a similar exposure period. This ratio of exposure to toxicity is called the hazard quotient (HQ). If the Site-specific exposure level exceeds the threshold (*i.e.*, the HQ exceeds a value greater than 1.0), there may be concern for potential noncancer effects.

To assess the overall potential for noncancer effects posed by multiple constituents, a hazard index (HI) is derived by summing the individual HQs. This approach assumes additivity of critical effects of multiple constituents. This is appropriate only for compounds that induce the

same effect by the same mechanism of action. This conservative approach significantly overestimates the actual potential for adverse health impacts.

In cancer risk assessment, the US EPA has required the use of the upper limit which produces an estimate of potential risk that has a 95% probability of exceeding the actual risk, which may, in fact, be zero. The following formula was utilized to estimate the upper bound excess cancer risk for each carcinogen (note that not all COPCs are carcinogens):

$$TR = CLDI \times SF \qquad \textbf{[Equation 8]}$$

where:

TR	=	Target risk - excess probability of an individual developing cancer (unitless);
CLDI	=	Calculated lifetime average daily intake of carcinogenic COPC (mg/kg-day); and
SF	=	Cancer slope factor $(mg/kg\text{-}day)^{-1}$.

For exposures to multiple carcinogens, the upper limits of cancer risks are summed to derive a total cancer risk. The US EPA recognizes that it is not technically appropriate to sum upper confidence limits of the risk to produce a realistic total probability, but requires this approach be used.

Carcinogenic risk refers to the probability of developing cancer as a result of exposure to known or suspected carcinogens. The National Contingency Plan (NCP) endorses an acceptable risk range of 10^{-4} to 10^{-6} for exposure to multiple carcinogens. This range represents an incremental increase of 1 in 10,000 to 1 in 1,000,000 in the chance of developing cancer over a lifetime. The MCEQ (1999) indicates that the target risk level is 1×10^{-6} per individual carcinogen and an acceptable cumulative risk level is 1×10^{-4}. As such, risk levels totaled across oral, dermal, and inhalation pathways may exceed 1×10^{-6} and still be in compliance with MCEQ requirements (1999) as long as no single carcinogen exceeds 1×10^{-6} and the cumulative risk for a single receptor does not exceed 1×10^{-4}.

Table 23 provides a summary of the non-carcinogenic effects and carcinogenic risks associated with each of the pathways evaluated in this assessment.

The overall hazard index across the assessed pathways and EUs was 0.1 for the Site visitor scenario. This value is below the acceptable benchmark of 1.0. The highest hazard index associated with the Site visitor scenario was 0.07 corresponding to dermal exposure to sediment in EU4. The overall cancer risk for exposures to Site visitors was estimated to be 9×10^{-5} and is primarily attributable to oral and dermal exposure to benzo(a)pyrene and associated cPAHs in EU4 soil and sediments. Oral exposure to the same constituents in EU4 and EU5 surface soils also contributed to the cancer risk estimate for the site visitor. Additional discussion regarding remediation goals for this scenario has been provided in section 8.0.

The overall hazard index for the maintenance worker scenarios was 0.08 and is below the acceptable benchmark of 1.0. The highest hazard index associated with the maintenance worker scenario was 0.05 corresponding to oral exposure to sediment in EU4. The overall cancer risk for the maintenance worker scenario was 4×10^{-4} and was primarily attributable to dermal and oral exposure to benzo(a)pyrene and other cPAHs in surface soils in EUs 2, 4, and 5. Additional discussion regarding remediation goals for this scenario has been provided in section 8.0.

The overall hazard index for the hypothetical future construction worker was 0.000001 and is well below the acceptable benchmark of 1.0. The highest hazard index associated with the construction worker scenario was 9×10^{-7} corresponding to dermal exposure to surface water in EU 4. The overall cancer risk for the hypothetical future construction worker scenario was 5×10^{-5} and is attributable to benzo(a)pyrene and associated cPAH oral exposure in EU4 sediment and oral and dermal exposure to EU4 and EU5 soils. Additional discussion regarding remediation goals for this scenario has been provided in section 8.0.

The off-Site resident scenario revealed a hazard index of 6×10^{-4}. This value is considerably below the acceptable benchmark of 1.0. The overall cancer risk for the resident exposure

scenario was estimated to be 2×10^{-4} and is attributable to oral and dermal exposure to benzo(a)pyrene and associated cPAHs in EU6.

7.0 Uncertainty Analysis

Risk assessment uses a wide array of information sources and techniques. Even in those rare circumstances where constituent intake for an exposed individual may be measured relatively precisely, assumptions will still be required to evaluate the associated risk. Generally, data are not available for critical aspects of the risk assessment, and the use of professional judgment, inferences based on analogy, the use of default values, model estimation techniques, etc., result in uncertainty of varying degrees.

The expressions of risk in this assessment are not probabilistic; the expressions of risk are conditional, based on the conditions represented by the single-point values selected for the analysis. This section is intended to identify and qualitatively evaluate the more salient Site-specific uncertainties and their potential influence on the credibility of the estimated Site risks.

7.1 Uncertainty of Data Evaluation Factors

Uncertainties in data analysis include analytical error, selection of COPCs, adequacy of sampling design, etc. Generally, there is far less uncertainty in this phase of the risk assessment process than other aspects contribute.

Laboratory analysis is extremely accurate relative to the potential error of "professional judgment" in exposure assessments. The uncertainty of analytical data is likely to be less than 25 percent, most of the time.

The adequacy of the sampling strategies to characterize Site conditions is a potentially large source of uncertainty. Because of the limited availability of resources, sample collection is generally limited. However, sampling (especially in multiple surveys) is not random, but is designed to locate the areas with the highest levels of constituents. Thus, test data are biased toward overestimation of average constituent levels. In addition, in most instances, the upper 95-percent confidence limit of the average concentration is utilized as an exposure-point

concentration in the risk assessment. The use of this value likely will result in an overestimation of risk, as the 95% UCL represents a value that will be greater than the true average 95% of the time.

Oftentimes, only a portion of detected constituents are carried through the risk assessment process because constituents are eliminated through COPC screening procedures (US EPA, 1989). This could result in an underestimation of risk, although the COPC selection process is intended to identify those constituents that account for the vast majority of potential risk. COPCs lacking published RfD values were not quantitatively evaluated and this may result in an underestimation of potential hazards (non-carcinogenic effects).

7.2 Uncertainty of Toxicity Values

The US EPA's IRIS states that the uncertainty associated with RfD values for non-carcinogenic endpoints of toxicity "span perhaps an order of magnitude." In fact, the uncertainty of extrapolating dose-response data from animals to humans with the application of multiple safety factors (100 to 10,000 or more) is likely to be several orders of magnitude. Current policies for deriving RfD values will often result in an overestimation of risk.

The uncertainty associated with the estimation of cancer risk contributes, by far, the major source of potential error and uncertainty. It is beyond the scope of this analysis to explore this toxicity assessment factor in any detail. However, a few salient points are noted below.

Some constituents classified as carcinogens have been shown to produce an increased incidence of cancer in mice but not rats, for example. If the mouse is not an adequate model for the rat, it may be wondered how reliable a model it is for human beings. The assumption of linearity and a non-threshold phenomenon in the dose versus risk relationship may not be valid and could result in a very large overestimation of actual cancer risk, if any even exist at low doses in humans.

The US EPA evaluated the uncertainty of cancer risk estimates from exposures to trichloroethene and several other related VOCs in public drinking water supplies (Cothern *et al.*, 1984). These US EPA scientists concluded the following:

- The largest uncertainty in the calculations is due to the choice of the model [Multistage, Weiball, Logit, Probit, etc.] used in extrapolating risk to low doses in humans, and is 5 to 6 orders of magnitude;

- If a single model were chosen [assumed to be valid], the overall uncertainty in risk estimates would be 2 to 3 orders of magnitude;

- The exposure estimates contribute, at most, an order of magnitude to the uncertainty; and

- It would appear that until a particular compound's mechanisms of cancer are better known, it is likely that the uncertainty in the toxicity will not be improved.

7.3 Uncertainties in Assessing Potential Exposure

Ideally, Site-specific exposure values should be used when assessing potential intakes of chemicals at a Site. Oftentimes, however, Site-specific data are not available; therefore, the risk assessor must estimate values that most accurately reflect Site conditions. In doing so, US EPA or other regulatory default values were utilized in place of Site-specific data. These values may over- or under-estimate risks, depending on Site conditions and the percentile range in which the default values fall (*e.g.*, 50^{th}, 95^{th}).

Although a considerable amount of published data is available on the most common exposure parameters (*e.g.*, body weight, skin surface area), even these data contain uncertainties. Studies conducted by different scientists often provide differing levels of detail, statistics, and accuracy based on sample size, study design, geographic area, etc. Such discrepancies can increase uncertainty when the data are combined to derive a single-point default value. These data may be the best available; however, the reflection of reality may still be imprecise.

Where published exposure parameters were not available, best professional judgment had to be used, thereby increasing uncertainty. The default or estimated exposure parameters used in this assessment likely resulted in a moderate over-estimation of risk.

The intakes estimated for dermal absorption of PAHs adsorbed into soils adhering to skin may overestimate risks for a host of reasons. Early studies conducted by Falk and coworkers indicated that the carcinogenic effect of B(a)P on subcutaneous injection in mice could be markedly inhibited by the simultaneous administration of various non-carcinogenic PAHs (Falk *et al.*, 1964, as cited in ATSDR, 1988. In other subcutaneous injection and skin-painting studies with mice, it was shown that a combination of several non-carcinogenic PAH compounds, mixed according to the proportion occurring in auto exhaust, did not enhance or inhibit the action of two potent PAH carcinogens, B(a)P and dibenz(a,h)anthracene- (ATSDR, 1988).

The carcinogenic potency of B(a)P and other carcinogenic PAHs is generally determined by injecting solutions under the skin, painting the skin with the carcinogenic PAH dissolved in a solvent, or dissolved in corn oil in feeding studies. This vehicle or matrix affords a high level of bioavailability of the carcinogenic PAH compound. Recently, Krueger *et al.* (1999) conducted *in vitro* percutaneous absorption studies with contaminated soils and organic solvent extracts of contaminated soils collected at former manufactured gas plant (MGP) sites. The MGP tar-contaminated soils contained PAHs at levels ranging from 10 to 2400 mg/kg. The dermal penetration rates of PAH from the MGP tar-contaminated soils and soil solvent extracts were determined experimentally through human skin using tritrum-labelled B(a)P as a surrogate. Results showed reductions of two to three orders of magnitude in PAH absorption through human skin from the most contaminated soils in comparison to the soil extracts. Reduction in PAH penetration was attributed to soil matrix properties. That is, PAH compounds adsorbed to organic carbon in a soil matrix are far less bioavailable for dermal flux than PAH compounds dissolved in a solvent. [No correction for such a profound soil matrix effect was applied in quantitatively estimating cancer risks due to dermal absorption of B(a)P and other carcinogenic PAHs in this assessment.]

8.0 Summary of Findings

The results of the baseline human health risk assessment indicate potentially unacceptable risk levels for the following exposure scenarios:

Potentially Exposed Population	Media	EU
Site Visitor	Sediment	4
	Surface Soil	4, 5
Maintenance Worker	Sediment	4
	Surface Soil	2, 4, 5
Construction Worker	Sediment	4
	Subsurface Soil	4, 5
Off-Site Resident	Sediment	6

The risk levels associated with the above scenarios were driven by cPAHs, particularly benzo(a)pyrene. To determine the extent of remediation necessary to reduce these risks to acceptable levels, sediment and soil data for cPAHs in EUs 2, 4, 5, and 6 were closely examined.

The benzo(a)pyrene exposure-point concentration used to evaluate maintenance worker exposures to surface soil in EU2 was 5.2 mg/kg (sample location GEO-13/0-1'). This was the maximum benzo(a)pyrene concentration found in surface soil in EU2. The next highest concentration of benzo(a)pyrene in surface soil was found at SS-10 (2.4 mg/kg). However, as previously noted, these samples were collected at locations within a densely wooded area. No remediation is planned to address surface soils at these locations for the following reasons:

- No maintenance activities are currently conducted in this area;
- Any remediation would require significant clearing; and
- Cancer risks associated with surface soils at these locations only slightly exceed 1×10^{-6} for two individual constituents, and the total cancer risk level is still less than 1×10^{-5}.

In EU4, the maximum concentration of benzo(a)pyrene was used as the exposure-point concentration for site visitor, maintenance worker, and construction worker exposure to sediment. The benzo(a)pyrene exposure-point concentration used to evaluate these in EU4 was 130 mg/kg (sample location SD-02, see Figure 2). The next two highest concentrations of benzo(a)pyrene in sediment were found at SD-12 (71 mg/kg) and SD-23 (5.57 mg/kg), respectively. Implementing a remedy to remove, treat, or preclude contact with sediment at sample locations SD-02, SD-12, and SD-23 would leave a concentration of 3.1 mg/kg (sample location SD-18) as the maximum concentration in sediment that could be potentially contacted by site visitors, maintenance workers, and/or construction workers in EU 4. Excluding samples SD-02, SD-12, and SD-23 and using 3.1 mg/kg as the exposure-point concentration drops the risk level for dermal and oral contact with sediment by a visitor and oral contact with sediment by a maintenance worker or construction worker to within acceptable levels (i.e., no risk level associated with a single carcinogen exceeds 1×10^{-6}; Tables 79 - 83).

In EU4, the maximum concentration of benzo(a)pyrene was also used as the exposure-point concentration for site visitor, maintenance worker, and construction worker soil exposures. Each of these receptors could potentially be exposed to soils at different depth ranges: visitor 0-1' bgs, maintenance worker 0-6' bgs, and construction worker 0-20' bgs. The sample locations and corresponding concentrations of benzo(a)pyrene that contributed to elevated risk estimates in the three exposure scenarios are presented in the table below:

Sample Location	Benzo(a)pyrene Concentration (mg/kg)
GEO-48/0-1'	500
GEO-21/0-1'	230
GEO-21/2-3'	190
GEO-19/0-1'	56
GEO-46/0-1'	16

Sample Location	Benzo(a)pyrene Concentration (mg/kg)
GEO-20/5-6'	11
GEO-47/5-6'	9.6
GEO-48/2-3'	6.1
GEO-20/0-1'	3.2
GEO-47/0-1'	3
GEO-19/2-3'	2.4

Implementing a remedy to remove, treat, or preclude contact with the surface (0-1' bgs) soil sample locations tabulated above would result in eliminating exposures for the site visitor scenario (*i.e.*, the 0-1' bgs samples listed above comprise the entire data set for visitor exposures to surface soils in EU4). In addition, implementation of a remedy addressing the sample locations tabulated above would leave a maximum benzo(a)pyrene soil concentration in the 0-6' horizon of 0.29 mg/kg (sample location GEO-19/5-6'). Using the concentration of 0.29 mg/kg as the exposure-point concentration for estimating risk to maintenance workers drops the risk levels to within acceptable levels (Tables 84 - 85). Implementation of this remedy would also reduce the benzo(a)pyrene exposure-point concentration in soils in the 0-20' horizon for construction workers to 5.2 mg/kg resulting in estimated risk values well below acceptable levels (Tables 86-88). In situ biological treatment is proposed to address impacted soils within EU4. This will include clearing, tilling, application of inorganic nutrients, and, once soils are remediated to the extent practicable, placement of concrete cover. The area to be remediated will extend at least from Courtesy Ford to the edge of the railroad right-of-way, and may extend onto the railroad right-of-way with the permission of the Southern railway.

In EU5, the surface soil sample locations contributing most to elevated risk levels for the maintenance worker, construction worker, and site visitor scenarios were GEO-33/0-1', GEO-33/2-3', GEO-30/0-1', GEO-59/0-1, GEO-29/0-1', and GEO-28/0-1' (see Figure 2). All sample locations, with the exception of GEO-59/0-1', are located underneath paved areas in a parcel of land extending from Courtesy Ford to the southeast (Figure 2). Pavement in this area precludes direct contact with surface and subsurface soils; therefore, it is not anticipated that current or future maintenance workers or site visitors will have access to soils in or around these sample locations. In addition, a deed restriction will be implemented requiring the maintenance of the paved areas to ensure protection of human health in the future. Sample location GEO-59/0-1', with a benzo(a)pyrene exposure point concentration is 6.1 mg/kg, however, is adjacent to West Pine Street in an unpaved area. Implementing a remedy to remove, treat, or preclude contact with surface soil at this location would leave a concentration of 0.37 mg/kg (GEO-60/0-1') as the maximum concentration in surface soil not covered by pavement that could potentially be contacted by any of the three receptors in this EU. Excluding sample GEO-59/0-1' and using 0.37 mg/kg as the exposure-point concentration drops the estimated exposures in EU5 to within acceptable levels (i.e., no risk level associated with a single carcinogen exceeds 1×10^{-6}; Tables 89 - 92).

The benzo(a)pyrene exposure-point concentration used to evaluate adult and child resident exposures to sediment in EU6 was 49 mg/kg (sample location SD-03, see Figure 3). This was the maximum benzo(a)pyrene concentration found in sediments in EU6. Sample locations SD-04, SD-14, SD-13, SD-16, SD-15, and SD-17 (33, 12.2, 3.27, 2.8, 2.42, and 2.26 mg/kg, respectively) also contributed to elevated cancer risk estimates for both receptors. Implementing a remedy to remove, treat, or preclude contact with sediment at these sample locations would leave a concentration of 0.97 mg/kg (sample location SD-05). Using the benzo(a)pyrene concentration of 0.97 mg/kg as the exposure-point concentration for sediment exposure to adult and child residents reduces the risk estimate to within acceptable limits (i.e., no risk level associated with a single carcinogen exceeds 1×10^{-6}; Tables 93 - 96). Remediation activities are proposed to remove impacted sediment and preclude contact with residuals in the northeast drainage ditch. These activities include removal and off-Site treatment and/or disposal of impacted sediments, installation of a storm water collection and conveyance pipe, backfilling around the culvert, and planting with native grass.

Bibliography

Andelman, J. B., and M. J. Suess. 1980. Polynuclear aromatic hydrocarbons in the water environment. Bull. WHO 43:479-508.

Alexander, M. Aging, Bioavailability, and Overestimation of Risk from Environmental Pollutants. Environ. Sci. Technol, 2000, 34(20):4259.

ATSDR (Agency for Toxic Substances and Disease Registry). Toxicological Profile for Benzo(a)Pyrene. Oak Ridge National Laboratory. 1988.

ATSDR (Agency for Toxic Substances and Disease Registry). ATSDR's Toxicological Profiles on CD-ROM. Polycyclic Aromatic Hydrocarbons (PAHs), Update. CRC Press, 1999.

Audere, A. K., Z. Y. Lindberg, G. A. Smirnov, and L. M. Shabad. 1973. Experiment in studying the influence of an airport located within the limits of a city on the level of environmental pollution by benzo(a)pyrene. Gig. Sanit. 38(9): 90-92.

Bartek, M.J. and J.A. LaBudde. Percutaneous Absorption *in vitro*, in Animal Models in Dermatology. Ed. H.I. Maibach. New York: Churchill Livingstone, 1975. p. 103.

Blumer, M. 1961. Benzopyrenes in soil. Science 134, 474-475.

Blumer, M., W. Blumer, and T. Relch. 1977. Polycyclic aromatic hydrocarbons in soils of a mountain valley; correlation with highway traffic and cancer incidence. Environ. Sci. Technol. 11 (12), 1082-1084.

Butler, J. D., V. Butterworth, C. Kellow, and H. G. Robinson. 1984. Some observations on the polycyclic aromatic hydrocarbon (PAH) content of surface soils in urban areas. Sci. Total Environ. 38, 75-85.

Chu, M. M. L. and G. W. Chem. 1984. Evaluation and estimation of potential carcinogenic risks of polynuclear aromatic hydrocarbons. Paper presented at the Pacific Rim Risk Conference.

Chung, N. and Alexander, M. Differences in Sequestration and Bioavailability of Organic Compounds Aged in Dissimilar Soils. Environ Sci. Technol. 32: 855.

Coomes, R. M. 1981. Carcinogenic testing of oil shale materials. Twelfth Oil Shale Symposium Proceedings. Colorado School of Mines Pres.

Cothern, C. R., W. Conniglio, W. Marcus. Techniques for the Assessment of the Carcinogenic Risk to the US Population due to Exposure from Selected Volatile Organic Compounds from Drinking Water via the Ingestion, Inhalation and Dermal Routes. NTIS PB84-213941. Office of Drinking Water. Washington DC: Environmental Protection Agency, 1984.

Edwards, C.A., Beck, S.D. and Lichtenstein, E.P., J. Econ. Entomol. 1957, 50: 622.

Edwards, N. T. 1983. Polycyclic aromatic hydrocarbons (PAHs) in the terrestrial environment – a review. J. Environ. Qual. 12 (4), 427-441.

Falk, H. L., and P. T. S. Kotin. Inhibition of carcinogenesis: The effects of polycyclic hydrocarbons and related compounds. Arch. Environ. Health Vol. 9 (1964):169-179.

Fritz, W. 1971. Extent and sources of contamination of our food with carcinogenic hydrocarbons. Ernaehrungsforschung 16(4), 547-557.

Health & Welfare Canada. Polycyclic Aromatic Hydrocarbons, Report No. 80-EHD-50, (1979) p. 38.

Horst, T. W. Langrangian Similarity Modeling of Vertical Diffusion for a Ground Level Source. Int. Applied Met, Vol. 18 (1979): 733-740.

HSDB (Hazardous Substances Data Bank), 1999. National Library of Medicine (NLM) On-Line Toxicological Network (TOXNET). Bethesda, MD.

ICRP (International Commission on Radiological Protection). Report of Committee IV on Evaluation of Radiation Doses to Body Tissues from Internal Contamination due to Occupational Exposure. ICRP Publication 10. New York: Pergamon Press, 1968.

Kao, J.K., F.K. Patterson, and J. Hall. Skin Penetration and Metabolism of Topically Applied Chemicals in Six Mammalian Species, Including Man: an in vitro Study with Benzo(a)pyrene and Testcaterone. Toxicol. Appl. Pharmacol, Vol. 81 (1985): 502-516.

Kelsey, J.W. and Alexander, M. Declining Bioavailability and Inappropriate Estimation of Risk of Persistent Compounds. Environ. Toxicol. Chem. 1997. 16(3): 582

Kelsey, J.W., Kottler, B.D. and Alexander, M. Environ. Sci. Technol. 1997, 31: 214.

Kissel, J., K. Richter, and R. Fenske. Field Measurements of Dermal Soil Loading Attributable to Various Activities: Implications for Exposure Assessment. Risk Analysis, Vol. 16, No. 1 (1996): 115-125.

Magee, B., P. Anderson, and D. Burmaster. Absorption Adjustment Factor (AAF) Distributions for Polycyclic Aromatic Hydrocarbons (PAHs). Human and Ecological Assessment: An International Journal. Vol. 2, No. 4 (December 1996): 841-873.

Menzi, C.A., B.B. Potocki and J. Santodonato. Exposure to Carcinogenic PAHs in the Environment. Environ. Sci. Technol. Vol. 26, No. 7, 1992.

Michael Pisani & Associates. Remedial Investigation Report, Former Gulf States Creosoting Site, Hattiesburg, Mississippi. New Orleans, Louisiana. 1997.

Michael Pisani & Associates. Phase II Remedial Investigation Report, Former Gulf States Creosoting Site, Hattiesburg, Mississippi. New Orleans, Louisiana. 1998.

Mississippi Commission on Environmental Quality (MCEQ). Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi. 1999.

Mississippi Department of Environmental Quality (MDEQ). Guidance for Remediation of Uncontrolled Hazardous Substance Sites in Mississippi. Office of Pollution Control. 1990.

Mississippi Department of Environmental Quality (MDEQ). Letter to Glen Pilie, Adams and Reese, from Tony Russell, MDEQ. August 2, 2000.

Mississippi Department of Environmental Quality (MDEQ). Letter to Glen Pilie, Adams and Reese, from Tony Russell, MDEQ. February 6, 2001.

Morrison, DE., Robertson, B.K. and Alexander, M. Bioavailability to Earthworms of Aged DDT, DDE, DDD, and Dieldrin in Soil. Environ. Sci. Technol. 2000 34: 709.

Moore, M.R., P.A. Meredith, W.S. Watson, D.J. Sumner, M.K. Taylor, and A. Goldberg. "The Percutaneous Absorption of Lead-203 in Humans From Cosmetic Preparations Containing Lead Acetate, as Assessed by Whole-Body Counting and Other Techniques." Food Cosmet. Toxicol. 18. (1980): 399.

Pancirov, R. J. and R. A. Brown. 1975. Analytical methods for polynuclear aromatic hydrocarbons in crude oil, heating oils, and marine tissues. In: Conference on prevention and control or oil pollution, San Francisco, CA, March, 1975. American Petroleum Institute, Wash., DC. pp 103-13.

Pao, E. M. *et al.* Home Economics Research Report No. 44. United States Department of Agriculture, Washington, DC. 1982.

Pasquill, I.. The Dispersion of Material in the Atmospheric Boundary Layer - The Basis for Generalization. In: Lectures on Air Pollution and Environmental Impact Analysis. Boston, MA: American Meteorological Society, 1975.

Ryan, E.A., E.T. Hawkins *et al.* "Assessing Risk From Dermal Exposure at Hazardous Waste Sites. in Bennett." Ed. G. and J. Bennett. Superfund '87: Proceedings of the Eighth National Conference. Washington, DC, 16-18 November 1987. The Hazardous Material Control Research Institute. p.166-168.

Santodonato, J., P. Howard, and D. Basu. Health and Ecological Assessment of Polynuclear Aromatic Hydrocarbons. Pathotox Publishers, Inc., Park Forest South, IL. 1981.

Shabad, L. M. 1980. Circulation of carcinogenic polycyclic aromatic hydrocarbons in the human environment and cancer prevention. J. Natl. Cancer Inst. 64(3): 405-410.

Shu, H.P., P. Teitelbaum, A.S. Webb, L. Marple, B. Brunck, D. Dei Rossi, F.J. Murray, and D.J. Paustenbach. "Bioavailability of Soil Bound TCDD: Dermal Bioavailability in the Rat." Fundam. Appl. Toxicol., Vol. 10 (1988): 648-654.

Smirnov, G. A. 1970. The study of benzo(a)pyrene content in soil and vegetation in the airfield region. Vopr. Onkol. 16(5): 83-86.

State of Mississippi. Mississippi Code 1972 Annotated. Title 29 Public Lands, Buildings, and Property, Chapter 3, Sixteenth Section and Lieu Lands in General. 1998.

Suess, M. J. 1976. The environmental load and cycle of polycyclic aromatic hydrocarbons. Sci. Total Environ. 6:239-250.

Ta, Roy *et al.*, Studies Estimating the Dermal Bioavailability of Polynuclear Aromatic Hydrocarbons from Manufactured Gas Plan Tar-Contaminated Soils. Env. Sci. Tech. 32(20). 1998. 3113-3117.

Tang, W.C., White, J.C., and Alexander, M. Appl. Microbiol. Biotechnol. 1998, 49: 117.

Tang, J and Alexander, M. Environ. Toxicol. Chem. 1999, 18: 2711.

Thomas, J.F., M. Mukai, and B.D. Teggens. Fate of airborne benzo(a)pyrene. Environ. Sci. Technol. 2:33-39, 1968.

United States Department of Agriculture (USDA). Nationwide Food Consumption Survey: Continuing Survey of Food Intakes by Individuals, Men 19-50 years, 1 Day, 1985; United States Department of Agriculture. Human Nutrition Information Service. Nutrition Monitoring Division; Washington, DC, Report No. 86-1. 1986.

US EPA (United States Environmental Protection Agency). Rapid Assessment of Exposure to Particulate Emission from Surface Contamination Sites. EPA/OHEA/EPA. 600/8-85/002. Cowherd, C., Jr., G.E. Muleski, P.J. Engelhart and D.A. Gillett, Ed. Washington DC: Midwest Research Inst.. 1985.

US EPA (United States Environmental Protection Agency). "Guidelines for Carcinogenic Risk Assessment." Federal Register 51:33992-34003. 1986.

US EPA (United States Environmental Protection Agency). Superfund Exposure Assessment Manual (SEAM). EPA 540/1-88/001. Office of Remedial Response. Washington, DC, 1988.

US EPA (United States Environmental Protection Agency). Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Interim Final. EPA/540/1-89/002. Office of Emergency and Remedial Response. Washington, DC, 1989.

US EPA (United States Environmental Protection Agency). Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive. 9285.6-03. Office of Solid Waste and Emergency Response. Washington, DC, 1991.

US EPA (United States Environmental Protection Agency). Dermal Exposure Assessment: Principles and Applications. Office of Research and Development. EPA/600/8-91/011B. Washington, DC, 1992.

US EPA (United States Environmental Protection Agency). Estimating Exposure to Dioxin-Like Compounds. Office of Research and Development. EPA/600/6-88/005B. Washington, DC, 1992.

US EPA (United States Environmental Protection Agency). Provisional Guidance for Quantitative Risk Assessment of Polynuclear Aromatic Hydrocarbons. Office of Solid Waste and Environmental Remediation. EPA/600/R-93/089, July 1993

US EPA (United States Environmental Protection Agency). Land Use Directive in the CERCLA Remedy Selection Process. OSWER Directive 9355.7-04. Office of Solid Waste and Emergency Response. Washington, DC, May 1995.

US EPA (United States Environmental Protection Agency) Region 3. Technical Guidance Manual: Risk Assessment, Assessing Dermal Exposure From Soil. EPA/903-K-95-003. Office of Superfund Programs, Hazardous Waste Management Division. Washington, DC, 1995.

US EPA (United States Environmental Protection Agency) Region 4. Technical Services Supplemental Guidance to RAGS: Region 4 Bulletins. Waste Management Division, Atlanta, GA. 1995.

US EPA (United States Environmental Protection Agency). Supplement B to Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources. AP-42, Fifth Edition, Supplement B. Office of Air Quality Planning and Standards, Office of Air and Radiation. Research Triangle Park, NC, 1996

US EPA (United States Environmental Protection Agency). Exposure Factors Handbook,. EPA/600/P-95/002F. Office of Research and Development, Washington, DC, August 1997.

US EPA (United States Environmental Protection Agency). Health Effects Assessment Summary Tables (HEAST). Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office (ECAO). Cincinnati OH, 1997.

US EPA (United States Environmental Protection Agency). IRIS (Integrated Risk Information System). A Continuously Updated Electronic Database Maintained by the US Environmental Protection Agency. Bethesda, Maryland: National Library of Medicine, 1999.

US EPA (United States Environmental Protection Agency) Region 3. Updated Risk-Based Concentration Tables. Office of RCRA Technical & Program Support Branch. Philadelphia, PA, April, 1999.

Wallcave, L., H. Garcia, R. Fedlman, W. Linjinsky, and P. Shubik. 1971. Skin tumorigenesis in mice by petroleum asphalts and coal-tar pitches of known po9lynuclear aromatic hydrocarbon content. Toxicol. Appl. Pharmacol. 18, 41-52.

Weissenfels, W.D., Klewer, H.J. and Langhoff, J., J. Appl. Microbiol. Biotechnol. 1992, 36: 689.

White, J.C., Kelsey, J.W., Hatzinger, P.B and Alexander, M. Factors Affecting Sequestration and Bioavailability of Phenanthrene in Soils. Environ. Toxicol. Chem. 1997, 16(10): 2040.

Youngblood, W. W., and M. Blumer. 1975. Polycyclic aromatic hydrocarbons in the environment: homologous series in soils and recent marine sediments. Geochim. Cosmochim. Acta 39:1303-1315.

Figure 1
Site Conceptual Model and Selection of Exposure Pathways
Kerr McGee, Hattiesburg, MS

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Soil	Surface Soil (0-1')	Exposure Unit 1	Visitor	Adolescent	Dermal	On-Site	None	EU1 includes only surface water and sediment. Soils in this area are included in EU2
						Oral		None	EU1 includes only surface water and sediment. Soils in this area are included in EU2
						Inhalation		None	EU1 includes only surface water and sediment. Soils in this area are included in EU2
			Exposure Unit 2	Visitor	Adolescent	Dermal	On-Site	Quantitative	Area potentially attractive for occasional recreational use
						Oral		Quantitative	Area potentially attractive for occasional recreational use
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 3	Visitor	Adolescent	Dermal	On-Site	Quantitative	Area potentially attractive for occasional recreational use
						Oral		Quantitative	Area potentially attractive for occasional recreational use
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 4	Visitor	Adolescent	Dermal	On-Site	Quantitative	Exposed ground around drainage ditch potentially contacted by a visitor
						Oral		Quantitative	Exposed ground around drainage ditch potentially contacted by a visitor
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 5	Visitor	Adolescent	Dermal	On-Site	Quantitative	Visitors may traverse the area
						Oral		Quantitative	Visitors may traverse the area
						Inhalation		None	VOCs not present at levels of concern
		Surface Soil (0-6')	Exposure Unit 1	Maintenance Worker	Adult	Dermal	On-Site	None	EU1 includes only surface water and sediment. *Soils in this area are included* in EU2
						Oral		None	EU1 includes only surface water and sediment. Soils in this area are included in EU2
						Inhalation		None	EU1 includes only surface water and sediment. Soils in this area are included in EU2
			Exposure Unit 2	Maintenance Worker	Adult	Dermal	On-Site	None	Surface Soil exposures addressed in EU2 under a future scenario
						Oral		None	Surface Soil exposures addressed in EU2 under a future scenario
						Inhalation		None	Surface Soil exposures addressed in EU2 under a future scenario
			Exposure Unit 3	Maintenance Worker	Adult	Dermal	On-Site	None	Surface Soil exposures addressed in EU3 under a *future scenario*
						Oral		None	Surface Soil exposures addressed in EU3 under a future scenario
						Inhalation		None	Surface Soil exposures addressed in EU3 under a future scenario
			Exposure Unit 4	Maintenance Worker	Adult	Dermal	On-Site	Quantitative	Infrequent maintenance of drainage ditch
						Oral		Quantitative	Infrequent maintenance of drainage ditch
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 5	Maintenance Worker	Adult	Dermal	On-Site	None	Surface Soil exposures addressed *in EU5 under a future scenario*
						Oral		None	Surface Soil exposures addressed in EU5 under a future scenario
						Inhalation		None	Surface Soil exposures addressed in EU5 under a future scenario
			Exposure Unit 6	Resident	Child/Adult	Demal	Off-Site	None	Sediment exposures represent worst-case; no soil data
						Oral		None	Sediment exposures represent worst-case; no soil data
						Inhalation		None	Sediment exposures represent worst-case; no soil data
	Sediment	Sediment	Exposure Unit 1	Visitor	Adolescent	Dermal	On-Site	Quantitative	Visitor may potentially *wade in Gordon's Creek*
						Oral		Quantitative	Visitor may potentially wade in Gordon's Creek
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 4	Visitor	Adolescent	Dermal	On-Site	Quantitative	Visitor may potentially walk through drainage ditch
						Oral		Quantitative	Visitor may potentially walk through drainage ditch
						Inhalation		None	VOCs not present at levels of concern

Figure 1

Site Conceptual Model and Selection of Exposure Pathways

Kerr McGee, Hattiesburg, MS

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
			Exposure Unit 1	Maintenance Worker	Adult	Dermal	On-Site	None	Sediment exposures addressed in EU1 under a future scenario
						Oral		None	Sediment exposures addressed in EU1 under a future scenario
						Inhalation		None	Sediment exposures addressed in EU1 under a future scenario
			Exposure Unit 4	Maintenance Worker	Adult	Dermal	On-Site	Quantitative	Infrequent maintenance of *drainage ditch*
						Oral		Quantitative	Infrequent maintenance of drainage ditch
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 6	Resident	Child/Adult	Demal	Off-Site	Quantitative	Playing/working in drainage ditch
						Oral		Quantitative	Playing/working in drainage ditch
						Inhalation		None	VOCs not present at levels of concern
	Surface Water	Surface Water	Exposure Unit 1	Visitor	Adolescent	Dermal	On-Site	Quantitative	Visitor may potentially wade in Gordon's Creek
						Oral		Quantitative	Visitor may potentially wade in Gordon's Creek
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 4	*Visitor*	Adolescent	Dermal	On-Site	Quantitative	Visitor may potentially walk through drainage ditch
						Oral		Quantitative	Visitor may potentially walk through drainage *ditch*
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 1	Maintenance Worker	Adult	Dermal	On-Site	None	Surface Water exposures addressed in EU1 under a future scenario
						Oral		None	Surface Water exposures addressed in EU1 under a future scenario
						Inhalation		None	Surface Water exposures addressed in EU1 under a future scenario
			Exposure Unit 4	Maintenance Worker	Adult	Dermal	On-Site	Quantitative	Infrequent maintenance of drainage ditch
						Oral		Quantitative	Infrequent maintenance of drainage ditch
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 6	Resident	Child/Adult	Demal	Off-Site	Quantitative	Playing/working in drainage ditch
						Oral		Quantitative	Playing/working in drainage ditch
						Inhalation		None	VOCs not present at levels of concern
Future	Surface Soil	Surface Soil (0-6')	Exposure Unit 1	Maintenance Worker	Adult	Dermal	On-Site	None	EU1 includes only surface water and sediment. Soils in this area are included in EU2
						Oral		None	EU1 includes only surface water and sediment. Soils in this area are included in EU2
						Inhalation		None	EU1 includes only surface water and sediment. Soils in this area are included in EU2
			Exposure Unit 2	Maintenance Worker	Adult	Dermal	On-Site	Quantitative	May potentially become a maintained area
						Oral		Quantitative	May potentially become a maintained area
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 3	Maintenance Worker	Adult	Dermal	On-Site	None	COPCs eliminated during screening process
						Oral		None	COPCs eliminated during screening process
						Inhalation		None	COPCs eliminated during screening process
			Exposure Unit 4	Maintenance Worker	Adult	Dermal	On-Site	None	Surface Soil exposures addressed in EU4 under a current scenario
						Oral		None	Surface Soil exposures addressed in EU4 under a current scenario
						Inhalation		None	Surface Soil exposures addressed in EU4 under a current scenario
			Exposure Unit 5	Maintenance Worker	Adult	Dermal	On-Site	Quantitative	May potentially become a maintained area
						Oral		Quantitative	May potentially become a maintained area
						Inhalation		None	VOCs not present at levels of concern

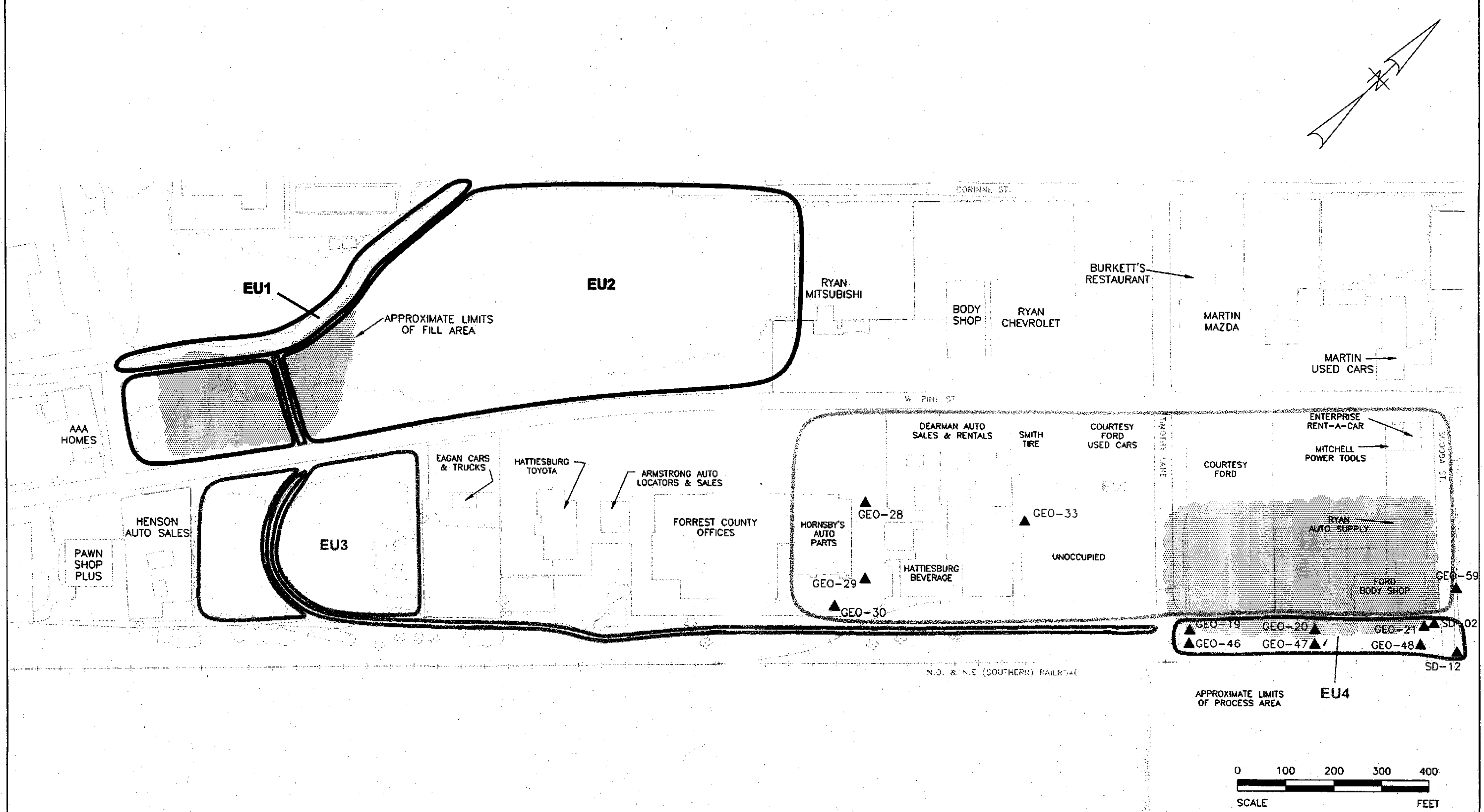
ENVIRONMENTAL STANDARDS

Figure 1

Site Conceptual Model and Selection of Exposure Pathways

Kerr McGee, Hattiesburg, MS

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
	Subsurface Soil	Subsurface Soil (0' to water table)	Exposure Unit 1	Construction Worker	Adult	Dermal	On-Site	None	EU1 includes only surface water and sediment. Soils in this area are included in EU2
						Oral		None	EU1 includes only surface water and sediment. Soils in this area are included in EU2
						Inhalation		None	EU1 includes only surface water and sediment. Soils in this area are included in EU2
			Exposure Unit 2	Construction Worker	Adult	Dermal	On-Site	Quantitative	Potentially constructable area in the future
						Oral		Quantitative	Potentially constructable area in the future
						Inhalation		Quantitative	Non-VOC entrained fugitive dust generation during potential construction activities
			Exposure Unit 3	Construction Worker	Adult	Dermal	On-Site	None	COPCs eliminated during screening process
						Oral		None	COPCs eliminated during screening process
						Inhalation		None	COPCs eliminated during screening process
			Exposure Unit 4	Construction Worker	Adult	Dermal	On-Site	Quantitative	Infrequent construction activities may occur in the future
						Oral		Quantitative	Infrequent construction activities may occur in the future
						Inhalation		Quantitative	Non-VOC entrained fugitive dust generation during potential construction activities
			Exposure Unit 5	Construction Worker	Adult	Dermal	On-Site	Quantitative	Potentially constructable area in the future
						Oral		Quantitative	Potentially constructable area in the future
						Inhalation		Quantitative	Non-VOC entrained fugitive dust generation during potential construction activities
	Sediment	Sediment	Exposure Unit 1	Maintenance Worker	Adult	Dermal	On-Site	Quantitative	Infrequent maintenance of Gordon's Creek
						Oral		Quantitative	Infrequent maintenance of Gordon's Creek
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 4	Maintenance Worker	Adult	Dermal	On-Site	None	Sediment exposures addressed in EU4 under a current scenario
						Oral		None	Sediment exposures addressed in EU4 under a current scenario
						Inhalation		None	Sediment exposures addressed in EU4 under a current scenario
			Exposure Unit 1	Construction Worker	Adult	Dermal	On-Site	Quantitative	Infrequent construction activities may occur in the future
						Oral		Quantitative	Infrequent construction activities may occur in the future
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 4	Construction Worker	Adult	Dermal	On-Site	Quantitative	Infrequent construction activities may occur in the future
						Oral		Quantitative	Infrequent construction activities may occur in the future
						Inhalation		None	VOCs not present at levels of concern
	Surface Water	Surface Water	Exposure Unit 1	Maintenance Worker	Adult	Dermal	On-Site	Quantitative	Infrequent maintenance of Gordon's Creek
						Oral		Quantitative	Infrequent maintenance of Gordon's Creek
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 4	Maintenance Worker	Adult	Dermal	On-Site	None	Surface Water exposures addressed in EU4 under a current scenario
						Oral		None	Surface Water exposures addressed in EU4 under a current scenario
						Inhalation		None	Surface Water exposures addressed in EU4 under a current scenario
			Exposure Unit 1	Construction Worker	Adult	Dermal	On-Site	Quantitative	Infrequent construction activities may occur in the future
						Oral		Quantitative	Infrequent construction activities may occur in the future
						Inhalation		None	VOCs not present at levels of concern
			Exposure Unit 4	Construction Worker	Adult	Dermal	On-Site	Quantitative	Infrequent construction activities may occur in the future
						Oral		Quantitative	Infrequent construction activities may occur in the future
						Inhalation		None	VOCs not present at levels of concern



▲ SAMPLE LOCATIONS WHERE PROPOSED REMEDIAL ACTIVITIES AND/OR IMPLEMENTATION OF DEED RESTRICTIONS WILL RESULT IN ACCEPTABLE RISK LEVELS (SEE SECTION 8 OF TEXT)

BASE MAP FROM ATLANTIC TECHNOLOGIES, LTD., HUNTSVILLE, ALABAMA, APRIL 1, 1996
BASED ON A MAP PROVIDED BY MICHAEL PISANI AND ASSOCIATES

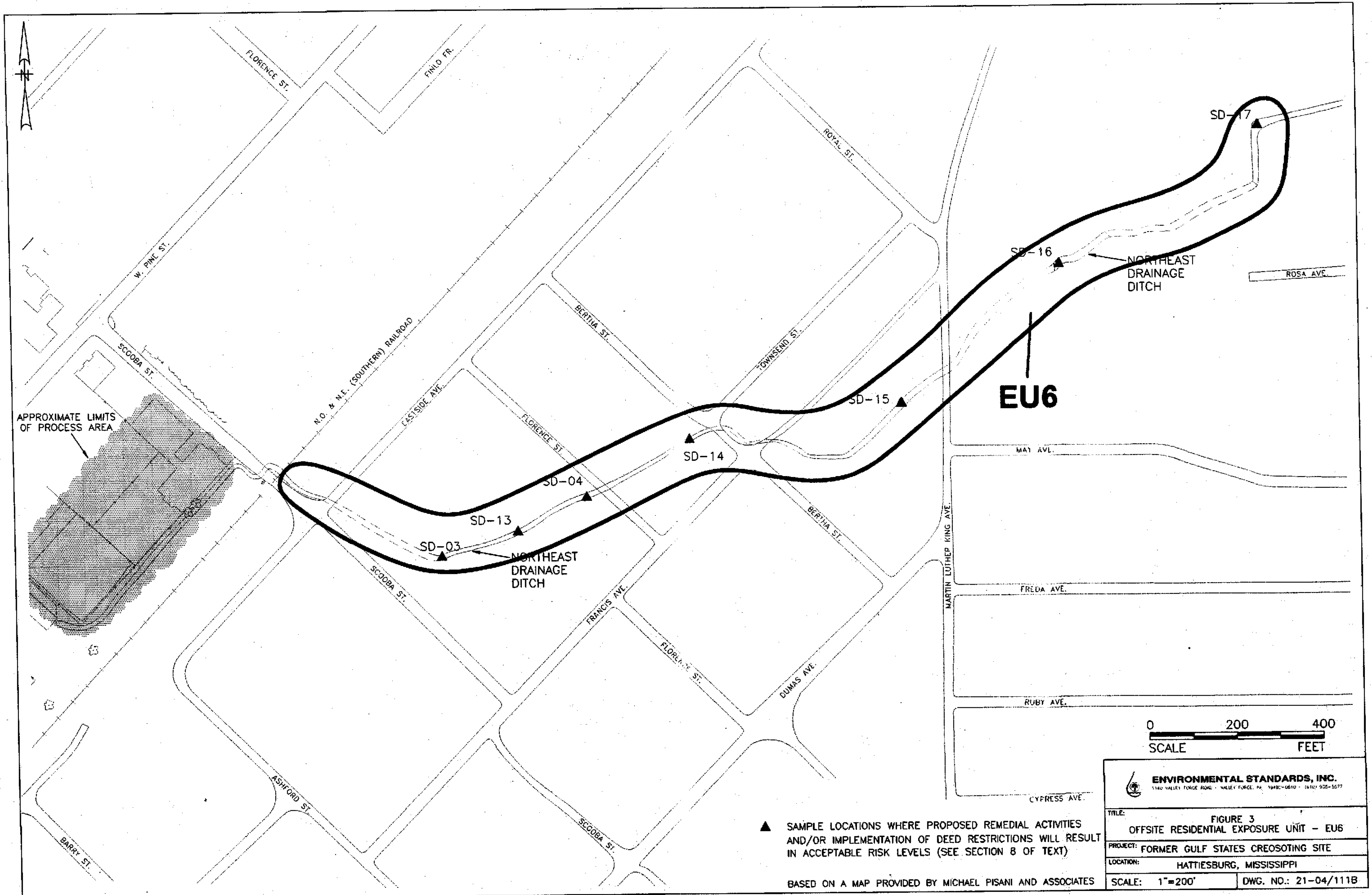
ENVIRONMENTAL STANDARDS, INC.

TITLE: FIGURE 2
SITE MAP AND EXPOSURE UNIT DELINEATION

PROJECT: FORMER GULF STATES CREOSOTING SITE

LOCATION: HATTIESBURG, MISSISSIPPI

SCALE: 1"=200' | DWG. NO.: 21-02/31B



▲ SAMPLE LOCATIONS WHERE PROPOSED REMEDIAL ACTIVITIES AND/OR IMPLEMENTATION OF DEED RESTRICTIONS WILL RESULT IN ACCEPTABLE RISK LEVELS (SEE SECTION 8 OF TEXT)

BASED ON A MAP PROVIDED BY MICHAEL PISANI AND ASSOCIATES

ENVIRONMENTAL STANDARDS, INC.

TITLE: FIGURE 3 OFFSITE RESIDENTIAL EXPOSURE UNIT – EU6

PROJECT: FORMER GULF STATES CREOSOTING SITE

LOCATION: HATTIESBURG, MISSISSIPPI

SCALE: 1"=200' DWG. NO.: 21-04/111B

Ta

Statistical Summary and Selection of COPCs in EU1 Sediment

Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2-methylnaphthalene	91-57-6	2	2	100	0.00E+00	0.00E+00	7.40E-02	J	2.92E-01	1.94E-01	5.10E-01		SD-07	3.08E-01
Acenaphthene	83-32-9	2	2	100	0.00E+00	0.00E+00	1.80E-01	J	3.15E-01	2.85E-01	4.50E-01		SD-07	1.91E-01
Acenaphthylene	208-96-8	2	1	50	4.00E-02	4.00E-02	7.80E-02	J	4.90E-02	3.95E-02	7.80E-02	J	SD-07	4.10E-02
Anthracene	120-12-7	2	2	100	0.00E+00	0.00E+00	2.60E-01	J	3.60E-01	3.46E-01	4.60E-01		SD-07	1.41E-01
Benzo(a)anthracene	56-55-3	2	2	100	0.00E+00	0.00E+00	1.80E-01	J	3.85E-01	3.26E-01	5.90E-01		SD-07	2.90E-01
Benzo(a)pyrene	50-32-8	2	2	100	0.00E+00	0.00E+00	1.20E-01	J	2.55E-01	2.16E-01	3.90E-01	J	SD-07	1.91E-01
Benzo(b)fluoranthene	205-99-2	2	2	100	0.00E+00	0.00E+00	1.70E-01	J	3.75E-01	3.14E-01	5.80E-01		SD-07	2.90E-01
Benzo(ghi)perylene	191-24-2	2	2	100	0.00E+00	0.00E+00	6.50E-02	J	1.23E-01	1.08E-01	1.80E-01	J	SD-07	8.13E-02
Benzo(k)fluoranthene	207-08-9	2	2	100	0.00E+00	0.00E+00	6.40E-02	J	1.27E-01	1.10E-01	1.90E-01	J	SD-07	8.91E-02
Carbazole	86-74-8	2	2	100	0.00E+00	0.00E+00	1.60E-01	J	3.65E-01	3.02E-01	5.70E-01		SD-07	2.90E-01
Chrysene	218-01-9	2	2	100	0.00E+00	0.00E+00	1.80E-01	J	3.55E-01	3.09E-01	5.30E-01		SD-07	2.47E-01
Dibenz(a,h)anthracene	53-70-3	2	1	50	4.00E-02	4.00E-02	6.20E-02	J	4.10E-02	3.52E-02	6.20E-02	J	SD-07	2.97E-02
Dibenzofuran	132-64-9	2	2	100	0.00E+00	0.00E+00	1.50E-01	J	2.80E-01	2.48E-01	4.10E-01		SD-07	1.84E-01
Fluoranthene	206-44-0	2	2	100	0.00E+00	0.00E+00	6.80E-01		1.19E+00	1.08E+00	1.70E+00		SD-07	7.21E-01
Fluorene	86-73-7	2	2	100	0.00E+00	0.00E+00	2.30E-01	J	4.25E-01	3.78E-01	6.20E-01		SD-07	2.76E-01
Indeno(1,2,3-cd)pyrene	193-39-5	2	2	100	0.00E+00	0.00E+00	6.90E-02	J	1.45E-01	1.23E-01	2.20E-01	J	SD-07	1.07E-01
Naphthalene	91-20-3	2	2	100	0.00E+00	0.00E+00	1.80E-01	J	6.40E-01	4.45E-01	1.10E+00		SD-07	6.51E-01
Phenanthrene	85-01-8	2	2	100	0.00E+00	0.00E+00	7.20E-01		1.21E+00	1.11E+00	1.70E+00		SD-07	6.93E-01
Pyrene	129-00-0	2	2	100	0.00E+00	0.00E+00	4.80E-01		9.40E-01	8.20E-01	1.40E+00		SD-07	6.51E-01

Table 1
Statistical Summary and Selection of COPCs in EU1 Sediment
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier 1 Unrestricted Soil TRG mg/kg	Is Maximum Detected > TRG?	Is the 95% UCL > TRG?
Semivolatiles							
2-methylnaphthalene	1.67E+00	1.60E+22	Unknown	5.10E-01	3.13E+03	no	
Acenaphthene	1.17E+00	3.23E+04	Unknown	4.50E-01	4.69E+03	no	
Acenaphthylene	2.32E-01	8.34E+09	Unknown	7.80E-02	4.69E+03	no	
Anthracene	9.91E-01	2.23E+01	Unknown	4.60E-01	2.35E+04	no	
Benzo(a)anthracene	1.68E+00	1.25E+08	Unknown	5.90E-01	8.75E-01	no	YES*
Benzo(a)pyrene	1.11E+00	6.25E+07	Unknown	3.90E-01	8.75E-02	YES	YES - COPC
Benzo(b)fluoranthene	1.67E+00	4.79E+08	Unknown	5.80E-01	8.75E-01	no	YES*
Benzo(ghi)perylene	4.86E-01	2.08E+05	Unknown	1.80E-01	2.35E+03	no	
Benzo(k)fluoranthene	5.25E-01	1.71E+06	Unknown	1.90E-01	8.75E+00	no	YES*
Carbazole	1.66E+00	2.15E+09	Unknown	5.70E-01	3.19E+01	no	
Chrysene	1.46E+00	3.73E+06	Unknown	5.30E-01	8.75E+01	no	YES*
Dibenz(a,h)anthracene	1.74E-01	2.15E+06	Unknown	6.20E-02	8.75E-02	no	YES*
Dibenzofuran	1.10E+00	3.27E+05	Unknown	4.10E-01	3.13E+02	no	
Fluoranthene	4.41E+00	1.22E+05	Unknown	1.70E+00	3.13E+03	no	
Fluorene	1.66E+00	3.35E+05	Unknown	6.20E-01	3.13E+03	no	
Indeno(1,2,3-cd)pyrene	6.21E-01	1.88E+07	Unknown	2.20E-01	8.75E-01	no	YES*
Naphthalene	3.54E+00	6.10E+19	Unknown	1.10E+00	6.45E+02	no	
Phenanthrene	4.30E+00	2.92E+04	Unknown	1.70E+00	2.35E+03	no	
Pyrene	3.84E+00	7.40E+06	Unknown	1.40E+00	2.35E+03	no	

* Retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH family, one of which has been retained as a C

Table 2
Statistical Summary and Selection of COPCs in EU1 Surface Water
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/L	Maximum Detection Limit mg/L	Minimum Detected mg/L	Minimum Detected Qualifier	Mean mg/L	Logarithmic Mean mg/L	Maximum Detected mg/L	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/L
Semivolatiles														
Benzo(a)anthracene	56-55-3	2	1	50	1.00E-03	1.00E-03	1.00E-03	J	7.50E-04	7.07E-04	1.00E-03	J	SW-08	3.54E-04
Benzo(a)pyrene	50-32-8	2	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-08	0.00E+00
Benzo(b)fluoranthene	205-99-2	2	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-08	0.00E+00
Benzo(k)fluoranthene	207-08-9	2	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-08	0.00E+00
Chrysene	218-01-9	2	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-08	0.00E+00
Dibenz(a,h)anthracene	53-70-3	2	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-08	0.00E+00
Indeno(1,2,3-cd)pyrene	193-39-5	2	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-08	0.00E+00
Fluoranthene	206-44-0	2	1	50	1.00E-03	1.00E-03	7.50E-03		4.00E-03	1.94E-03	7.50E-03		SW-08	4.95E-03
Pyrene	129-00-0	2	1	50	1.00E-03	1.00E-03	1.00E-03	J	7.50E-04	7.07E-04	1.00E-03	J	SW-08	3.54E-04

NA - Not applicable: constituent not detected in media.

Table 2
Statistical Summary and Selection of COPCs in EU1 Surface Water
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/L	Logarithmic 95% UCL mg/L	*Distribution* 99% Confidence	Exposure Point Concentration mg/L	Human Health Consumption of Water & Organisms AWQC mg/L	Is Maximum Detected > AWQC?
Semivolatiles						
Benzo(a)anthracene	2.33E-03	4.37E-01	Unknown	1.00E-03	4.40E-06	YES - COPC
Benzo(a)pyrene	5.00E-04	5.00E-04	Unknown	5.00E-04	4.40E-06	YES**
Benzo(b)fluoranthene	5.00E-04	5.00E-04	Unknown	5.00E-04	4.40E-06	YES**
Benzo(k)fluoranthene	5.00E-04	5.00E-04	Unknown	5.00E-04	4.40E-06	YES**
Chrysene	5.00E-04	5.00E-04	Unknown	5.00E-04	4.40E-06	YES**
Dibenz(a,h)anthracene	5.00E-04	5.00E-04	Unknown	5.00E-04	4.40E-06	YES**
Indeno(1,2,3-cd)pyrene	5.00E-04	5.00E-04	Unknown	5.00E-04	4.40E-06	YES**
Fluoranthene	2.61E-02	2.90E+42	Unknown	7.50E-03	3.00E-01	no
Pyrene	2.33E-03	4.37E-01	Unknown	1.00E-03	9.60E-01	no

NA - Not Available
*Retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH family, one of which has been retained as a COPC.

Table 3

Statistical Summary and Selection of COPCs in EU2 Soil (0-1' bgs)

Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2-methylnaphthalene	91-57-6	14	2	14.29	3.30E-02	3.30E-02	7.00E-02	J	3.06E-02	2.15E-02	1.60E-01	J	SS-10	3.99E-02
Acenaphthene	83-32-9	14	1	7.14	3.30E-02	3.30E-02	4.90E-02	J	1.88E-02	1.78E-02	4.90E-02	J	GEO-13	8.69E-03
Acenaphthylene	208-96-8	14	6	42.86	3.30E-02	3.30E-02	3.70E-02	J	1.59E-01	4.29E-02	1.30E+00		GEO-13	3.52E-01
Anthracene	120-12-7	14	7	50	3.30E-02	3.30E-02	4.10E-02	J	1.89E-01	5.00E-02	1.60E+00		GEO-13	4.28E-01
Benzo(a)anthracene	56-55-3	14	12	85.71	3.30E-02	3.30E-02	4.10E-02	J	8.98E-01	2.28E-01	6.70E+00		GEO-13	1.78E+00
Benzo(a)pyrene	50-32-8	14	11	78.57	6.70E-02	6.70E-02	8.40E-02	J	8.31E-01	2.82E-01	5.20E+00		GEO-13	1.42E+00
Benzo(b)fluoranthene	205-99-2	14	12	85.71	6.70E-02	6.70E-02	1.10E-01	J	1.84E+00	5.95E-01	9.20E+00		GEO-13	2.62E+00
Benzo(ghi)perylene	191-24-2	14	10	71.43	6.70E-02	6.70E-02	1.70E-01	J	5.17E-01	2.20E-01	2.30E+00		GEO-13	6.95E-01
Benzo(k)fluoranthene	207-08-9	14	9	64.29	1.30E-01	1.30E-01	1.90E-01	J	7.01E-01	2.88E-01	3.60E+00		GEO-13	1.04E+00
Carbazole	86-74-8	14	4	28.57	3.30E-02	3.30E-02	4.30E-02	J	6.28E-02	2.94E-02	3.50E-01	J	GEO-13	1.05E-01
Chrysene	218-01-9	14	12	85.71	3.30E-02	3.30E-02	6.20E-02	J	1.19E+00	3.11E-01	8.00E+00		GEO-13	2.16E+00
Dibenz(a,h)anthracene	53-70-3	14	7	50	6.70E-02	6.70E-02	7.20E-02	J	1.85E-01	8.87E-02	9.10E-01		GEO-13	2.66E-01
Dibenzofuran	132-64-9	14	2	14.29	3.30E-02	3.30E-02	7.20E-02	J	2.63E-02	2.08E-02	9.80E-02	J	SS-10	2.54E-02
Di-n-butylphthalate	84-74-2	14	9	64.29	3.30E-02	7.20E-02	3.60E-02	J	4.30E-02	3.68E-02	1.10E-01	J	SS-10	2.50E-02
Fluoranthene	206-44-0	14	12	85.71	3.30E-02	3.30E-02	6.60E-02	J	1.40E+00	3.00E-01	1.20E+01		GEO-13	3.16E+00
Fluorene	86-73-7	14	2	14.29	3.30E-02	3.30E-02	4.50E-02	J	4.38E-02	2.21E-02	3.70E-01		GEO-13	9.42E-02
Indeno(1,2,3-cd)pyrene	193-39-5	14	10	71.43	6.70E-02	6.70E-02	9.60E-02	J	6.59E-01	2.37E-01	3.70E+00		GEO-13	1.03E+00
Naphthalene	91-20-3	14	2	14.29	3.30E-02	3.30E-02	8.80E-02	J	3.26E-02	2.20E-02	1.70E-01	J	SS-10	4.39E-02
Phenanthrene	85-01-8	14	8	57.14	3.30E-02	3.30E-02	3.70E-02	J	1.28E-01	5.30E-02	7.40E-01		GEO-13	2.08E-01
Pyrene	129-00-0	14	12	85.71	6.70E-02	6.70E-02	9.80E-02	J	1.70E+00	4.60E-01	1.40E+01		GEO-13	3.66E+00

Table 3
Statistical Summary and Selection of COPCs in EU2 Soil (0-1' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier I Unrestricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
Semivolatiles							
2-methylnaphthalene	4.95E-02	4.29E-02	Unknown	4.29E-02	3.13E+03	no	
Acenaphthene	2.29E-02	2.17E-02	Unknown	2.17E-02	4.69E+03	no	
Acenaphthylene	3.26E-01	4.99E-01	Unknown	4.99E-01	4.69E+03	no	
Anthracene	3.91E-01	6.29E-01	Unknown	6.29E-01	2.35E+04	no	
Benzo(a)anthracene	1.74E+00	9.91E+00	Lognormal	6.70E+00	8.75E-01	YES	YES - COPC
Benzo(a)pyrene	1.50E+00	5.08E+00	Lognormal	5.08E+00	8.75E-02	YES	YES - COPC
Benzo(b)fluoranthene	3.08E+00	2.53E+01	Lognormal	9.20E+00	8.75E-01	YES	YES - COPC
Benzo(ghi)perylene	8.46E-01	2.74E+00	Lognormal	2.30E+00	2.35E+03	no	
Benzo(k)fluoranthene	1.19E+00	2.93E+00	Lognormal	2.93E+00	8.75E+00	no	YES*
Carbazole	1.12E-01	1.24E-01	Unknown	1.24E-01	3.19E+01	no	
Chrysene	2.22E+00	1.68E+01	Lognormal	8.00E+00	8.75E+01	no	YES*
Dibenz(a,h)anthracene	3.11E-01	4.93E-01	Unknown	4.93E-01	8.75E-02	YES	YES - COPC
Dibenzofuran	3.83E-02	3.57E-02	Unknown	3.57E-02	3.13E+02	no	
Di-n-butylphthalate	5.48E-02	6.30E-02	Normal/Lognormal	6.30E-02	2.28E+03	no	
Fluoranthene	2.89E+00	1.66E+01	Lognormal	1.20E+01	3.13E+03	no	
Fluorene	8.84E-02	5.84E-02	Unknown	5.84E-02	3.13E+03	no	
Indeno(1,2,3-cd)pyrene	1.15E+00	4.29E+00	Lognormal	3.70E+00	8.75E-01	YES	YES - COPC
Naphthalene	5.34E-02	4.71E-02	Unknown	4.71E-02	6.45E+02	no	
Phenanthrene	2.26E-01	3.96E-01	Lognormal	3.96E-01	2.35E+03	no	
Pyrene	3.43E+00	1.25E+01	Lognormal	1.25E+01	2.35E+03	no	

*Retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH family, one of which has been retained as a COPC.

Table 4
Statistical Summary and Selection of COPCs in EU2 Soil (0-6' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2-methylnaphthalene	91-57-6	20	2	10	3.30E-02	3.90E-02	7.00E-02	J	2.71E-02	2.07E-02	1.60E-01	J	SS-10	3.34E-02
Acenaphthene	83-32-9	21	1	4.76	3.30E-02	3.00E-01	4.90E-02	J	2.51E-02	2.01E-02	4.90E-02	J	GEO-13	2.95E-02
Acenaphthylene	208-96-8	21	6	28.57	3.30E-02	3.00E-01	3.70E-02	J	1.19E-01	3.60E-02	1.30E+00		GEO-13	2.91E-01
Anthracene	120-12-7	21	8	38.1	3.30E-02	3.90E-02	4.10E-02	J	1.37E-01	3.94E-02	1.60E+00		GEO-13	3.54E-01
Benzo(a)anthracene	56-55-3	21	14	66.67	3.30E-02	3.80E-02	4.10E-02	J	6.10E-01	1.12E-01	6.70E+00		GEO-13	1.49E+00
Benzo(a)pyrene	50-32-8	21	12	57.14	3.70E-02	6.70E-02	8.40E-02	J	5.65E-01	1.25E-01	5.20E+00		GEO-13	1.21E+00
Benzo(b)fluoranthene	205-99-2	21	16	76.19	3.70E-02	6.70E-02	9.50E-02	J	1.29E+00	3.16E-01	9.20E+00		GEO-13	2.26E+00
Benzo(ghi)perylene	191-24-2	21	11	52.38	3.70E-02	6.70E-02	8.50E-02	J	3.54E-01	1.04E-01	2.30E+00		GEO-13	6.08E-01
Benzo(k)fluoranthene	207-08-9	21	13	61.9	3.70E-02	1.30E-01	5.10E-02	J	5.21E-01	1.84E-01	3.60E+00		GEO-13	8.79E-01
Bis(2-ethylhexyl)phthalate	117-81-7	20	1	5	6.70E-02	7.80E-02	3.70E-01	J	5.15E-02	3.91E-02	3.70E-01	J	GEO-13	7.50E-02
Carbazole	86-74-8	20	4	20	3.30E-02	3.90E-02	4.30E-02	J	4.96E-02	2.57E-02	3.50E-01	J	GEO-13	8.92E-02
Chrysene	218-01-9	21	13	61.9	3.30E-02	7.40E-02	5.10E-02	J	8.03E-01	1.32E-01	8.00E+00		GEO-13	1.83E+00
Dibenz(a,h)anthracene	53-70-3	21	8	38.1	3.70E-02	6.70E-02	1.88E-02	J	1.29E-01	5.30E-02	9.10E-01		GEO-13	2.29E-01
Dibenzofuran	132-64-9	20	2	10	3.30E-02	3.90E-02	7.20E-02	J	2.41E-02	2.02E-02	9.80E-02	J	SS-10	2.13E-02
Di-n-butylphthalate	84-74-2	20	9	45	3.30E-02	7.80E-02	3.60E-02	J	4.15E-02	3.71E-02	1.10E-01	J	SS-10	2.08E-02
Fluoranthene	206-44-0	21	14	66.67	3.30E-02	3.80E-02	5.00E-02	J	9.54E-01	1.42E-01	1.20E+01		GEO-13	2.63E+00
Fluorene	86-73-7	21	4	19.05	3.30E-02	3.80E-02	2.90E-02	J	5.08E-02	2.45E-02	3.70E-01		GEO-13	9.99E-02
Indeno(1,2,3-cd)pyrene	193-39-5	21	11	52.38	3.70E-02	6.70E-02	9.60E-02	J	4.50E-01	1.11E-01	3.70E+00		GEO-13	8.86E-01
Naphthalene	91-20-3	21	2	9.52	3.30E-02	3.00E-01	8.80E-02	J	3.43E-02	2.31E-02	1.70E-01	J	SS-10	4.47E-02
Phenanthrene	85-01-8	21	9	42.86	3.30E-02	3.90E-02	3.70E-02	J	1.01E-01	4.22E-02	7.40E-01		GEO-13	1.77E-01
Phenol	108-95-2	20	2	10	3.30E-02	7.80E-02	1.10E-01	J	3.51E-02	2.52E-02	1.90E-01	J	GEO-13	4.24E-02
Pyrene	129-00-0	21	14	66.67	3.70E-02	6.70E-02	6.80E-02	J	1.16E+00	1.92E-01	1.40E+01		GEO-13	3.05E+00

Table 4

Statistical Summary and Selection of COPCs in EU2 Soil (0-6' bgs)

Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier 1 Restricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
Semivolatiles							
2-methylnaphthalene	4.00E-02	3.22E-02	Unknown	3.22E-02	8.18E+04	no	
Acenaphthene	3.62E-02	2.90E-02	Unknown	2.90E-02	1.23E+05	no	
Acenaphthylene	2.28E-01	1.83E-01	Unknown	1.83E-01	1.23E+05	no	
Anthracene	2.70E-01	2.09E-01	Unknown	2.09E-01	6.13E+05	no	YES*
Benzo(a)anthracene	1.17E+00	2.80E+00	Lognormal	2.80E+00	7.84E+00	no	YES - COPC
Benzo(a)pyrene	1.02E+00	2.64E+00	Lognormal	2.64E+00	7.84E-01	YES	YES - COPC
Benzo(b)fluoranthene	2.14E+00	1.09E+01	Lognormal	9.20E+00	7.84E+00	YES	
Benzo(ghi)perylene	5.83E-01	1.41E+00	Lognormal	1.41E+00	6.13E+04	no	
Benzo(k)fluoranthene	8.52E-01	1.84E+00	Lognormal	1.84E+00	7.84E+01	no	YES*
Bis(2-ethylhexyl)phthalate	8.05E-02	5.77E-02	Unknown	5.77E-02	4.09E+02	no	
Carbazole	8.41E-02	6.51E-02	Unknown	6.51E-02	2.86E+02	no	
Chrysene	1.49E+00	5.33E+00	Lognormal	5.33E+00	7.84E+02	no	YES*
Dibenz(a,h)anthracene	2.16E-01	2.39E-01	Unknown	2.39E-01	7.84E-01	YES	YES**
Dibenzofuran	3.23E-02	2.86E-02	Unknown	2.86E-02	8.18E+03	no	
Di-n-butylphthalate	4.95E-02	5.24E-02	Lognormal	5.24E-02	2.28E+03	no	
Fluoranthene	1.94E+00	5.34E+00	Lognormal	5.34E+00	8.17E+04	no	
Fluorene	8.84E-02	6.16E-02	Unknown	6.16E-02	8.17E+04	no	
Indeno(1,2,3-cd)pyrene	7.83E-01	1.97E+00	Lognormal	1.97E+00	7.84E+00	no	YES*
Naphthalene	5.11E-02	4.37E-02	Unknown	4.37E-02	8.24E+02	no	
Phenanthrene	1.67E-01	1.88E-01	Unknown	1.88E-01	6.13E+04	no	
Phenol	5.15E-02	4.60E-02	Unknown	4.60E-02	1.23E+05	no	
Pyrene	2.31E+00	7.47E+00	Lognormal	7.47E+00	6.13E+04	no	

Table 5
Statistical Summary and Selection of COPCs in EU2 Soil (0-10' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Pesticides														
Endosulfan I	959-98-8	1	1	100	0.00E+00	0.00E+00	4.00E-03	J	4.00E-03	4.00E-03	4.00E-03	J	SB-05	--
Heptachlor	76-44-8	1	1	100	0.00E+00	0.00E+00	1.00E-02		1.00E-02	1.00E-02	1.00E-02		SB-05	--
Semivolatiles														
2,4-dimethylphenol	105-67-9	23	1	4.35	6.70E-02	3.30E-01	1.10E+00	J	8.68E-02	4.33E-02	1.10E+00	J	SB-05	2.23E-01
2-methylnaphthalene	91-57-6	23	4	17.39	3.30E-02	3.90E-02	7.00E-02	J	1.87E+01	4.58E-02	2.30E+02		SB-07	6.21E+01
Acenaphthene	83-32-9	26	3	11.54	2.80E-02	3.10E-01	4.90E-02	J	1.14E+01	4.20E-02	2.00E+02		SB-07	4.29E+01
Acenaphthylene	208-96-8	26	8	30.77	2.80E-02	3.10E-01	3.70E-02	J	*6.65E-01*	*5.37E-02*	7.70E+00		SB-07	1.97E+00
Anthracene	120-12-7	26	10	38.46	7.90E-04	3.90E-02	4.10E-02	J	8.11E+00	5.28E-02	1.20E+02		SB-07	2.86E+01
Benzo(a)anthracene	56-55-3	26	16	61.54	8.60E-04	3.80E-02	4.10E-02	J	4.69E+00	1.16E-01	6.10E+01		SB-07	1.48E+01
Benzo(a)pyrene	50-32-8	26	16	61.54	3.70E-02	6.70E-02	1.69E-03	J	2.09E+00	1.33E-01	2.20E+01		SB-07	5.75E+00
Benzo(b)fluoranthene	205-99-2	26	20	76.92	3.70E-02	6.70E-02	7.60E-04	J	3.49E+00	2.74E-01	3.30E+01	J	SB-07	8.58E+00
Benzo(ghi)perylene	191-24-2	26	14	53.85	1.70E-02	6.70E-02	1.80E-03	J	7.49E-01	1.06E-01	6.40E+00		SB-07	1.65E+00
Benzo(k)fluoranthene	207-08-9	26	17	65.38	3.70E-02	1.30E-01	5.10E-04	J	1.18E+00	1.62E-01	1.10E+01		SB-07	2.70E+00
Bis(2-ethylhexyl)phthalate	117-81-7	23	1	4.35	6.70E-02	5.00E-01	3.70E-01	J	6.43E-02	4.48E-02	3.70E-01	J	GEO-13	8.41E-02
Carbazole	86-74-8	23	6	26.09	3.30E-02	3.90E-02	4.30E-02	J	3.39E+00	4.75E-02	5.00E+01		SB-05	1.16E+01
Chrysene	218-01-9	26	15	57.69	2.50E-03	7.40E-02	5.10E-02	J	4.36E+00	1.44E-01	5.20E+01		SB-07	1.31E+01
Dibenz(a,h)anthracene	53-70-3	26	10	38.46	5.30E-04	6.70E-02	1.88E-02	J	3.23E-01	5.14E-02	3.40E+00		SB-07	7.82E-01
Dibenzofuran	132-64-9	23	4	17.39	3.30E-02	3.90E-02	7.20E-02	J	1.33E+01	4.35E-02	1.80E+02		SB-07	4.47E+01
Di-n-butylphthalate	84-74-2	23	9	39.13	3.30E-02	2.50E-01	3.60E-02	J	4.59E-02	3.91E-02	1.10E-01	J	SS-10	2.80E-02
Fluoranthene	206-44-0	26	16	61.54	2.00E-03	3.80E-02	5.00E-02	J	1.73E+01	1.63E-01	2.50E+02		SB-07	5.91E+01
Fluorene	86-73-7	26	6	23.08	2.60E-03	3.80E-02	2.90E-02	J	1.48E+01	4.19E-02	2.50E+02		SB-07	5.48E+01
Indeno(1,2,3-cd)pyrene	193-39-5	26	14	53.85	1.10E-02	6.70E-02	1.40E-03	J	1.01E+00	1.11E-01	8.70E+00		SB-07	2.30E+00
Naphthalene	91-20-3	26	5	19.23	2.80E-02	3.10E-01	8.80E-02	J	2.31E+01	5.46E-02	3.90E+02		SB-05	8.54E+01
Phenanthrene	85-01-8	26	11	42.31	2.10E-03	3.90E-02	3.70E-02	J	3.34E+01	6.64E-02	5.10E+02		SB-07	1.20E+02
Phenol	108-95-2	23	2	8.7	3.30E-02	2.50E-01	1.10E-01	J	4.04E-02	2.79E-02	1.90E-01	J	GEO-03	4.49E-02
Pyrene	129-00-0	26	16	61.54	4.50E-03	6.70E-02	6.80E-02	J	1.59E+01	2.33E-01	2.30E+02		SB-07	5.37E+01
Volatiles														
Acetone	67-64-1	3	1	33.33	7.00E-03	3.50E-02	6.30E-02	J	2.80E-02	1.57E-02	6.30E-02	J	SB-05	3.11E-02
Ethylbenzene	100-41-4	3	2	66.67	1.00E-03	1.00E-03	6.80E-02		9.62E-02	1.96E-02	2.20E-01		SB-05	1.12E-01
Toluene	108-88-3	3	2	66.67	1.00E-03	1.00E-03	1.40E-02	J	2.07E-02	6.93E-03	4.75E-02		SB-05	2.42E-02
Xylene (total)	1330-20-7	3	2	66.67	1.00E-03	1.00E-03	4.90E-01		5.64E-01	6.65E-02	1.20E+00		SB-05	6.03E-01

Table 5
Statistical Summary and Selection of COPCs in EU2 Soil (0-10' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier I Restricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
Pesticides							
Endosulfan I	--	--	Unknown	4.00E-03	1.23E+03	no	
Heptachlor	--	--	Unknown	1.00E-02	1.95E-01	no	
Semivolatiles							
2,4-dimethylphenol	1.66E-01	8.51E-02	Unknown	8.51E-02	4.08E+04	no	
2-methylnaphthalene	4.10E+01	3.97E+01	Unknown	3.97E+01	8.18E+04	no	
Acenaphthene	2.58E+01	8.98E+00	Unknown	8.98E+00	1.23E+05	no	
Acenaphthylene	1.33E+00	1.26E+00	Unknown	1.26E+00	1.23E+05	no	
Anthracene	1.77E+01	3.27E+01	Unknown	3.27E+01	6.13E+05	no	
Benzo(a)anthracene	9.66E+00	9.96E+01	Lognormal	6.10E+01	7.84E+00	YES	YES-COPC
Benzo(a)pyrene	4.02E+00	2.17E+01	Lognormal	2.17E+01	7.84E-01	YES	YES-COPC
Benzo(b)fluoranthene	6.36E+00	1.42E+02	Lognormal	3.30E+01	7.84E+00	YES	YES-COPC
Benzo(ghi)perylene	1.30E+00	5.31E+00	Lognormal	5.31E+00	6.13E+04	no	
Benzo(k)fluoranthene	2.08E+00	1.71E+01	Lognormal	1.10E+01	7.84E+01	no	COPC*
Bis(2-ethylhexyl)phthalate	9.44E-02	7.81E-02	Unknown	7.81E-02	4.09E+02	no	
Carbazole	7.55E+00	5.44E+00	Unknown	5.44E+00	2.86E+02	no	
Chrysene	8.74E+00	7.90E+01	Lognormal	5.20E+01	7.84E+02	no	COPC*
Dibenz(a,h)anthracene	5.85E-01	1.69E+00	Lognormal	1.69E+00	7.84E-01	YES	YES-COPC
Dibenzofuran	2.93E+01	2.24E+01	Unknown	2.24E+01	8.18E+03	no	
Di-n-butylphthalate	5.59E-02	5.95E-02	Lognormal	5.95E-02	2.28E+03	no	
Fluoranthene	3.71E+01	4.36E+02	Lognormal	2.50E+02	8.17E+04	no	
Fluorene	3.32E+01	2.15E+01	Unknown	2.15E+01	8.17E+04	no	
Indeno(1,2,3-cd)pyrene	1.78E+00	9.60E+00	Lognormal	8.70E+00	7.84E+00	YES	YES-COPC
Naphthalene	5.17E+01	2.83E+01	Unknown	2.83E+01	8.24E+02	no	
Phenanthrene	7.34E+01	1.11E+02	Unknown	1.11E+02	6.13E+04	no	
Phenol	5.65E-02	5.50E-02	Unknown	5.50E-02	1.23E+05	no	
Pyrene	3.39E+01	2.55E+02	Lognormal	2.30E+02	6.13E+04	no	
Volatiles							
Acetone	8.04E-02	1.17E+07	Normal/Lognormal	6.30E-02	1.04E+05	no	
Ethylbenzene	2.86E-01	2.68E+42	Normal/Lognormal	2.20E-01	3.95E+02	no	
Toluene	6.15E-02	2.26E+21	Normal/Lognormal	4.75E-02	3.80E+01	no	
Xylene (total)	1.58E+00	3.97E+75	Normal/Lognormal	1.20E+00	3.18E+02	no	

*Retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of a carcinogenic PAH family one of which has been retained as a COPC.

Table 6
Statistical Summary and Selection of COPCs in EU3 Soil (0-1' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2-methylnaphthalene	91-57-6	3	1	33.33	3.30E-02	3.30E-02	2.30E-01	J	8.77E-02	3.97E-02	2.30E-01	J	SS-16	1.23E-01
Acenaphthylene	208-96-8	3	2	66.67	3.30E-02	3.30E-02	1.20E-01	J	1.02E-01	6.96E-02	1.70E-01	J	SS-16	7.83E-02
Anthracene	120-12-7	3	2	66.67	3.30E-02	3.30E-02	1.20E-01	J	1.02E-01	6.96E-02	1.70E-01	J	SS-16	7.83E-02
Benzo(a)anthracene	56-55-3	3	3	100	0.00E+00	0.00E+00	5.60E-02	J	3.62E-01	2.46E-01	5.40E-01		SS-15	2.66E-01
Benzo(a)pyrene	50-32-8	3	2	66.67	6.70E-02	6.70E-02	5.60E-01		4.35E-01	2.37E-01	7.10E-01		SS-16	3.55E-01
Benzo(b)fluoranthene	205-99-2	3	3	100	0.00E+00	0.00E+00	1.90E-01	J	9.30E-01	6.83E-01	1.40E+00		SS-16	6.49E-01
Benzo(ghi)perylene	191-24-2	3	3	100	0.00E+00	0.00E+00	8.00E-02	J	6.53E-01	4.03E-01	1.20E+00		SS-16	5.60E-01
Benzo(k)fluoranthene	207-08-9	3	2	66.67	1.30E-01	1.30E-01	4.70E-01		3.42E-01	2.46E-01	4.90E-01		SS-16	2.40E-01
Carbazole	86-74-8	3	2	66.67	3.30E-02	3.30E-02	4.60E-02	J	5.75E-02	4.37E-02	1.10E-01	J	SS-15	4.78E-02
Chrysene	218-01-9	3	3	100	0.00E+00	0.00E+00	1.10E-01	J	5.93E-01	4.25E-01	8.70E-01		SS-16	4.20E-01
Dibenz(a,h)anthracene	53-70-3	3	2	66.67	6.70E-02	6.70E-02	1.40E-01	J	1.11E-01	9.09E-02	1.60E-01	J	SS-16	6.80E-02
Dibenzofuran	132-64-9	3	2	66.67	3.30E-02	3.30E-02	3.60E-02	J	4.85E-02	3.81E-02	9.30E-02	J	SS-16	3.98E-02
Di-n-butyl phthalate	84-74-2	3	3	100	0.00E+00	0.00E+00	4.00E-02	J	8.30E-02	7.58E-02	1.10E-01	J	SS-16	3.76E-02
Fluoranthene	206-44-0	3	3	100	0.00E+00	0.00E+00	1.20E-01	J	5.27E-01	3.99E-01	7.80E-01		SS-16	3.56E-01
Indeno(1,2,3-cd)pyrene	193-39-5	3	3	100	0.00E+00	0.00E+00	8.60E-02	J	3.85E-01	2.89E-01	6.00E-01		SS-16	2.67E-01
Naphthalene	91-20-3	3	1	33.33	3.30E-02	3.30E-02	1.60E-01	J	6.43E-02	3.52E-02	1.60E-01	J	SS-16	8.28E-02
Phenanthrene	85-01-8	3	2	66.67	3.30E-02	3.30E-02	1.30E-01	J	1.32E-01	8.12E-02	2.50E-01	J	SS-16	1.17E-01
Pyrene	129-00-0	3	3	100	0.00E+00	0.00E+00	1.20E-01	J	6.90E-01	4.85E-01	1.00E+00		SS-17	4.94E-01

Table 6
Statistical Summary and Selection of COPCs in EU3 Soil (0-1' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier I Unrestricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the Logarithmic 95% UCL > TRG>
Semivolatiles							
2-methylnaphthalene	2.95E-01	2.43E+08	Unknown	2.30E-01	3.13E+03	no	
Acenaphthylene	2.34E-01	3.45E+05	Normal/Lognormal	1.70E-01	4.69E+03	no	
Anthracene	2.34E-01	3.45E+05	Normal/Lognormal	1.70E-01	2.35E+04	no	
Benzo(a)anthracene	8.11E-01	2.15E+06	Normal/Lognormal	5.40E-01	8.75E-01	no	YES*
Benzo(a)pyrene	1.03E+00	3.82E+11	Normal/Lognormal	7.10E-01	8.75E-02	YES	YES - COPC
Benzo(b)fluoranthene	2.02E+00	1.13E+05	Normal/Lognormal	1.40E+00	8.75E-01	YES	YES - COPC
Benzo(ghi)perylene	1.60E+00	1.70E+08	Normal/Lognormal	1.20E+00	2.35E+03	no	
Benzo(k)fluoranthene	7.46E-01	1.06E+05	Normal/Lognormal	4.90E-01	8.75E+00	no	YES*
Carbazole	1.38E-01	2.81E+02	Normal/Lognormal	1.10E-01	3.19E+01	no	
Chrysene	1.30E+00	2.63E+05	Normal/Lognormal	8.70E-01	8.75E+01	no	YES*
Dibenz(a,h)anthracene	2.26E-01	1.35E+02	Normal/Lognormal	1.60E-01	8.75E-02	YES	YES - COPC
Dibenzofuran	1.16E-01	5.59E+01	Normal/Lognormal	9.30E-02	3.13E+02	no	
Di-n-butyl phthalate	1.46E-01	1.52E+00	Normal/Lognormal	1.10E-01	2.28E+03	no	
Fluoranthene	1.13E+00	1.59E+04	Normal/Lognormal	7.80E-01	3.13E+03	no	
Indeno(1,2,3-cd)pyrene	8.36E-01	1.56E+04	Normal/Lognormal	6.00E-01	8.75E-01	no	YES*
Naphthalene	2.04E-01	6.64E+05	Unknown	1.60E-01	6.45E+02	no	
Phenanthrene	3.29E-01	2.65E+07	Normal/Lognormal	2.50E-01	2.35E+03	no	
Pyrene	1.52E+00	7.45E+05	Normal/Lognormal	1.00E+00	2.35E+03	no	

*Retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH family, one of which has been retained as a COPC.

Tabl[redacted]
Statistical Summary and Selection of COPCs in EU3 Soil (0-6' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2-methylnaphthalene	91-57-6	7	1	14.29	3.30E-02	4.00E-02	2.30E-01	J	4.85E-02	2.62E-02	2.30E-01	J	SS-16	8.00E-02
Acenaphthylene	208-96-8	7	2	28.57	3.30E-02	4.00E-02	1.20E-01	J	5.47E-02	3.33E-02	1.70E-01	J	SS-16	6.34E-02
Anthracene	120-12-7	7	2	28.57	3.30E-02	4.00E-02	1.20E-01	J	5.47E-02	3.33E-02	1.70E-01	J	SS-16	6.34E-02
Benzo(a)anthracene	56-55-3	7	3	42.86	3.70E-02	4.00E-02	5.60E-02	J	1.66E-01	5.71E-02	5.40E-01		SS-15	2.39E-01
Benzo(a)pyrene	50-32-8	7	2	28.57	3.70E-02	6.70E-02	5.60E-01		1.97E-01	5.62E-02	7.10E-01		SS-16	3.02E-01
Benzo(b)fluoranthene	205-99-2	7	3	42.86	3.70E-02	4.00E-02	1.90E-01	J	4.10E-01	8.85E-02	1.40E+00		SS-16	6.14E-01
Benzo(ghi)perylene	191-24-2	7	3	42.86	3.70E-02	4.00E-02	8.00E-02	J	2.91E-01	7.06E-02	1.20E+00		SS-16	4.69E-01
Benzo(k)fluoranthene	207-08-9	7	2	28.57	3.70E-02	1.30E-01	4.70E-01		1.57E-01	5.72E-02	4.90E-01		SS-16	2.21E-01
Carbazole	86-74-8	7	2	28.57	3.30E-02	4.00E-02	4.60E-02	J	3.56E-02	2.72E-02	1.10E-01	J	SS-15	3.44E-02
Chrysene	218-01-9	7	3	42.86	3.70E-02	4.00E-02	1.10E-01	J	2.65E-01	7.22E-02	8.70E-01		SS-16	3.91E-01
Dibenz(a,h)anthracene	53-70-3	7	2	28.57	3.70E-02	6.70E-02	1.40E-01	J	5.86E-02	3.73E-02	1.60E-01	J	SS-16	6.29E-02
Dibenzofuran	132-64-9	7	2	28.57	3.30E-02	4.00E-02	3.60E-02	J	3.17E-02	2.57E-02	9.30E-02	J	SS-16	2.78E-02
Di-n-butylphthalate	84-74-2	7	3	42.86	7.50E-02	7.90E-02	4.00E-02	J	5.74E-02	5.13E-02	1.10E-01	J	SS-16	3.23E-02
Fluoranthene	206-44-0	7	3	42.86	3.70E-02	4.00E-02	1.20E-01	J	2.37E-01	7.03E-02	7.80E-01		SS-16	3.40E-01
Indeno(1,2,3-cd)pyrene	193-39-5	7	3	42.86	3.70E-02	4.00E-02	8.60E-02	J	1.76E-01	6.13E-02	6.00E-01		SS-16	2.49E-01
Naphthalene	91-20-3	7	1	14.29	3.30E-02	4.00E-02	1.60E-01	J	3.85E-02	2.48E-02	1.60E-01	J	SS-16	5.36E-02
Phenanthrene	85-01-8	7	2	28.57	3.30E-02	4.00E-02	1.30E-01	J	6.76E-02	3.55E-02	2.50E-01	J	SS-16	9.05E-02
Phenol	108-95-2	7	2	28.57	3.30E-02	7.90E-02	9.60E-02	J	6.47E-02	3.95E-02	2.30E-01	J	GEO-17	7.81E-02
Pyrene	129-00-0	7	3	42.86	3.70E-02	4.00E-02	1.20E-01	J	3.07E-01	7.64E-02	1.00E+00		SS-17	4.58E-01

Table 7
Statistical Summary and Selection of COPCs in EU3 Soil (0-6' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier 1 Restricted Soil TRG mg/kg	Is the Maximum Detected > TRG?
Semivolatiles						
2-methylnaphthalene	1.07E-01	1.70E-01	Unknown	1.70E-01	8.18E+04	no
Acenaphthylene	1.01E-01	2.50E-01	Unknown	1.70E-01	1.23E+05	no
Anthracene	1.01E-01	2.50E-01	Unknown	1.70E-01	6.13E+05	no
Benzo(a)anthracene	3.42E-01	5.64E+00	Unknown	5.40E-01	7.84E+00	no
Benzo(a)pyrene	4.19E-01	1.08E+01	Unknown	7.10E-01	7.84E-01	no
Benzo(b)fluoranthene	8.61E-01	1.83E+02	Lognormal	1.40E+00	7.84E+00	no
Benzo(ghi)perylene	6.35E-01	3.79E+01	Lognormal	1.20E+00	6.13E+04	no
Benzo(k)fluoranthene	3.20E-01	4.72E+00	Lognormal	4.90E-01	7.84E+01	no
Carbazole	6.08E-02	8.08E-02	Unknown	8.08E-02	2.86E+02	no
Chrysene	5.52E-01	3.06E+01	Lognormal	8.70E-01	7.84E+02	no
Dibenz(a,h)anthracene	1.05E-01	2.52E-01	Unknown	1.60E-01	7.84E-01	no
Dibenzofuran	5.21E-02	6.21E-02	Unknown	6.21E-02	8.18E+03	no
Di-n-butylphthalate	8.12E-02	9.38E-02	Unknown	9.38E-02	2.28E+03	no
Fluoranthene	4.87E-01	2.06E+01	Lognormal	7.80E-01	8.17E+04	no
Indeno(1,2,3-cd)pyrene	3.59E-01	6.92E+00	Lognormal	6.00E-01	7.84E+00	no
Naphthalene	7.79E-02	1.03E-01	Unknown	1.03E-01	8.24E+02	no
Phenanthrene	1.34E-01	4.34E-01	Unknown	2.50E-01	6.13E+04	no
Phenol	1.22E-01	3.11E-01	Lognormal	2.30E-01	1.23E+05	no
Pyrene	6.43E-01	5.32E+01	Lognormal	1.00E+00	6.13E+04	no

Table 6
Statistical Summary and Selection of COPCs in EU3 Soil (0-20' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2-methylnaphthalene	91-57-6	7	1	14.29	3.30E-02	4.00E-02	2.30E-01	J	4.85E-02	2.62E-02	2.30E-01	J	SS-16	8.00E-02
Acenaphthylene	208-96-8	7	2	28.57	3.30E-02	4.00E-02	1.20E-01	J	5.47E-02	3.33E-02	1.70E-01	J	SS-16	6.34E-02
Anthracene	120-12-7	7	2	28.57	3.30E-02	4.00E-02	1.20E-01	J	5.47E-02	3.33E-02	1.70E-01	J	SS-16	6.34E-02
Benzo(a)anthracene	56-55-3	7	3	42.86	3.70E-02	4.00E-02	5.60E-02	J	1.66E-01	5.71E-02	5.40E-01		SS-15	2.39E-01
Benzo(a)pyrene	50-32-8	7	2	28.57	3.70E-02	6.70E-02	5.60E-01		1.97E-01	5.62E-02	7.10E-01		SS-16	3.02E-01
Benzo(b)fluoranthene	205-99-2	7	3	42.86	3.70E-02	4.00E-02	1.90E-01	J	4.10E-01	8.85E-02	1.40E+00		SS-16	6.14E-01
Benzo(ghi)perylene	191-24-2	7	3	42.86	3.70E-02	4.00E-02	8.00E-02	J	2.91E-01	7.06E-02	1.20E+00		SS-16	4.69E-01
Benzo(k)fluoranthene	207-08-9	7	2	28.57	3.70E-02	1.30E-01	4.70E-01		1.57E-01	5.72E-02	4.90E-01		SS-16	2.21E-01
Carbazole	86-74-8	7	2	28.57	3.30E-02	4.00E-02	4.60E-02	J	3.56E-02	2.72E-02	1.10E-01	J	SS-15	3.44E-02
Chrysene	218-01-9	7	3	42.86	3.70E-02	4.00E-02	1.10E-01	J	2.65E-01	7.22E-02	8.70E-01		SS-16	3.91E-01
Dibenz(a,h)anthracene	53-70-3	7	2	28.57	3.70E-02	6.70E-02	1.40E-01	J	5.86E-02	3.73E-02	1.60E-01	J	SS-16	6.29E-02
Dibenzofuran	132-64-9	7	2	28.57	3.30E-02	4.00E-02	3.60E-02	J	3.17E-02	2.57E-02	9.30E-02	J	SS-16	2.78E-02
Di-n-butylphthalate	84-74-2	7	3	42.86	7.50E-02	7.90E-02	4.00E-02	J	5.74E-02	5.13E-02	1.10E-01	J	SS-16	3.23E-02
Fluoranthene	206-44-0	7	3	42.86	3.70E-02	4.00E-02	1.20E-01	J	2.37E-01	7.03E-02	7.80E-01		SS-16	3.40E-01
Indeno(1,2,3-cd)pyrene	193-39-5	7	3	42.86	3.70E-02	4.00E-02	8.60E-02	J	1.76E-01	6.13E-02	6.00E-01		SS-16	2.49E-01
Naphthalene	91-20-3	7	1	14.29	3.30E-02	4.00E-02	1.60E-01	J	3.85E-02	2.48E-02	1.60E-01	J	SS-16	5.36E-02
Phenanthrene	85-01-8	7	2	28.57	3.30E-02	4.00E-02	1.30E-01	J	6.76E-02	3.55E-02	2.50E-01	J	SS-16	9.05E-02
Phenol	108-95-2	7	2	28.57	3.30E-02	7.90E-02	9.60E-02	J	6.47E-02	3.95E-02	2.30E-01	J	GEO-17	7.81E-02
Pyrene	129-00-0	7	3	42.86	3.70E-02	4.00E-02	1.20E-01	J	3.07E-01	7.64E-02	1.00E+00		SS-17	4.58E-01

Table 8
Statistical Summary and Selection of COPCs in EU3 Soil (0-20' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier I Restricted Soil TRG mg/kg	Is the Maximum Detected > TRG?
Semivolatiles						
2-methylnaphthalene	1.07E-01	1.70E-01	Unknown	1.70E-01	8.18E+04	no
Acenaphthylene	1.01E-01	2.50E-01	Unknown	1.70E-01	1.23E+05	no
Anthracene	1.01E-01	2.50E-01	Unknown	1.70E-01	6.13E+05	no
Benzo(a)anthracene	3.42E-01	5.64E+00	Unknown	5.40E-01	7.84E+00	no
Benzo(a)pyrene	4.19E-01	1.08E+01	Unknown	7.10E-01	7.84E-01	no
Benzo(b)fluoranthene	8.61E-01	1.83E+02	Lognormal	1.40E+00	7.84E+00	no
Benzo(ghi)perylene	6.35E-01	3.79E+01	Lognormal	1.20E+00	6.13E+04	no
Benzo(k)fluoranthene	3.20E-01	4.72E+00	Lognormal	4.90E-01	7.84E+01	no
Carbazole	6.08E-02	8.08E-02	Unknown	8.08E-02	2.86E+02	no
Chrysene	5.52E-01	3.06E+01	Lognormal	8.70E-01	7.84E+02	no
Dibenz(a,h)anthracene	1.05E-01	2.52E-01	Unknown	1.60E-01	7.84E-01	no
Dibenzofuran	5.21E-02	6.21E-02	Unknown	6.21E-02	8.18E+03	no
Di-n-butylphthalate	8.12E-02	9.38E-02	Unknown	9.38E-02	2.28E+03	no
Fluoranthene	4.87E-01	2.06E+01	Lognormal	7.80E-01	8.17E+04	no
Indeno(1,2,3-cd)pyrene	3.59E-01	6.92E+00	Lognormal	6.00E-01	7.84E+00	no
Naphthalene	7.79E-02	1.03E-01	Unknown	1.03E-01	8.24E+02	no
Phenanthrene	1.34E-01	4.34E-01	Unknown	2.50E-01	6.13E+04	no
Phenol	1.22E-01	3.11E-01	Lognormal	2.30E-01	1.23E+05	no
Pyrene	6.43E-01	5.32E+01	Lognormal	1.00E+00	6.13E+04	no

Tab[illegible]
Statistical Summary and Selection of COPCs in EU4 Sediment
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2,4-dimethylphenol	105-67-9	1	1	100	0.00E+00	0.00E+00	1.50E+00	J	1.50E+00	1.50E+00	1.50E+00	J	SD-02	NA
2-methylnaphthalene	91-57-6	1	1	100	0.00E+00	0.00E+00	1.50E+03		1.50E+03	1.50E+03	1.50E+03		SD-02	NA
Acenaphthene	83-32-9	8	2	25	5.70E-01	1.00E+03	6.50E+00	J	1.08E+02	6.96E+00	3.45E+02	J	SD-12	1.99E+02
Acenaphthylene	208-96-8	8	1	12.5	5.70E-01	1.85E+02	3.50E+01		1.72E+01	3.57E+00	3.50E+01		SD-02	3.26E+01
Anthracene	120-12-7	8	4	50	3.80E-02	5.56E-01	1.80E+00	Z	4.01E+02	1.78E+00	1.90E+03		SD-02	7.57E+02
Benzo(a)anthracene	56-55-3	8	8	100	0.00E+00	0.00E+00	2.29E-01	Z	6.52E+01	4.98E+00	3.30E+02		SD-02	1.23E+02
Benzo(a)pyrene	50-32-8	8	8	100	0.00E+00	0.00E+00	2.80E-01	Z	2.69E+01	4.43E+00	1.30E+02	J	SD-02	4.81E+01
Benzo(b)fluoranthene	205-99-2	8	8	100	0.00E+00	0.00E+00	4.25E-01	Z	3.29E+01	6.00E+00	1.80E+02	J	SD-02	6.31E+01
Benzo(ghi)perylene	191-24-2	8	8	100	0.00E+00	0.00E+00	1.73E-01	J	7.24E+00	2.05E+00	3.60E+01		SD-02	1.25E+01
Benzo(k)fluoranthene	207-08-9	8	8	100	0.00E+00	0.00E+00	2.13E-01	Z	1.38E+01	2.88E+00	6.40E+01		SD-02	2.38E+01
Carbazole	86-74-8	1	1	100	0.00E+00	0.00E+00	5.90E+02		5.90E+02	5.90E+02	5.90E+02		SD-02	NA
Chrysene	218-01-9	8	8	100	0.00E+00	0.00E+00	2.50E-01	Z	5.44E+01	4.85E+00	2.90E+02		SD-02	1.05E+02
Dibenz(a,h)anthracene	53-70-3	8	7	87.5	6.00E-02	6.00E-02	5.70E-02	J	2.93E+00	5.99E-01	1.20E+01		SD-02	4.76E+00
Dibenzofuran	132-64-9	1	1	100	0.00E+00	0.00E+00	9.40E+02		9.40E+02	9.40E+02	9.40E+02		SD-02	NA
Fluoranthene	206-44-0	8	8	100	0.00E+00	0.00E+00	2.60E-01	Z	3.27E+02	1.42E+01	1.60E+03		SD-02	6.16E+02
Fluorene	86-73-7	8	3	37.5	5.30E-02	4.50E-01	7.40E+00	Z	2.32E+02	1.93E+00	1.20E+03		SD-02	4.51E+02
Indeno(1,2,3-cd)pyrene	193-39-5	8	8	100	0.00E+00	0.00E+00	2.23E-01	J	1.08E+01	2.98E+00	4.70E+01		SD-02	1.75E+01
Naphthalene	91-20-3	8	2	25	5.70E-01	1.85E+02	8.20E+00	J	3.89E+02	7.60E+00	3.00E+03		SD-02	1.06E+03
Phenanthrene	85-01-8	8	3	37.5	3.10E-02	1.05E+00	2.38E+01	Z	6.49E+02	3.49E+00	3.20E+03		SD-02	1.24E+03
Pyrene	129-00-0	8	8	100	0.00E+00	0.00E+00	4.59E-01	J	2.48E+02	1.67E+01	1.00E+03		SD-02	4.44E+02

Table 9
Statistical Summary and Selection of COPCs in EU4 Sediment
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier I Unrestricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
Semivolatiles							
2,4-dimethylphenol	NA	NA	Unknown	1.50E+00	1.56E+03	no	
2-methylnaphthalene	NA	NA	Unknown	1.50E+03	3.13E+03	no	
Acenaphthene	2.41E+02	8.24E+05	Lognormal	3.45E+02	4.69E+03	no	
Acenaphthylene	3.90E+01	1.12E+03	Lognormal	3.50E+01	4.69E+03	no	
Anthracene	9.08E+02	1.74E+15	Lognormal	1.90E+03	2.35E+04	no	
Benzo(a)anthracene	1.48E+02	3.91E+05	Lognormal	3.30E+02	8.75E-01	YES	YES - COPC
Benzo(a)pyrene	5.91E+01	6.94E+03	Lognormal	1.30E+02	8.75E-02	YES	YES - COPC
Benzo(b)fluoranthene	7.52E+01	4.80E+03	Lognormal	1.80E+02	8.75E-01	YES	YES - COPC
Benzo(ghi)perylene	1.56E+01	2.97E+02	Lognormal	3.60E+01	2.35E+03	no	
Benzo(k)fluoranthene	2.98E+01	1.74E+03	Lognormal	6.40E+01	8.75E+00	YES	YES - COPC
Carbazole	NA	NA	Unknown	5.90E+02	3.19E+01	YES	YES - COPC
Chrysene	1.25E+02	1.18E+05	Lognormal	2.90E+02	8.75E+01	YES	YES - COPC
Dibenz(a,h)anthracene	6.12E+00	9.77E+02	Lognormal	1.20E+01	8.75E-02	YES	YES - COPC
Dibenzofuran	NA	NA	Unknown	9.40E+02	3.13E+02	YES	YES - COPC
Fluoranthene	7.40E+02	6.03E+07	Lognormal	1.60E+03	3.13E+03	no	
Fluorene	5.34E+02	1.26E+12	Lognormal	1.20E+03	3.13E+03	no	
Indeno(1,2,3-cd)pyrene	2.26E+01	5.97E+02	Lognormal	4.70E+01	8.75E-01	YES	YES - COPC
Naphthalene	1.10E+03	8.93E+06	Lognormal	3.00E+03	6.45E+02	YES	YES - COPC
Phenanthrene	1.48E+03	1.30E+15	Lognormal	3.20E+03	2.35E+03	YES	YES - COPC
Pyrene	5.46E+02	5.33E+06	Lognormal	1.00E+03	2.35E+03	no	

Tab

Statistical Summary and Selection of COPCs in EU4 Surface Water

Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/L	Maximum Detection Limit mg/L	Minimum Detected mg/L	Minimum Detected Qualifier	Mean mg/L	Logarithmic Mean mg/L	Maximum Detected mg/L	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/L
Semivolatiles														
Acenaphthene	83-32-9	1	1	100	0.00E+00	0.00E+00	1.40E-02		1.40E-02	1.40E-02	1.40E-02		SW-02	0.00E+00
Anthracene	120-12-7	1	1	100	0.00E+00	0.00E+00	1.30E-02		1.30E-02	1.30E-02	1.30E-02		SW-02	0.00E+00
Benzo(a)anthracene	56-55-3	1	1	100	0.00E+00	0.00E+00	5.00E-03	J	5.00E-03	5.00E-03	5.00E-03	J	SW-02	0.00E+00
Benzo(a)pyrene	50-32-8	1	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-02	0.00E+00
Benzo(b)fluoranthene	205-99-2	1	1	100	0.00E+00	0.00E+00	1.20E-02		1.20E-02	1.20E-02	1.20E-02		SW-02	0.00E+00
Benzo(k)fluoranthene	207-08-9	1	1	100	0.00E+00	0.00E+00	2.00E-03	J	2.00E-03	2.00E-03	2.00E-03	J	SW-02	0.00E+00
Bis(2-ethylhexyl)phthalate	117-81-7	1	1	100	0.00E+00	0.00E+00	3.00E-03	J	3.00E-03	3.00E-03	3.00E-03	J	SW-02	0.00E+00
Carbazole	86-74-8	1	1	100	0.00E+00	0.00E+00	1.00E-02	J	1.00E-02	1.00E-02	1.00E-02	J	SW-02	0.00E+00
Chrysene	218-01-9	1	1	100	0.00E+00	0.00E+00	6.00E-03	J	6.00E-03	6.00E-03	6.00E-03	J	SW-02	0.00E+00
Dibenz(a,h)anthracene	53-70-3	1	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-02	0.00E+00
Dibenzofuran	132-64-9	1	1	100	0.00E+00	0.00E+00	1.10E-02		1.10E-02	1.10E-02	1.10E-02		SW-02	0.00E+00
Fluoranthene	206-44-0	1	1	100	0.00E+00	0.00E+00	3.90E-02		3.90E-02	3.90E-02	3.90E-02		SW-02	0.00E+00
Fluorene	86-73-7	1	1	100	0.00E+00	0.00E+00	1.20E-02		1.20E-02	1.20E-02	1.20E-02		SW-02	0.00E+00
Indeno(1,2,3-cd)pyrene	193-39-5	1	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-02	0.00E+00
Phenanthrene	85-01-8	1	1	100	0.00E+00	0.00E+00	1.70E-02		1.70E-02	1.70E-02	1.70E-02		SW-02	0.00E+00
Pyrene	129-00-0	1	1	100	0.00E+00	0.00E+00	2.10E-02		2.10E-02	2.10E-02	2.10E-02		SW-02	0.00E+00

NA - Not applicable: constituent not detected in media.

Table 10
Statistical Summary and Selection of COPCs in EU4 Surface Water
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/L	Logarithmic 95% UCL mg/L	Distribution 99% Confidence	Exposure Point Concentration mg/L	Human Health Consumption of Water & Organisms AWQC mg/L	Is Maximum Detected > AWQC?
Semivolatiles						
Acenaphthene	NA	NA	Unknown	1.40E-02	1.20E+00	no
Anthracene	NA	NA	Unknown	1.30E-02	9.60E+00	no
Benzo(a)anthracene	NA	NA	Unknown	5.00E-03	4.40E-06	YES - COPC
Benzo(a)pyrene	NA	NA	Unknown	5.00E-04	4.40E-06	YES**
Benzo(b)fluoranthene	NA	NA	Unknown	1.20E-02	4.40E-06	YES - COPC
Benzo(k)fluoranthene	NA	NA	Unknown	2.00E-03	4.40E-06	YES - COPC
Bis(2-ethylhexyl)phthalate	NA	NA	Unknown	3.00E-03	1.80E-03	YES - COPC
Carbazole*	NA	NA	Unknown	1.00E-02	NA	no
Chrysene	NA	NA	Unknown	6.00E-03	4.40E-06	YES - COPC
Dibenz(a,h)anthracene	NA	NA	Unknown	5.00E-04	4.40E-06	YES**
Dibenzofuran*	NA	NA	Unknown	1.10E-02	NA	no
Fluoranthene	NA	NA	Unknown	3.90E-02	3.00E-01	no
Fluorene	NA	NA	Unknown	1.20E-02	1.30E+00	no
Indeno(1,2,3-cd)pyrene	NA	NA	Unknown	5.00E-04	4.40E-06	YES**
Phenanthrene*	NA	NA	Unknown	1.70E-02	NA	no
Pyrene	NA	NA	Unknown	2.10E-02	9.60E-01	no

NA - Not Available
* Constituent will be retained as a COPC due to lack of published screening criteria.
**Retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH family, one of which has been retained as a COPC.

Table 11
Statistical Summary and Selection of COPCs in EU4 Soil (0-1' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2,4-dimethylphenol	105-67-9	3	1	33.33	4.10E-01	9.90E+00	2.50E-01	J	1.80E+00	6.33E-01	2.50E-01	J	GEO-19	2.73E+00
2-methylnaphthalene	91-57-6	3	3	100	0.00E+00	0.00E+00	2.70E-01	J	9.36E+01	3.42E+00	2.80E+02	J	GEO-21	1.61E+02
2-methylphenol	95-48-7	3	1	33.33	2.00E-01	5.00E+00	7.30E-02	J	8.91E-01	2.63E-01	7.30E-02	J	GEO-19	1.39E+00
3- and 4-methylphenol	106-44-5	3	1	33.33	4.10E-01	9.90E+00	2.10E-01	J	1.79E+00	5.97E-01	2.10E-01	J	GEO-19	2.74E+00
Acenaphthene	83-32-9	6	2	33.33	2.00E-01	1.50E+03	1.00E+00		1.58E+02	7.02E+00	1.90E+02		GEO-21	3.00E+02
Acenaphthylene	208-96-8	6	3	50	2.80E+00	1.50E+03	1.40E+00	J	1.37E+02	1.34E+01	4.70E+01	J	GEO-21	3.01E+02
Anthracene	120-12-7	6	5	83.33	5.30E-02	5.30E-02	2.10E+00		6.35E+02	2.06E+01	3.00E+03	Z	GEO-48	1.20E+03
Benzo(a)anthracene	56-55-3	6	6	100	0.00E+00	0.00E+00	2.10E+00	Z	2.16E+02	3.61E+01	9.30E+02	Z	GEO-48	3.65E+02
Benzo(a)pyrene	50-32-8	6	6	100	0.00E+00	0.00E+00	3.00E+00		1.35E+02	3.16E+01	5.00E+02	Z	GEO-48	1.99E+02
Benzo(b)fluoranthene	205-99-2	6	6	100	0.00E+00	0.00E+00	3.50E+00		1.86E+02	4.59E+01	5.30E+02	Z	GEO-48	2.43E+02
Benzo(ghi)perylene	191-24-2	6	6	100	0.00E+00	0.00E+00	1.60E+00	J	4.27E+01	1.45E+01	1.30E+02	J	GEO-48	5.43E+01
Benzo(k)fluoranthene	207-08-9	6	6	100	0.00E+00	0.00E+00	1.80E+00	Z	8.28E+01	1.94E+01	2.90E+02	Z	GEO-48	1.18E+02
Carbazole	86-74-8	3	3	100	0.00E+00	0.00E+00	6.00E-01	J	7.88E+01	9.34E+00	2.30E+02		GEO-21	1.31E+02
Chrysene	218-01-9	6	6	100	0.00E+00	0.00E+00	2.70E+00	Z	1.79E+02	3.72E+01	6.90E+02	Z	GEO-48	2.73E+02
Dibenz(a,h)anthracene	53-70-3	6	6	100	0.00E+00	0.00E+00	4.80E-01	J	1.83E+01	4.98E+00	6.40E+01	J	GEO-48	2.57E+01
Dibenzofuran	132-64-9	3	3	100	0.00E+00	0.00E+00	3.40E-01	J	6.37E+01	3.65E+00	1.90E+02		GEO-21	1.09E+02
Fluoranthene	206-44-0	6	6	100	0.00E+00	0.00E+00	2.80E+00	Z	9.04E+02	7.65E+01	4.60E+03	Z	GEO-48	1.83E+03
Fluorene	86-73-7	6	4	66.67	2.00E-01	2.60E-01	1.40E+00		3.44E+02	4.84E+00	1.80E+03	Z	GEO-48	7.21E+02
Indeno(1,2,3-cd)pyrene	193-39-5	6	6	100	0.00E+00	0.00E+00	2.00E+00	Z	6.94E+01	1.94E+01	2.50E+02	J	GEO-48	9.91E+01
Naphthalene	91-20-3	6	4	66.67	2.80E+00	1.20E+01	6.80E-01	J	4.50E+02	1.30E+01	2.20E+03	J	GEO-48	8.79E+02
N-nitrosodiphenylamine	86-30-6	3	1	33.33	3.70E-02	5.00E+00	2.00E-01		9.06E-01	2.10E-01	2.00E-01		GEO-20	1.38E+00
Phenanthrene	85-01-8	6	6	100	0.00E+00	0.00E+00	3.10E-01	J	1.19E+03	2.33E+01	6.40E+03	Z	GEO-48	2.57E+03
Pyrene	129-00-0	6	6	100	0.00E+00	0.00E+00	5.10E+00	Z	8.76E+02	9.14E+01	4.40E+03		GEO-20	1.74E+03

Table 11

Statistical Summary and Selection of COPCs in EU4 Soil (0-1' bgs)

Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier I Unrestricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
Semivolatiles							
2,4-dimethylphenol	6.40E+00	1.83E+13	Normal/Lognormal	2.50E-01	1.56E+03	no	
2-methylnaphthalene	3.66E+02	4.06E+62	Lognormal	2.80E+02	3.13E+03	no	
2-methylphenol	3.24E+00	3.99E+15	Normal/Lognormal	7.30E-02	3.91E+03	no	
3- and 4-methylphenol	6.40E+00	9.25E+13	Lognormal	2.10E-01	3.91E+02	no	
Acenaphthene	4.05E+02	5.72E+11	Lognormal	1.90E+02	4.69E+03	no	
Acenaphthylene	3.84E+02	4.19E+06	Lognormal	4.70E+01	4.69E+03	no	
Anthracene	1.62E+03	8.99E+17	Lognormal	3.00E+03	2.35E+04	no	
Benzo(a)anthracene	5.17E+02	1.56E+07	Lognormal	9.30E+02	8.75E-01	YES	YES - COPC
Benzo(a)pyrene	2.98E+02	9.02E+05	Normal/Lognormal	5.00E+02	8.75E-02	YES	YES - COPC
Benzo(b)fluoranthene	3.85E+02	1.50E+06	Normal/Lognormal	5.30E+02	8.75E-01	YES	YES - COPC
Benzo(ghi)perylene	8.73E+01	2.25E+04	Normal/Lognormal	1.30E+02	2.35E+03	no	
Benzo(k)fluoranthene	1.80E+02	6.89E+05	Normal/Lognormal	2.90E+02	8.75E+00	YES	YES - COPC
Carbazole	3.00E+02	1.23E+39	Normal/Lognormal	2.30E+02	3.19E+01	YES	YES - COPC
Chrysene	4.04E+02	3.19E+06	Normal/Lognormal	6.90E+02	8.75E+01	YES	YES - COPC
Dibenz(a,h)anthracene	3.95E+01	3.75E+04	Normal/Lognormal	6.40E+01	8.75E-02	YES	YES - COPC
Dibenzofuran	2.48E+02	7.02E+50	Lognormal	1.90E+02	3.13E+02	no	
Fluoranthene	2.41E+03	3.17E+09	Lognormal	4.60E+03	3.13E+03	YES	YES - COPC
Fluorene	9.37E+02	1.95E+16	Lognormal	1.80E+03	3.13E+03	no	
Indeno(1,2,3-cd)pyrene	1.51E+02	1.07E+05	Normal/Lognormal	2.50E+02	8.75E-01	YES	YES - COPC
Naphthalene	1.17E+03	7.77E+12	Lognormal	2.20E+03	6.45E+02	YES	YES - COPC
N-nitrosodiphenylamine	3.24E+00	6.32E+24	Normal/Lognormal	2.00E-01	1.30E+02	no	
Phenanthrene	3.31E+03	9.46E+14	Lognormal	6.40E+03	2.35E+03	YES	YES - COPC
Pyrene	2.31E+03	6.40E+08	Lognormal	4.40E+03	2.35E+03	YES	YES - COPC

Table 12
Statistical Summary and Selection of COPCs in EU4 Soil (0-6' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2,4-dimethylphenol	105-67-9	9	3	33.33	7.30E-02	9.90E+00	7.90E-02	J	1.63E+00	2.30E-01	8.90E+00	J	GEO-21	3.16E+00
2-methylnaphthalene	91-57-6	9	8	88.89	4.00E-02	4.00E-02	6.20E-02	J	2.11E+02	1.91E+00	1.50E+03		GEO-21	4.93E+02
2-methylphenol	95-48-7	9	1	11.11	3.70E-02	5.00E+00	7.30E-02	J	4.61E-01	8.75E-02	7.30E-02	J	GEO-19	8.70E-01
3- and 4-methylphenol	106-44-5	9	1	11.11	7.30E-02	9.90E+00	2.10E-01	J	9.17E-01	1.82E-01	2.10E-01	J	GEO-19	1.72E+00
Acenaphthene	83-32-9	18	9	50	4.00E-02	1.50E+03	9.70E-02	J	1.30E+02	2.05E+00	1.20E+03		GEO-21	3.21E+02
Acenaphthylene	208-96-8	18	7	38.89	3.80E-02	1.50E+03	8.30E-02	J	4.90E+01	1.14E+00	5.00E+01		GEO-21	1.76E+02
Anthracene	120-12-7	18	14	77.78	2.60E-03	5.30E-02	1.20E-01	Z	3.15E+02	1.93E+00	3.00E+03	Z	GEO-48	8.06E+02
Benzo(a)anthracene	56-55-3	18	18	100	0.00E+00	0.00E+00	4.90E-03	J	9.72E+01	2.57E+00	9.30E+02	Z	GEO-48	2.34E+02
Benzo(a)pyrene	50-32-8	18	18	100	0.00E+00	0.00E+00	1.10E-02	J	5.71E+01	2.04E+00	5.00E+02	Z	GEO-48	1.29E+02
Benzo(b)fluoranthene	205-99-2	18	18	100	0.00E+00	0.00E+00	1.10E-02	J	7.89E+01	2.53E+00	5.30E+02	Z	GEO-48	1.65E+02
Benzo(ghi)perylene	191-24-2	18	17	94.44	3.80E-02	3.80E-02	8.90E-03	J	1.86E+01	8.49E-01	1.30E+02	J	GEO-48	3.79E+01
Benzo(k)fluoranthene	207-08-9	18	16	88.89	3.80E-02	4.00E-02	5.60E-03	J	3.27E+01	1.03E+00	2.90E+02	Z	GEO-48	7.57E+01
Carbazole	86-74-8	9	8	88.89	4.00E-02	4.00E-02	2.10E-01	J	9.80E+01	2.78E+00	6.20E+02		GEO-21	2.10E+02
Chrysene	218-01-9	18	17	94.44	5.10E-03	5.10E-03	9.90E-03	J	8.58E+01	2.42E+00	6.90E+02	Z	GEO-48	1.88E+02
Dibenz(a,h)anthracene	53-70-3	18	14	77.78	2.60E-03	4.00E-02	3.80E-03	J	7.52E+00	2.96E-01	6.40E+01	J	GEO-48	1.68E+01
Dibenzofuran	132-64-9	9	8	88.89	4.00E-02	4.00E-02	7.80E-02	J	1.54E+02	2.43E+00	1.10E+03		GEO-21	3.61E+02
Fluoranthene	206-44-0	18	18	100	0.00E+00	0.00E+00	1.00E-02	J	4.29E+02	7.56E+00	4.60E+03	Z	GEO-48	1.15E+03
Fluorene	86-73-7	18	12	66.67	1.30E-02	2.60E-01	1.40E-01	J	2.09E+02	1.40E+00	1.80E+03	Z	GEO-48	5.31E+02
Indeno(1,2,3-cd)pyrene	193-39-5	18	17	94.44	6.00E-03	6.00E-03	9.00E-03	J	2.83E+01	1.05E+00	2.50E+02	J	GEO-48	6.42E+01
Naphthalene	91-20-3	18	12	66.67	4.00E-02	1.20E+01	7.60E-02	J	3.73E+02	2.99E+00	3.50E+03		GEO-21	9.37E+02
N-nitrosodiphenylamine	86-30-6	9	1	11.11	3.70E-02	5.00E+00	2.00E-01		4.66E-01	8.11E-02	2.00E-01		GEO-20	8.69E-01
Phenanthrene	85-01-8	18	17	94.44	4.00E-02	4.00E-02	5.30E-03	J	6.51E+02	4.31E+00	6.40E+03	Z	GEO-48	1.72E+03
Pyrene	129-00-0	18	18	100	0.00E+00	0.00E+00	1.60E-02	J	3.77E+02	7.72E+00	4.40E+03		GEO-20	1.06E+03

Table 12
Statistical Summary and Selection of COPCs in EU4 Soil (0-6' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier I Restricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
Semivolatiles							
2,4-dimethylphenol	3.59E+00	1.33E+02	Lognormal	8.90E+00	4.08E+04	no	
2-methylnaphthalene	5.17E+02	1.40E+11	Lognormal	1.50E+03	8.18E+04	no	
2-methylphenol	1.00E+00	1.71E+01	Lognormal	7.30E-02	1.02E+05	no	
3- and 4-methylphenol	1.98E+00	3.49E+01	Lognormal	2.10E-01	1.02E+04	no	
Acenaphthene	2.61E+02	7.82E+05	Lognormal	1.20E+03	1.23E+05	no	
Acenaphthylene	1.21E+02	8.90E+03	Lognormal	5.00E+01	1.23E+05	no	
Anthracene	6.46E+02	3.29E+08	Lognormal	3.00E+03	6.13E+05	no	
Benzo(a)anthracene	1.93E+02	1.43E+06	Lognormal	9.30E+02	7.84E+00	YES	YES - COPC
Benzo(a)pyrene	1.10E+02	1.87E+05	Lognormal	5.00E+02	7.84E-01	YES	YES - COPC
Benzo(b)fluoranthene	1.47E+02	5.68E+05	Lognormal	5.30E+02	7.84E+00	YES	YES - COPC
Benzo(ghi)perylene	3.42E+01	2.74E+04	Lognormal	1.30E+02	6.13E+04	no	
Benzo(k)fluoranthene	6.37E+01	2.16E+05	Lognormal	2.90E+02	7.84E+01	YES	YES - COPC
Carbazole	2.28E+02	1.00E+08	Lognormal	6.20E+02	2.86E+02	YES	YES - COPC
Chrysene	1.63E+02	3.02E+06	Lognormal	6.90E+02	7.84E+02	no	YES*
Dibenz(a,h)anthracene	1.44E+01	1.67E+04	Lognormal	6.40E+01	7.84E-01	YES	YES - COPC
Dibenzofuran	3.78E+02	4.19E+09	Lognormal	1.10E+03	8.18E+03	no	
Fluoranthene	8.99E+02	1.07E+07	Lognormal	4.60E+03	8.17E+04	no	
Fluorene	4.27E+02	4.71E+07	Lognormal	1.80E+03	8.17E+04	no	
Indeno(1,2,3-cd)pyrene	5.47E+01	1.10E+05	Lognormal	2.50E+02	7.84E+00	YES	YES - COPC
Naphthalene	7.57E+02	2.43E+07	Lognormal	3.50E+03	8.24E+02	YES	YES - COPC
N-nitrosodiphenylamine	1.00E+00	2.74E+01	Lognormal	2.00E-01	1.17E+03	no	
Phenanthrene	1.35E+03	6.44E+08	Lognormal	6.40E+03	6.13E+04	no	
Pyrene	8.10E+02	5.56E+06	Lognormal	4.40E+03	6.13E+04	no	

*Retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH family, one of which has been retained as a COPC.

Table [redacted]
Statistical Summary and Selection of COPCs in EU4 Soil (0-20' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	*Logarithmic* Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2,4-dimethylphenol	105-67-9	11	4	36.36	7.30E-02	9.90E+00	7.90E-02	J	1.36E+00	1.95E-01	8.90E+00	J	GEO-21	2.89E+00
2-methylnaphthalene	91-57-6	11	10	90.91	4.00E-02	4.00E-02	6.20E-02	J	1.79E+02	2.30E+00	1.50E+03		GEO-21	4.47E+02
2-methylphenol	95-48-7	11	2	18.18	3.70E-02	5.00E+00	5.10E-02	J	3.83E-01	7.23E-02	7.30E-02	J	GEO-19	7.97E-01
3- and 4-methylphenol	106-44-5	11	1	9.09	7.30E-02	9.90E+00	2.10E-01	J	7.58E-01	1.37E-01	2.10E-01	J	GEO-19	1.58E+00
Acenaphthene	83-32-9	21	12	57.14	4.00E-02	1.50E+03	9.70E-02	J	1.14E+02	2.39E+00	1.20E+03		GEO-21	2.98E+02
Acenaphthylene	208-96-8	21	8	38.1	3.80E-02	1.50E+03	8.30E-02	J	4.22E+01	9.69E-01	5.00E+01		GEO-21	1.63E+02
Anthracene	120-12-7	21	17	80.95	2.60E-03	5.30E-02	1.20E-01	Z	2.71E+02	2.00E+00	3.00E+03	Z	GEO-48	7.51E+02
Benzo(a)anthracene	56-55-3	21	21	100	0.00E+00	0.00E+00	4.90E-03	J	8.42E+01	2.53E+00	9.30E+02	Z	GEO-48	2.18E+02
Benzo(a)pyrene	50-32-8	21	21	100	0.00E+00	0.00E+00	1.10E-02	J	4.93E+01	1.83E+00	5.00E+02	Z	GEO-48	1.21E+02
Benzo(b)fluoranthene	205-99-2	21	21	100	0.00E+00	0.00E+00	1.10E-02	Z	6.80E+01	2.27E+00	5.30E+02	Z	GEO-48	1.55E+02
Benzo(ghi)perylene	191-24-2	21	19	90.48	3.80E-02	4.00E-02	8.90E-03	J	1.61E+01	7.03E-01	1.30E+02	J	GEO-48	3.56E+01
Benzo(k)fluoranthene	207-08-9	21	19	90.48	3.80E-02	4.00E-02	5.60E-03	J	2.82E+01	9.39E-01	2.90E+02	Z	GEO-48	7.07E+01
Carbazole	86-74-8	11	10	90.91	4.00E-02	4.00E-02	2.10E-01	J	8.10E+01	2.49E+00	6.20E+02		GEO-21	1.91E+02
Chrysene	218-01-9	21	20	95.24	5.10E-03	5.10E-03	9.90E-03	J	7.42E+01	2.29E+00	6.90E+02	Z	GEO-48	1.76E+02
Dibenz(a,h)anthracene	53-70-3	21	16	76.19	2.60E-03	4.00E-02	3.80E-03	J	6.48E+00	2.65E-01	6.40E+01	J	GEO-48	1.57E+01
Dibenzofuran	132-64-9	11	10	90.91	4.00E-02	4.00E-02	7.80E-02	J	1.30E+02	2.74E+00	1.10E+03		GEO-21	3.27E+02
Fluoranthene	206-44-0	21	21	100	0.00E+00	0.00E+00	1.00E-02	J	3.72E+02	7.99E+00	4.60E+03	Z	GEO-48	1.07E+03
Fluorene	86-73-7	21	15	71.43	1.30E-02	2.60E-01	1.40E-01	J	1.82E+02	1.76E+00	1.80E+03	Z	GEO-48	4.94E+02
Indeno(1,2,3-cd)pyrene	193-39-5	21	20	95.24	6.00E-03	6.00E-03	9.00E-03	J	2.44E+01	9.11E-01	2.50E+02	J	GEO-48	6.00E+01
Naphthalene	91-20-3	21	15	71.43	4.00E-02	1.20E+01	7.60E-02	J	3.27E+02	3.63E+00	3.50E+03		GEO-21	8.72E+02
N-nitrosodiphenylamine	86-30-6	11	1	9.09	3.70E-02	5.00E+00	2.00E-01		3.84E-01	6.25E-02	2.00E-01		GEO-20	7.98E-01
Phenanthrene	85-01-8	21	20	95.24	4.00E-02	4.00E-02	5.30E-03	J	5.68E+02	5.46E+00	6.40E+03	Z	GEO-48	1.60E+03
Phenol	108-95-2	11	1	9.09	7.30E-02	9.90E+00	1.00E-01	J	7.48E-01	1.28E-01	1.00E-01	J	GEO-20	1.58E+00
Pyrene	129-00-0	21	21	100	0.00E+00	0.00E+00	1.60E-02	J	3.26E+02	7.75E+00	4.40E+03	Z	GEO-20	9.82E+02

Table 13
Statistical Summary and Selection of COPCs in EU4 Soil (0-20' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier 1 Restricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
Semivolatiles							
2,4-dimethylphenol	2.94E+00	2.48E+01	Lognormal	8.90E+00	4.08E+04	no	
2-methylnaphthalene	4.23E+02	4.96E+08	Lognormal	1.50E+03	8.18E+04	no	
2-methylphenol	8.19E-01	3.98E+00	Unknown	7.30E-02	1.02E+05	no	
3- and 4-methylphenol	1.62E+00	9.14E+00	Unknown	2.10E-01	1.02E+04	no	
Acenaphthene	2.26E+02	1.38E+05	Lognormal	1.20E+03	1.23E+05	no	
Acenaphthylene	1.03E+02	2.70E+03	Lognormal	5.00E+01	1.23E+05	no	
Anthracene	5.54E+02	1.16E+07	Lognormal	3.00E+03	6.13E+05	no	
Benzo(a)anthracene	1.66E+02	1.53E+05	Lognormal	9.30E+02	7.84E+00	YES	YES - COPC
Benzo(a)pyrene	9.47E+01	2.66E+04	Lognormal	5.00E+02	7.84E-01	YES	YES - COPC
Benzo(b)fluoranthene	1.26E+02	6.79E+04	Lognormal	5.30E+02	7.84E+00	YES	YES - COPC
Benzo(ghi)perylene	2.95E+01	5.59E+03	Lognormal	1.30E+02	6.13E+04	no	
Benzo(k)fluoranthene	5.48E+01	2.80E+04	Lognormal	2.90E+02	7.84E+01	YES	YES - COPC
Carbazole	1.86E+02	1.17E+06	Lognormal	6.20E+02	2.86E+02	YES	YES - COPC
Chrysene	1.40E+02	2.66E+05	Lognormal	6.90E+02	7.84E+02	no	*YES
Dibenz(a,h)anthracene	1.24E+01	2.39E+03	Lognormal	6.40E+01	7.84E-01	YES	YES - COPC
Dibenzofuran	3.09E+02	3.01E+07	Lognormal	1.10E+03	8.18E+03	no	
Fluoranthene	7.73E+02	1.06E+06	Lognormal	4.60E+03	8.17E+04	no	
Fluorene	3.68E+02	4.04E+06	Lognormal	1.80E+03	8.17E+04	no	
Indeno(1,2,3-cd)pyrene	4.70E+01	1.53E+04	Lognormal	2.50E+02	7.84E+00	YES	YES - COPC
Naphthalene	6.55E+02	2.85E+06	Lognormal	3.50E+03	8.24E+02	YES	YES - COPC
N-nitrosodiphenylamine	8.20E-01	5.77E+00	Unknown	2.00E-01	1.17E+03	no	
Phenanthrene	1.17E+03	4.13E+07	Lognormal	6.40E+03	6.13E+04	no	
Phenol	1.61E+00	8.43E+00	Unknown	1.00E-01	1.23E+05	no	
Pyrene	6.96E+02	5.88E+05	Lognormal	4.40E+03	6.13E+04	no	

*Retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH family, one of which has been retained as a COPC.

Table 14
Statistical Summary and Selection of COPCs in EU5 Soil (0-1' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2,4-dimethylphenol	105-67-9	6	1	16.67	7.60E-02	4.55E-01	1.10E-01	J	1.07E-01	8.03E-02	1.10E-01	J	GEO-30	8.38E-02
2-methylnaphthalene	91-57-6	6	4	66.67	3.80E-02	3.90E-02	5.10E-02	J	1.68E+00	1.71E-01	9.20E+00		GEO-30	3.69E+00
2-methylphenol	95-48-7	6	1	16.67	3.80E-02	2.09E-01	4.20E-02	J	4.94E-02	3.77E-02	4.20E-02	J	GEO-30	3.92E-02
3- and 4-methylphenol	106-44-5	6	1	16.67	7.60E-02	4.13E-01	1.40E-01	J	1.08E-01	8.22E-02	1.40E-01	J	GEO-30	7.94E-02
Acenaphthene	83-32-9	8	2	25	3.80E-02	2.40E+00	1.60E-01	J	6.91E+00	1.92E-01	5.35E+01	J	GEO-33	1.88E+01
Acenaphthylene	208-96-8	8	5	62.5	3.80E-02	2.40E+00	4.80E-02	J	2.61E+00	4.28E-01	1.60E+01		GEO-33	5.47E+00
Anthracene	120-12-7	8	4	50	1.00E-02	4.40E-02	1.30E-01	J	1.07E+01	2.00E-01	7.97E+01		GEO-33	2.79E+01
Benzo(a)anthracene	56-55-3	8	7	87.5	3.80E-02	3.80E-02	2.60E-01	Z	1.30E+01	1.39E+00	8.35E+01		GEO-33	2.87E+01
Benzo(a)pyrene	50-32-8	8	7	87.5	3.80E-02	3.80E-02	3.10E-01	J	8.82E+00	1.38E+00	5.25E+01	J	GEO-33	1.79E+01
Benzo(b)fluoranthene	205-99-2	8	7	87.5	3.80E-02	3.80E-02	4.40E-01	Z	1.38E+01	2.15E+00	7.95E+01		GEO-33	2.71E+01
Benzo(ghi)perylene	191-24-2	8	6	75	3.80E-02	3.80E-02	2.30E-01	J	4.30E+00	5.42E-01	2.55E+01		GEO-33	8.71E+00
Benzo(k)fluoranthene	207-08-9	8	7	87.5	3.80E-02	3.80E-02	2.10E-01	Z	5.07E+00	1.01E+00	2.85E+01		GEO-33	9.68E+00
Carbazole	86-74-8	6	3	50	3.80E-02	3.90E-02	5.30E-01	J	2.63E+00	2.10E-01	1.35E+01		GEO-33	5.36E+00
Chrysene	218-01-9	8	7	87.5	3.80E-02	3.80E-02	2.70E-01	Z	1.35E+01	1.62E+00	8.25E+01		GEO-33	2.83E+01
Dibenz(a,h)anthracene	53-70-3	8	7	87.5	3.80E-02	3.80E-02	6.30E-02	J	1.33E+00	3.02E-01	7.45E+00		GEO-33	2.53E+00
Dibenzofuran	132-64-9	6	4	66.67	3.80E-02	3.90E-02	3.90E-02	J	4.94E+00	1.77E-01	2.90E+01		GEO-33	1.18E+01
Fluoranthene	206-44-0	8	7	87.5	3.80E-02	3.80E-02	1.30E-01	J	5.01E+01	2.31E+00	3.55E+02		GEO-33	1.23E+02
Fluorene	86-73-7	8	4	50	3.80E-02	5.20E-02	3.30E-01	J	8.10E+00	1.90E-01	6.30E+01		GEO-33	2.22E+01
Indeno(1,2,3-cd)pyrene	193-39-5	8	7	87.5	3.80E-02	3.80E-02	2.60E-01	J	5.49E+00	1.02E+00	3.10E+01		GEO-33	1.05E+01
Naphthalene	91-20-3	8	5	62.5	3.80E-02	5.60E-01	7.50E-02	J	1.63E+00	2.97E-01	6.85E+00		GEO-33	2.65E+00
Phenanthrene	85-01-8	8	6	75	3.80E-02	3.90E-02	1.50E-01	J	3.25E+01	7.56E-01	2.45E+02		GEO-33	8.59E+01
Phenol	108-95-2	6	4	66.67	7.70E-02	4.13E-01	1.40E-01	J	1.99E-01	1.64E-01	3.80E-01		GEO-29	1.13E-01
Pyrene	129-00-0	8	7	87.5	3.80E-02	3.80E-02	2.50E-01	J	3.78E+01	2.54E+00	2.60E+02		GEO-33	9.01E+01

Table 14
Statistical Summary and Selection of COPCs in EU5 Soil (0-1' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier I Unrestricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
Semivolatiles							
2,4-dimethylphenol	1.76E-01	4.42E-01	Normal/Lognormal	1.10E-01	1.56E+03	no	
2-methylnaphthalene	4.71E+00	4.63E+04	Lognormal	9.20E+00	3.13E+03	no	
2-methylphenol	8.17E-02	1.82E-01	Normal/Lognormal	4.20E-02	3.91E+03	no	
3- and 4-methylphenol	1.74E-01	4.55E-01	Normal/Lognormal	1.40E-01	3.91E+02	no	
Acenaphthene	1.95E+01	3.47E+04	Lognormal	5.35E+01	4.69E+03	no	
Acenaphthylene	6.27E+00	1.25E+03	Lognormal	1.60E+01	4.69E+03	no	
Anthracene	2.94E+01	1.81E+07	Lognormal	7.97E+01	2.35E+04	no	
Benzo(a)anthracene	3.23E+01	9.31E+04	Lognormal	8.35E+01	8.75E-01	YES	YES - COPC
Benzo(a)pyrene	2.08E+01	2.16E+04	Lognormal	5.25E+01	8.75E-02	YES	YES - COPC
Benzo(b)fluoranthene	3.20E+01	8.21E+04	Lognormal	7.95E+01	8.75E-01	YES	YES - COPC
Benzo(ghi)perylene	1.01E+01	2.82E+04	Lognormal	2.55E+01	2.35E+03	no	
Benzo(k)fluoranthene	1.16E+01	3.72E+03	Lognormal	2.85E+01	8.75E+00	YES	YES - COPC
Carbazole	7.04E+00	8.43E+06	Lognormal	1.35E+01	3.19E+01	no	YES*
Chrysene	3.25E+01	1.14E+05	Lognormal	8.25E+01	8.75E+01	no	
Dibenz(a,h)anthracene	3.02E+00	1.76E+02	Lognormal	7.45E+00	8.75E-02	YES	YES - COPC
Dibenzofuran	1.46E+01	4.28E+06	Lognormal	2.90E+01	3.13E+02	no	
Fluoranthene	1.33E+02	2.93E+07	Lognormal	3.55E+02	3.13E+03	no	
Fluorene	2.30E+01	1.21E+05	Lognormal	6.30E+01	3.13E+03	no	
Indeno(1,2,3-cd)pyrene	1.25E+01	5.34E+03	Lognormal	3.10E+01	8.75E-01	YES	YES - COPC
Naphthalene	3.41E+00	1.19E+03	Lognormal	6.85E+00	6.45E+02	no	
Phenanthrene	9.00E+01	2.29E+07	Lognormal	2.45E+02	2.35E+03	no	
Phenol	2.92E-01	7.33E-01	Normal/Lognormal	3.80E-01	4.69E+04	no	
Pyrene	9.82E+01	4.13E+06	Lognormal	2.60E+02	2.35E+03	no	

*Retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH family, one of which has been retained as a COPC.

Table 13

Statistical Summary and Selection of COPCs in EU5 Soil (0-6' bgs)

Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2,4-dimethylphenol	105-67-9	18	1	5.56	7.50E-02	4.55E-01	1.10E-01	J	6.17E-02	4.98E-02	1.10E-01	J	GEO-30	5.60E-02
2-methylnaphthalene	91-57-6	18	5	27.78	3.80E-02	4.10E-02	5.10E-02	J	6.21E-01	4.99E-02	9.20E+00		GEO-33	2.15E+00
2-methylphenol	95-48-7	18	1	5.56	3.80E-02	2.09E-01	4.20E-02	J	2.95E-02	2.44E-02	4.20E-02	J	GEO-30	2.57E-02
3- and 4-methylphenol	106-44-5	18	1	5.56	7.50E-02	4.13E-01	1.40E-01	J	6.22E-02	5.02E-02	1.40E-01	J	GEO-30	5.46E-02
Acenaphthene	83-32-9	24	4	16.67	2.90E-02	2.40E+00	1.10E-01	J	2.53E+00	6.24E-02	5.35E+01		GEO-33	1.09E+01
Acenaphthylene	208-96-8	24	6	25	3.80E-02	2.40E+00	4.80E-02	J	9.59E-01	7.93E-02	1.60E+01		GEO-33	3.26E+00
Anthracene	120-12-7	24	6	25	5.40E-04	6.00E-02	1.30E-01	J	3.94E+00	4.33E-02	7.97E+01		GEO-33	1.63E+01
Benzo(a)anthracene	56-55-3	24	13	54.17	3.80E-02	4.10E-02	6.80E-03	Z	4.81E+00	1.11E-01	8.35E+01		GEO-33	1.71E+01
Benzo(a)pyrene	50-32-8	24	13	54.17	3.80E-02	4.10E-02	8.30E-03	Z	3.17E+00	1.15E-01	5.25E+01		GEO-33	1.07E+01
Benzo(b)fluoranthene	205-99-2	24	14	58.33	3.80E-02	4.10E-02	9.00E-03	Z	4.99E+00	1.59E-01	7.95E+01	J	GEO-33	1.63E+01
Benzo(ghi)perylene	191-24-2	24	12	50	3.80E-02	4.10E-02	6.70E-03	J	1.55E+00	7.48E-02	2.55E+01		GEO-33	5.22E+00
Benzo(k)fluoranthene	207-08-9	24	14	58.33	3.80E-02	4.10E-02	4.70E-03	Z	1.84E+00	9.91E-02	2.85E+01		GEO-33	5.86E+00
Bis(2-ethylhexyl)phthalate	117-81-7	18	2	11.11	7.50E-02	4.13E-01	1.40E-01	J	6.84E-02	5.41E-02	1.50E-01		GEO-32	5.80E-02
Carbazole	86-74-8	18	4	22.22	3.80E-02	4.10E-02	5.30E-01	J	9.78E-01	5.52E-02	1.35E+01	J	GEO-33	3.17E+00
Chrysene	218-01-9	24	14	58.33	3.80E-02	4.10E-02	2.40E-03	J	4.91E+00	1.16E-01	8.25E+01		GEO-33	1.69E+01
Dibenz(a,h)anthracene	53-70-3	24	12	50	3.80E-02	4.10E-02	1.70E-03	J	4.89E-01	4.58E-02	7.45E+00		GEO-33	1.53E+00
Dibenzofuran	132-64-9	18	6	33.33	3.80E-02	4.10E-02	3.90E-02	J	1.82E+00	5.87E-02	2.90E+01		GEO-33	6.81E+00
Fluoranthene	206-44-0	24	14	58.33	3.80E-02	4.10E-02	1.30E-02	Z	1.85E+01	1.82E-01	3.55E+02		GEO-33	7.23E+01
Fluorene	86-73-7	24	8	33.33	2.90E-03	5.20E-02	3.60E-03	J	2.98E+00	4.72E-02	6.30E+01		GEO-33	1.28E+01
Indeno(1,2,3-cd)pyrene	193-39-5	24	13	54.17	3.80E-02	4.10E-02	7.80E-03	J	1.97E+00	9.68E-02	3.10E+01		GEO-33	6.37E+00
Naphthalene	91-20-3	24	6	25	2.90E-02	5.60E-01	7.50E-02	J	5.93E-01	6.22E-02	6.85E+00		GEO-33	1.65E+00
Phenanthrene	85-01-8	24	13	54.17	3.80E-02	4.10E-02	6.80E-03	J	1.21E+01	1.17E-01	2.45E+02		GEO-33	5.00E+01
Phenol	108-95-2	18	13	72.22	7.50E-02	4.13E-01	1.00E-01	J	1.48E-01	1.22E-01	3.80E-01		GEO-29	8.68E-02
Pyrene	129-00-0	24	14	58.33	3.80E-02	4.10E-02	1.60E-02	J	1.39E+01	1.87E-01	2.60E+02		GEO-33	5.30E+01

Table 15

Statistical Summary and Selection of COPCs in EU5 Soil (0-6' bgs)

Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier 1 Restricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
Semivolatiles							
2,4-dimethylphenol	8.47E-02	7.85E-02	Unknown	7.85E-02	4.08E+04	no	
2-methylnaphthalene	1.50E+00	1.43E+00	Unknown	1.43E+00	8.18E+04	no	
2-methylphenol	4.01E-02	3.69E-02	Unknown	3.69E-02	1.02E+05	no	
3- and 4-methylphenol	8.46E-02	7.99E-02	Unknown	7.99E-02	1.02E+04	no	
Acenaphthene	6.35E+00	3.21E+00	Unknown	3.21E+00	1.23E+05	no	
Acenaphthylene	2.10E+00	2.70E+00	Unknown	2.70E+00	1.23E+05	no	
Anthracene	9.62E+00	6.15E+01	Unknown	6.15E+01	6.13E+05	no	
Benzo(a)anthracene	1.08E+01	7.77E+01	Unknown	7.77E+01	7.84E+00	YES	YES - COPC
Benzo(a)pyrene	6.93E+00	4.10E+01	Unknown	4.10E+01	7.84E-01	YES	YES - COPC
Benzo(b)fluoranthene	1.07E+01	1.30E+02	Unknown	7.95E+01	7.84E+00	YES	YES - COPC
Benzo(ghi)perylene	3.38E+00	8.53E+00	Unknown	8.53E+00	6.13E+04	no	
Benzo(k)fluoranthene	3.89E+00	1.97E+01	Unknown	1.97E+01	7.84E+01	no	YES*
Bis(2-ethylhexyl)phthalate	9.21E-02	9.19E-02	Unknown	9.19E-02	4.09E+02	no	
Carbazole	2.28E+00	4.56E+00	Unknown	4.56E+00	2.86E+02	no	
Chrysene	1.08E+01	1.27E+02	Unknown	8.25E+01	7.84E+02	no	YES*
Dibenz(a,h)anthracene	1.02E+00	2.04E+00	Unknown	2.04E+00	7.84E-01	YES	YES - COPC
Dibenzofuran	4.61E+00	4.75E+00	Unknown	4.75E+00	8.18E+03	no	
Fluoranthene	4.38E+01	7.28E+02	Unknown	3.55E+02	8.17E+04	no	
Fluorene	7.47E+00	7.47E+00	Unknown	7.47E+00	8.17E+04	no	
Indeno(1,2,3-cd)pyrene	4.20E+00	1.71E+01	Unknown	1.71E+01	7.84E+00	YES	YES - COPC
Naphthalene	1.17E+00	1.53E+00	Unknown	1.53E+00	8.24E+02	no	
Phenanthrene	2.96E+01	1.26E+02	Unknown	1.26E+02	6.13E+04	no	
Phenol	1.84E-01	2.27E-01	Normal/Lognormal	2.27E-01	1.23E+05	no	
Pyrene	3.24E+01	4.64E+02	Unknown	2.60E+02	6.13E+04	no	

*Logarithmic 95% UCL is less than benchmark but retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH family, one of which has been retained as a COPC.

RECEIVED APR - 4 DEQ-OPC

Table 16
Statistical Summary and Selection of COPCs in EU5 Soil (0-20' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2,4-dimethylphenol	105-67-9	23	1	4.35	6.70E-02	1.30E+00	1.10E-01	J	8.81E-02	5.57E-02	1.10E-01	J	GEO-30	1.34E-01
2-methylnaphthalene	91-57-6	23	8	34.78	3.30E-02	4.10E-02	5.10E-02	J	2.37E+01	1.19E-01	4.40E+02		SB-05	9.23E+01
2-methylphenol	95-48-7	23	1	4.35	3.80E-02	1.30E+00	4.20E-02	J	6.29E-02	3.18E-02	4.20E-02	J	GEO-30	1.33E-01
3- and 4-methylphenol	106-44-5	23	1	4.35	7.50E-02	2.00E+00	1.40E-01	J	1.10E-01	6.12E-02	1.40E-01	J	GEO-30	2.04E-01
Acenaphthene	83-32-9	30	7	23.33	2.90E-02	2.40E+00	1.10E-01	J	1.29E+01	1.15E-01	2.90E+02		SB-05	5.34E+01
Acenaphthylene	208-96-8	30	9	30	3.30E-02	2.40E+00	4.80E-02	J	1.15E+00	9.90E-02	1.60E+01		GEO-33	3.36E+00
Anthracene	120-12-7	30	9	30	5.40E-04	6.00E-02	1.30E-01	J	7.18E+00	6.99E-02	9.80E+01		SB-05	2.26E+01
Benzo(a)anthracene	56-55-3	30	17	56.67	3.30E-02	4.10E-02	6.80E-03	Z	6.52E+00	1.56E-01	8.35E+01		GEO-33	1.93E+01
Benzo(a)pyrene	50-32-8	30	17	56.67	3.80E-02	6.70E-02	8.30E-03	Z	3.56E+00	1.55E-01	5.25E+01	J	GEO-33	1.05E+01
Benzo(b)fluoranthene	205-99-2	30	18	60	3.80E-02	6.70E-02	9.00E-03	Z	5.47E+00	2.09E-01	7.95E+01		GEO-33	1.59E+01
Benzo(ghi)perylene	191-24-2	30	16	53.33	3.80E-02	6.70E-02	6.70E-03	J	1.51E+00	9.66E-02	2.55E+01		GEO-33	4.77E+00
Benzo(k)fluoranthene	207-08-9	30	18	60	3.80E-02	1.30E-01	4.70E-03	Z	1.99E+00	1.32E-01	2.85E+01		GEO-33	5.64E+00
Bis(2-ethylhexyl)phthalate	117-81-7	23	2	8.7	6.70E-02	1.30E+00	1.40E-01	J	9.40E-02	6.04E-02	1.50E-01	J	GEO-32	1.34E-01
Carbazole	86-74-8	23	7	30.43	3.30E-02	4.10E-02	5.30E-01	J	4.29E+00	9.66E-02	6.90E+01		SB-05	1.45E+01
Chrysene	218-01-9	30	18	60	3.30E-02	4.10E-02	2.40E-03	J	6.33E+00	1.59E-01	8.25E+01		GEO-33	1.85E+01
Dibenz(a,h)anthracene	53-70-3	30	15	50	3.80E-02	3.30E-01	1.70E-03	J	4.87E-01	5.48E-02	7.45E+00		GEO-33	1.42E+00
Dibenzofuran	132-64-9	23	9	39.13	3.30E-02	4.10E-02	3.90E-02	J	1.47E+01	1.23E-01	2.70E+02		SB-05	5.62E+01
Fluoranthene	206-44-0	30	18	60	3.30E-02	4.10E-02	1.30E-02	Z	3.13E+01	2.82E-01	4.30E+02		SB-05	9.95E+01
Fluorene	86-73-7	30	11	36.67	2.90E-03	5.20E-02	3.60E-03	J	1.52E+01	8.67E-02	3.30E+02		SB-05	6.11E+01
Indeno(1,2,3-cd)pyrene	193-39-5	30	17	56.67	3.80E-02	6.70E-02	7.80E-03	J	1.92E+00	1.22E-01	3.10E+01		GEO-33	5.84E+00
Naphthalene	91-20-3	30	9	30	2.90E-02	5.60E-01	7.50E-02	J	3.80E+01	1.33E-01	9.10E+02		SB-05	1.68E+02
Phenanthrene	85-01-8	30	17	56.67	3.30E-02	4.10E-02	6.80E-03	J	3.77E+01	2.06E-01	7.10E+02		SB-05	1.36E+02
Phenol	108-95-2	23	13	56.52	3.30E-02	6.70E-01	1.00E-01	J	1.36E-01	9.66E-02	3.80E-01		GEO-29	9.90E-02
Pyrene	129-00-0	30	18	60	3.80E-02	6.70E-02	1.60E-02	J	2.04E+01	2.85E-01	2.60E+02		GEO-33	6.43E+01
Volatiles														
Acetone	67-64-1	5	5	100	0.00E+00	0.00E+00	9.00E-03	J	4.40E-02	2.95E-02	1.00E-01	J	SB-05	3.79E-02
Benzene	71-43-2	5	2	40	1.00E-03	1.00E-03	5.00E-03	J	2.70E-03	1.34E-03	7.00E-03	J	SB-05	3.09E-03
Ethylbenzene	100-41-4	5	3	60	1.00E-03	1.00E-03	2.40E-02		3.82E-02	8.02E-03	1.20E-01		SB-05	4.95E-02
Styrene	100-42-5	5	1	20	1.00E-03	1.00E-03	1.00E-01		2.04E-02	1.44E-03	1.00E-01		SB-05	4.45E-02
Toluene	108-88-3	5	3	60	1.00E-03	1.00E-03	1.30E-02		3.38E-02	5.85E-03	1.40E-01		SB-05	5.98E-02
Xylene (total)	1330-20-7	5	3	60	1.00E-03	1.00E-03	7.50E-02		2.27E-01	2.10E-02	7.80E-01		SB-05	3.30E-01

Table 16
Statistical Summary and Selection of COPCs in EU5 Soil (0-20' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier I Restricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
Semivolatiles							
2,4-dimethylphenol	1.36E-01	1.12E-01	Unknown	1.10E-01	4.08E+04	no	
2-methylnaphthalene	5.67E+01	6.89E+02	Unknown	4.40E+02	8.18E+04	no	
2-methylphenol	1.11E-01	7.64E-02	Unknown	4.20E-02	1.02E+05	no	
3- and 4-methylphenol	1.83E-01	1.37E-01	Unknown	1.37E-01	1.02E+04	no	
Acenaphthene	2.95E+01	8.04E+01	Unknown	8.04E+01	1.23E+05	no	
Acenaphthylene	2.19E+00	3.82E+00	Unknown	3.82E+00	1.23E+05	no	
Anthracene	1.42E+01	4.31E+02	Unknown	9.80E+01	6.13E+05	no	
Benzo(a)anthracene	1.25E+01	1.52E+02	Unknown	8.35E+01	7.84E+00	Yes	YES-COPC
Benzo(a)pyrene	6.82E+00	4.42E+01	Unknown	4.42E+01	7.84E-01	Yes	YES-COPC
Benzo(b)fluoranthene	1.04E+01	1.19E+02	Unknown	7.95E+01	7.84E+00	Yes	YES-COPC
Benzo(ghi)perylene	2.99E+00	7.40E+00	Unknown	7.40E+00	6.13E+04	no	
Benzo(k)fluoranthene	3.74E+00	1.68E+01	Unknown	1.68E+01	7.84E+01	no	COPC*
Bis(2-ethylhexyl)phthalate	1.42E-01	1.24E-01	Unknown	1.24E-01	4.09E+02	no	
Carbazole	9.49E+00	6.44E+01	Unknown	6.44E+01	2.86E+02	no	
Chrysene	1.21E+01	2.00E+02	Unknown	8.25E+01	7.84E+02	Yes	YES-COPC
Dibenz(a,h)anthracene	9.29E-01	1.53E+00	Unknown	1.53E+00	7.84E-01	no	COPC*
Dibenzofuran	3.48E+01	4.46E+02	Unknown	2.70E+02	8.18E+03	no	
Fluoranthene	6.22E+01	3.34E+03	Unknown	4.30E+02	8.17E+04	no	
Fluorene	3.42E+01	2.24E+02	Unknown	2.24E+02	8.17E+04	no	
Indeno(1,2,3-cd)pyrene	3.73E+00	1.32E+01	Unknown	1.32E+01	7.84E+00	no	COPC*
Naphthalene	9.01E+01	2.69E+02	Unknown	2.69E+02	8.24E+02	no	
Phenanthrene	7.98E+01	2.37E+03	Unknown	7.10E+02	6.13E+04	no	
Phenol	1.72E-01	2.53E-01	Normal/Lognormal	2.53E-01	1.23E+05	no	
Pyrene	4.03E+01	1.08E+03	Unknown	2.60E+02	6.13E+04	no	
Volatiles							
Acetone	8.01E-02	9.07E-01	Normal/Lognormal	1.00E-01	1.04E+05	no	
Benzene	5.65E-03	2.77E-01	Normal/Lognormal	7.00E-03	1.36E+00	no	
Ethylbenzene	8.54E-02	1.58E+06	Normal/Lognormal	1.20E-01	3.95E+02	no	
Styrene	6.28E-02	1.19E+04	Unknown	1.00E-01	3.84E+02	no	
Toluene	9.08E-02	1.16E+05	Lognormal	1.40E-01	3.80E+01	no	
Xylene (total)	5.41E-01	2.82E+13	Normal/Lognormal	7.80E-01	3.18E+02	no	

*Logarithmic 95% UCL is less than benchmark but retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH family, one of which has been retained as a COPC.

Table 17
Statistical Summary and Selection of COPCs in EU6 Sediment
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
1,2,4-trichlorobenzene	120-82-1	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
1,2-dichlorobenzene	95-50-1	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
1,3-dichlorobenzene	541-73-1	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
1,4-dichlorobenzene	106-46-7	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
2,2'-oxybis (1-chloropropane)	108-60-1	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
2,4,5-trichlorophenol	95-95-4	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
2,4,6-trichlorophenol	88-06-2	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
2,4-dichlorophenol	120-83-2	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
2,4-dimethylphenol	105-67-9	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
2,4-dinitrophenol	51-28-5	3	1	33.33	2.40E-01	2.50E-01	2.30E+00		8.48E-01	3.26E-01	2.30E+00		SD-04	1.26E+00
2,4-dinitrotoluene	121-14-2	3	1	33.33	8.40E-02	8.50E-02	4.00E-01		1.62E-01	8.94E-02	4.00E-01		SD-04	2.07E-01
2,6-dinitrotoluene	606-20-2	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
2-chloronaphthalene	91-58-7	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
2-chlorophenol	95-57-8	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
2-methylnaphthalene	91-57-6	3	3	100	0.00E+00	0.00E+00	9.10E-02	J	1.28E+01	1.15E+00	3.80E+01		SD-04	2.18E+01
2-methylphenol	95-48-7	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
2-nitroaniline*	88-74-4	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
2-nitrophenol*	88-75-5	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
3- and 4-methylphenol	106-44-5	3	3	100	0.00E+00	0.00E+00	9.30E-02	J	3.34E-01	2.02E-01	8.00E-01		SD-04	4.03E-01
3,3'-dichlorobenzidine	91-94-1	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
3-nitroaniline*	99-09-2	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
4,6-dinitro-2-methylphenol	534-52-1	3	1	33.33	2.10E-01	2.10E-01	2.00E+00		7.37E-01	2.80E-01	2.00E+00		SD-04	1.09E+00
4-bromophenylphenylether*	101-55-3	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
4-chloro-3-methylphenol*	59-50-7	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
4-chloroaniline	106-47-8	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
4-chlorophenylphenylether*	7005-72-3	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
4-nitroaniline*	100-01-6	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
4-nitrophenol	100-02-7	3	1	33.33	2.10E-01	2.10E-01	2.00E+00		7.37E-01	2.80E-01	2.00E+00		SD-04	1.09E+00
Acenaphthene	83-32-9	8	4	50	1.80E+00	3.50E+00	1.00E-01	J	1.89E+01	1.96E+00	1.40E+02	J	SD-04	4.90E+01
Acenaphthylene	208-96-8	8	3	37.5	1.80E+00	3.50E+00	1.70E-01	J	2.92E+00	1.69E+00	8.90E+00		SD-03	3.14E+00
Anthracene	120-12-7	8	7	87.5	4.57E-01	4.57E-01	8.80E-01		6.08E+00	2.86E+00	2.39E+01	Z	SD-16	7.83E+00
Benzo(a)anthracene	56-55-3	8	8	100	0.00E+00	0.00E+00	9.30E-01		1.85E+01	4.83E+00	1.00E+02	J	SD-04	3.41E+01
Benzo(a)pyrene	50-32-8	8	8	100	0.00E+00	0.00E+00	9.70E-01	J	1.32E+01	5.59E+00	4.90E+01	J	SD-03	1.80E+01
Benzo(b)fluoranthene	205-99-2	8	8	100	0.00E+00	0.00E+00	1.40E+00		1.90E+01	7.10E+00	7.80E+01		SD-03	2.82E+01
Benzo(ghi)perylene	191-24-2	8	8	100	0.00E+00	0.00E+00	4.20E-01		6.50E+00	2.58E+00	3.20E+01		SD-03	1.07E+01
Benzo(k)fluoranthene	207-08-9	8	8	100	0.00E+00	0.00E+00	5.00E-01		6.96E+00	3.14E+00	2.30E+01		SD-03	8.76E+00
Bis(2-chloroethoxy)methane*	111-91-1	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
Bis(2-chloroethyl)ether	111-44-4	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01

Table 17
Statistical Summary and Selection of COPCs in EU6 Sediment
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier I Unrestricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
1,2,4-trichlorobenzene	5.16E-01	7.97E+10	Lognormal	4.00E-01	5.27E+02	no	
1,2-dichlorobenzene	5.16E-01	7.97E+10	Lognormal	4.00E-01	2.79E+02	no	
1,3-dichlorobenzene	5.16E-01	7.97E+10	Lognormal	4.00E-01	2.35E+03	no	
1,4-dichlorobenzene	5.16E-01	7.97E+10	Lognormal	4.00E-01	2.66E+01	no	
2,2'-oxybis (1-chloropropane)	5.16E-01	7.97E+10	Lognormal	4.00E-01	5.93E+00	no	
2,4,5-trichlorophenol	1.03E+00	1.77E+11	Unknown	8.00E-01	7.82E+03	no	
2,4,6-trichlorophenol	1.03E+00	1.77E+11	Unknown	8.00E-01	5.81E+01	no	
2,4-dichlorophenol	1.03E+00	1.77E+11	Unknown	8.00E-01	2.35E+02	no	
2,4-dimethylphenol	1.03E+00	1.77E+11	Unknown	8.00E-01	1.56E+03	no	
2,4-dinitrophenol	2.97E+00	4.39E+11	Lognormal	2.30E+00	1.56E+02	no	
2,4-dinitrotoluene	5.10E-01	1.19E+06	Lognormal	4.00E-01	1.56E+02	no	
2,6-dinitrotoluene	5.16E-01	7.97E+10	Lognormal	4.00E-01	7.82E+01	no	
2-chloronaphthalene	5.16E-01	7.97E+10	Lognormal	4.00E-01	6.26E+03	no	
2-chlorophenol	5.16E-01	7.97E+10	Lognormal	4.00E-01	3.91E+02	no	
2-methylnaphthalene	4.96E+01	3.37E+41	Normal/Lognormal	3.80E+01	3.13E+03	no	
2-methylphenol	5.16E-01	7.97E+10	Lognormal	4.00E-01	3.91E+03	no	
2-nitroaniline*	5.16E-01	7.97E+10	Lognormal	4.00E-01	NA		
2-nitrophenol*	1.03E+00	1.77E+11	Unknown	8.00E-01	NA		
3- and 4-methylphenol	1.01E+00	2.30E+05	Normal/Lognormal	8.00E-01	3.91E+02	no	
3,3'-dichlorobenzidine	1.03E+00	1.77E+11	Unknown	8.00E-01	1.42E+00	no	
3-nitroaniline*	1.03E+00	1.77E+11	Unknown	8.00E-01	NA		
4,6-dinitro-2-methylphenol	2.58E+00	4.94E+11	Unknown	2.00E+00	7.82E+00	no	
4-bromophenylphenylether*	1.03E+00	1.77E+11	Unknown	8.00E-01	NA		
4-chloro-3-methylphenol*	1.03E+00	1.77E+11	Unknown	8.00E-01	NA		
4-chloroaniline	5.16E-01	7.97E+10	Lognormal	4.00E-01	3.13E+02	no	
4-chlorophenylphenylether*	5.16E-01	7.97E+10	Lognormal	4.00E-01	NA		
4-nitroaniline*	1.03E+00	1.77E+11	Unknown	8.00E-01	NA		
4-nitrophenol	2.58E+00	4.94E+11	Unknown	2.00E+00	6.26E+02	no	
Acenaphthene	5.17E+01	1.82E+03	Lognormal	1.40E+02	4.69E+03	no	
Acenaphthylene	5.02E+00	2.23E+01	Normal/Lognormal	8.90E+00	4.69E+03	no	
Anthracene	1.13E+01	1.03E+02	Lognormal	2.39E+01	2.35E+04	no	
Benzo(a)anthracene	4.14E+01	7.51E+02	Lognormal	1.00E+02	8.75E-01	YES	YES - COPC
Benzo(a)pyrene	2.53E+01	1.63E+02	Lognormal	4.90E+01	8.75E-02	YES	YES - COPC
Benzo(b)fluoranthene	3.79E+01	2.88E+02	Lognormal	7.80E+01	8.75E-01	YES	YES - COPC
Benzo(ghi)perylene	1.37E+01	6.89E+01	Lognormal	3.20E+01	2.35E+03	no	
Benzo(k)fluoranthene	1.28E+01	8.18E+01	Lognormal	2.30E+01	8.75E+00	YES	YES - COPC
Bis(2-chloroethoxy)methane*	1.03E+00	1.77E+11	Unknown	8.00E-01	NA		
Bis(2-chloroethyl)ether	5.16E-01	7.97E+10	Lognormal	4.00E-01	2.73E-01	YES	YES - COPC

Table 17
Statistical Summary and Selection of COPCs in EU6 Sediment
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Bis(2-ethylhexyl)phthalat	117-81-7	3	1	33.33	1.50E-01	2.50E-01	8.80E-01		3.60E-01	2.02E-01	8.80E-01		SD-04	4.51E-01
Butylbenzylphthalate	85-68-7	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
Carbazole	86-74-8	3	3	100	0.00E+00	0.00E+00	2.20E-01		3.37E+01	2.77E+00	1.00E+02	J	SD-04	5.74E+01
Chrysene	218-01-9	8	6	75	9.40E-01	1.20E+00	1.30E+00		1.82E+01	4.61E+00	7.60E+01	J	SD-03	2.75E+01
Dibenz(a,h)anthracene	53-70-3	8	8	100	0.00E+00	0.00E+00	1.50E-01	J	2.03E+00	8.14E-01	9.60E+00		SD-04	3.23E+00
Dibenzofuran	132-64-9	3	3	100	0.00E+00	0.00E+00	1.00E-01	J	5.02E+01	1.93E+00	1.50E+02	J	SD-04	8.64E+01
Diethylphthalate	84-66-2	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
Dimethylphthalate	131-11-3	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
Di-n-butylphthalate	84-74-2	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
Di-n-octylphthalate	117-84-0	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
Fluoranthene	206-44-0	8	8	100	0.00E+00	0.00E+00	9.20E-01	Z	6.71E+01	8.91E+00	4.70E+02		SD-04	1.63E+02
Fluorene	86-73-7	8	6	75	3.20E-01	3.30E-01	1.80E-01	J	3.32E+01	1.07E+00	2.60E+02		SD-04	9.16E+01
Hexachlorobenzene	118-74-1	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
Hexachlorobutadiene	87-68-3	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
Hexachlorocyclopentadiene	77-47-4	3	1	33.33	2.10E-01	2.10E-01	2.00E+00		7.37E-01	2.80E-01	2.00E+00		SD-04	1.09E+00
Hexachloroethane	67-72-1	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
Indeno(1,2,3-cd)pyrene	193-39-5	8	8	100	0.00E+00	0.00E+00	5.40E-01		8.32E+00	3.53E+00	3.90E+01		SD-03	1.30E+01
Isophorone	78-59-1	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
Naphthalene	91-20-3	8	3	37.5	1.80E+00	3.50E+00	1.60E-01		2.91E+00	1.48E+00	1.40E+01		SD-04	4.52E+00
Nitrobenzene	98-95-3	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
N-nitrosodi-n-propylamine	621-64-7	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
N-nitrosodiphenylamine	86-30-6	3	1	33.33	4.20E-02	4.30E-02	4.00E-01		1.48E-01	5.65E-02	4.00E-01		SD-04	2.19E-01
Pentachlorophenol	87-86-5	3	1	33.33	2.10E-01	2.10E-01	2.00E+00		7.37E-01	2.80E-01	2.00E+00		SD-04	1.09E+00
Phenanthrene	85-01-8	8	5	62.5	1.30E-01	1.20E+00	6.60E-01		1.10E+02	1.84E+00	8.70E+02		SD-04	3.07E+02
Phenol	108-95-2	3	1	33.33	8.40E-02	8.50E-02	8.00E-01		2.95E-01	1.13E-01	8.00E-01		SD-04	4.37E-01
Pyrene	129-00-0	8	8	100	0.00E+00	0.00E+00	1.60E+00		4.88E+01	1.16E+01	3.00E+02		SD-04	1.02E+02

Table 17
Statistical Summary and Selection of COPCs in EU6 Sediment
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier 1 Unrestricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
Bis(2-ethylhexyl)phthalat	1.12E+00	2.81E+06	Normal/Lognormal	8.80E-01	4.56E+01	no	
Butylbenzylphthalate	1.03E+00	1.77E+11	Unknown	8.00E-01	9.28E+02	no	
Carbazole	1.30E+02	3.75E+43	Normal/Lognormal	1.00E+02	3.19E+01	YES	YES - COPC
Chrysene	3.66E+01	2.31E+03	Lognormal	7.60E+01	8.75E+01	no	YES**
Dibenz(a,h)anthracene	4.20E+00	2.18E+01	Lognormal	9.60E+00	8.75E-02	YES	YES - COPC
Dibenzofuran	1.96E+02	1.09E+63	Lognormal	1.50E+02	3.13E+02	no	
Diethylphthalate	1.03E+00	1.77E+11	Unknown	8.00E-01	1.97E+03	no	
Dimethylphthalate	1.03E+00	1.77E+11	Unknown	8.00E-01	7.82E+05	no	
Di-n-butylphthalate	1.03E+00	1.77E+11	Unknown	8.00E-01	2.28E+03	no	
Di-n-octylphthalate	1.03E+00	1.77E+11	Unknown	8.00E-01	1.56E+03	no	
Fluoranthene	1.76E+02	8.33E+03	Lognormal	4.70E+02	3.13E+03	no	
Fluorene	9.46E+01	1.95E+04	Lognormal	2.60E+02	3.13E+03	no	
Hexachlorobenzene	5.16E-01	7.97E+10	Lognormal	4.00E-01	3.99E-01	YES	YES - COPC
Hexachlorobutadiene	1.03E+00	1.77E+11	Unknown	8.00E-01	8.82E-02	YES	no
Hexachlorocyclopentadiene	2.58E+00	4.94E+11	Unknown	2.00E+00	9.51E-01	YES	YES - COPC
Hexachloroethane	5.16E-01	7.97E+10	Lognormal	4.00E-01	4.56E+01	no	
Indeno(1,2,3-cd)pyrene	1.70E+01	8.48E+01	Lognormal	3.90E+01	8.75E-01	YES	YES***
Isophorone	5.16E-01	7.97E+10	Lognormal	4.00E-01	6.72E+02	no	
Naphthalene	5.93E+00	1.92E+01	Lognormal	1.40E+01	6.45E+02	no	
Nitrobenzene	5.16E-01	7.97E+10	Lognormal	4.00E-01	8.41E+00	no	
N-nitrosodi-n-propylamine	5.16E-01	7.97E+10	Lognormal	4.00E-01	9.12E-02	YES	YES - COPC
N-nitrosodiphenylamine	5.16E-01	7.97E+10	Lognormal	4.00E-01	1.30E+02	no	
Pentachlorophenol	2.58E+00	4.94E+11	Unknown	2.00E+00	2.66E+00	no	
Phenanthrene	3.16E+02	1.66E+06	Lognormal	8.70E+02	2.35E+03	no	
Phenol	1.03E+00	1.77E+11	Unknown	8.00E-01	4.69E+04	no	
Pyrene	1.17E+02	1.89E+03	Lognormal	3.00E+02	2.35E+03	no	

NA - Not Available
* Constituent will be retained as a COPC due to lack of Tier 1 TRG.
**Retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH family, one of which has been retained as a COPC.
***Logarithmic 95% UCL is less than benchmark but retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH fami
one of which has been retained as a COPC.

Table 18
Statistical Summary and Selection of COPCs in EU6 Surface Water
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/L	Maximum Detection Limit mg/L	Minimum Detected mg/L	Minimum Detected Qualifier	Mean mg/L	Logarithmic Mean mg/L	Maximum Detected mg/L	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/L
Semivolatiles														
Acenaphthene	83-32-9	2	1	50	1.00E-03	1.00E-03	9.00E-03	J	4.75E-03	2.12E-03	9.00E-03	J	SW-03	6.01E-03
Benzo(a)anthracene	56-55-3	2	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-03	0.00E+00
Benzo(a)pyrene	50-32-8	2	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-03	0.00E+00
Benzo(b)fluoranthene	205-99-2	2	1	50	1.00E-03	1.00E-03	9.00E-03	J	4.75E-03	2.12E-03	9.00E-03	J	SW-03	6.01E-03
Benzo(k)fluoranthene	207-08-9	2	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-03	0.00E+00
Chrysene	218-01-9	2	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-03	0.00E+00
Dibenz(a,h)anthracene	53-70-3	2	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-03	0.00E+00
Fluoranthene	206-44-0	2	2	100	0.00E+00	0.00E+00	1.20E-02		1.25E-02	1.25E-02	1.30E-02		SW-03	7.07E-04
Fluorene	86-73-7	2	1	50	1.00E-03	1.00E-03	1.10E-02		5.75E-03	2.35E-03	1.10E-02		SW-03	7.42E-03
Indeno(1,2,3-cd)pyrene	193-39-5	2	0	0	1.00E-03	1.00E-03	0.00E+00	NA	5.00E-04	5.00E-04	0.00E+00	NA	SW-03	0.00E+00

NA - Not applicable: constituent not detected in media.

Table 18
Statistical Summary and Selection of COPCs in EU6 Surface Water
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/L	Logarithmic 95% UCL mg/L	Distribution 99% Confidence	Exposure Point Concentration mg/L	Human Health Consumption of Water & Organisms AWQC mg/L	Is Maximum Detected > AWQC?
Semivolatiles						
Acenaphthene	3.16E-02	6.39E+48	Unknown	9.00E-03	1.20E+00	no
Benzo(a)anthracene	5.00E-04	5.00E-04	Unknown	5.00E-04	4.40E-06	YES*
Benzo(a)pyrene	5.00E-04	5.00E-04	Unknown	5.00E-04	4.40E-06	YES*
Benzo(b)fluoranthene	3.16E-02	6.39E+48	Unknown	9.00E-03	4.40E-06	YES - COPC
Benzo(k)fluoranthene	5.00E-04	5.00E-04	Unknown	5.00E-04	4.40E-06	YES*
Chrysene	5.00E-04	5.00E-04	Unknown	5.00E-04	4.40E-06	YES*
Dibenz(a,h)anthracene	5.00E-04	5.00E-04	Unknown	5.00E-04	4.40E-06	YES*
Fluoranthene	1.57E-02	1.53E-02	Unknown	1.30E-02	3.00E-01	no
Fluorene	3.89E-02	1.87E+56	Unknown	1.10E-02	1.30E+00	no
Indeno(1,2,3-cd)pyrene	5.00E-04	5.00E-04	Unknown	5.00E-04	4.40E-06	YES*

*Retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH family, one of which has been retained as a COPC.

Table 19
Summary of Human Health Exposure Parameters
Kerr McGee, Hattiesburg, MS

Receptors:		Adolescent Visitor		Maintenance Worker		Construction Worker		Off-Site Resident Child		Off-Site Resident Adult	
Parameter	**Units**										
Surface area available for exposure - soil	cm^2/day	3052	1	3000	1	5560	1	1724	1	4780	1
Surface area available for exposure - sed. & sw	cm^2/day	3945	1	3000	1	3000	1	2229	1	6180	1
Total skin surface area	cm^2	12768.3	2	20000	2	20000	2	7213	2	20000	2
Skin surface area available for exposure - soil	%	23.9%	2	15%	2	27.8%	2	23.9%	2	23.9%	2
Skin surface area available for exposure - sed. & sw	%	30.9%	2	15.0%	2	15.0%	2	30.9%	2	30.9%	2
Adherence factor - soil	mg/cm^2	0.026	2	0.038	2	0.1	2	0.026	2	0.026	2
Adherence factor - sed.	mg/cm^3	0.33	2	0.038	2	0.13	2	0.33	2	0.33	2
Dermal absorption factor - cPAHs		0.03	3	0.03	3	0.03	3	0.03	3	0.03	3
Dermal absorption factor - other SVOCs		0.1	3	0.1	3	0.1	3	0.1	3	0.1	3
Exposure time	hours/day	1	5	1	5	1	5	1	5	1	5
Exposure frequency - soils	days/year	12	5	150	5	10/70*	5	NA		NA	
Exposure frequency - soils (EU4)	days/year	12	5	30	5	10/70*	5	NA		NA	
Exposure frequency - sed. & sw	days/year	12	5	30	5	8	5	40	5	40	5
Exposure duration	years	10	6	25	6	1	5	6	6	24	6
Body weight	kg	45	6	70	6	70	6	15	7	70	6
Averaging time - noncarcinogenic	days	3650	7	9125	7	365	7	2190	7	8760	7
Averaging time - carcinogenic	days	25550	7	25550	7	25550	7	25550	7	25550	7
Ingestion rate - soil	mg/day	100	2	100	2	480/100*	2	200	2	100	2
Ingestion rate - surface water	L/hour	0.01	6	0.01	6	0.01	5	0.05	6	0.01	6
Matrix effect - PAHs		1	5	1	5	1	5	1	5	1	5
Inhalation rate	m^3/day	NA		NA		20	6	NA		NA	
Retention factor - semivolatiles		NA		NA		0.75	8	NA		NA	

NA - Not Applicable
1 Calculated
2 USEPA 1997, Exposure Factors Handbook
3 USEPA 1995, Region III Technical Guidance Manual: Assessing Dermal Exposure to Soil
4 USEPA 1992, Dermal Exposure Assessment
5 Reasonable Maximum
6 USEPA 1995, Region IV
7 USEPA 1991, HHEM Supplemental Guidances
8 International Commission on Radiological Protection, 1968
*Exposure Scenario A/Exposure Scenario B

Table 20
Particulate Emission Rate for Vehicular Movement and Excavation
Kerr McGee, Hattiesburg, MS

Vehicular Movement

E = k * (5.9) * (s/12)(S/30) * (W/3)^0.7((w/4)^0.5) * ((365-p)/365) = 16.49 lbs/vehicle mile

E =	16.49	particulate emission rate (lbs/vehicle mile - 30 miles travelled total over 80 - 8 hr days)	
k =	0.5	particle size multiplier	US EPA AP-42, 1996
s =	50	percent silt content	Site Specific
S =	15	mean vehicle speed (mi/hr)	US EPA SEAM, 1988
W =	12.5	mean vehicle weight (ton)	US EPA SEAM, 1988
w =	8	mean number of wheels per vehicle	US EPA SEAM, 1988
p =	110	mean number of days with ≥0.01 inches of precipitation per year	US EPA SEAM, 1988

Emission Rate	lbs/sec =	(E lbs/mi) * (30 mi/job) * (job/80 days) * (1 day/8 hrs) * (1 hr/3600 sec)
	2.15E-04	lbs/sec
	9.74E-02	g/sec
	0.00010	**kg/sec**

Excavation

$E = (1.0 * s^{1.5})/M^{1.4} =$ 7.90E+00 lbs/hour

E =	7.90E+00	particulate emission factor (lbs/hr)	
s =	50	percent silt content	Site Specific
M =	15.1	percent soil moisture content	Site Specific

Emission Rate =	2.20E-03	lbs/sec
	0.996	g/sec
	0.000996	**kg/sec**

Table 21
Summary of Windrose Data
Kerr McGee, Hattiesburg, MS

GRAPHICAL EXPOSURE MODELING SYSTEM
STAR STATION JACKSON/THOMPSON, MS 1974-1978

DIRECTION	FREQUENCY	WINDSPEED	DIRECTION	FREQUENCY	WINDSPEED
N	3.33325	0.03	S	0.05336	3.08
NNE	1.89301	0.03	SSW	0.09995	3.29
NE	3.56791	0.07	SW	0.10061	3.65
ENE	0.12132	4.04	WSW	0.14723	3.93
E	0.04843	3.39	W	0.05047	3.7
ESE	0.04328	3.12	WNW	0.04341	3.51
SE	0.03686	3	NW	0.02908	3.25
SSE	0.05274	2.99	NNW	0.0406	3.26

STABILITY	FREQUENCY	WINDSPEED	AUXILIARY VARIABLES	
1	259.2	0.13	Afternoon mixing height (meters)	1409
2	0.053	0.24	Nocturnal mixing height (meters)	472
3	11.3	1	Ambient air temperature (Kelvin)	303.6
4	0.01264	2.17	Precipitation frequency (fraction)	289.8
5	0.08137	2.98	Precipitation intensity (mm/hour)	73.66
6	0.1315	3.91	Grand average windspeed (m/s)	4.69

Table 22
Summary of Toxicity Values
Kerr McGee, Hattiesburg, MS

Chemical	Oral Chronic RfD mg/kg-day	Source	Inhalation Chronic RfD mg/kg-day	Source	Range of Absorption by G.I. Tract	Source	Dermal Chronic RfD mg/kg-day	Oral Subchronic RfD mg/kg-day	Source	Inhalation Subchronic RfD mg/kg-day	Source	Dermal Subchronic RfD mg/kg-day	Oral CSF 1/(mg/kg-day)	Source	Dermal CSF 1/(mg/kg-day)	Source	Inhalation CSF 1/(mg/kg-day)	Source
Semivolatiles																		
2-Methylnaphthalene	2.00E-02	E			0.5	Region IV	1.00E-02											
2-Nitroaniline			5.70E-05	H	0.5	Region IV				5.70E-04	HE							
2-Nitrophenol					0.5	Region IV												
3-Nitroaniline					0.5	Region IV												
4-Bromophenylphenylether	5.80E-02	O			0.5	Region IV	2.90E-02											
4-Chloro-3-methylphenol					0.5	Region IV												
4-Chlorophenylphenylether					0.5	Region IV												
4-Nitroaniline					0.5	Region IV												
Acenaphthylene					0.5	Region IV												
Benzo(a)anthracene					0.5	Region IV							7.30E-01	E	1.46E+00	MDEQ	3.10E-01	E
Benzo(a)pyrene					0.5	Region IV							7.30E+00	IRIS	1.46E+01	MDEQ	3.10E+00	E
Benzo(b)fluoranthene					0.5	Region IV							7.30E-01	E	1.46E+00	MDEQ	3.10E-01	E
Benzo(g,h,i)perylene					0.5	Region IV												
Benzo(k)fluoranthene					0.5	Region IV							7.30E-02	E	1.46E-01	MDEQ	3.10E-02	E
Bis(2-chloroethoxy)methane					0.5	Region IV												
Bis(2-chloroethyl)ether					0.5	Region IV							1.10E+00	IRIS			1.10E+00	IRIS
Bis(2-ethylhexyl) phthalate	2.00E-02	IRIS			0.5	Region IV	1.00E-02	2.00E-02	W			1.00E-02	1.40E-02	IRIS			1.40E-02	E
Carbazole					0.5	Region IV							2.00E-02	H				
Chrysene					0.5	Region IV							7.30E-03	E	1.46E-02	MDEQ	3.10E-03	E
Dibenz(a,h)anthracene					0.5	Region IV							7.30E+00	E	1.46E+01	MDEQ	3.10E+00	E
Dibenzofuran	4.00E-03	E			0.5	Region IV	2.00E-03											
Fluoranthene	4.00E-02	IRIS			0.5	Region IV	2.00E-02	4.00E-01	H			2.00E-01						
Fluorene	4.00E-02	IRIS			0.5	Region IV	2.00E-02	4.00E-01	H			2.00E-01						
Hexachlorobenzene	8.00E-04	IRIS			0.5	Region IV	4.00E-04						1.60E+00	IRIS			1.60E+00	IRIS
Hexachlorocyclopentadiene	7.00E-03	IRIS	2.00E-05	H	0.5	Region IV	3.50E-03											
Indeno(1,2,3-cd)pyrene					0.5	Region IV							7.30E-01	E	1.46E+00	MDEQ	3.10E-01	E
N-nitrosodi-n-propylamine					0.5	Region IV							7.00E+00	IRIS				
Naphthalene	2.00E-02	IRIS	9.00E-04	IRIS	0.5	Region IV	1.00E-02											
Phenanthrene					0.5	Region IV												
Pyrene	3.00E-02	IRIS			0.5	Region IV	1.50E-02	3.00E-01	H			1.50E-01						

E - EPA-NCEA Regional Support provisional value from Region III RBC Tables, April 2000
H - Values are published in HEAST, 1997
IRIS - Values are available in IRIS, 2000
MDEQ - Based on MDEQ's recommendation of using the Oral CSF with an absorption efficiency of 50%.
O - *Values are withdrawn from* other EPA documents as presented in the Region III RBC Tables, April 1999
Region IV - Region IV default value, 1995
W - Withdrawn from IRIS or HEAST

Table 23
Summary of Hazard and Risk Calculations
Kerr McGee, Hattiesburg, MS

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Cancer Risk	Driving Constituent	Table Referenced
Dermal Exposure to Sediment in EU1	Visitor	NA	4E-08		24
Oral Exposure to Sediment in EU1	Visitor	NA	5E-08		25
	Sub-Total	NA	8E-08		
Dermal Exposure to Surface Water in EU1	Visitor	NA	4E-07		26
Oral Exposure to Surface Water in EU1	Visitor	NA	9E-09		27
	Sub-Total	NA	4E-07		
Dermal Exposure to Surface Soil in EU2	Visitor	NA	3E-08		28
Oral Exposure to Surface Soil in EU2	Visitor	NA	6E-07		29
	Sub-Total	NA	6E-07		
Dermal Exposure to Surface Soil in EU3	Visitor	NA	4E-09		30
Oral Exposure to Surface Soil in EU3	Visitor	NA	9E-08		31
	Sub-Total	NA	9E-08		
Dermal Exposure to Sediment in EU4	Visitor	7E-02	1E-05	cPAHs	32
Oral Exposure to Sediment in EU4	Visitor	3E-02	2E-05	cPAHs	33
	Sub-Total	1E-01	3E-05		
Dermal Exposure to Surface Water in EU4	Visitor	2E-04	9E-07		34
Oral Exposure to Surface Water in EU4	Visitor	2E-05	2E-08		35
	Sub-Total	3E-04	9E-07		
Dermal Exposure to Surface Soil in EU4	Visitor	4E-03	3E-06	*	36
Oral Exposure to Surface Soil in EU4	Visitor	3E-02	6E-05	cPAHs	37
	Sub-Total	3E-02	6E-05		
Dermal Exposure to Surface Soil in EU5	Visitor	NA	3E-07		38
Oral Exposure to Surface Soil in EU5	Visitor	NA	6E-06	Benzo(a)pyrene	39
	Sub-Total	NA	6E-06		
	Visitor Total:	***1E-01***	***9E-05***		

Table 23
Summary of Hazard and Risk Calculations
Kerr McGee, Hattiesburg, MS

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Cancer Risk	Driving Constituent	Table Referenced
Dermal Exposure to Sediment in EU1	Maintenance Worker	NA	1E-08		40
Oral Exposure to Sediment in EU1	Maintenance Worker	NA	2E-07		41
	Sub-Total	NA	2E-07		
Dermal Exposure to Surface Water in EU1	Maintenance Worker	NA	1E-06	*	42
Oral Expposure to Surface Water in EU1	Maintenance Worker	NA	4E-08		43
	Sub-Total	NA	1E-06		
Dermal Exposure to Surface Soil in EU2	Maintenance Worker	NA	5E-07		44
Oral Exposure to Surface Soil in EU2	Maintenance Worker	NA	7E-06	cPAHs	45
	Sub-Total	NA	7E-06		
Dermal Exposure to Sediment in EU4	Maintenance Worker	1E-02	4E-06	Benzo(a)pyrene	46
Oral Exposure to Sediment in EU4	Maintenance Worker	5E-02	6E-05	cPAHs	47
	Sub-Total	6E-02	7E-05		
Dermal Exposure to Surface Water in EU4	Maintenance Worker	3E-04	3E-06	*	48
Oral Exposure to Surface Water in EU4	Maintenance Worker	3E-05	9E-08		49
	Sub-Total	3E-04	3E-06		
Dermal Exposure to Surface Soil in EU4	Maintenance Worker	5E-03	2E-05	cPAHs	50
Oral Exposure to Surface Soil in EU4	Maintenance Worker	2E-02	2E-04	cPAHs	51
	Sub-Total	3E-02	2E-04		
Dermal Exposure to Surface Soil in EU5	Maintenance Worker	NA	6E-06	Benzo(a)pyrene	52
Oral Exposure to Surface Soil in EU5	Maintenance Worker	NA	9E-05	cPAHs	53
	Sub-Total	NA	1E-04		
	Maintenance Worker Total:	**8E-02**	**4E-04**		

Table 23
Summary of Hazard and Risk Calculations
Kerr McGee, Hattiesburg, MS

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Cancer Risk	Driving Constituent	Table Referenced
Dermal Exposure to Sediment in EU1	Construction Worker	NA	5E-10		54
Oral Exposure to Sediment in EU1	Construction Worker	NA	9E-09		55
	Sub-Total	NA	1E-08		
Dermal Exposure to Surface Water in EU1	Construction Worker	NA	1E-08		56
Oral Exposure to Surface Water in EU1	Construction Worker	NA	4E-10		57
	Sub-Total	NA	1E-08		
Dermal Exposure to Soil in EU2	Construction Worker	NA	4E-07		58
Oral Exposure to Soil in EU2	Construction Worker	NA	2E-06	*	59
Inhalation of Fugitive Dust in EU2	Construction Worker	NA	7E-08		60
	Sub-Total	NA	2E-06		
Dermal Exposure to Sediment in EU4	Construction Worker	NA	2E-07		61
Oral Exposure to Sediment in EU4	Construction Worker	NA	3E-06	Benzo(a)pyrene	62
	Sub-Total	NA	3E-06		
Dermal Exposure to Surface Water in EU4	Construction Worker	9E-07	3E-08		63
Oral Exposure to Surface Water in EU4	Construction Worker	5E-07	9E-10		64
	Sub-Total	1E-06	3E-08		
Dermal Exposure to Soil in EU4	Construction Worker	NA	8E-06	Benzo(a)pyrene	65
Oral Exposure to Soil in EU4	Construction Worker	NA	4E-05	cPAHs	66
Inhalation of Fugitive Dust in EU4	Construction Worker	NA	1E-06	Benzo(a)pyrene	67
	Sub-Total	NA	5E-05		
Dermal Exposure to Soil in EU5	Construction Worker	NA	7E-07		68
Oral Exposure to Soil in EU5	Construction Worker	NA	3E-06	Benzo(a)pyrene	69
Inhalation of Fugitive Dust in EU5	Construction Worker	NA	1E-07		70
	Sub-Total	NA	4E-06		
	Construction Worker Total:	**1E-06**	**5E-05**		

Dermal Exposure to Sediment in EU6	Child Off-Site Resident	NA	2E-05	cPAHs	71
Oral Exposure to Sediment in EU6	Child Off-Site Resident	NA	7E-05	cPAHs	72
	Sub-Total	NA	9E-05		
Dermal Exposure to Sediment in EU6	Adult Off-Site Resident	5E-04	4E-05	cPAHs	73
Oral Exposure to Sediment in EU6	Adult Off-Site Resident	1E-04	3E-05	cPAHs	74
	Sub-Total	6E-04	7E-05		
Dermal Exposure to Surface Water in EU6	Child Off-Site Resident	NA	2E-06	*	75
Oral Exposure to Surface Water in EU6	Child Off-Site Resident	NA	5E-07		76
	Sub-Total	NA	3E-06		
Dermal Exposure to Surface Water in EU6	Adult Off-Site Resident	NA	5E-06	*	77
Oral Exposure to Surface Water in EU6	Adult Off-Site Resident	NA	8E-08		78
	Sub-Total	NA	5E-06		
	Off-Site Resident Total:	**6E-04**	**2E-04**		

*Estimated carcinogenic risk level is below *de minimis* level as no single constituent exceeded $1x10^{-6}$ and the cumulative site carcinogenic risk is below $1x10^{-4}$ (Section 501, MCEQ, 1999).

Table 24
Dermal Exposure to EU1 Sediment by an Adolescent Visitor (Aged 7-16 years)
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3945	calculated
SA_t - Total skin surface area =	cm^2	12768.3	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.33	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.90E-01	1.68E-08	NA	NA	2.41E-09	1.46E+00	3.51E-09
Benzo(a)pyrene	3.90E-01	1.11E-08	NA	NA	1.59E-09	1.46E+01	2.32E-08
Benzo(b)fluoranthene	5.80E-01	1.66E-08	NA	NA	2.36E-09	1.46E+00	3.45E-09
Benzo(k)fluoranthene	1.90E-01	5.42E-09	NA	NA	7.75E-10	1.46E-01	1.13E-10
Chrysene	5.30E-01	1.51E-08	NA	NA	2.16E-09	1.46E-02	3.15E-11
Dibenz(a,h)anthracene	6.20E-02	1.77E-09	NA	NA	2.53E-10	1.46E+01	3.69E-09
Indeno(1,2,3-cd)pyrene	2.20E-01	6.28E-09	NA	NA	8.97E-10	1.46E+00	1.31E-09

NA - Not Available

Total Cancer Risk = 3.53E-08

Table 25
Oral Exposure to EU1 Sediment by an Adolescent Visitor (Aged 7-16 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1994, Region I
EF - Exposure frequency =	days/year	12	USEPA 1991, HHEM
ED - Exposure duration =	years	10	reasonable assumption
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	reasonable assumption
BW - Body weight =	kg	45	USEPA 1997, EFH
AT_n - Averaging time - noncarcinogenic =	days	3650	reasonable assumption
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.90E-01	4.31E-08	NA	NA	6.16E-09	7.30E-01	4.50E-09
Benzo(a)pyrene	3.90E-01	2.85E-08	NA	NA	4.07E-09	7.30E+00	2.97E-08
Benzo(b)fluoranthene	5.80E-01	4.24E-08	NA	NA	6.05E-09	7.30E-01	4.42E-09
Benzo(k)fluoranthene	1.90E-01	1.39E-08	NA	NA	1.98E-09	7.30E-02	1.45E-10
Chrysene	5.30E-01	3.87E-08	NA	NA	5.53E-09	7.30E-03	4.04E-11
Dibenz(a,h)anthracene	6.20E-02	4.53E-09	NA	NA	6.47E-10	7.30E+00	4.72E-09
Indeno(1,2,3-cd)pyrene	2.20E-01	1.61E-08	NA	NA	2.30E-09	7.30E-01	1.68E-09
						Total Cancer Risk =	4.52E-08

ENVIRONMENTAL STANDARDS

Table 26
Dermal Exposure to EU1 Surface Water by an Adolescent Visitor (aged 7-16 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cw*SA*Kp*ABS*ET*EF*ED*CF}{BW*AT}$$

Cw - Concentration in surface water =	mg/L	see below	
SA - Surface area available for exposure =	cm^2	3945	*calculated*
SA_t - Total skin surface area =	cm^2	12768.3	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
Kp - Dermal permeability constant =	cm/hr	see below	
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Kp cm/hr	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles								
Benzo(a)anthracene	1.00E-03	8.10E-01	7.00E-08	NA	NA	1.00E-08	1.46E+00	1.46E-08
Benzo(a)pyrene	5.00E-04	1.20E+00	5.19E-08	NA	NA	7.41E-09	1.46E+01	1.08E-07
Benzo(b)fluoranthene	5.00E-04	1.20E+00	5.19E-08	NA	NA	7.41E-09	1.46E+00	1.08E-08
Benzo(k)fluoranthene	5.00E-04	4.48E+01	1.94E-06	NA	NA	2.77E-07	1.46E-01	4.04E-08
Chrysene	5.00E-04	8.10E-01	3.50E-08	NA	NA	5.00E-09	1.46E-02	7.30E-11
Dibenz(a,h)anthracene	5.00E-04	2.70E+00	1.17E-07	NA	NA	1.67E-08	1.46E+01	2.43E-07
Indeno(1,2,3-cd)pyrene	5.00E-04	1.90E+00	8.22E-08	NA	NA	1.17E-08	1.46E+00	1.71E-08

NA - Not Available

Total Cancer Risk = 4.35E-07

RECEIVED
APR - 4 2001
DEQ-OPC

Table 27
Oral Exposure to EU1 Surface Water by an Adolescent Visitor (aged 7-16 years)
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Csw*IngR*EF*ED*ET}{BW*AT}$

Csw - Concentration in surface water =	mg/L	see below	
IngR - Ingestion rate for surface water =	L/hour	0.01	USEPA 1995, Region IV
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.00E-03	7.31E-09	NA	NA	1.04E-09	7.30E-01	7.62E-10
Benzo(a)pyrene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E+00	3.81E-09
Benzo(b)fluoranthene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E-01	3.81E-10
Benzo(k)fluoranthene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E-02	3.81E-11
Chrysene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E-03	3.81E-12
Dibenz(a,h)anthracene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E+00	3.81E-09
Indeno(1,2,3-cd)pyrene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E-01	3.81E-10

NA - Not Available

Total Cancer Risk = 9.18E-09

Table 28

Dermal Exposure to EU2 Surface Soil (0-1') by an Adolescent Visitor (aged 10-16 years)

Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3052	calculated
SA_t - Total skin surface area =	cm^2	12768.3	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		23.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.026	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	6.70E+00	1.17E-08	NA	NA	1.66E-09	1.46E+00	2.43E-09
Benzo(a)pyrene	5.08E+00	8.83416E-09	NA	NA	1.26E-09	1.46E+01	1.84E-08
Benzo(b)fluoranthene	9.20E+00	1.60E-08	NA	NA	2.29E-09	1.46E+00	3.34E-09
Benzo(k)fluoranthene	2.93E+00	5.10E-09	NA	NA	7.28E-10	1.46E-01	1.06E-10
Chrysene	8.00E+00	1.39121E-08	NA	NA	1.99E-09	1.46E-02	2.90E-11
Dibenz(a,h)anthracene	4.93E-01	8.57E-10	NA	NA	1.22E-10	1.46E+01	1.79E-09
Indeno(1,2,3-cd)pyrene	3.70E+00	6.43E-09	NA	NA	9.19E-10	1.46E+00	1.34E-09

NA - Not Available

Total Cancer Risk = 2.75E-08

Table 29
Oral Exposure to EU2 Surface Soil (0-1') by an Adolescent Visitor (aged 10-16 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	6.70E+00	4.89E-07	NA	NA	6.99E-08	7.30E-01	5.10E-08
Benzo(a)pyrene	5.08E+00	3.71E-07	NA	NA	5.30E-08	7.30E+00	3.87E-07
Benzo(b)fluoranthene	9.20E+00	6.72E-07	NA	NA	9.60E-08	7.30E-01	7.01E-08
Benzo(k)fluoranthene	2.93E+00	2.14E-07	NA	NA	3.06E-08	7.30E-02	2.23E-09
Chrysene	8.00E+00	5.84E-07	NA	NA	8.35E-08	7.30E-03	6.10E-10
Dibenz(a,h)anthracene	4.93E-01	3.60E-08	NA	NA	5.15E-09	7.30E+00	3.76E-08
Indeno(1,2,3-cd)pyrene	3.70E+00	2.70E-07	NA	NA	3.86E-08	7.30E-01	2.82E-08

NA - Not Applicable

Total Cancer Risk = 5.77E-07

Table 30
Dermal Exposure to EU3 Surface Soil (0-1') by an Adolescent Visitor (aged 10-16 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3052	calculated
SA_t - Total skin surface area =	cm^2	12768.3	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		23.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.026	USEPA 1997, EFH
ABS_{bap} - Absorption - cPAHs =		0.03	USEPA 1995, Region III
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.40E-01	9.39E-10	NA	NA	1.34E-10	1.46E+00	1.96E-10
Benzo(a)pyrene	7.10E-01	1.23E-09	NA	NA	1.76E-10	1.46E+01	2.58E-09
Benzo(b)fluoranthene	1.40E+00	2.43E-09	NA	NA	3.48E-10	1.46E+00	5.08E-10
Benzo(k)fluoranthene	4.90E-01	8.52E-10	NA	NA	1.22E-10	1.46E-01	1.78E-11
Chrysene	8.70E-01	1.51E-09	NA	NA	2.16E-10	1.46E-02	3.16E-12
Dibenz(a,h)anthracene	1.60E-01	2.78E-10	NA	NA	3.97E-11	1.46E+01	5.80E-10
Indeno(1,2,3-cd)pyrene	6.00E-01	1.04E-09	NA	NA	1.49E-10	1.46E+00	2.18E-10

NA - Not Available

Total Cancer Risk = 4.10E-09

Table 31
Oral Exposure to EU3 Surface Soil by an Adolescent Visitor (aged 10-16 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME_s - Matrix effect - PAHs =		1	Magee, et al., 1996
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.40E-01	3.95E-08	NA	NA	5.64E-09	7.30E-01	4.11E-09
Benzo(a)pyrene	7.10E-01	5.19E-08	NA	NA	7.41E-09	7.30E+00	5.41E-08
Benzo(b)fluoranthene	1.40E+00	1.02E-07	NA	NA	1.46E-08	7.30E-01	1.07E-08
Benzo(k)fluoranthene	4.90E-01	3.58E-08	NA	NA	5.11E-09	7.30E-02	3.73E-10
Chrysene	8.70E-01	6.36E-08	NA	NA	9.08E-09	7.30E-03	6.63E-11
Dibenz(a,h)anthracene	1.60E-01	1.17E-08	NA	NA	1.67E-09	7.30E+00	1.22E-08
Indeno(1,2,3-cd)pyrene	6.00E-01	4.38E-08	NA	NA	6.26E-09	7.30E-01	4.57E-09
						Total Cancer Risk =	8.61E-08

NA - Not Applicable

Table 32
Dermal Exposure to EU4 Sediment by an Adolescent Visitor (Aged 7-16 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3945	calculated
SA_t - Total skin surface area =	cm^2	12768.3	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.33	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	3.30E+02	9.42E-06	NA	NA	1.35E-06	1.46E+00	1.96E-06
Benzo(a)pyrene	1.30E+02	3.71E-06	NA	NA	5.30E-07	1.46E+01	7.74E-06
Benzo(b)fluoranthene	1.80E+02	5.14E-06	NA	NA	7.34E-07	1.46E+00	1.07E-06
Benzo(k)fluoranthene	6.40E+01	1.83E-06	NA	NA	2.61E-07	1.46E-01	3.81E-08
Carbazole	5.90E+02	5.61E-05	NA	NA	8.02E-06	NA	NA
Chrysene	2.90E+02	8.28E-06	NA	NA	1.18E-06	1.46E-02	1.73E-08
Dibenz(a,h)anthracene	1.20E+01	3.42E-07	NA	NA	4.89E-08	1.46E+01	7.14E-07
Dibenzofuran	9.40E+02	8.94E-05	2.00E-03	4.47E-02	1.28E-05	NA	NA
Indeno(1,2,3-cd)pyrene	4.70E+01	1.34E-06	NA	NA	1.92E-07	1.46E+00	2.80E-07
Naphthalene	3.00E+03	2.85E-04	1.00E-02	2.85E-02	4.08E-05	NA	NA
Phenanthrene	3.20E+03	3.04E-04	NA	NA	4.35E-05	NA	NA

NA - Not Available

Total Hazard Index = 7.32E-02

Total Cancer Risk = 1.18E-05

Table 33
Oral Exposure to EU4 Sediment by an Adolescent Visitor (Aged 7-16 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for sediment =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	3.30E+02	2.41E-05	NA	NA	3.44E-06	7.30E-01	2.51E-06
Benzo(a)pyrene	1.30E+02	9.50E-06	NA	NA	1.36E-06	7.30E+00	9.90E-06
Benzo(b)fluoranthene	1.80E+02	1.32E-05	NA	NA	1.88E-06	7.30E-01	1.37E-06
Benzo(k)fluoranthene	6.40E+01	4.68E-06	NA	NA	6.68E-07	7.30E-02	4.88E-08
Carbazole	5.90E+02	4.31E-05	NA	NA	6.16E-06	2.00E-02	1.23E-07
Chrysene	2.90E+02	2.12E-05	NA	NA	3.03E-06	7.30E-03	2.21E-08
Dibenz(a,h)anthracene	1.20E+01	8.77E-07	NA	NA	1.25E-07	7.30E+00	9.14E-07
Dibenzofuran	9.40E+02	6.87E-05	4.00E-03	1.72E-02	9.81E-06	NA	NA
Indeno(1,2,3-cd)pyrene	4.70E+01	3.43E-06	NA	NA	4.91E-07	7.30E-01	3.58E-07
Naphthalene	3.00E+03	2.19E-04	2.00E-02	1.10E-02	3.13E-05	NA	NA
Phenanthrene	3.20E+03	2.34E-04	NA	NA	3.34E-05	NA	NA

NA - Not Applicable

Total Hazard Index = 2.81E-02

Total Cancer Risk = 1.53E-05

ENVIRONMENTAL STANDARDS

Table 34
Dermal Exposure to EU4 Surface Water by an Adolescent Visitor (aged 7-16 years)
Kerr McGee, Hattiesburg, MS

RECEIVED
APR - 4 2001
DEQ-OPC

$$\text{Intake (mg/kg-day)} = \frac{Cw*SA*Kp*ABS*ET*EF*ED*CF}{BW*AT}$$

Cw - Concentration in surface water =	mg/L	see below	
SA - Surface area available for exposure =	cm^2	3945	calculated
SA_t - Total skin surface area =	cm^2	12768.3	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
Kp - Dermal permeability constant =	cm/hr	see below	
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPS 1995, Region IV
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Kp cm/hr	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles								
Benzo(a)anthracene	5.00E-03	8.10E-01	3.50E-07	NA	NA	5.00E-08	1.46E+00	7.30E-08
Benzo(a)pyrene	5.00E-04	1.20E+00	5.19E-08	NA	NA	7.41E-09	1.46E+01	1.08E-07
Benzo(b)fluoranthene	1.20E-02	1.20E+00	1.25E-06	NA	NA	1.78E-07	1.46E+00	2.60E-07
Benzo(k)fluoranthene	2.00E-03	4.48E+01	7.74E-06	NA	NA	1.11E-06	1.46E-01	1.62E-07
Bis(2-ethylhexyl)phthalate	3.00E-03	3.30E-02	2.85E-08	1.00E-02	2.85E-06	4.08E-09	NA	NA
Carbazole	1.00E-02	3.57E-02	1.03E-07	NA	NA	1.47E-08	NA	NA
Chrysene	6.00E-03	8.10E-01	4.20E-07	NA	NA	6.00E-08	1.46E-02	8.77E-10
Dibenz(a,h)anthracene	5.00E-04	2.70E+00	1.17E-07	NA	NA	1.67E-08	1.46E+01	2.43E-07
Dibenzofuran	1.10E-02	1.51E-01	4.79E-07	2.00E-03	2.40E-04	6.84E-08	NA	NA
Indeno(1,2,3-cd)pyrene	5.00E-04	1.90E+00	8.22E-08	NA	NA	1.17E-08	1.46E+00	1.71E-08
Phenanthrene	1.70E-02	2.30E-01	1.13E-06	NA	NA	1.61E-07	NA	NA

NA - Not Available

Total Hazard Index = 2.42E-04

Total Cancer Risk = 8.64E-07

Table 35
Oral Exposure to EU4 Surface Water by an Adolescent Visitor (aged 7-16 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Csw*IngR*EF*ED*ET}{BW*AT}$$

Csw - Concentration in surface water =	mg/L	see below	
IngR - Ingestion rate for surface water =	L/hour	0.01	USEPA 1995, Region IV
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.00E-03	3.65E-08	NA	NA	5.22E-09	7.30E-01	3.81E-09
Benzo(a)pyrene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E+00	3.81E-09
Benzo(b)fluoranthene	1.20E-02	8.77E-08	NA	NA	1.25E-08	7.30E-01	9.14E-09
Benzo(k)fluoranthene	2.00E-03	1.46E-08	NA	NA	2.09E-09	7.30E-02	1.52E-10
Bis(2-ethylhexyl)phthalate	3.00E-03	2.19E-08	2.00E-02	1.10E-06	3.13E-09	1.40E-02	4.38E-11
Carbazole	1.00E-02	7.31E-08	NA	NA	1.04E-08	2.00E-02	2.09E-10
Chrysene	6.00E-03	4.38E-08	NA	NA	6.26E-09	7.30E-03	4.57E-11
Dibenz(a,h)anthracene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E+00	3.81E-09
Dibenzofuran	1.10E-02	8.04E-08	4.00E-03	2.01E-05	1.15E-08	NA	NA
Indeno(1,2,3-cd)pyrene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E-01	3.81E-10
Phenanthrene	1.70E-02	1.24E-07	NA	NA	1.77E-08	NA	NA

NA - Not Applicable

Total Hazard Index = 2.12E-05

Total Cancer Risk = 2.14E-08

ENVIRONMENTAL STANDARDS

Table 36
Dermal Exposure to EU4 Surface Soil (0-1') by an Adolescent Visitor (Aged 7-16 years)
Kerr McGee, Hattiesburg, MS

RECEIVED
APR - 4 2001
DEQ-OPC

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3052	calculated
SA_t - Total skin surface area =	cm^2	12768.3	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		23.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.026	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
ATc - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.30E+02	1.62E-06	NA	NA	2.31E-07	1.46E+00	3.37E-07
Benzo(a)pyrene	5.00E+02	8.70E-07	NA	NA	1.24E-07	1.46E+01	1.81E-06
Benzo(b)fluoranthene	5.30E+02	9.22E-07	NA	NA	1.32E-07	1.46E+00	1.92E-07
Benzo(k)fluoranthene	2.90E+02	5.04E-07	NA	NA	7.20E-08	1.46E-01	1.05E-08
Carbazole	2.30E+02	1.33E-06	NA	NA	1.90E-07	NA	NA
Chrysene	6.90E+02	1.20E-06	NA	NA	1.71E-07	1.46E-02	2.50E-09
Dibenz(a,h)anthracene	6.40E+01	1.11E-07	NA	NA	1.59E-08	1.46E+01	2.32E-07
Fluoranthene	4.60E+03	2.67E-05	2.00E-02	1.33E-03	3.81E-06	NA	NA
Indeno(1,2,3-cd)pyrene	2.50E+02	4.35E-07	NA	NA	6.21E-08	1.46E+00	9.07E-08
Naphthalene	2.20E+03	1.28E-05	1.00E-02	1.28E-03	1.82E-06	NA	NA
Phenanthrene	6.40E+03	3.71E-05	NA	NA	5.30E-06	NA	NA
Pyrene	4.40E+03	2.55E-05	1.50E-02	1.70E-03	3.64E-06	NA	NA

NA - Not Available

Total Hazard Index = 4.31E-03

Total Cancer Risk = 2.68E-06

Table 37
Oral Exposure to EU4 Surface Soil (0-1') by an Adolescent Visitor (Aged 7-16 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in soil =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.30E+02	6.79E-05	NA	NA	9.71E-06	7.30E-01	7.09E-06
Benzo(a)pyrene	5.00E+02	3.65E-05	NA	NA	5.22E-06	7.30E+00	3.81E-05
Benzo(b)fluoranthene	5.30E+02	3.87E-05	NA	NA	5.53E-06	7.30E-01	4.04E-06
Benzo(k)fluoranthene	2.90E+02	2.12E-05	NA	NA	3.03E-06	7.30E-02	2.21E-07
Carbazole	2.30E+02	1.68E-05	NA	NA	2.40E-06	2.00E-02	4.80E-08
Chrysene	6.90E+02	5.04E-05	NA	NA	7.20E-06	7.30E-03	5.26E-08
Dibenz(a,h)anthracene	6.40E+01	4.68E-06	NA	NA	6.68E-07	7.30E+00	4.88E-06
Fluoranthene	4.60E+03	3.36E-04	4.00E-02	8.40E-03	4.80E-05	NA	NA
Indeno(1,2,3-cd)pyrene	2.50E+02	1.83E-05	NA	NA	2.61E-06	7.30E-01	1.90E-06
Naphthalene	2.20E+03	1.61E-04	2.00E-02	8.04E-03	2.30E-05	NA	NA
Phenanthrene	3.20E+03	2.34E-04	NA	NA	3.34E-05	NA	NA
Pyrene	4.40E+03	3.21E-04	3.00E-02	1.07E-02	4.59E-05	NA	NA

NA - Not Applicable

Total Hazard Index = 2.72E-02

Total Cancer Risk = 5.63E-05

Table 38

Dermal Exposure to EU5 Surface Soil (0-1') by an Adolescent Visitor (Aged 7-16 years)

Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3052	calculated
SA_t - Total skin surface area =	cm^2	12768.3	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		23.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.026	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	8.35E+01	1.45E-07	NA	NA	2.07E-08	1.46E+00	3.03E-08
Benzo(a)pyrene	5.25E+01	9.13E-08	NA	NA	1.30E-08	1.46E+01	1.90E-07
Benzo(b)fluoranthene	7.95E+01	1.38E-07	NA	NA	1.98E-08	1.46E+00	2.88E-08
Benzo(k)fluoranthene	2.85E+01	4.96E-08	NA	NA	7.08E-09	1.46E-01	1.03E-09
Chrysene	8.25E+01	1.43E-07	NA	NA	2.05E-08	1.46E-02	2.99E-10
Dibenz(a,h)anthracene	7.45E+00	1.30E-08	NA	NA	1.85E-09	1.46E+01	2.70E-08
Indeno(1,2,3-cd)pyrene	3.10E+01	5.39E-08	NA	NA	7.70E-09	1.46E+00	1.12E-08

NA - Not Available

Total Cancer Risk = 2.89E-07

Table 39

Oral Exposure to EU5 Surface Soil (0-1') by an Adolescent Visitor (Aged 7-16 years)

Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	8.35E+01	6.10E-06	NA	NA	8.71E-07	7.30E-01	6.36E-07
Benzo(a)pyrene	5.25E+01	3.84E-06	NA	NA	5.48E-07	7.30E+00	4.00E-06
Benzo(b)fluoranthene	7.95E+01	5.81E-06	NA	NA	8.30E-07	7.30E-01	6.06E-07
Benzo(k)fluoranthene	2.85E+01	2.08E-06	NA	NA	2.97E-07	7.30E-02	2.17E-08
Chrysene	8.25E+01	6.03E-06	NA	NA	8.61E-07	7.30E-03	6.29E-09
Dibenz(a,h)anthracene	7.45E+00	5.44E-07	NA	NA	7.78E-08	7.30E+00	5.68E-07
Indeno(1,2,3-cd)pyrene	3.10E+01	2.26E-06	NA	NA	3.24E-07	7.30E-01	2.36E-07

NA - Not Applicable

Total Cancer Risk = 6.07E-06

Table 40
Dermal Exposure to EU1 Sediment by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABSp - Absorption - cPAHs =		0.03	USEPA 1995, Region III
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.90E-01	2.37E-09	NA	NA	8.46E-10	1.46E+00	1.24E-09
Benzo(a)pyrene	3.90E-01	1.57E-09	NA	NA	5.59E-10	1.46E+01	8.17E-09
Benzo(b)fluoranthene	5.80E-01	2.33E-09	NA	NA	8.32E-10	1.46E+00	1.21E-09
Benzo(k)fluoranthene	1.90E-01	7.63E-10	NA	NA	2.72E-10	1.46E-01	3.98E-11
Chrysene	5.30E-01	2.13E-09	NA	NA	7.60E-10	1.46E-02	1.11E-11
Dibenz(a,h)anthracene	6.20E-02	2.49E-10	NA	NA	8.89E-11	1.46E+01	1.30E-09
Indeno(1,2,3-cd)pyrene	2.20E-01	8.83E-10	NA	NA	3.16E-10	1.46E+00	4.61E-10

NA - Not Available

Total Cancer Risk = 1.24E-08

Table 41
Oral Exposure to EU1 Sediment by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.90E-01	6.93E-08	NA	NA	2.47E-08	7.30E-01	1.81E-08
Benzo(a)pyrene	3.90E-01	4.58E-08	NA	NA	1.64E-08	7.30E+00	1.19E-07
Benzo(b)fluoranthene	5.80E-01	6.81E-08	NA	NA	2.43E-08	7.30E-01	1.78E-08
Benzo(k)fluoranthene	1.90E-01	2.23E-08	NA	NA	7.97E-09	7.30E-02	5.82E-10
Chrysene	5.30E-01	6.22E-08	NA	NA	2.22E-08	7.30E-03	1.62E-10
Dibenz(a,h)anthracene	6.20E-02	7.28E-09	NA	NA	2.60E-09	7.30E+00	1.90E-08
Indeno(1,2,3-cd)pyrene	2.20E-01	2.58E-08	NA	NA	9.23E-09	7.30E-01	6.73E-09

NA - Not Available

Total Cancer Risk = 1.82E-07

Table 42
Dermal Exposure to EU1 Surface Water by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cw*SA*Kp*ABS*ET*EF*ED*CF}{BW*AT}$$

Cw - Concentration in surface water =	mg/L	see below	
SA - Surface area available for exposure =	cm^2	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
Kp - Dermal permeability constant =	cm/hr	see below	
ABSp - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Kp cm/hr	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles								
Benzo(a)anthracene	1.00E-03	8.10E-01	8.56E-08	NA	NA	3.06E-08	1.46E+00	4.46E-08
Benzo(a)pyrene	5.00E-04	1.20E+00	6.34E-08	NA	NA	2.26E-08	1.46E+01	3.31E-07
Benzo(b)fluoranthene	5.00E-04	1.20E+00	6.34E-08	NA	NA	2.26E-08	1.46E+00	3.31E-08
Benzo(k)fluoranthene	5.00E-04	4.48E+01	2.37E-06	NA	NA	8.45E-07	1.46E-01	1.23E-07
Chrysene	5.00E-04	8.10E-01	4.28E-08	NA	NA	1.53E-08	1.46E-02	2.23E-10
Dibenz(a,h)anthracene	5.00E-04	2.70E+00	1.43E-07	NA	NA	5.10E-08	1.46E+01	7.44E-07
Indeno(1,2,3-cd)pyrene	5.00E-04	1.90E+00	1.00E-07	NA	NA	3.59E-08	1.46E+00	5.23E-08

NA - Not Available

Total Cancer Risk = 1.33E-06

Table 43
Oral Exposure to EU1 Surface Water by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Csw*IngR*EF*ED*ET}{BW*AT}$$

Csw - Concentration in surface water =	mg/L	see below	
IngR - Ingestion rate for surface water =	L/hour	0.01	USEPA 1995, Region IV
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.00E-03	1.17E-08	NA	NA	4.19E-09	7.30E-01	3.06E-09
Benzo(a)pyrene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E+00	1.53E-08
Benzo(b)fluoranthene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E-01	1.53E-09
Benzo(k)fluoranthene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E-02	1.53E-10
Chrysene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E-03	1.53E-11
Dibenz(a,h)anthracene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E+00	1.53E-08
Indeno(1,2,3-cd)pyrene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E-01	1.53E-09

NA - Not Available

Total Cancer Risk = 3.69E-08

Table 44
Dermal Exposure to EU2 Surface Soil (0-6') by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABSp - Absorption - cPAHs =		0.03	USEPA 1995, Region III
EF - Exposure frequency =	days/year	150	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	2.80E+00	5.62E-08	NA	NA	2.01E-08	1.46E+00	2.93E-08
Benzo(a)pyrene	2.64E+00	5.30E-08	NA	NA	1.89E-08	1.46E+01	2.76E-07
Benzo(b)fluoranthene	9.20E+00	1.85E-07	NA	NA	6.60E-08	1.46E+00	9.63E-08
Benzo(k)fluoranthene	1.84E+00	3.69E-08	NA	NA	1.32E-08	1.46E-01	1.93E-09
Chrysene	5.33E+00	1.07E-07	NA	NA	3.82E-08	1.46E-02	5.58E-10
Dibenz(a,h)anthracene	2.39E-01	4.80E-09	NA	NA	1.71E-09	1.46E+01	2.50E-08
Indeno(1,2,3-cd)pyrene	1.97E+00	3.96E-08	NA	NA	1.41E-08	1.46E+00	2.06E-08

NA - Not Available

Total Cancer Risk = 4.50E-07

Table 45
Oral Exposure to EU2 Surface Soil (0-6') by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	150	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	2.80E+00	1.64E-06	NA	NA	5.87E-07	7.30E-01	4.29E-07
Benzo(a)pyrene	2.64E+00	1.55E-06	NA	NA	5.54E-07	7.30E+00	4.04E-06
Benzo(b)fluoranthene	9.20E+00	5.40E-06	NA	NA	1.93E-06	7.30E-01	1.41E-06
Benzo(k)fluoranthene	1.84E+00	1.08E-06	NA	NA	3.86E-07	7.30E-02	2.82E-08
Chrysene	5.33E+00	3.13E-06	NA	NA	1.12E-06	7.30E-03	8.16E-09
Dibenz(a,h)anthracene	2.39E-01	1.40E-07	NA	NA	5.01E-08	7.30E+00	3.66E-07
Indeno(1,2,3-cd)pyrene	1.97E+00	1.16E-06	NA	NA	4.13E-07	7.30E-01	3.02E-07

NA - Not Applicable

Total Cancer Risk = 6.58E-06

RECEIVED
APR - 4 2001
DEQ-OPC

Table 46
Dermal Exposure to EU4 Sediment by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in *Sediment* mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	3.30E+02	1.33E-06	NA	NA	4.73E-07	1.46E+00	6.91E-07
Benzo(a)pyrene	1.30E+02	5.22E-07	NA	NA	1.86E-07	1.46E+01	2.72E-06
Benzo(b)fluoranthene	1.80E+02	7.23E-07	NA	NA	2.58E-07	1.46E+00	3.77E-07
Benzo(k)fluoranthene	6.40E+01	2.57E-07	NA	NA	9.18E-08	1.46E-01	1.34E-08
Carbazole	5.90E+02	7.90E-06	NA	NA	2.82E-06	NA	NA
Chrysene	2.90E+02	1.16E-06	NA	NA	4.16E-07	1.46E-02	6.07E-09
Dibenz(a,h)anthracene	1.20E+01	4.82E-08	NA	NA	1.72E-08	1.46E+01	2.51E-07
Dibenzofuran	9.40E+02	1.26E-05	2.00E-03	6.29E-03	4.49E-06	NA	NA
Indeno(1,2,3-cd)pyrene	4.70E+01	1.89E-07	NA	NA	6.74E-08	1.46E+00	9.84E-08
Naphthalene	3.00E+03	4.02E-05	1.00E-02	4.02E-03	1.43E-05	NA	NA
Phenanthrene	3.20E+03	4.28E-05	NA	NA	1.53E-05	NA	NA

NA - Not Available

Total Hazard Index = 1.03E-02

Total Cancer Risk = 4.16E-06

RECEIVED
APR - 4 2001
DEQ-OPC

Table 47
Oral Exposure to EU4 Sediment by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	3.30E+02	3.87E-05	NA	NA	1.38E-05	7.30E-01	1.01E-05
Benzo(a)pyrene	1.30E+02	1.53E-05	NA	NA	5.45E-06	7.30E+00	3.98E-05
Benzo(b)fluoranthene	1.80E+02	2.11E-05	NA	NA	7.55E-06	7.30E-01	5.51E-06
Benzo(k)fluoranthene	6.40E+01	7.51E-06	NA	NA	2.68E-06	7.30E-02	1.96E-07
Carbazole	5.90E+02	6.93E-05	NA	NA	2.47E-05	2.00E-02	4.95E-07
Chrysene	2.90E+02	3.41E-05	NA	NA	1.22E-05	7.30E-03	8.88E-08
Dibenz(a,h)anthracene	1.20E+01	1.41E-06	NA	NA	5.03E-07	7.30E+00	3.67E-06
Dibenzofuran	9.40E+02	1.10E-04	4.00E-03	2.76E-02	3.94E-05	NA	NA
Indeno(1,2,3-cd)pyrene	4.70E+01	5.52E-06	NA	NA	1.97E-06	7.30E-01	1.44E-06
Naphthalene	3.00E+03	3.52E-04	2.00E-02	1.76E-02	1.26E-04	NA	NA
Phenanthrene	3.20E+03	3.76E-04	NA	NA	1.34E-04	NA	NA

NA - Not Available   Total Hazard Index = 4.52E-02   Total Cancer Risk = 6.13E-05

RECEIVED
APR - 4 2001
DEQ-OPC

Table 48
Dermal Exposure to EU4 Surface Water by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cw*SA*Kp*ABS*ET*EF*ED*CF}{BW*AT}$

Cw - Concentration in surface water =	mg/L	see below	
SA - Surface area available for exposure =	cm^2	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
Kp - Dermal permeability constant =	cm/hr	see below	
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Kp cm/hr	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles								
Benzo(a)anthracene	5.00E-03	8.10E-01	4.28E-07	NA	NA	1.53E-07	1.46E+00	2.23E-07
Benzo(a)pyrene	5.00E-04	1.20E+00	6.34E-08	NA	NA	2.26E-08	1.46E+01	3.31E-07
Benzo(b)fluoranthene	1.20E-02	1.20E+00	1.52E-06	NA	NA	5.43E-07	1.46E+00	7.93E-07
Benzo(k)fluoranthene	2.00E-03	4.48E+01	9.46E-06	NA	NA	3.38E-06	1.46E-01	4.93E-07
Bis(2-ethylhexyl)phthalate	3.00E-03	3.30E-02	3.49E-08	1.00E-02	3.49E-06	1.25E-08	NA	NA
Carbazole	1.00E-02	3.57E-02	1.26E-07	NA	NA	4.50E-08	NA	NA
Chrysene	6.00E-03	8.10E-01	5.14E-07	NA	NA	1.83E-07	1.46E-02	2.68E-09
Dibenz(a,h)anthracene	5.00E-04	2.70E+00	1.43E-07	NA	NA	5.10E-08	1.46E+01	7.44E-07
Dibenzofuran	1.10E-02	1.51E-01	5.85E-07	2.00E-03	2.93E-04	2.09E-07	NA	NA
Indeno(1,2,3-cd)pyrene	5.00E-04	1.90E+00	1.00E-07	NA	NA	3.59E-08	1.46E+00	5.23E-08
Phenanthrene	1.70E-02	2.30E-01	1.38E-06	NA	NA	4.92E-07	NA	NA

NA - Not Available

Total Hazard Index = 2.96E-04

Total Cancer Risk = 2.64E-06

ENVIRONMENTAL STANDARDS

Table 49
Oral Exposure to EU4 Surface Water by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

RECEIVED
APR - 4 2001
DEQ-OPC

Intake (mg/kg-day) = $\frac{Csw*IngR*EF*ED*ET}{BW*AT}$

Csw - Concentration in surface water =	mg/L	see below	
IngR - Ingestion rate for surface water =	L/hour	0.01	USEPA 1995, Region IV
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.00E-03	5.87E-08	NA	NA	2.10E-08	7.30E-01	1.53E-08
Benzo(a)pyrene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E+00	1.53E-08
Benzo(b)fluoranthene	1.20E-02	1.41E-07	NA	NA	5.03E-08	7.30E-01	3.67E-08
Benzo(k)fluoranthene	2.00E-03	2.35E-08	NA	NA	8.39E-09	7.30E-02	6.12E-10
Bis(2-ethylhexyl)phthalate	3.00E-03	3.52E-08	2.00E-02	1.76E-06	1.26E-08	1.40E-02	1.76E-10
Carbazole	1.00E-02	1.17E-07	NA	NA	4.19E-08	2.00E-02	8.39E-10
Chrysene	6.00E-03	7.05E-08	NA	NA	2.52E-08	7.30E-03	1.84E-10
Dibenz(a,h)anthracene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E+00	1.53E-08
Dibenzofuran	1.10E-02	1.29E-07	4.00E-03	3.23E-05	4.61E-08	NA	NA
Indeno(1,2,3-cd)pyrene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E-01	1.53E-09
Phenanthrene	1.70E-02	2.00E-07	NA	NA	7.13E-08	NA	NA

NA - Not Available

Total Hazard Index = 3.41E-05

Total Cancer Risk = 8.60E-08

Table 50
Dermal Exposure to EU4 Surface Soil (0-6') by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

RECEIVED
APR - 4 2001
DEQ-OPC

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.30E+02	3.73E-06	NA	NA	1.33E-06	1.46E+00	1.95E-06
Benzo(a)pyrene	5.00E+02	2.01E-06	NA	NA	7.17E-07	1.46E+01	1.05E-05
Benzo(b)fluoranthene	5.30E+02	2.13E-06	NA	NA	7.60E-07	1.46E+00	1.11E-06
Benzo(k)fluoranthene	2.90E+02	1.16E-06	NA	NA	4.16E-07	1.46E-01	6.07E-08
Carbazole	6.20E+02	8.30E-06	NA	NA	2.96E-06	NA	NA
Chrysene	6.90E+02	2.77E-06	NA	NA	9.90E-07	1.46E-02	1.44E-08
Dibenz(a,h)anthracene	6.40E+01	2.57E-07	NA	NA	9.18E-08	1.46E+01	1.34E-06
Indeno(1,2,3-cd)pyrene	2.50E+02	1.00E-06	NA	NA	3.59E-07	1.46E+00	5.23E-07
Naphthalene	3.50E+03	4.68E-05	1.00E-02	4.68E-03	1.67E-05	NA	NA

NA - Not Available　　Total Hazard Index = 4.68E-03　　Total Cancer Risk = 1.55E-05

Table 51
Oral Exposure to EU4 Surface Soil (0-6') by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in soil =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.30E+02	1.09E-04	NA	NA	3.90E-05	7.30E-01	2.85E-05
Benzo(a)pyrene	5.00E+02	5.87E-05	NA	NA	2.10E-05	7.30E+00	1.53E-04
Benzo(b)fluoranthene	5.30E+02	6.22E-05	NA	NA	2.22E-05	7.30E-01	1.62E-05
Benzo(k)fluoranthene	2.90E+02	3.41E-05	NA	NA	1.22E-05	7.30E-02	8.88E-07
Carbazole	6.20E+02	7.28E-05	NA	NA	2.60E-05	2.00E-02	5.20E-07
Chrysene	6.90E+02	8.10E-05	NA	NA	2.89E-05	7.30E-03	2.11E-07
Dibenz(a,h)anthracene	6.40E+01	7.51E-06	NA	NA	2.68E-06	7.30E+00	1.96E-05
Indeno(1,2,3-cd)pyrene	2.50E+02	2.94E-05	NA	NA	1.05E-05	7.30E-01	7.65E-06
Naphthalene	3.50E+03	4.11E-04	2.00E-02	2.05E-02	1.47E-04	NA	NA

NA - Not Available

Total Hazard Index = 2.05E-02

Total Cancer Risk = 2.27E-04

Table 52
Dermal Exposure to EU5 Surface Soil (0-6') by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
EF - Exposure frequency =	days/year	150	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	7.77E+01	1.56E-06	NA	NA	5.57E-07	1.46E+00	8.13E-07
Benzo(a)pyrene	4.10E+01	8.23E-07	NA	NA	2.94E-07	1.46E+01	4.29E-06
Benzo(b)fluoranthene	7.95E+01	1.60E-06	NA	NA	5.70E-07	1.46E+00	8.32E-07
Benzo(k)fluoranthene	1.97E+01	3.96E-07	NA	NA	1.41E-07	1.46E-01	2.06E-08
Chrysene	8.25E+01	1.66E-06	NA	NA	5.92E-07	1.46E-02	8.64E-09
Dibenz(a,h)anthracene	2.04E+00	4.10E-08	NA	NA	1.46E-08	1.46E+01	2.14E-07
Indeno(1,2,3-cd)pyrene	1.71E+01	3.43E-07	NA	NA	1.23E-07	1.46E+00	1.79E-07

NA - Not Available

Total Cancer Risk = 6.36E-06

Table 53
Oral Exposure to EU5 Surface Soil (0-6') by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	*USEPA 1997, EFH*
EF - Exposure frequency =	days/year	150	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	7.77E+01	4.56E-05	NA	NA	1.63E-05	7.30E-01	1.19E-05
Benzo(a)pyrene	4.10E+01	2.41E-05	NA	NA	8.60E-06	7.30E+00	6.28E-05
Benzo(b)fluoranthene	7.95E+01	4.67E-05	NA	NA	1.67E-05	7.30E-01	1.22E-05
Benzo(k)fluoranthene	1.97E+01	1.16E-05	NA	NA	4.13E-06	7.30E-02	3.02E-07
Chrysene	8.25E+01	4.84E-05	NA	NA	1.73E-05	7.30E-03	1.26E-07
Dibenz(a,h)anthracene	2.04E+00	1.20E-06	NA	NA	4.28E-07	7.30E+00	3.12E-06
Indeno(1,2,3-cd)pyrene	1.71E+01	1.00E-05	NA	NA	3.59E-06	7.30E-01	2.62E-06

NA - Not Applicable

Total Cancer Risk = 9.30E-05

Table 54
Dermal Exposure to EU1 Sediment by a Construction Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.13	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
EF - Exposure frequency =	days/year	8	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.90E-01	2.16E-09	NA	NA	3.09E-11	1.46E+00	4.51E-11
Benzo(a)pyrene	3.90E-01	1.43E-09	NA	NA	2.04E-11	1.46E+01	2.98E-10
Benzo(b)fluoranthene	5.80E-01	2.12E-09	NA	NA	3.04E-11	1.46E+00	4.43E-11
Benzo(k)fluoranthene	1.90E-01	6.96E-10	NA	NA	9.94E-12	1.46E-01	1.45E-12
Chrysene	5.30E-01	1.94E-09	NA	NA	2.77E-11	1.46E-02	4.05E-13
Dibenz(a,h)anthracene	6.20E-02	2.27E-10	NA	NA	3.24E-12	1.46E+01	4.74E-11
Indeno(1,2,3-cd)pyrene	2.20E-01	8.06E-10	NA	NA	1.15E-11	1.46E+00	1.68E-11

Total Cancer Risk = 4.53E-10

NA - Not Available

Table 55
Oral Exposure to EU1 Sediment by a Construction Worker
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	480	USEPA 1997, EFH
EF - Exposure frequency =	days/year	8	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.90E-01	8.87E-08	NA	NA	1.27E-09	7.30E-01	9.25E-10
Benzo(a)pyrene	3.90E-01	5.86E-08	NA	NA	8.37E-10	7.30E+00	6.11E-09
Benzo(b)fluoranthene	5.80E-01	8.72E-08	NA	NA	1.25E-09	7.30E-01	9.09E-10
Benzo(k)fluoranthene	1.90E-01	2.86E-08	NA	NA	4.08E-10	7.30E-02	2.98E-11
Chrysene	5.30E-01	7.97E-08	NA	NA	1.14E-09	7.30E-03	8.31E-12
Dibenz(a,h)anthracene	6.20E-02	9.32E-09	NA	NA	1.33E-10	7.30E+00	9.72E-10
Indeno(1,2,3-cd)pyrene	2.20E-01	3.31E-08	NA	NA	4.72E-10	7.30E-01	3.45E-10

NA - Not Applicable

Total Cancer Risk = 9.30E-09

Table 56
Dermal Exposure to EU1 Surface Water by a Construction Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cw*SA*Kp*ABS*ET*EF*ED*CF}{BW*AT}$$

Cw - Concentration in surface water =	mg/L	see below	
SA - Surface area available for exposure =	cm^2	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
Kp - Dermal permeability constant =	cm/hr	see below	
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
EF - Exposure frequency =	days/year	8	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Kp cm/hr	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles								
Benzo(a)anthracene	1.00E-03	8.10E-01	2.28E-08	NA	NA	3.26E-10	1.46E+00	4.76E-10
Benzo(a)pyrene	5.00E-04	1.20E+00	1.69E-08	NA	NA	2.42E-10	1.46E+01	3.53E-09
Benzo(b)fluoranthene	5.00E-04	1.20E+00	1.69E-08	NA	NA	2.42E-10	1.46E+00	3.53E-10
Benzo(k)fluoranthene	5.00E-04	4.48E+01	6.31E-07	NA	NA	9.02E-09	1.46E-01	1.32E-09
Chrysene	5.00E-04	8.10E-01	1.14E-08	NA	NA	1.63E-10	1.46E-02	2.38E-12
Dibenz(a,h)anthracene	5.00E-04	2.70E+00	3.80E-08	NA	NA	5.43E-10	1.46E+01	7.93E-09
Indeno(1,2,3-cd)pyrene	5.00E-04	1.90E+00	2.68E-08	NA	NA	3.82E-10	1.46E+00	5.58E-10

NA - Not Available

Total Cancer Risk = 1.42E-08

Table 57
Oral Exposure to EU1 Surface Water by a Construction Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Csw*IngR*EF*ED*ET}{BW*AT}$$

Csw - Concentration in surface water =	mg/L	see below	
IngR - Ingestion rate for surface water =	L/hour	0.01	USEPA 1995, Region IV
EF - Exposure frequency =	days/year	8	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.00E-03	3.13E-09	NA	NA	4.47E-11	7.30E-01	3.27E-11
Benzo(a)pyrene	5.00E-04	1.57E-09	NA	NA	2.24E-11	7.30E+00	1.63E-10
Benzo(b)fluoranthene	5.00E-04	1.57E-09	NA	NA	2.24E-11	7.30E-01	1.63E-11
Benzo(k)fluoranthene	5.00E-04	1.57E-09	NA	NA	2.24E-11	7.30E-02	1.63E-12
Chrysene	5.00E-04	1.57E-09	NA	NA	2.24E-11	7.30E-03	1.63E-13
Dibenz(a,h)anthracene	5.00E-04	1.57E-09	NA	NA	2.24E-11	7.30E+00	1.63E-10
Indeno(1,2,3-cd)pyrene	5.00E-04	1.57E-09	NA	NA	2.24E-11	7.30E-01	1.63E-11

NA - Not Applicable

Total Cancer Risk = 3.94E-10

ENVIRONMENTAL STANDARDS

RECEIVED
APR - 4 2001
DEQ-OPC

Table 58
Dermal Exposure to EU2 Soil (0-10') by a Construction Worker
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	5560	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		27.8%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.1	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
EF - Exposure frequency =	days/year	80	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	6.10E+01	3.19E-06	NA	NA	4.55E-08	1.46E+00	6.64E-08
Benzo(a)pyrene	2.17E+01	1.13E-06	NA	NA	1.62E-08	1.46E+01	2.36E-07
Benzo(b)fluoranthene	3.30E+01	1.72E-06	NA	NA	2.46E-08	1.46E+00	3.59E-08
Benzo(k)fluoranthene	1.10E+01	5.74E-07	NA	NA	8.21E-09	1.46E-01	1.20E-09
Chrysene	5.20E+01	2.72E-06	NA	NA	3.88E-08	1.46E-02	5.66E-10
Dibenz(a,h)anthracene	1.69E+00	8.82E-08	NA	NA	1.26E-09	1.46E+01	1.84E-08
Indeno(1,2,3-cd)pyrene	8.70E+00	4.54E-07	NA	NA	6.49E-09	1.46E+00	9.48E-09

NA - Not Available

Total Cancer Risk = 3.68E-07

Table 59
Oral Exposure to EU2 Soil (0-10') by a Construction Worker
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$

Parameter	Units	Value	Source
Cd - Concentration in soil =	mg/kg	see below	
$IngR_a$ - Ingestion rate for soil =	mg/day	480	USEPA 1997, EFH
$IngR_b$ - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF_a - Exposure frequency =	days/year	10	reasonable assumption
EF_b - Exposure frequency =	days/year	70	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Exposure Level A

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	6.10E+01	1.15E-05	NA	NA	1.64E-07	7.30E-01	1.20E-07
Benzo(a)pyrene	2.17E+01	4.07E-06	NA	NA	5.82E-08	7.30E+00	4.25E-07
Benzo(b)fluoranthene	3.30E+01	6.20E-06	NA	NA	8.86E-08	7.30E-01	6.47E-08
Benzo(k)fluoranthene	1.10E+01	2.07E-06	NA	NA	2.95E-08	7.30E-02	2.16E-09
Chrysene	5.20E+01	9.77E-06	NA	NA	1.40E-07	7.30E-03	1.02E-09
Dibenz(a,h)anthracene	1.69E+00	3.17E-07	NA	NA	4.53E-09	7.30E+00	3.31E-08
Indeno(1,2,3-cd)pyrene	8.70E+00	1.63E-06	NA	NA	2.33E-08	7.30E-01	1.70E-08
						Cancer Risk =	6.62E-07

NA - Not Available

Exposure Level B

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	6.10E+01	1.67E-05	NA	NA	2.39E-07	7.30E-01	1.74E-07
Benzo(a)pyrene	2.17E+01	5.94E-06	NA	NA	8.48E-08	7.30E+00	6.19E-07
Benzo(b)fluoranthene	3.30E+01	9.04E-06	NA	NA	1.29E-07	7.30E-01	9.43E-08
Benzo(k)fluoranthene	1.10E+01	3.01E-06	NA	NA	4.31E-08	7.30E-02	3.14E-09
Chrysene	5.20E+01	1.42E-05	NA	NA	2.04E-07	7.30E-03	1.49E-09
Dibenz(a,h)anthracene	1.69E+00	4.63E-07	NA	NA	6.61E-09	7.30E+00	4.83E-08
Indeno(1,2,3-cd)pyrene	8.70E+00	2.38E-06	NA	NA	3.41E-08	7.30E-01	2.49E-08
						Cancer Risk =	9.65E-07

NA - Not Available

Total Cancer Risk = 1.63E-06

Table 60

Exposure to Construction Workers from Inhalation of Fugitive Dust in EU2

Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Ca*InhR*EF*ED*RF}{BW*AT}$$

Ca - Concentration in air =	mg/m^3	chem.spec.	
InhR - Inhalation Rate =	m^3/shift	20	USEPA 1995, Region IV
EF - Exposure Frequency =	shifts/year	80	reasonable assumption
ED - Exposure Duration =	years	1	reasonable assumption
RF_s - Retention Factor - semivolatiles =		0.75	ICRP, 1968
AT_n - Averaging Time noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM
BW - Body Weight =	kg	70	USEPA 1995, Region IV

E_i - Emission Rate (mg/sec) = Cs*(PERv+PERe)

Cs - Concentration in soil = mg/kg chem.spec.

Ca = Concentration in Air (mg/m^3) = Ei / (Hb * W * V)

Ei - Emission Rate of Component (mg/sec) = see below

Hb - Downwind Ht (m) = 4.81

W - Width (m) = 50

V - Wind speed (m/sec) = 4.69

Length (downwind distance) (m) = 50

r - Roughness Ht. (m) = 0.20

z - downwind distance (m) = 50

z = 6.25r[Hb/r * Ln(Hb/r) - 1.58*Hb/r + 1.58]

Chemicals	Concentration in Soil mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles									
Benzo(a)anthracene	6.10E+01	6.67E-02	5.92E-05	2.78E-06	NA	NA	3.97E-08	3.10E-01	1.23E-08
Benzo(a)pyrene	2.17E+01	2.37E-02	2.10E-05	9.88E-07	NA	NA	1.41E-08	3.10E+00	4.37E-08
Benzo(b)fluoranthene	3.30E+01	3.61E-02	3.20E-05	1.50E-06	NA	NA	2.15E-08	3.10E-01	6.66E-09
Benzo(k)fluoranthene	1.10E+01	1.20E-02	1.07E-05	5.01E-07	NA	NA	7.16E-09	3.10E-02	2.22E-10
Chrysene	5.20E+01	5.69E-02	5.05E-05	2.37E-06	NA	NA	3.39E-08	3.10E-03	1.05E-10
Dibenz(a,h)anthracene	1.69E+00	1.85E-03	1.64E-06	7.70E-08	NA	NA	1.10E-09	3.10E+00	3.41E-09
Indeno(1,2,3-cd)pyrene	8.70E+00	9.51E-03	8.44E-06	3.96E-07	NA	NA	5.66E-09	3.10E-01	1.76E-09
								Total Cancer Risk:	6.82E-08

NA - Not Available

Table 61
Dermal Exposure to EU4 Sediment by a Construction Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.13	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	8	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	3.30E+02	1.21E-06	NA	NA	1.73E-08	1.46E+00	2.52E-08
Benzo(a)pyrene	1.30E+02	4.76E-07	NA	NA	6.80E-09	1.46E+01	9.93E-08
Benzo(b)fluoranthene	1.80E+02	6.59E-07	NA	NA	9.42E-09	1.46E+00	1.38E-08
Benzo(k)fluoranthene	6.40E+01	2.34E-07	NA	NA	3.35E-09	1.46E-01	4.89E-10
Carbazole	5.90E+02	7.20E-06	NA	NA	1.03E-07	NA	NA
Chrysene	2.90E+02	1.06E-06	NA	NA	1.52E-08	1.46E-02	2.22E-10
Dibenz(a,h)anthracene	1.20E+01	4.40E-08	NA	NA	6.28E-10	1.46E+01	9.17E-09
Dibenzofuran	9.40E+02	1.15E-05	NA	NA	1.64E-07	NA	NA
Indeno(1,2,3-cd)pyrene	4.70E+01	1.72E-07	NA	NA	2.46E-09	1.46E+00	3.59E-09
Naphthalene	3.00E+03	3.66E-05	NA	NA	5.23E-07	NA	NA
Phenanthrene	3.20E+03	3.91E-05	NA	NA	5.58E-07	NA	NA

NA - Not Available

Total Cancer Risk = 1.52E-07

Table 62
Oral Exposure to EU4 Sediment by a Construction Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for sediment =	mg/day	480	USEPA 1997, EFH
EF - Exposure frequency =	days/year	8	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	3.30E+02	4.96E-05	NA	NA	7.09E-07	7.30E-01	5.17E-07
Benzo(a)pyrene	1.30E+02	1.95E-05	NA	NA	2.79E-07	7.30E+00	2.04E-06
Benzo(b)fluoranthene	1.80E+02	2.71E-05	NA	NA	3.86E-07	7.30E-01	2.82E-07
Benzo(k)fluoranthene	6.40E+01	9.62E-06	NA	NA	1.37E-07	7.30E-02	1.00E-08
Carbazole	5.90E+02	8.87E-05	NA	NA	1.27E-06	2.00E-02	2.53E-08
Chrysene	2.90E+02	4.36E-05	NA	NA	6.23E-07	7.30E-03	4.55E-09
Dibenz(a,h)anthracene	1.20E+01	1.80E-06	NA	NA	2.58E-08	7.30E+00	1.88E-07
Dibenzofuran	9.40E+02	1.41E-04	NA	NA	2.02E-06	NA	NA
Indeno(1,2,3-cd)pyrene	4.70E+01	7.06E-06	NA	NA	1.01E-07	7.30E-01	7.37E-08
Naphthalene	3.00E+03	4.51E-04	NA	NA	6.44E-06	NA	NA
Phenanthrene	3.20E+03	4.81E-04	NA	NA	6.87E-06	NA	NA

NA - Not Applicable

Total Cancer Risk = 3.14E-06

RECEIVED
APR - 4 2001
DEQ-OPC

Table 63
Dermal Exposure to EU4 Surface Water by a Construction Worker
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cw*SA*Kp*ABS*ET*EF*ED*CF}{BW*AT}$

Cw - Concentration in surface water =	mg/L	see below	
SA - Surface area available for exposure =	cm^2	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
Kp - Dermal permeability constant =	cm/hr	see below	
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
EF - Exposure frequency =	days/year	8	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Kp cm/hr	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles								
Benzo(a)anthracene	5.00E-03	8.10E-01	1.14E-07	NA	NA	1.63E-09	1.46E+00	2.38E-09
Benzo(a)pyrene	5.00E-04	1.20E+00	1.69E-08	NA	NA	2.42E-10	1.46E+01	3.53E-09
Benzo(b)fluoranthene	1.20E-02	1.20E+00	4.06E-07	NA	NA	5.80E-09	1.46E+00	8.46E-09
Benzo(k)fluoranthene	2.00E-03	4.48E+01	2.52E-06	NA	NA	3.60E-08	1.46E-01	5.26E-09
Bis(2-ethylhexyl)phthalate	3.00E-03	3.30E-02	9.30E-09	1.00E-02	9.30E-07	1.33E-10	NA	NA
Carbazole	1.00E-02	3.57E-02	3.36E-08	NA	NA	4.80E-10	NA	NA
Chrysene	6.00E-03	8.10E-01	1.37E-07	NA	NA	1.96E-09	1.46E-02	2.86E-11
Dibenz(a,h)anthracene	5.00E-04	2.70E+00	3.80E-08	NA	NA	5.43E-10	1.46E+01	7.93E-09
Dibenzofuran	1.10E-02	1.51E-01	1.56E-07	NA	NA	2.23E-09	NA	NA
Indeno(1,2,3-cd)pyrene	5.00E-04	1.90E+00	2.68E-08	NA	NA	3.82E-10	1.46E+00	5.58E-10
Phenanthrene	1.70E-02	2.30E-01	3.67E-07	NA	NA	5.25E-09	NA	NA

NA - Not Available

Total Hazard Index = 9.30E-07

Total Cancer Risk = 2.82E-08

Table 64
Oral Exposure to EU4 Surface Water by a Construction Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Csw*IngR*EF*ED*ET}{BW*AT}$$

Csw - Concentration in surface water =	mg/L	see below	
IngR - Ingestion rate for surface water =	L/hour	0.01	USEPA 1995, Region IV
EF - Exposure frequency =	days/year	8	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.00E-03	1.57E-08	NA	NA	2.24E-10	7.30E-01	1.63E-10
Benzo(a)pyrene	5.00E-04	1.57E-09	NA	NA	2.24E-11	7.30E+00	1.63E-10
Benzo(b)fluoranthene	1.20E-02	3.76E-08	NA	NA	5.37E-10	7.30E-01	3.92E-10
Benzo(k)fluoranthene	2.00E-03	6.26E-09	NA	NA	8.95E-11	7.30E-02	6.53E-12
Bis(2-ethylhexyl)phthalate	3.00E-03	9.39E-09	2.00E-02	4.70E-07	1.34E-10	1.40E-02	1.88E-12
Carbazole	1.00E-02	3.13E-08	NA	NA	4.47E-10	2.00E-02	8.95E-12
Chrysene	6.00E-03	1.88E-08	NA	NA	2.68E-10	7.30E-03	1.96E-12
Dibenz(a,h)anthracene	5.00E-04	1.57E-09	NA	NA	2.24E-11	7.30E+00	1.63E-10
Dibenzofuran	1.10E-02	3.44E-08	NA	NA	4.92E-10	NA	NA
Indeno(1,2,3-cd)pyrene	5.00E-04	1.57E-09	NA	NA	2.24E-11	7.30E-01	1.63E-11
Phenanthrene	1.70E-02	5.32E-08	NA	NA	7.60E-10	NA	NA

NA - Not Applicable

Total Hazard Index = 4.70E-07

Total Cancer Risk = 9.17E-10

ENVIRONMENTAL STANDARDS

Table 65
Dermal Exposure to EU4 Soil (0-20') by a Construction Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	5560	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		27.8%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.1	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	80	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.30E+02	4.86E-05	NA	NA	6.94E-07	1.46E+00	1.01E-06
Benzo(a)pyrene	5.00E+02	2.61E-05	NA	NA	3.73E-07	1.46E+01	5.45E-06
Benzo(b)fluoranthene	5.30E+02	2.77E-05	NA	NA	3.95E-07	1.46E+00	5.77E-07
Benzo(k)fluoranthene	2.90E+02	1.51E-05	NA	NA	2.16E-07	1.46E-01	3.16E-08
Carbazole	6.20E+02	1.08E-04	NA	NA	1.54E-06	NA	NA
Chrysene	6.90E+02	3.60E-05	NA	NA	5.15E-07	1.46E-02	7.52E-09
Dibenz(a,h)anthracene	6.40E+01	3.34E-06	NA	NA	4.78E-08	1.46E+01	6.97E-07
Indeno(1,2,3-cd)pyrene	2.50E+02	1.31E-05	NA	NA	1.87E-07	1.46E+00	2.72E-07
Naphthalene	3.50E+03	6.09E-04	NA	NA	8.70E-06	NA	NA

NA - Not Available

Total Cancer Risk = 8.05E-06

Table 66
Oral Exposure to EU4 Soil (0-20') by a Construction Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in soil =	mg/kg	see below	
$IngR_a$ - Ingestion rate for soil =	mg/day	480	USEPA 1997, EFH
$IngR_b$ - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF_a - Exposure frequency =	days/year	10	reasonable assumption
EF_b - Exposure frequency =	days/year	70	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Exposure Level A

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.30E+02	1.75E-04	NA	NA	2.50E-06	7.30E-01	1.82E-06
Benzo(a)pyrene	5.00E+02	9.39E-05	NA	NA	1.34E-06	7.30E+00	9.80E-06
Benzo(b)fluoranthene	5.30E+02	9.96E-05	NA	NA	1.42E-06	7.30E-01	1.04E-06
Benzo(k)fluoranthene	2.90E+02	5.45E-05	NA	NA	7.78E-07	7.30E-02	5.68E-08
Carbazole	6.20E+02	1.16E-04	NA	NA	1.66E-06	2.00E-02	3.33E-08
Chrysene	6.90E+02	1.30E-04	NA	NA	1.85E-06	7.30E-03	1.35E-08
Dibenz(a,h)anthracene	6.40E+01	1.20E-05	NA	NA	1.72E-07	7.30E+00	1.25E-06
Indeno(1,2,3-cd)pyrene	2.50E+02	4.70E-05	NA	NA	6.71E-07	7.30E-01	4.90E-07
Naphthalene	3.50E+03	6.58E-04	NA	NA	9.39E-06	NA	NA

NA - Not Applicable

Cancer Risk = 1.45E-05

Exposure Level B

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.30E+02	2.55E-04	NA	NA	3.64E-06	7.30E-01	2.66E-06
Benzo(a)pyrene	5.00E+02	1.37E-04	NA	NA	1.96E-06	7.30E+00	1.43E-05
Benzo(b)fluoranthene	5.30E+02	1.45E-04	NA	NA	2.07E-06	7.30E-01	1.51E-06
Benzo(k)fluoranthene	2.90E+02	7.95E-05	NA	NA	1.14E-06	7.30E-02	8.29E-08
Carbazole	6.20E+02	1.70E-04	NA	NA	2.43E-06	2.00E-02	4.85E-08
Chrysene	6.90E+02	1.89E-04	NA	NA	2.70E-06	7.30E-03	1.97E-08
Dibenz(a,h)anthracene	6.40E+01	1.75E-05	NA	NA	2.50E-07	7.30E+00	1.83E-06
Indeno(1,2,3-cd)pyrene	2.50E+02	6.85E-05	NA	NA	9.78E-07	7.30E-01	7.14E-07
Naphthalene	3.50E+03	9.59E-04	NA	NA	1.37E-05	NA	NA

NA - Not Applicable

Cancer Risk = 2.12E-05

Total Cancer Risk = 3.57E-05

Table 67

Exposure to Construction Workers from Inhalation of Fugitive Dust in EU4

Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Ca*InhR*EF*ED*RF}{BW*AT}$

Ca - Concentration in air =	mg/m^3	see below	
InhR - Inhalation Rate =	m^3/shift	20	USEPA 1995, Region IV
EF - Exposure Frequency =	shifts/year	80	reasonable assumption
ED - Exposure Duration =	years	1	reasonable assumption
RF_s - Retention Factor - semivolatiles =		0.75	ICRP, 1968
AT_n - Averaging Time noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM
BW - Body Weight =	kg	70	USEPA 1995, Region IV

E_i - Emission Rate (mg/sec) = Cs*(PERv+PERe)

Cs - Concentration in soil = mg/kg see below

Ca = Concentration in Air (mg/m^3) = Ei / (Hb * W * V)

Ei - Emission Rate of Component (mg/sec) = see below

Hb - Downwind Ht (m) = 4.81

W - Width (m) = 50

V - Wind speed (m/sec) = 4.69

Length (downwind distance) (m) = 50

r - Roughness Ht. (m) = 0.20

z - downwind distance (m) = 50

z = 6.25r[Hb/r * Ln(Hb/r) - 1.58*Hb/r + 1.58]

Chemicals	Concentration in Soil mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor l/(mg/kg-day)	Cancer Risk
Semivolatiles									
Benzo(a)anthracene	9.30E+02	1.02E+00	9.02E-04	4.24E-05	NA	NA	6.05E-07	3.10E-01	1.88E-07
Benzo(a)pyrene	5.00E+02	5.47E-01	4.85E-04	2.28E-05	NA	NA	3.26E-07	3.10E+00	1.01E-06
Benzo(b)fluoranthene	5.30E+02	5.79E-01	5.14E-04	2.42E-05	NA	NA	3.45E-07	3.10E-01	1.07E-07
Benzo(k)fluoranthene	2.90E+02	3.17E-01	2.81E-04	1.32E-05	NA	NA	1.89E-07	3.10E-02	5.85E-09
Carbazole	6.20E+02	6.78E-01	6.02E-04	2.83E-05	NA	NA	4.04E-07	NA	NA
Chrysene	6.90E+02	7.54E-01	6.70E-04	3.14E-05	NA	NA	4.49E-07	3.10E-03	1.39E-09
Dibenz(a,h)anthracene	6.40E+01	7.00E-02	6.21E-05	2.92E-06	NA	NA	4.17E-08	3.10E+00	1.29E-07
Indeno(1,2,3-cd)pyrene	2.50E+02	2.73E-01	2.43E-04	1.14E-05	NA	NA	1.63E-07	3.10E-01	5.05E-08
Naphthalene	3.50E+03	3.83E+00	3.40E-03	1.60E-04	NA	NA	2.28E-06	NA	NA
								Total Cancer Risk:	1.49E-06

NA - Not Available

Table 68
Dermal Exposure to EU5 Soil (0-20') by a Construction Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	5560	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		27.8%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.1	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	80	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	8.35E+01	4.36E-06	NA	NA	6.23E-08	1.46E+00	9.10E-08
Benzo(a)pyrene	4.42E+01	2.31E-06	NA	NA	3.30E-08	1.46E+01	4.81E-07
Benzo(b)fluoranthene	7.95E+01	4.15E-06	NA	NA	5.93E-08	1.46E+00	8.66E-08
Benzo(k)fluoranthene	1.68E+01	8.77E-07	NA	NA	1.25E-08	1.46E-01	1.83E-09
Chrysene	8.25E+01	4.31E-06	NA	NA	6.16E-08	1.46E-02	8.99E-10
Dibenz(a,h)anthracene	1.53E+00	7.99E-08	NA	NA	1.14E-09	1.46E+01	1.67E-08
Indeno(1,2,3-cd)pyrene	1.32E+01	6.89E-07	NA	NA	9.85E-09	1.46E+00	1.44E-08

NA - Not Available

Total Cancer Risk = 6.93E-07

Table 69
Oral Exposure to EU5 Soil (0-20') by a Construction Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
$IngR_a$ - Ingestion rate for soil =	mg/day	480	USEPA 1997, EFH
$IngR_b$ - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF_a - Exposure frequency =	days/year	10	reasonable assumption
EF_b - Exposure frequency =	days/year	70	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Exposure Level A

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	8.35E+01	1.57E-05	NA	NA	2.24E-07	7.30E-01	1.64E-07
Benzo(a)pyrene	4.42E+01	8.30E-06	NA	NA	1.19E-07	7.30E+00	8.66E-07
Benzo(b)fluoranthene	7.95E+01	1.49E-05	NA	NA	2.13E-07	7.30E-01	1.56E-07
Benzo(k)fluoranthene	1.68E+01	3.16E-06	NA	NA	4.51E-08	7.30E-02	3.29E-09
Chrysene	8.25E+01	1.55E-05	NA	NA	2.21E-07	7.30E-03	1.62E-09
Dibenz(a,h)anthracene	1.53E+00	2.87E-07	NA	NA	4.11E-09	7.30E+00	3.00E-08
Indeno(1,2,3-cd)pyrene	1.32E+01	2.48E-06	NA	NA	3.54E-08	7.30E-01	2.59E-08

NA - Not Available

Cancer Risk = 1.25E-06

Exposure Level B

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	8.35E+01	2.29E-05	NA	NA	3.27E-07	7.30E-01	2.39E-07
Benzo(a)pyrene	4.42E+01	1.21E-05	NA	NA	1.73E-07	7.30E+00	1.26E-06
Benzo(b)fluoranthene	7.95E+01	2.18E-05	NA	NA	3.11E-07	7.30E-01	2.27E-07
Benzo(k)fluoranthene	1.68E+01	4.60E-06	NA	NA	6.58E-08	7.30E-02	4.80E-09
Chrysene	8.25E+01	2.26E-05	NA	NA	3.23E-07	7.30E-03	2.36E-09
Dibenz(a,h)anthracene	1.53E+00	4.19E-07	NA	NA	5.99E-09	7.30E+00	4.37E-08
Indeno(1,2,3-cd)pyrene	1.32E+01	3.62E-06	NA	NA	5.17E-08	7.30E-01	3.77E-08

NA - Not Available

Cancer Risk = 1.82E-06

Total Cancer Risk = 3.06E-06

Table 70
Exposure to Construction Workers from Inhalation of Fugitive Dust in EU5
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Ca*InhR*EF*ED*RF}{BW*AT}$$

Ca - Concentration in air =	mg/m^3	see below	
InhR - Inhalation Rate =	m^3/shift	20	USEPA 1995, Region IV
EF - Exposure Frequency =	shifts/year	80	reasonable assumption
ED - Exposure Duration =	years	1	reasonable assumption
RF_s - Retention Factor - semivolatiles =		0.75	ICRP, 1968
AT_n - Averaging Time noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM
BW - Body Weight =	kg	70	USEPA 1995, Region IV

E_i - Emission Rate (mg/sec) = Cs*(PERv+PERe)
Cs - Concentration in soil = mg/kg see below

Ca = Concentration in Air (mg/m^3) = Ei / (Hb * W * V)
Ei - Emission Rate of Component (mg/sec) = see below
Hb - Downwind Ht (m) = 4.81
W - Width (m) = 50
V - Wind speed (m/sec) = 4.69
Length (downwind distance) (m) = 50
r - Roughness Ht. (m) = 0.20
z - downwind distance (m) = 50
z = 6.25r[Hb/r * Ln(Hb/r) - 1.58*Hb/r + 1.58]

Chemicals	Concentration in Soil mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles									
Benzo(a)anthracene	8.35E+01	9.13E-02	8.10E-05	3.81E-06	NA	NA	5.44E-08	3.10E-01	1.69E-08
Benzo(a)pyrene	4.42E+01	4.83E-02	4.29E-05	2.01E-06	NA	NA	2.88E-08	3.10E+00	8.92E-08
Benzo(b)fluoranthene	7.95E+01	8.69E-02	7.71E-05	3.62E-06	NA	NA	5.18E-08	3.10E-01	1.60E-08
Benzo(k)fluoranthene	1.68E+01	1.84E-02	1.63E-05	7.66E-07	NA	NA	1.09E-08	3.10E-02	3.39E-10
Chrysene	8.25E+01	9.02E-02	8.01E-05	3.76E-06	NA	NA	5.37E-08	3.10E-03	1.67E-10
Dibenz(a,h)anthracene	1.53E+00	1.67E-03	1.48E-06	6.97E-08	NA	NA	9.96E-10	3.10E+00	3.09E-09
Indeno(1,2,3-cd)pyrene	1.32E+01	1.44E-02	1.28E-05	6.02E-07	NA	NA	8.59E-09	3.10E-01	2.66E-09
								Total Cancer Risk:	1.28E-07

NA - Not Available

Table 71
Dermal Exposure to EU6 Sediment by a Child Resident (Aged 1 to 6 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	2229	calculated
SA_t - Total skin surface area =	cm^2	7213	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.33	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	6	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	15	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	2190	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.00E-01	2.15E-07	NA	NA	1.84E-08	NA	NA
2-Nitrophenol	8.00E-01	4.30E-07	NA	NA	3.68E-08	NA	NA
3-Nitroaniline	8.00E-01	4.30E-07	NA	NA	3.68E-08	NA	NA
4-Bromophenylphenylether	8.00E-01	4.30E-07	NA	NA	3.68E-08	NA	NA
4-Chloro-3-methylphenol	8.00E-01	4.30E-07	NA	NA	3.68E-08	NA	NA
4-Chlorophenylphenylether	4.00E-01	2.15E-07	NA	NA	1.84E-08	NA	NA
4-Nitroaniline	8.00E-01	4.30E-07	NA	NA	3.68E-08	NA	NA
Benzo(a)anthracene	1.00E+02	1.61E-05	NA	NA	1.38E-06	1.46E+00	2.02E-06
Benzo(a)pyrene	4.90E+01	7.90E-06	NA	NA	6.77E-07	1.46E+01	9.89E-06
Benzo(b)fluoranthene	7.80E+01	1.26E-05	NA	NA	1.08E-06	1.46E+00	1.57E-06
Benzo(k)fluroanthene	2.30E+01	3.71E-06	NA	NA	3.18E-07	1.46E-01	4.64E-08
Bis(2-chloroethoxy)methane	8.00E-01	4.30E-07	NA	NA	3.68E-08	NA	NA
Bis(2-chloroethyl)ether	4.00E-01	2.15E-07	NA	NA	1.84E-08	NA	NA
Carbazole	1.00E+02	5.37E-05	NA	NA	4.61E-06	NA	NA
Chrysene	7.60E+01	1.23E-05	NA	NA	1.05E-06	1.46E-02	1.53E-08
Dibenz(a,h)anthracene	9.60E+00	1.55E-06	NA	NA	1.33E-07	1.46E+01	1.94E-06
Hexachlorobenzene	4.00E-01	2.15E-07	NA	NA	1.84E-08	NA	NA
Hexachlorocyclopentadiene	2.00E+00	1.07E-06	NA	NA	9.21E-08	NA	NA
Indeno(1,2,3-cd)pyrene	3.90E+01	6.29E-06	NA	NA	5.39E-07	1.46E+00	7.87E-07
N-nitrosodi-n-propylamine	4.00E-01	2.15E-07	NA	NA	1.84E-08	NA	NA

NA - Not Available

Total Cancer Risk = 1.63E-05

Table 72
Oral Exposure to EU6 Sediment by a Child Resident (Aged 1 to 6 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for sediment =	mg/day	200	USEPA 1997, EFH
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	6	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	15	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	2190	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.00E-01	5.84E-07	NA	NA	5.01E-08	NA	NA
2-Nitrophenol	8.00E-01	1.17E-06	NA	NA	1.00E-07	NA	NA
3-Nitroaniline	8.00E-01	1.17E-06	NA	NA	1.00E-07	NA	NA
4-Bromophenylphenylether	8.00E-01	1.17E-06	NA	NA	1.00E-07	NA	NA
4-Chloro-3-methylphenol	8.00E-01	1.17E-06	NA	NA	1.00E-07	NA	NA
4-Chlorophenylphenylether	4.00E-01	5.84E-07	NA	NA	5.01E-08	NA	NA
4-Nitroaniline	8.00E-01	1.17E-06	NA	NA	1.00E-07	NA	NA
Benzo(a)anthracene	1.00E+02	1.46E-04	NA	NA	1.25E-05	7.30E-01	9.14E-06
Benzo(a)pyrene	4.90E+01	7.16E-05	NA	NA	6.14E-06	7.30E+00	4.48E-05
Benzo(b)fluoranthene	7.80E+01	1.14E-04	NA	NA	9.77E-06	7.30E-01	7.13E-06
Benzo(k)fluroanthene	2.30E+01	3.36E-05	NA	NA	2.88E-06	7.30E-02	2.10E-07
Bis(2-chloroethoxy)methane	8.00E-01	1.17E-06	NA	NA	1.00E-07	NA	NA
Bis(2-chloroethyl)ether	4.00E-01	5.84E-07	NA	NA	5.01E-08	1.10E+00	5.51E-08
Carbazole	1.00E+02	1.46E-04	NA	NA	1.25E-05	2.00E-02	2.50E-07
Chrysene	7.60E+01	1.11E-04	NA	NA	9.52E-06	7.30E-03	6.95E-08
Dibenz(a,h)anthracene	9.60E+00	1.40E-05	NA	NA	1.20E-06	7.30E+00	8.78E-06
Hexachlorobenzene	4.00E-01	5.84E-07	NA	NA	5.01E-08	1.60E+00	8.02E-08
Hexachlorocyclopentadiene	2.00E+00	2.92E-06	NA	NA	2.50E-07	NA	NA
Indeno(1,2,3-cd)pyrene	3.90E+01	5.70E-05	NA	NA	4.88E-06	7.30E-01	3.57E-06
N-nitrosodi-n-propylamine	4.00E-01	5.84E-07	NA	NA	5.01E-08	7.00E+00	3.51E-07

NA - Not Applicable

Total Cancer Risk = 7.44E-05

RECEIVED
APR - 4 2001
DEQ-OPC

Table 73
Dermal Exposure to EU6 Sediment by an Adult Resident (Aged 7 to 30 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	6180	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.33	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	24	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	8760	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.00E-01	1.28E-07	NA	NA	4.38E-08	NA	NA
2-Nitrophenol	8.00E-01	2.55E-07	NA	NA	8.76E-08	NA	NA
3-Nitroaniline	8.00E-01	2.55E-07	NA	NA	8.76E-08	NA	NA
4-Bromophenylphenylether	8.00E-01	2.55E-07	NA	NA	8.76E-08	NA	NA
4-Chloro-3-methylphenol	8.00E-01	2.55E-07	NA	NA	8.76E-08	NA	NA
4-Chlorophenylphenylether	4.00E-01	1.28E-07	NA	NA	4.38E-08	NA	NA
4-Nitroaniline	8.00E-01	2.55E-07	NA	NA	8.76E-08	NA	NA
Benzo(a)anthracene	1.00E+02	9.58E-06	NA	NA	3.28E-06	1.46E+00	4.79E-06
Benzo(a)pyrene	4.90E+01	4.69E-06	NA	NA	1.61E-06	1.46E+01	2.35E-05
Benzo(b)fluoranthene	7.80E+01	7.47E-06	NA	NA	2.56E-06	1.46E+00	3.74E-06
Benzo(k)fluroanthene	2.30E+01	2.20E-06	NA	NA	7.55E-07	1.46E-01	1.10E-07
Bis(2-chloroethoxy)methane	8.00E-01	2.55E-07	NA	NA	8.76E-08	NA	NA
Bis(2-chloroethyl)ether	4.00E-01	1.28E-07	NA	NA	4.38E-08	NA	NA
Carbazole	1.00E+02	3.19E-05	NA	NA	1.09E-05	NA	NA
Chrysene	7.60E+01	7.28E-06	NA	NA	2.50E-06	1.46E-02	3.64E-08
Dibenz(a,h)anthracene	9.60E+00	9.20E-07	NA	NA	3.15E-07	1.46E+01	4.60E-06
Hexachlorobenzene	4.00E-01	1.28E-07	4.00E-04	3.19E-04	4.38E-08	NA	NA
Hexachlorocyclopentadiene	2.00E+00	6.39E-07	3.50E-03	1.82E-04	2.19E-07	NA	NA
Indeno(1,2,3-cd)pyrene	3.90E+01	3.74E-06	NA	NA	1.28E-06	1.46E+00	1.87E-06
N-nitrosodi-n-propylamine	4.00E-01	1.28E-07	NA	NA	4.38E-08	NA	NA

NA - Not Available

Total Hazard Index = 5.02E-04

Total Cancer Risk = 3.86E-05

Table 74
Oral Exposure to EU6 Sediment by an Adult Resident (Aged 7 to 30 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for sediment =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	24	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	8760	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.00E-01	6.26E-08	NA	NA	2.15E-08	NA	NA
2-Nitrophenol	8.00E-01	1.25E-07	NA	NA	4.29E-08	NA	NA
3-Nitroaniline	8.00E-01	1.25E-07	NA	NA	4.29E-08	NA	NA
4-Bromophenylphenylether	8.00E-01	1.25E-07	NA	NA	4.29E-08	NA	NA
4-Chloro-3-methylphenol	8.00E-01	1.25E-07	NA	NA	4.29E-08	NA	NA
4-Chlorophenylphenylether	4.00E-01	6.26E-08	NA	NA	2.15E-08	NA	NA
4-Nitroaniline	8.00E-01	1.25E-07	NA	NA	4.29E-08	NA	NA
Benzo(a)anthracene	1.00E+02	1.57E-05	NA	NA	5.37E-06	7.30E-01	3.92E-06
Benzo(a)pyrene	4.90E+01	7.67E-06	NA	NA	2.63E-06	7.30E+00	1.92E-05
Benzo(b)fluoranthene	7.80E+01	1.22E-05	NA	NA	4.19E-06	7.30E-01	3.06E-06
Benzo(k)fluroanthene	2.30E+01	3.60E-06	NA	NA	1.23E-06	7.30E-02	9.01E-08
Bis(2-chloroethoxy)methane	8.00E-01	1.25E-07	NA	NA	4.29E-08	NA	NA
Bis(2-chloroethyl)ether	4.00E-01	6.26E-08	NA	NA	2.15E-08	1.10E+00	2.36E-08
Carbazole	1.00E+02	1.57E-05	NA	NA	5.37E-06	2.00E-02	1.07E-07
Chrysene	7.60E+01	1.19E-05	NA	NA	4.08E-06	7.30E-03	2.98E-08
Dibenz(a,h)anthracene	9.60E+00	1.50E-06	NA	NA	5.15E-07	7.30E+00	3.76E-06
Hexachlorobenzene	4.00E-01	6.26E-08	8.00E-04	7.83E-05	2.15E-08	1.60E+00	3.44E-08
Hexachlorocyclopentadiene	2.00E+00	3.13E-07	7.00E-03	4.47E-05	1.07E-07	NA	NA
Indeno(1,2,3-cd)pyrene	3.90E+01	6.11E-06	NA	NA	2.09E-06	7.30E-01	1.53E-06
N-nitrosodi-n-propylamine	4.00E-01	6.26E-08	NA	NA	2.15E-08	7.00E+00	1.50E-07

NA - Not Applicable | Total Hazard Index = 1.23E-04 | Total Cancer Risk = 3.19E-05

Table 75
Dermal Exposure to EU6 Surface Water by a Child Resident (Aged 1 to 6 years)
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cw*SA*Kp*ABS*ET*EF*ED*CF}{BW*AT}$

Parameter	Units	Value	Source
Cw - Concentration in surface water =	mg/L	see below	
SA - Surface area available for exposure =	cm^2	2229	calculated
SA_t - Total skin surface area =	cm^2	7213	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
Kp - Dermal permeability constant =	cm/hr	see below	
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	6	USEPA 1995, Region IV
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	15	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	2190	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Kp cm/hr	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles								
Benzo(a)anthracene	5.00E-04	8.10E-01	1.98E-07	NA	NA	1.70E-08	1.46E+00	2.48E-08
Benzo(a)pyrene	5.00E-04	1.20E+00	2.93E-07	NA	NA	2.51E-08	1.46E+01	3.67E-07
Benzo(b)fluoranthene	9.00E-03	1.20E+00	5.28E-06	NA	NA	4.52E-07	1.46E+00	6.60E-07
Benzo(k)fluoranthene	5.00E-04	4.48E+01	1.09E-05	NA	NA	9.38E-07	1.46E-01	1.37E-07
Chrysene	5.00E-04	8.10E-01	1.98E-07	NA	NA	1.70E-08	1.46E-02	2.48E-10
Dibenz(a,h)anthracene	5.00E-04	2.70E+00	6.59E-07	NA	NA	5.65E-08	1.46E+01	8.25E-07
Indeno(1,2,3-cd)pyrene	5.00E-04	1.90E+00	4.64E-07	NA	NA	3.98E-08	1.46E+00	5.81E-08

NA - Not Available

Total Cancer Risk = 2.07E-06

Table 76
Oral Exposure to EU6 Surface Water by a Child Resident (Aged 1 to 6 years)
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Csw*IngR*EF*ED*ET}{BW*AT}$

Csw - Concentration in surface water =	mg/L	see below	
IngR - Ingestion rate for surface water =	L/hour	0.05	USEPA 1995, Region IV
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	6	USEPA 1995, Region IV
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
BW - Body weight =	kg	15	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	2190	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.00E-04	1.83E-07	NA	NA	1.57E-08	7.30E-01	1.14E-08
Benzo(a)pyrene	5.00E-04	1.83E-07	NA	NA	1.57E-08	7.30E+00	1.14E-07
Benzo(b)fluoranthene	9.00E-03	3.29E-06	NA	NA	2.82E-07	7.30E-01	2.06E-07
Benzo(k)fluoranthene	5.00E-04	1.83E-07	NA	NA	1.57E-08	7.30E-02	1.14E-09
Chrysene	5.00E-04	1.83E-07	NA	NA	1.57E-08	7.30E-03	1.14E-10
Dibenz(a,h)anthracene	5.00E-04	1.83E-07	NA	NA	1.57E-08	7.30E+00	1.14E-07
Indeno(1,2,3-cd)pyrene	5.00E-04	1.83E-07	NA	NA	1.57E-08	7.30E-01	1.14E-08

NA - Not Applicable

Total Cancer Risk = 4.58E-07

Table 77
Dermal Exposure to EU6 Surface Water by an Adult Resident (Aged 7 to 30 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cw*SA*Kp*ABS*ET*EF*ED*CF}{BW*AT}$$

Parameter	Units	Value	Source
Cw - Concentration in surface water =	mg/L	see below	
SA - Surface area available for exposure =	cm^2	6180	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
Kp - Dermal permeability constant =	cm/hr	see below	
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	24	USEPA 1995, Region IV
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	8760	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Kp cm/hr	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles								
Benzo(a)anthracene	5.00E-04	8.10E-01	1.18E-07	NA	NA	4.03E-08	1.46E+00	5.88E-08
Benzo(a)pyrene	5.00E-04	1.20E+00	1.74E-07	NA	NA	5.97E-08	1.46E+01	8.72E-07
Benzo(b)fluoranthene	9.00E-03	1.20E+00	3.13E-06	NA	NA	1.07E-06	1.46E+00	1.57E-06
Benzo(k)fluoranthene	5.00E-04	4.48E+01	6.50E-06	NA	NA	2.23E-06	1.46E-01	3.25E-07
Chrysene	5.00E-04	8.10E-01	1.18E-07	NA	NA	4.03E-08	1.46E-02	5.88E-10
Dibenz(a,h)anthracene	5.00E-04	2.70E+00	3.92E-07	NA	NA	1.34E-07	1.46E+01	1.96E-06
Indeno(1,2,3-cd)pyrene	5.00E-04	1.90E+00	2.76E-07	NA	NA	9.45E-08	1.46E+00	1.38E-07
							Total Cancer Risk =	4.93E-06

NA - Not Available

Table 78
Oral Exposure to EU6 Surface Water by an Adult Resident (Aged 7 to 30 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Csw*IngR*EF*ED*ET}{BW*AT}$$

Csw - Concentration in surface water =	mg/L	see below	
IngR - Ingestion rate for surface water =	L/hour	0.01	USEPA 1995, Region IV
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	24	USEPA 1995, Region IV
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	8760	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.00E-04	7.83E-09	NA	NA	2.68E-09	7.30E-01	1.96E-09
Benzo(a)pyrene	5.00E-04	7.83E-09	NA	NA	2.68E-09	7.30E+00	1.96E-08
Benzo(b)fluoranthene	9.00E-03	1.41E-07	NA	NA	4.83E-08	7.30E-01	3.53E-08
Benzo(k)fluoranthene	5.00E-04	7.83E-09	NA	NA	2.68E-09	7.30E-02	1.96E-10
Chrysene	5.00E-04	7.83E-09	NA	NA	2.68E-09	7.30E-03	1.96E-11
Dibenz(a,h)anthracene	5.00E-04	7.83E-09	NA	NA	2.68E-09	7.30E+00	1.96E-08
Indeno(1,2,3-cd)pyrene	5.00E-04	7.83E-09	NA	NA	2.68E-09	7.30E-01	1.96E-09

NA - Not Applicable

Total Cancer Risk = 7.86E-08

Table 79
Dermal Exposure to EU4 Sediment by an Adolescent Visitor (Aged 7-16 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3945	calculated
SA_t - Total skin surface area =	cm^2	12768.3	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.33	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	2.56E+00	7.31E-08	NA	NA	1.04E-08	1.46E+00	1.52E-08
Benzo(a)pyrene	3.10E+00	8.85E-08	NA	NA	1.26E-08	1.46E+01	1.85E-07
Benzo(b)fluoranthene	4.78E+00	1.36E-07	NA	NA	1.95E-08	1.46E+00	2.85E-08
Benzo(k)fluoranthene	2.27E+00	6.48E-08	NA	NA	9.25E-09	1.46E-01	1.35E-09
Carbazole	*	NA	NA	NA	NA	NA	NA
Chrysene	*	NA	NA	NA	NA	1.46E-02	NA
Dibenz(a,h)anthracene	5.87E-01	1.68E-08	NA	NA	2.39E-09	1.46E+01	3.49E-08
Dibenzofuran	*	NA	2.00E-03	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.40E+00	6.85E-08	NA	NA	9.78E-09	1.46E+00	1.43E-08
Naphthalene	*	NA	1.00E-02	NA	NA	NA	NA
Phenanthrene	*	NA	NA	NA	NA	NA	NA

NA - Not Available/Not Applicable

Total Cancer Risk = 2.79E-07

*Constituent not present in remaining samples.

Table 80
Oral Exposure to EU4 Sediment by an Adolescent Visitor (Aged 7-16 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for sediment =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	2.56E+00	1.87E-07	NA	NA	2.67E-08	7.30E-01	1.95E-08
Benzo(a)pyrene	3.10E+00	2.26E-07	NA	NA	3.24E-08	7.30E+00	2.36E-07
Benzo(b)fluoranthene	4.78E+00	3.49E-07	NA	NA	4.99E-08	7.30E-01	3.64E-08
Benzo(k)fluoranthene	2.27E+00	1.66E-07	NA	NA	2.37E-08	7.30E-02	1.73E-09
Carbazole	*	NA	NA	NA	NA	2.00E-02	NA
Chrysene	*	NA	NA	NA	NA	7.30E-03	NA
Dibenz(a,h)anthracene	5.87E-01	4.29E-08	NA	NA	6.13E-09	7.30E+00	4.47E-08
Dibenzofuran	*	NA	4.00E-03	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.40E+00	1.75E-07	NA	NA	2.50E-08	7.30E-01	1.83E-08
Naphthalene	*	NA	2.00E-02	NA	NA	NA	NA
Phenanthrene	*	NA	NA	NA	NA	NA	NA

NA - Not Available/Not Applicable

Total Cancer Risk = 3.57E-07

*Constituent not present in remaining samples.

Table 81
Dermal Exposure to EU4 Sediment by a Maintenance Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	2.56E+00	1.03E-08	NA	NA	3.67E-09	1.46E+00	5.36E-09
Benzo(a)pyrene	3.10E+00	1.24E-08	NA	NA	4.45E-09	1.46E+01	6.49E-08
Benzo(b)fluoranthene	4.78E+00	1.92E-08	NA	NA	6.86E-09	1.46E+00	1.00E-08
Benzo(k)fluoranthene	2.27E+00	9.12E-09	NA	NA	3.26E-09	1.46E-01	4.75E-10
Carbazole	*	NA	NA	NA	NA	NA	NA
Chrysene	*	NA	NA	NA	NA	1.46E-02	NA
Dibenz(a,h)anthracene	5.87E-01	2.36E-09	NA	NA	8.42E-10	1.46E+01	1.23E-08
Dibenzofuran	*	NA	2.00E-03	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.40E+00	9.64E-09	NA	NA	3.44E-09	1.46E+00	5.03E-09
Naphthalene	*	NA	1.00E-02	NA	NA	NA	NA
Phenanthrene	*	NA	NA	NA	NA	NA	NA

NA - Not Available/Not Applicable

Total Cancer Risk = 9.81E-08

*Constituent not present in remaining samples.

RECEIVED APR - 4 2001 DEQ-OPC

Table 82
Oral Exposure to EU4 Sediment by a Maintenance Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	**Concentration in Sediment mg/kg**	**Average Daily Intake mg/kg-day**	**Oral Chronic RfD mg/kg-day**	**Hazard Index**	**Average Lifetime Daily Intake mg/kg-day**	**Oral Cancer Slope Factor 1/(mg/kg-day)**	**Cancer Risk**
Semivolatiles							
Benzo(a)anthracene	2.56E+00	3.01E-07	NA	NA	1.07E-07	7.30E-01	7.84E-08
Benzo(a)pyrene	3.10E+00	3.64E-07	NA	NA	1.30E-07	7.30E+00	9.49E-07
Benzo(b)fluoranthene	4.78E+00	5.61E-07	NA	NA	2.00E-07	7.30E-01	1.46E-07
Benzo(k)fluoranthene	2.27E+00	2.67E-07	NA	NA	9.52E-08	7.30E-02	6.95E-09
Carbazole	*	NA	NA	NA	NA	2.00E-02	NA
Chrysene	*	NA	NA	NA	NA	7.30E-03	NA
Dibenz(a,h)anthracene	5.87E-01	6.89E-08	NA	NA	2.46E-08	7.30E+00	1.80E-07
Dibenzofuran	*	NA	4.00E-03	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.40E+00	2.82E-07	NA	NA	1.01E-07	7.30E-01	7.35E-08
Naphthalene	*	NA	2.00E-02	NA	NA	NA	NA
Phenanthrene	*	NA	NA	NA	NA	NA	NA
						Total Cancer Risk =	1.43E-06

NA - Not Available/Not Applicable
*Constituent not present in remaining samples.

ENVIRONMENTAL STANDARDS

RECEIVED
APR - 4 2001
DEQ-OPC

Table 83
Oral Exposure to EU4 Sediment by a Construction Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for sediment =	mg/day	480	USEPA 1997, EFH
EF - Exposure frequency =	days/year	8	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	2.56E+00	3.85E-07	NA	NA	5.50E-09	7.30E-01	4.01E-09
Benzo(a)pyrene	3.10E+00	4.66E-07	NA	NA	6.66E-09	7.30E+00	4.86E-08
Benzo(b)fluoranthene	4.78E+00	7.18E-07	NA	NA	1.03E-08	7.30E-01	7.49E-09
Benzo(k)fluoranthene	2.27E+00	3.41E-07	NA	NA	4.87E-09	7.30E-02	3.56E-10
Carbazole	*	NA	NA	NA	NA	2.00E-02	NA
Chrysene	*	NA	NA	NA	NA	7.30E-03	NA
Dibenz(a,h)anthracene	5.87E-01	8.82E-08	NA	NA	1.26E-09	7.30E+00	9.20E-09
Dibenzofuran	*	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.40E+00	3.61E-07	NA	NA	5.15E-09	7.30E-01	3.76E-09
Naphthalene	*	NA	NA	NA	NA	NA	NA
Phenanthrene	*	NA	NA	NA	NA	NA	NA

Total Cancer Risk = 7.34E-08

NA - Not Available/Not Applicable
*Constituent not present in remaining samples.

Table 84
Dermal Exposure to EU4 Surface Soil (0-6') by a Maintenance Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	8.10E-01	3.25E-09	NA	NA	1.16E-09	1.46E+00	1.70E-09
Benzo(a)pyrene	2.90E-01	1.16E-09	NA	NA	4.16E-10	1.46E+01	6.07E-09
Benzo(b)fluoranthene	3.70E-01	1.49E-09	NA	NA	5.31E-10	1.46E+00	7.75E-10
Benzo(k)fluoranthene	1.60E-01	6.43E-10	NA	NA	2.29E-10	1.46E-01	3.35E-11
Carbazole	4.90E-01	6.56E-09	NA	NA	2.34E-09	NA	NA
Chrysene	6.10E-01	2.45E-09	NA	NA	8.75E-10	1.46E-02	1.28E-11
Dibenz(a,h)anthracene	1.10E-02	4.42E-11	NA	NA	1.58E-11	1.46E+01	2.30E-10
Indeno(1,2,3-cd)pyrene	9.40E-02	3.77E-10	NA	NA	1.35E-10	1.46E+00	1.97E-10
Naphthalene	4.00E-01	5.35E-09	1.00E-02	5.35E-07	1.91E-09	NA	NA

NA - Not Available

Total Hazard Index = 5.35E-07

Total Cancer Risk = 9.02E-09

Table 85
Oral Exposure to EU4 Surface Soil (0-6') by a Maintenance Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in soil =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	8.10E-01	9.51E-08	NA	NA	3.40E-08	7.30E-01	2.48E-08
Benzo(a)pyrene	2.90E-01	3.41E-08	NA	NA	1.22E-08	7.30E+00	8.88E-08
Benzo(b)fluoranthene	3.70E-01	4.34E-08	NA	NA	1.55E-08	7.30E-01	1.13E-08
Benzo(k)fluoranthene	1.60E-01	1.88E-08	NA	NA	6.71E-09	7.30E-02	4.90E-10
Carbazole	4.90E-01	5.75E-08	NA	NA	2.05E-08	2.00E-02	4.11E-10
Chrysene	6.10E-01	7.16E-08	NA	NA	2.56E-08	7.30E-03	1.87E-10
Dibenz(a,h)anthracene	1.10E-02	1.29E-09	NA	NA	4.61E-10	7.30E+00	3.37E-09
Indeno(1,2,3-cd)pyrene	9.40E-02	1.10E-08	NA	NA	3.94E-09	7.30E-01	2.88E-09
Naphthalene	4.00E-01	4.70E-08	2.00E-02	2.35E-06	1.68E-08	NA	NA

NA - Not Applicable　　Total Hazard Index = 2.35E-06　　Total Cancer Risk = 1.32E-07

ENVIRONMENTAL STANDARDS

Table 86
Dermal Exposure to EU4 Soil (0-20') by a Construction Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	5560	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		27.8%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.1	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	80	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.50E+01	7.83E-07	NA	NA	1.12E-08	1.46E+00	1.63E-08
Benzo(a)pyrene	5.20E+00	2.72E-07	NA	NA	3.88E-09	1.46E+01	5.66E-08
Benzo(b)fluoranthene	7.80E+00	4.07E-07	NA	NA	5.82E-09	1.46E+00	8.50E-09
Benzo(k)fluoranthene	3.70E+00	1.93E-07	NA	NA	2.76E-09	1.46E-01	4.03E-10
Carbazole	9.50E+00	1.65E-06	NA	NA	2.36E-08	NA	NA
Chrysene	1.20E+01	6.27E-07	NA	NA	8.95E-09	1.46E-02	1.31E-10
Dibenz(a,h)anthracene	5.00E-01	2.61E-08	NA	NA	3.73E-10	1.46E+01	5.45E-09
Indeno(1,2,3-cd)pyrene	2.00E+00	1.04E-07	NA	NA	1.49E-09	1.46E+00	2.18E-09
Naphthalene	1.50E+02	2.61E-05	NA	NA	3.73E-07	NA	NA

NA - Not Available

Total Cancer Risk = 8.96E-08

Table 87
Oral Exposure to EU4 Soil (0-20') by a Construction Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in soil =	mg/kg	see below	
$IngR_a$ - Ingestion rate for soil =	mg/day	480	USEPA 1997, EFH
$IngR_b$ - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF_a - Exposure frequency =	days/year	10	reasonable assumption
EF_b - Exposure frequency =	days/year	70	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Exposure Level A

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.50E+01	2.82E-06	NA	NA	4.03E-08	7.30E-01	2.94E-08
Benzo(a)pyrene	5.20E+00	9.77E-07	NA	NA	1.40E-08	7.30E+00	1.02E-07
Benzo(b)fluoranthene	7.80E+00	1.47E-06	NA	NA	2.09E-08	7.30E-01	1.53E-08
Benzo(k)fluoranthene	3.70E+00	6.95E-07	NA	NA	9.93E-09	7.30E-02	7.25E-10
Carbazole	9.50E+00	1.78E-06	NA	NA	2.55E-08	2.00E-02	5.10E-10
Chrysene	1.20E+01	2.25E-06	NA	NA	3.22E-08	7.30E-03	2.35E-10
Dibenz(a,h)anthracene	5.00E-01	9.39E-08	NA	NA	1.34E-09	7.30E+00	9.80E-09
Indeno(1,2,3-cd)pyrene	2.00E+00	3.76E-07	NA	NA	5.37E-09	7.30E-01	3.92E-09
Naphthalene	1.50E+02	2.82E-05	NA	NA	4.03E-07	NA	NA

NA - Not Available

Cancer Risk = 1.62E-07

Exposure Level B

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.50E+01	4.11E-06	NA	NA	5.87E-08	7.30E-01	4.29E-08
Benzo(a)pyrene	5.20E+00	1.42E-06	NA	NA	2.04E-08	7.30E+00	1.49E-07
Benzo(b)fluoranthene	7.80E+00	2.14E-06	NA	NA	3.05E-08	7.30E-01	2.23E-08
Benzo(k)fluoranthene	3.70E+00	1.01E-06	NA	NA	1.45E-08	7.30E-02	1.06E-09
Carbazole	9.50E+00	2.60E-06	NA	NA	3.72E-08	2.00E-02	7.44E-10
Chrysene	1.20E+01	3.29E-06	NA	NA	4.70E-08	7.30E-03	3.43E-10
Dibenz(a,h)anthracene	5.00E-01	1.37E-07	NA	NA	1.96E-09	7.30E+00	1.43E-08
Indeno(1,2,3-cd)pyrene	2.00E+00	5.48E-07	NA	NA	7.83E-09	7.30E-01	5.71E-09
Naphthalene	1.50E+02	4.11E-05	NA	NA	5.87E-07	NA	NA

NA - Not Available

Cancer Risk = 2.36E-07

Total Cancer Risk = 3.98E-07

Table 88

Exposure to Construction Workers from Inhalation of Fugitive Dust in EU4

Preliminary Remediation Goal Calculation

Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Ca*InhR*EF*ED*RF}{BW*AT}$

Parameter	Units	Value	Source
Ca - Concentration in air =	mg/m³	see below	
InhR - Inhalation Rate =	m³/shift	20	USEPA 1995, Region IV
EF - Exposure Frequency =	shifts/year	80	reasonable assumption
ED - Exposure Duration =	years	1	reasonable assumption
RF_s - Retention Factor - semivolatiles =		0.75	ICRP, 1968
AT_n - Averaging Time noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM
BW - Body Weight =	kg	70	USEPA 1995, Region IV

Ca = Concentration in Air (mg/m³) = Ei / (Hb * W * V)

Ei - Emission Rate of Component (mg/sec) = see below

Hb - Downwind Ht (m) = 4.81

W - Width (m) = 50

V - Wind speed (m/sec) = 4.69

Length (downwind distance) (m) = 50

r - Roughness Ht. (m) = 0.20

z - downwind distance (m) = 50

z = 6.25r[Hb/r * Ln(Hb/r) - 1.58*Hb/r + 1.58]

E_i - Emission Rate (mg/sec) = Cs*(PERv+PERe)

Cs - Concentration in soil = mg/kg see below

Chemicals	Concentration in Soil mg/kg	Emission Rate mg/sec	Concentration In Air mg/m³	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles									
Benzo(a)anthracene	1.50E+01	1.64E-02	1.46E-05	6.84E-07	NA	NA	9.77E-09	3.10E-01	3.03E-09
Benzo(a)pyrene	5.20E+00	5.69E-03	5.05E-06	2.37E-07	NA	NA	3.39E-09	3.10E+00	1.05E-08
Benzo(b)fluoranthene	7.80E+00	8.53E-03	7.57E-06	3.55E-07	NA	NA	5.08E-09	3.10E-01	1.57E-09
Benzo(k)fluoranthene	3.70E+00	4.05E-03	3.59E-06	1.69E-07	NA	NA	2.41E-09	3.10E-02	7.47E-11
Carbazole	9.50E+00	1.04E-02	9.22E-06	4.33E-07	NA	NA	6.19E-09	NA	NA
Chrysene	1.20E+01	1.31E-02	1.16E-05	5.47E-07	NA	NA	7.81E-09	3.10E-03	2.42E-11
Dibenz(a,h)anthracene	5.00E-01	5.47E-04	4.85E-07	2.28E-08	NA	NA	3.26E-10	3.10E+00	1.01E-09
Indeno(1,2,3-cd)pyrene	2.00E+00	2.19E-03	1.94E-06	9.11E-08	NA	NA	1.30E-09	3.10E-01	4.04E-10
Naphthalene	1.50E+02	1.64E-01	1.46E-04	6.84E-06	NA	NA	9.77E-08	NA	NA
								Total Cancer Risk:	1.66E-08

NA - Not Available

APR - 4 2001
DEQ-OPC

Table 89
Oral Exposure to EU5 Surface Soil (0-1') by an Adolescent Visitor (Aged 7-16 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	2.90E-01	2.12E-08	NA	NA	3.03E-09	7.30E-01	2.21E-09
Benzo(a)pyrene	3.70E-01	2.70E-08	NA	NA	3.86E-09	7.30E+00	2.82E-08
Benzo(b)fluoranthene	7.60E-01	5.55E-08	NA	NA	7.93E-09	7.30E-01	5.79E-09
Benzo(k)fluoranthene	4.60E-01	3.36E-08	NA	NA	4.80E-09	7.30E-02	3.50E-10
Chrysene	3.70E-01	2.70E-08	NA	NA	3.86E-09	7.30E-03	2.82E-11
Dibenz(a,h)anthracene	6.60E-02	4.82E-09	NA	NA	6.89E-10	7.30E+00	5.03E-09
Indeno(1,2,3-cd)pyrene	2.90E-01	2.12E-08	NA	NA	3.03E-09	7.30E-01	2.21E-09

NA - Not Available

Total Cancer Risk = 4.38E-08

Table 90
Dermal Exposure to EU5 Surface Soil (0-6') by a Maintenance Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
EF - Exposure frequency =	days/year	150	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.54E-02	1.91E-09	NA	NA	6.84E-10	1.46E+00	9.98E-10
Benzo(a)pyrene	1.18E-01	2.36E-09	NA	NA	8.43E-10	1.46E+01	1.23E-08
Benzo(b)fluoranthene	2.90E-01	5.82E-09	NA	NA	2.08E-09	1.46E+00	3.03E-09
Benzo(k)fluoranthene	1.55E-01	3.10E-09	NA	NA	1.11E-09	1.46E-01	1.62E-10
Chrysene	1.50E-01	3.01E-09	NA	NA	1.07E-09	1.46E-02	1.57E-11
Dibenz(a,h)anthracene	4.40E-02	8.83E-10	NA	NA	3.15E-10	1.46E+01	4.60E-09
Indeno(1,2,3-cd)pyrene	9.13E-02	1.83E-09	NA	NA	6.54E-10	1.46E+00	9.55E-10

NA - Not Available

Total Cancer Risk = 2.21E-08

Table 91
Oral Exposure to EU5 Surface Soil (0-6') by a Maintenance Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	150	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.54E-02	5.60E-08	NA	NA	2.00E-08	7.30E-01	1.46E-08
Benzo(a)pyrene	1.18E-01	6.91E-08	NA	NA	2.47E-08	7.30E+00	1.80E-07
Benzo(b)fluoranthene	2.90E-01	1.70E-07	NA	NA	6.08E-08	7.30E-01	4.44E-08
Benzo(k)fluoranthene	1.55E-01	9.08E-08	NA	NA	3.24E-08	7.30E-02	2.37E-09
Chrysene	1.50E-01	8.79E-08	NA	NA	3.14E-08	7.30E-03	2.29E-10
Dibenz(a,h)anthracene	4.40E-02	2.58E-08	NA	NA	9.22E-09	7.30E+00	6.73E-08
Indeno(1,2,3-cd)pyrene	9.13E-02	5.36E-08	NA	NA	1.91E-08	7.30E-01	1.40E-08

NA - Not Available

Total Cancer Risk = 3.23E-07

Table 92
Oral Exposure to EU5 Soil (0-20') by a Construction Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$

Cd - Concentration in sediment =	mg/kg	see below	
$IngR_a$ - Ingestion rate for soil =	mg/day	480	USEPA 1997, EFH
$IngR_b$ - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF_a - Exposure frequency =	days/year	10	reasonable assumption
EF_b - Exposure frequency =	days/year	70	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Exposure Level A

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.93E-01	3.62E-08	NA	NA	5.18E-10	7.30E-01	3.78E-10
Benzo(a)pyrene	1.91E-01	3.59E-08	NA	NA	5.13E-10	7.30E+00	3.74E-09
Benzo(b)fluoranthene	3.89E-01	7.30E-08	NA	NA	1.04E-09	7.30E-01	7.61E-10
Benzo(k)fluoranthene	1.90E-01	3.58E-08	NA	NA	5.11E-10	7.30E-02	3.73E-11
Chrysene	2.64E-01	4.95E-08	NA	NA	7.07E-10	7.30E-03	5.16E-12
Dibenz(a,h)anthracene	5.15E-02	9.68E-09	NA	NA	1.38E-10	7.30E+00	1.01E-09
Indeno(1,2,3-cd)pyrene	1.30E-01	2.45E-08	NA	NA	3.50E-10	7.30E-01	2.56E-10

Cancer Risk = 6.19E-09

NA - Not Available

Exposure Level B

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.93E-01	5.28E-08	NA	NA	7.55E-10	7.30E-01	5.51E-10
Benzo(a)pyrene	1.91E-01	5.23E-08	NA	NA	7.47E-10	7.30E+00	5.46E-09
Benzo(b)fluoranthene	3.89E-01	1.06E-07	NA	NA	1.52E-09	7.30E-01	1.11E-09
Benzo(k)fluoranthene	1.90E-01	5.22E-08	NA	NA	7.45E-10	7.30E-02	5.44E-11
Chrysene	2.64E-01	7.22E-08	NA	NA	1.03E-09	7.30E-03	7.53E-12
Dibenz(a,h)anthracene	5.15E-02	1.41E-08	NA	NA	2.02E-10	7.30E+00	1.47E-09
Indeno(1,2,3-cd)pyrene	1.30E-01	3.57E-08	NA	NA	5.11E-10	7.30E-01	3.73E-10

Cancer Risk = 9.02E-09

NA - Not Available

Total Cancer Risk = 1.52E-08

ENVIRONMENTAL STANDARDS

Table 93
Dermal Exposure to EU6 Sediment by an Adult Resident (Aged 7 to 30 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	6180	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.33	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	24	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	8760	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.20E-02	1.34E-08	NA	NA	4.60E-09	NA	NA
2-Nitrophenol	8.40E-02	2.68E-08	NA	NA	9.20E-09	NA	NA
3-Nitroaniline	8.40E-02	2.68E-08	NA	NA	9.20E-09	NA	NA
4-Bromophenylphenylether	8.40E-02	2.68E-08	NA	NA	9.20E-09	NA	NA
4-Chloro-3-methylphenol	8.40E-02	2.68E-08	NA	NA	9.20E-09	NA	NA
4-Chlorophenylphenylether	4.20E-02	1.34E-08	NA	NA	4.60E-09	NA	NA
4-Nitroaniline	8.40E-02	2.68E-08	NA	NA	9.20E-09	NA	NA
Benzo(a)anthracene	9.30E-01	8.91E-08	NA	NA	3.05E-08	1.46E+00	4.46E-08
Benzo(a)pyrene	9.70E-01	9.29E-08	NA	NA	3.19E-08	1.46E+01	4.65E-07
Benzo(b)fluoranthene	1.40E+00	1.34E-07	NA	NA	4.60E-08	1.46E+00	6.71E-08
Benzo(k)fluroanthene	5.00E-01	4.79E-08	NA	NA	1.64E-08	1.46E-01	2.40E-09
Bis(2-chloroethoxy)methane	8.40E-02	2.68E-08	NA	NA	9.20E-09	NA	NA
Bis(2-chloroethyl)ether	4.20E-02	1.34E-08	NA	NA	4.60E-09	NA	NA
Carbazole	2.20E-01	7.02E-08	NA	NA	2.41E-08	NA	NA
Chrysene	1.30E+00	1.25E-07	NA	NA	4.27E-08	1.46E-02	6.23E-10
Dibenz(a,h)anthracene	1.50E-01	1.44E-08	NA	NA	4.93E-09	1.46E+01	7.19E-08
Hexachlorobenzene	4.20E-02	1.34E-08	4.00E-04	3.35E-05	4.60E-09	NA	NA
Hexachlorocyclopentadiene	2.10E-01	6.70E-08	3.50E-03	1.92E-05	2.30E-08	NA	NA
Indeno(1,2,3-cd)pyrene	5.40E-01	5.17E-08	NA	NA	1.77E-08	1.46E+00	2.59E-08
N-nitrosodi-n-propylamine	4.20E-02	1.34E-08	NA	NA	4.60E-09	NA	NA

NA - Not Available

Total Hazard Index = 5.27E-05

Total Cancer Risk = 6.78E-07

Table 94
Oral Exposure to EU6 Sediment by an Adult Resident (Aged 7 to 30 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for sediment =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	24	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	8760	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.20E-02	6.58E-09	NA	NA	2.25E-09	NA	NA
2-Nitrophenol	8.40E-02	1.32E-08	NA	NA	4.51E-09	NA	NA
3-Nitroaniline	8.40E-02	1.32E-08	NA	NA	4.51E-09	NA	NA
4-Bromophenylphenylether	8.40E-02	1.32E-08	NA	NA	4.51E-09	NA	NA
4-Chloro-3-methylphenol	8.40E-02	1.32E-08	NA	NA	4.51E-09	NA	NA
4-Chlorophenylphenylether	4.20E-02	6.58E-09	NA	NA	2.25E-09	NA	NA
4-Nitroaniline	8.40E-02	1.32E-08	NA	NA	4.51E-09	NA	NA
Benzo(a)anthracene	9.30E-01	1.46E-07	NA	NA	4.99E-08	7.30E-01	3.64E-08
Benzo(a)pyrene	9.70E-01	1.52E-07	NA	NA	5.21E-08	7.30E+00	3.80E-07
Benzo(b)fluoranthene	1.40E+00	2.19E-07	NA	NA	7.51E-08	7.30E-01	5.49E-08
Benzo(k)fluroanthene	5.00E-01	7.83E-08	NA	NA	2.68E-08	7.30E-02	1.96E-09
Bis(2-chloroethoxy)methane	8.40E-02	1.32E-08	NA	NA	4.51E-09	NA	NA
Bis(2-chloroethyl)ether	4.20E-02	6.58E-09	NA	NA	2.25E-09	1.10E+00	2.48E-09
Carbazole	2.20E-01	3.44E-08	NA	NA	1.18E-08	2.00E-02	2.36E-10
Chrysene	1.30E+00	2.04E-07	NA	NA	6.98E-08	7.30E-03	5.09E-10
Dibenz(a,h)anthracene	1.50E-01	2.35E-08	NA	NA	8.05E-09	7.30E+00	5.88E-08
Hexachlorobenzene	4.20E-02	6.58E-09	8.00E-04	8.22E-06	2.25E-09	1.60E+00	3.61E-09
Hexachlorocyclopentadiene	2.10E-01	3.29E-08	7.00E-03	4.70E-06	1.13E-08	NA	NA
Indeno(1,2,3-cd)pyrene	5.40E-01	8.45E-08	NA	NA	2.90E-08	7.30E-01	2.12E-08
N-nitrosodi-n-propylamine	4.20E-02	6.58E-09	NA	NA	2.25E-09	7.00E+00	1.58E-08

NA - Not Available

Total Hazard Index = 1.29E-05

Total Cancer Risk = 5.76E-07

Table 95
Dermal Exposure to EU6 Sediment by a Child Resident (Aged 1 to 6 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	2229	calculated
SA_t - Total skin surface area =	cm^2	7213	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.33	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	6	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	15	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	2190	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.20E-02	2.26E-08	NA	NA	1.93E-09	NA	NA
2-Nitrophenol	8.40E-02	4.51E-08	NA	NA	3.87E-09	NA	NA
3-Nitroaniline	8.40E-02	4.51E-08	NA	NA	3.87E-09	NA	NA
4-Bromophenylphenylether	8.40E-02	4.51E-08	NA	NA	3.87E-09	NA	NA
4-Chloro-3-methylphenol	8.40E-02	4.51E-08	NA	NA	3.87E-09	NA	NA
4-Chlorophenylphenylether	4.20E-02	2.26E-08	NA	NA	1.93E-09	NA	NA
4-Nitroaniline	8.40E-02	4.51E-08	NA	NA	3.87E-09	NA	NA
Benzo(a)anthracene	9.30E-01	1.50E-07	NA	NA	1.29E-08	1.46E+00	1.88E-08
Benzo(a)pyrene	9.70E-01	1.56E-07	NA	NA	1.34E-08	1.46E+01	1.96E-07
Benzo(b)fluoranthene	1.40E+00	2.26E-07	NA	NA	1.93E-08	1.46E+00	2.82E-08
Benzo(k)fluroanthene	5.00E-01	8.06E-08	NA	NA	6.91E-09	1.46E-01	1.01E-09
Bis(2-chloroethoxy)methane	8.40E-02	4.51E-08	NA	NA	3.87E-09	NA	NA
Bis(2-chloroethyl)ether	4.20E-02	2.26E-08	NA	NA	1.93E-09	NA	NA
Carbazole	2.20E-01	1.18E-07	NA	NA	1.01E-08	NA	NA
Chrysene	1.30E+00	2.10E-07	NA	NA	1.80E-08	1.46E-02	2.62E-10
Dibenz(a,h)anthracene	1.50E-01	2.42E-08	NA	NA	2.07E-09	1.46E+01	3.03E-08
Hexachlorobenzene	4.20E-02	2.26E-08	NA	NA	1.93E-09	NA	NA
Hexachlorocyclopentadiene	2.10E-01	1.13E-07	NA	NA	9.67E-09	NA	NA
Indeno(1,2,3-cd)pyrene	5.40E-01	8.71E-08	NA	NA	7.46E-09	1.46E+00	1.09E-08
N-nitrosodi-n-propylamine	4.20E-02	2.26E-08	NA	NA	1.93E-09	NA	NA

NA - Not Available

Total Cancer Risk = 2.85E-07

Table 96
Oral Exposure to EU6 Sediment by a Child Resident (Aged 1 to 6 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for sediment =	mg/day	200	USEPA 1997, EFH
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	6	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	15	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	2190	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.20E-02	6.14E-08	NA	NA	5.26E-09	NA	NA
2-Nitrophenol	8.40E-02	1.23E-07	NA	NA	1.05E-08	NA	NA
3-Nitroaniline	8.40E-02	1.23E-07	NA	NA	1.05E-08	NA	NA
4-Bromophenylphenylether	8.40E-02	1.23E-07	NA	NA	1.05E-08	NA	NA
4-Chloro-3-methylphenol	8.40E-02	1.23E-07	NA	NA	1.05E-08	NA	NA
4-Chlorophenylphenylether	4.20E-02	6.14E-08	NA	NA	5.26E-09	NA	NA
4-Nitroaniline	8.40E-02	1.23E-07	NA	NA	1.05E-08	NA	NA
Benzo(a)anthracene	9.30E-01	1.36E-06	NA	NA	1.16E-07	7.30E-01	8.50E-08
Benzo(a)pyrene	9.70E-01	1.42E-06	NA	NA	1.21E-07	7.30E+00	8.87E-07
Benzo(b)fluoranthene	1.40E+00	2.05E-06	NA	NA	1.75E-07	7.30E-01	1.28E-07
Benzo(k)fluroanthene	5.00E-01	7.31E-07	NA	NA	6.26E-08	7.30E-02	4.57E-09
Bis(2-chloroethoxy)methane	8.40E-02	1.23E-07	NA	NA	1.05E-08	NA	NA
Bis(2-chloroethyl)ether	4.20E-02	6.14E-08	NA	NA	5.26E-09	1.10E+00	5.79E-09
Carbazole	2.20E-01	3.21E-07	NA	NA	2.76E-08	2.00E-02	5.51E-10
Chrysene	1.30E+00	1.90E-06	NA	NA	1.63E-07	7.30E-03	1.19E-09
Dibenz(a,h)anthracene	1.50E-01	2.19E-07	NA	NA	1.88E-08	7.30E+00	1.37E-07
Hexachlorobenzene	4.20E-02	6.14E-08	NA	NA	5.26E-09	1.60E+00	8.42E-09
Hexachlorocyclopentadiene	2.10E-01	3.07E-07	NA	NA	2.63E-08	NA	NA
Indeno(1,2,3-cd)pyrene	5.40E-01	7.89E-07	NA	NA	6.76E-08	7.30E-01	4.94E-08
N-nitrosodi-n-propylamine	4.20E-02	6.14E-08	NA	NA	5.26E-09	7.00E+00	3.68E-08

Total Cancer Risk = 1.34E-06

NA - Not Available

ENVIRONMENTAL STANDARDS

Setting the Standards for Innovative
Environmental Solutions

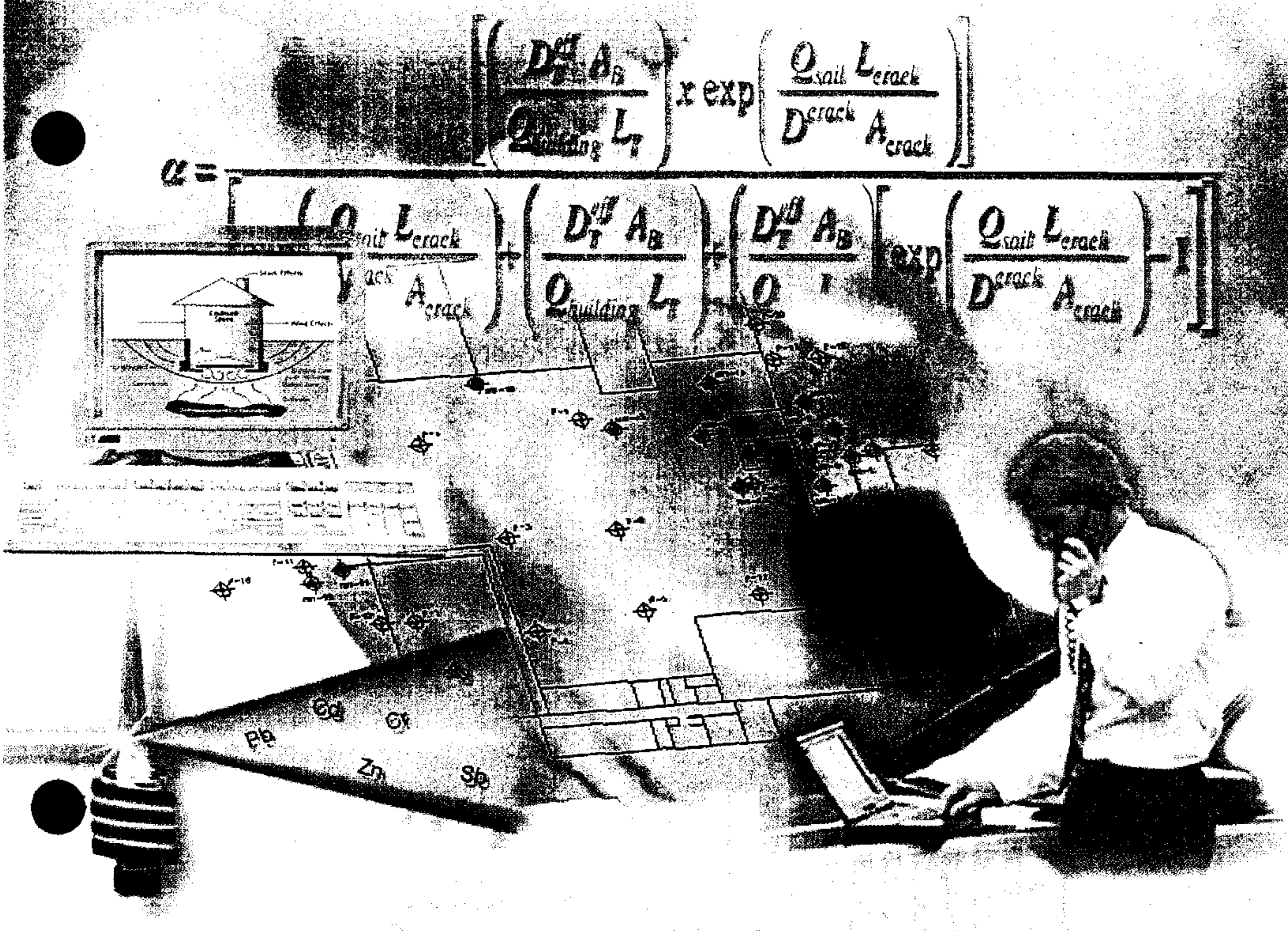
FILE COPY

HUMAN HEALTH RISK ASSESSMENT

FOR THE FORMER GULF STATES CREOSOTING FACILITY,

HATTIESBURG, MISSISSIPPI

May 2, 2001



HUMAN HEALTH RISK ASSESSMENT

FOR THE FORMER GULF STATES CREOSOTING FACILITY,

HATTIESBURG, MISSISSIPPI

May 2, 2001

Prepared for:

KERR-MCGEE CHEMICAL LLC
123 Robert S. Kerr Avenue
P.O. Box 25861
Oklahoma City, OK 73125-0861

Prepared by:

ENVIRONMENTAL STANDARDS, INC.
1140 Valley Forge Road
P.O. Box 810
Valley Forge, PA 19482-0810

Table of Contents

Table of Contents (Cont.)

Executive Summary

A baseline human health risk assessment (HHRA) was conducted for the Former Gulf States Creosoting facility in Hattiesburg, Mississippi. The HHRA was performed in accordance with: Mississippi Commission on Environmental Quality's (MCEQ's) *Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi* (1999); US EPA's *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* (1989); US EPA Region 4 guidance entitled *Technical Services Supplemental Guidance to RAGS, Region 4 Bulletins* (1995); and other relevant US EPA guidance documents.

Creosoting constituents of potential health concern include polycyclic aromatic hydrocarbons (PAHs), of which benzo(a)pyrene is the predominant contributor to potential risks. Much of the former creosoting process area is currently covered with asphalt or large building structures. Potential future exposure scenarios included a construction worker, a maintenance worker, an infrequent Site visitor, and off-Site residents. Media of concern included soils, sediment, and surface water.

Hazards posed by chemical constituents in soils, sediment, and surface water for health effects other than an increased risk of cancer were well below a threshold of possible concern for each receptor evaluated in this risk assessment. Cancer risks for all exposure scenarios were within or below the US EPA's acceptable target risk range of 1×10^{-6} to 1×10^{-4} (*i.e.*, one in one million to one in ten thousand) with the exception of maintenance worker exposure to soils in EU4 and off-site resident exposure to sediments in EU6. The added lifetime cancer risk conservatively estimated for a maintenance worker was 4×10^{-4} for the entire Site, while that for the off-site resident was 2×10^{-4} for the entire Site. The potential risk for a construction worker was estimated to be 5×10^{-5} for the entire Site. The estimated potential risk for an adolescent Site visitor was 9×10^{-5} for the entire Site. For the Site visitor, maintenance worker, and construction worker scenarios, oral contact with carcinogenic PAHs in sediment and soils drove the cancer risk level. For the off-Site resident scenario, oral contact with carcinogenic PAHs in sediment drove the cancer risk level.

Risk levels are mainly attributable to residual concentrations of carcinogenic polycyclic aromatic hydrocarbons (cPAH) in EUs 4, 5, and 6. Remedial actions currently planned for these areas, including deed restrictions, will result in incomplete exposure pathways thereby resulting in acceptable levels of risks to potential receptors. Proposed remediation activities to address impacted media in EUs 4, 5, and 6 include the following:

- Conduct in-situ biological treatment of impacted soils in the unpaved area between the former Process Area and the Southern railroad tracks (EU4);
- Attempt to recover free product from targeted areas within the former Process Area to address continuing sources (EU5);

- Remove impacted sediments from the northeast drainage ditch and install a culvert to provide for surface drainage (EU6);
- Establish deed restrictions limiting the use of property to non-residential (i.e., "restricted") purposes (EU4 and EU5); and
- Include in the deed restrictions provisions for maintaining pavement to preclude contact with impacted media left in place (EU5).

Constituent concentrations in surface soils at two isolated locations within EU2 also resulted in maintenance worker risk levels slightly greater than 1×10^{-6}. Because these locations are within a densely wooded area where no maintenance activities currently occur and remediation would require significant clearing, no remediation activities are planned to address surface soils at these locations. Deed restrictions limiting the use of properties within EU2 to non-residential purposes will be established.

1.0 Introduction

Environmental Standards, Inc. (Environmental Standards) was retained by Kerr-McGee Chemical Corporation (Kerr-McGee) to perform a human health risk assessment (HHRA) to evaluate hazards and risks potentially posed by residual levels of chemicals present at the Former Gulf States Creosoting facility (Site). The Site, located near the intersection of US Highways 49 and 11 in Hattiesburg, Mississippi, was formerly a wood treating facility that operated between the early 1900s and 1960. In the early 1960s, the Site was redeveloped for commercial and light industrial uses (Michael Pisani & Assoc., 1997). The land on which the Site is located is a portion of the Sixteenth Section land owned by the Hattiesburg Public School District and leased to the current tenants under a 99-year lease, granted on July 7, 1947. At the time of this report, the Site, with the exception of the grassy and wooded areas in the south and southwest, respectively, was primarily used for automobile dealerships. There are no residential or institutional (*i.e.*, schools) uses of the Site (Michael Pisani & Assoc., 1997).

Operations at the Site consisted of a small-scale wood preserving process using creosote. The creosoting process was primarily confined to a 2.5-acre area in the northeast corner of the Site; this is known as the former Process Area and is currently occupied by Courtesy Ford. During the redevelopment of the Site in the early 1960s, construction debris (*e.g.*, broken concrete, asphalt, etc.) appears to have been relocated to the southwestern corner of the Site along Gordon's Creek. This area is known as the Fill Area and currently remains undeveloped.

This assessment has been conducted as a result of an agreement between Kerr-McGee, the Mississippi Department of Environmental Quality (MDEQ), and the Mississippi Commission on Environmental Quality (MCEQ) pursuant to the Uncontrolled Site Voluntary Evaluation Program. The MDEQ Office of Pollution Control, Uncontrolled Sites Section has been providing oversight and review of investigations and reports relating to the former Gulf States Creosoting facility.

This report will address the potential for on-Site exposures to human receptors and off-Site exposures to humans along the northeast drainage ditch.

The primary guidance used to develop this risk assessment was the MCEQ *Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi* (1999). US EPA Region 4's *Technical Services Supplemental Guidance to RAGS: Region 4 Bulletins* (1995) were also referred to for guidance. Additional US EPA guidance documents cited herein include:

- *Guidance for Remediation of Uncontrolled Hazardous Substance Sites in Mississippi (MDEQ, 1990);*
- *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual/ Part A (RAGS/Part A)* (US EPA, 1989);
- *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (US EPA, 1991);
- *Exposure Factors Handbook* (US EPA, 1997);
- *Guidelines for Exposure Assessment* (US EPA 1992);
- *Dermal Exposure Assessment: Principles and Applications* (US EPA, 1992);

These documents are not listed in a hierarchical manner; other US EPA guidance documents and peer-reviewed technical papers may have also been referenced in this risk assessment report.

2.0 Hazard Identification and Conceptual Site Model

As a result of the historical wood preservation process, residual levels of creosote-related chemicals are present in soils in the former Process Area. Sediment and surface water in a drainage ditch along the southeast border of the former Process Area also contain chemical residuals. These Site-related chemicals, mostly polycyclic aromatic hydrocarbons (PAHs) are also present in the Fill Area. Residual levels of PAHs have been found in soil in the Fill Area and in Gordon's Creek surface water and sediment.

PAH residuals have also been detected in shallow groundwater underlying the Site. Currently, there are no private water wells located on-Site that access this shallow groundwater for potable purposes. The results of a door-to-door survey conducted by Michael Pisani and Associates on October 3, 2000 indicated no private uses of shallow groundwater downgradient of the Site. For these reasons, the groundwater exposure pathway, both on- and off-Site, was considered incomplete and not evaluated in this assessment.

A conceptual site model (CSM) was developed for the Site to aid in determining the potential receptors and exposure units to be evaluated under current and future potential land use (Figure 1). These receptors were identified as infrequent Site visitors, maintenance workers, construction workers, and off-Site residents.

Under current land use assumptions, Site visitors may potentially contact residual chemicals in Gordon's Creek surface water and sediment, and/or surface soils in the Fill Area and surrounding woods, the grassy field southeast of the Fill Area, and/or the drainage ditch along side of the former Process Area. Visitors may also potentially contact surface soil, surface water, and sediment along the former Process Area drainage ditch. The remaining affected areas of the Site are covered with either buildings or pavement precluding casual direct contact with surface soils. As a conservative measure, however, visitor exposure to soils from these paved areas was also assessed.

Under both current and future land use assumptions, a maintenance worker may contact surface soils in the Fill Area and surrounding woods, the grassy field southeast of the Fill Area, and/or the former Process Area and surrounding affected areas, including the drainage ditch located to the southeast of the former Process Area. Although most of the former Process Area and vicinity are paved, maintenance activities may involve some shallow digging; therefore, direct contact with shallow soils in this area was assessed. As a conservative measure, exposure to surface water and sediment in Gordon's Creek was assessed. The remainder of the Site was relatively unaffected by historical creosoting activities.

Although there are currently no major construction activities at the Site, these types of activities may occur at some time in the future. As with the maintenance worker scenario, construction activities could potentially occur in the Fill Area and vicinity, the grassy field southeast of the Fill Area, and the former Process Area and vicinity. Construction workers may be exposed to both surface and subsurface soils (down to the water table). Construction worker exposure to surface water and sediment in Gordon's Creek was assessed as a conservative measure. The remainder of the Site was relatively unaffected by historical creosoting activities.

Areas of the Site affected by historical creosoting activities will be deed restricted prohibiting future residential development. Off-Site areas along the northeast Drainage Ditch, currently a residential neighborhood, were assessed for residential exposures to soil, sediment, and surface water.

3.0 Data Evaluation

To characterize potential exposures to Site-related chemicals, the former Gulf States Creosoting facility was divided into six exposure units (EUs). Each exposure unit outlines potentially affected areas of the Site and adjacent on-Site locales that may be frequented by individuals accessing the Site for recreational or occupational purposes. The use of EUs is encouraged by the US EPA Region 4 (1995), which defines an EU as "an areal extent of a receptor's movements during a single day...." Each of these exposure units is depicted on Figure 2 and is discussed below.

A sixth EU was created for off-Site residential exposures to surface water and sediment along the northeast Drainage Ditch. This EU is delineated on Figure 3.

3.1 Exposure Unit Delineation

The following EUs were delineated based upon the presence of residual chemicals and the potential for receptors to contact those chemicals. Areas of the Site most affected were included in at least one of the five EUs while areas with relatively low or non-detectable concentrations of residuals were not included in an EU. By limiting Site-wide exposures to the EUs most affected by historical activities at the Site, worst-case scenarios were created.

3.1.1 Exposure Unit 1

EU1 outlines the on-Site areas in, adjacent to, and downstream of the Fill Area along Gordon's Creek (Figure 2). EU1 includes exposures to surface water and sediment by an infrequent Site visitor, future maintenance worker, and future construction worker. Although US EPA Region IV guidance indicates that "In most cases it is unnecessary to evaluate human exposures to sediments covered by surface water," (US EPA, 1995) dermal and oral surface water exposures were conservatively assessed herein at the request of the MDEQ (2000). Sediment samples included in EU 1 were SD07 and SD08. Surface water samples included in were SW-07 and SW-08.

Soil samples from this area were considered part of EU2 and exposures were assessed accordingly.

3.1.2 Exposure Unit 2

EU2 delineates the upland areas of the Fill Area and adjacent woody and grassy areas (Figure 2). Surface soils from zero to one foot and zero to six feet below ground surface [bgs] in this area were evaluated for potential visitor and future hypothetical maintenance worker scenarios, respectively. Surface and subsurface soils were also evaluated for a hypothetical future construction worker scenario. Available data for subsurface soils for a construction scenario were evaluated from the surface to the water table (approximately 10 feet bgs) as recommended by the MDEQ (2000). Soil samples included in EU2 are presented in the table below:

Soils (0-1' bgs)	GEO-13/0-1'	SS-1	SS-2	SS-3	SS-4
	SS-5	SS-6	SS-7	SS-8	SS-9
	SS-10	SS-11	SS-12	SS-13	
Soils (0-6' bgs)	GEO-03/2-3'	GEO-03/5-6''	GEO-10/2-3	GEO-10/5-6	GEO-13/0-1'
	GEO-13/2-3'	GEO-13/5-6'	GEO-44/5-6'	SS-1	SS-2
	SS-3	SS-4	SS-5	SS-6	SS-7
	SS-8	SS-9	SS-10	SS-11	SS-12
	SS-13				
Soils (0-10' bgs)	GEO-03/2-3'	GEO-03/5-6'	GEO-10/2-3	GEO-10/5-6'	GEO-13/0-1'
	GEO-13/2-3'	GEO-13/5-6'	GEO-43/7-8'	GEO-44/5-6'	GEO-45/7-8'
	SB-03/8-9.3	SB-05/4-9	SB-07/5-7	SS-1	SS-2
	SS-3	SS-4	SS-5	SS-6	SS-7
	SS-8	SS-9	SS-10	SS-11	SS-12
	SS-13				

3.1.3 Exposure Unit 3

In the southwest corner of the Site there exists a grassy field east of West Pine Street between Henson Auto Sales and Eagan Cars and Trucks. This grassy area has been defined as EU3 for

purposes of this risk assessment (Figure 2). Similar to EU2, surface soil from zero to one foot and zero to six feet bgs were evaluated in EU2 for visitor and hypothetical future maintenance worker scenarios, respectively. Surface and subsurface soils in this EU were evaluated for a hypothetical future construction worker scenario. Available data for subsurface soils for a construction scenario were evaluated from the surface to the water table(approximately 20 feet bgs) as recommended by the MDEQ (2000). Soil samples included in EU3 are presented in the table below:

Soils (0-1' bgs)	SS-15	SS-16	SS-17		
Soils (0-6' and 0-20' bgs)	GEO-16/2-3'	GEO-16/5-6'	GEO-17/2-3'	GEO-17/5-6'	SS-15
	SS-16	SS-17			

3.1.4 Exposure Unit 4

EU 4 encompasses the grassy drainage ditch area along the fenceline behind Courtesy Ford in the northeast corner of the Site and continues parallel to the railroad tracks, and west through EU 3 and EU 2 (Figure 2). EU 4, along the southeast side of the former Process Area, has been widened to include soil data from that area. Receptors associated with EU 4 included Site visitor exposures via casual contact with surface soil, sediment, and surface water. Maintenance worker and construction worker scenarios were also evaluated for exposures to surface water and sediment in EU 4 as well as soils in EU 4 near the former Process Area. Soils down to six feet bgs were evaluated for maintenance workers while soils down to the water table (approximately20 feet bgs) were evaluated for construction workers in this EU as requested by the MDEQ (2000). Sediment, surface water, and soil samples included in EU4 are presented in the following table:

Sediment	SD-02	SD-12	SD-18	SD-19	SD-20
	SD-21	SD-22	SD-23		
Surface Water	SW-02				
Soils (0-1' bgs)	GEO-19/0-1'	GEO-20/0-1'	GEO-21/0-1'	GEO-46/0-1'	GEO-47/0-1'
	GEO-48/0-1'				
Soils (0-6' bgs)	GEO-19/0-1'	GEO-19/2-3'	GEO-19/5-6'	GEO-20/0-1'	GEO-20/2-3'
	GEO-20/5-6'	GEO-21/0-1'	GEO-21/2-3'	GEO-21/5-6'	GEO-46/0-1'
	GEO-46/2-3'	GEO-46/5-6'	GEO-47/0-1'	GEO-47/2-3'	GEO-47/5-6'
	GEO-48/0-1'	GEO-48/2-3'	GEO-48/5-6'		
Soils (0-20' bgs)	GEO-19/0-1'	GEO-19/2-3'	GEO-19/5-6'	GEO-20/0-1'	GEO-20/2-3'
	GEO-20/5-6'	GEO-20/9-10'	GEO-21/0-1'	GEO-21/2-3'	GEO-21/5-6'
	GEO-21/9-10'	GEO-46/0-1'	GEO-46/2-3'	GEO-46/5-6'	GEO-47/0-1'
	GEO-47/2-3'	GEO-47/5-6'	GEO-47/7-8'	GEO-48/0-1'	GEO-48/2-3'
	GEO-48/5-6'				

3.1.5 Exposure Unit 5

EU5 outlines the former Process Area and the historical drip track and treated wood storage areas of the former Gulf States Creosoting facility (Figure 2). Surface soils from zero to six feet bgs were evaluated in EU5 for a hypothetical maintenance worker scenario. Available data for soils down to the water table (approximately 20 feet bgs) were evaluated in EU5 for a hypothetical future construction worker scenario. Soil samples included in EU5 are presented in the table below:

Soils (0-1' bgs)	GEO-28/0-1'	GEO-29/0-1'	GEO-30/0-1'	GEO-31/0-1'	GEO-32/0-1'
	GEO-33/0-1'	GEO-59/0-1'	GEO-60/0-1'		
Soils (0-6' bgs)	GEO-28/0-1'	GEO-28/2-3'	GEO-28/5-6'	GEO-29/0-1'	GEO-29/2-3'
	GEO-29/5-6'	GEO-30/0-1'	GEO-30/2-3'	GEO-30/5-6'	GEO-31/0-1'
	GEO-31/2-3'	GEO-31/5-6'	GEO-32/0-1'	GEO-32/2-3'	GEO-32/5-6'
	GEO-33/0-1'	GEO-33/2-3'	GEO-33/5-6'	GEO-59/0-1'	GEO-59/2-3'
	GEO-59/5-6'	GEO-60/0-1'	GEO-60/2-3'	GEO-60/5-6'	
Soils (0-20' bgs)	GEO-28/0-1'	GEO-28/2-3'	GEO-28/5-6'	GEO-29/0-1'	GEO-29/2-3'
	GEO-29/5-6'	GEO-30/0-1'	GEO-30/2-3'	GEO-30/5-6'	GEO-31/0-1'
	GEO-31/2-3'	GEO-31/5-6'	GEO-32/0-1'	GEO-32/2-3'	GEO-32/5-6'
	GEO-33/0-1'	GEO-33/2-3'	GEO-33/5-6'	GEO-59/0-1'	GEO-59/2-3'
	GEO-59/5-6'	GEO-60/0-1'	GEO-60/2-3'	GEO-60/5-6'	GEO-60/7-8'
	SB-01/8-10	SB-02/9-11	SB-05/10.5-12.5	SB-06/6-10	SB-07/14-16

3.1.6 Exposure Unit 6

EU6 outlines a stretch (approximately 2700 feet in length) of the northeast drainage ditch that leads from the Site into the neighboring residential area. EU6 exposures include oral and dermal exposures by off-Site residents to sediment and surface water along the northeast drainage ditch. Soil exposures were not assessed in this area for lack of soil data. Also, it was anticipated that sediment exposures in this area represent a more conservative estimate of exposure in that chemical concentrations in the exposed sediment along the drainage ditch are likely to be greater than concentrations in the surrounding soils. Sediment and surface water samples included in EU6 are presented in the table below:

Sediment	SD-03	SD-04	SD-05	SD-13
	SD-14	SD-15	SD-16	SD-17
Surface Water	SW-03	SW-04		

3.2 Statistical Evaluation

Environmental samples undergo laboratory analyses that are designed to quantitate the concentrations of constituents in the various environmental media. As a result of the analytical procedures, a constituent may be detected and its concentration measured, detected but not able to be quantitated, or not detected at all in a sample. The data set for the Site contains a number of nondetections for some chemicals of potential concern (COPCs) in various samples. Assuming that the COPC is present in these samples at the achieved detection limit is biased because the chemical may be absent altogether. Assuming a concentration of zero is also flawed because the chemical could be present at a level below laboratory capabilities to detect and quantify the concentration. Consequently, in the event that an analyte identified at least once in a given medium was not detected in a given sample, it was conservatively assumed for the risk assessment purposes to be present at a concentration equivalent to one-half of the sample quantitation limit (SQL). In addition, samples labeled with an "R" (rejected) qualifier were not included in the data analysis because those data were deemed unreliable and, therefore, unusable. Constituents that were not detected in any sample from a particular medium were eliminated from further consideration in accordance with US EPA guidelines (1989).

Site analytical data used in this assessment were collected during the Phase I (1997) and Phase II (1998) remedial investigations as well as the additional investigation conducted in 2000 at the request of the MDEQ. These data were fully validated by qualified technical professionals using standard data validation protocols, as required by the MCEQ (1999).

Previous investigations at the Site have been conducted since 1990. These investigations included the following:

- 1990 soil gas and soil sampling by Roy F. Weston
- 1991 MDEQ Site inspections and Phase II report
- 1994 Phase II Site investigation by Environmental Protection Systems (EPS)
- 1994 Site investigation by Bonner Analytical Testing Company (BATCO)
- 1994 preliminary subsurface investigation by BATCO

- 1995 three-dimension resistivity surveys by American Remediation Technology
- 1996 investigation by McLaren/Hart
- 1996 investigation by Kerr McGee Chemical Corporation

Data acquired from these historical (pre-1997) investigatory activities were not used in this assessment as they were not validated by qualified chemists and sampling locations for some of the data could not be accurately established. These historical data were not considered valid and were, therefore, not appropriate to use in this assessment of risks. Only validated data that were considered to be representative of Site conditions with a reasonable level of confidence were used for this assessment.

The validated laboratory data from 1997, 1998, and 2000 investigations were compiled into data sets representing areas of potential exposure (EUs) for each potential receptor. Each data set was analyzed statistically using SiteStat®, a commercially available software package, to calculate the minimum, maximum, arithmetic mean, logarithmic mean, standard error of the mean, and the 95% upper confidence limit of the mean concentration (95% UCL) for each constituent based on distributional analysis of the data (*i.e.*, utilizing goodness-of-fit statistical tests to determine whether the data are distributed normally or lognormally). The data qualifier associated with the minimum and maximum detected concentrations as well as the location of the maximum detected concentration for each EU were also determined. Results of the quantitative and statistical analyses for each of the EUs discussed above are presented in Tables 1 through 18.

Standard sampling protocol requires the collection of duplicate field samples used to ensure the quality of a laboratory analysis (i.e., to ensure that analytical results can be replicated). As such, duplicate sample results were provided as part of the database for the Hattiesburg Site. In accordance with US EPA guidance (1989), duplicate sample results were averaged (for any sample containing duplicates) and the average concentration was used as a single concentration for that sample in the calculation of summary statistics as discussed below.

Soils down to one foot deep were assumed to be representative of surface soils at the Site for infrequent visitor exposures. A depth of 0 to 6 feet was used to define surface soils for maintenance worker exposures. These assumptions were recommended by the MDEQ (2000). The groundwater table was considered the extent of subsurface soils as recommended by MDEQ (2000). This value (depth-to-groundwater) varies significantly across the Site and, as such, the extent of subsurface soil was EU-specific as follows:

EU2 – soils down to 10 feet
EU3 – soils down to 20 feet
EU4 – soils down to 20 feet
EU5 – soils down to 20 feet

This risk assessment focuses mainly on environmental data collected from the former Process and Fill Areas and any other portions of the Site that were affected by former creosoting operations. Virtually unaffected areas (e.g., the developed area north of West Pine Street) as delineated using historical data were not considered to contribute significantly to risk levels and, therefore, were excluded from this risk assessment.

3.3 Determination of Exposure-Point Concentrations

Exposure-point concentrations were determined to be the 95% UCL or the maximum concentration of a COPC in an EU, whichever was lower. This methodology is in accordance with US EPA guidance (1989). If the distribution of the concentration data was determined to be lognormal, then the lognormal 95% UCL was compared to the maximum concentration to determine the exposure-point concentration. In the event that the distribution of a chemical in any given medium could not be confidently labeled as normal or lognormal, it is termed either "unknown" or "normal/lognormal." In these cases, the lognormal 95% UCL was compared to maximum concentration when determining the exposure-point concentration. It should be noted, however, that in cases where the distribution is "unknown," the normal and lognormal 95% UCLs could not be reliably predicted. Assuming a lognormal distribution of the data increases

the uncertainty associated with this step of the risk assessment process; however, hazard and risk estimates are likely to be less uncertain than if the maximum concentrations were used.

Exposure-point concentrations are provided on the statistical summary tables, Tables 1 through 18.

3.4 COPC Selection

Soils (both surface and subsurface) were screened according to MCEQ (1999) guidance. The first tier of the screening process compared maximum concentrations of a constituent in an EU with the Restricted Tier 1 target remediation goal (TRG) for maintenance worker and construction worker scenarios. Restricted TRGs were used because the Site is not currently used for residential purposes and the current commercial/industrial land-use is anticipated to remain into the future as a result of the implementation of deed restrictions on the impacted areas of the Site. If a maximum concentration of a constituent was less than the Restricted Tier 1 TRG, then that constituent was eliminated from further quantitative assessment.

Surface soil data (zero to one foot bgs) for the visitor scenario was screened using Unrestricted Tier 1 TRGs at the request of MDEQ (2000). If a maximum concentration of a constituent was less than the Unrestricted Tier 1 TRG, then that constituent was eliminated from further quantitative assessment. Conversely, if the maximum concentration of a constituent exceeded the Tier 1 TRG, that constituent was retained for quantitative analysis.

If the maximum concentration of a constituent in an EU exceeded the Tier 1 TRG, then the 95% UCL of the constituent was compared to the Tier 1 TRG (Restricted or Unrestricted, depending on the exposure scenarios as described above) as part of the Tier II screening process. In the event that the concentrations of a chemical were distributed lognormally, the lognormal 95% UCL of that constituent was compared to the Tier 1 TRG. If the distribution of data of a chemical could not be positively identified as either normal or lognormal, the lognormal 95% UCL was used in the screening process. In these cases, either the maximum concentration or the lognormal 95% UCL can be conservatively used. The US EPA, however, justifies the use of an

average concentration as the exposure-point concentration by explaining that toxicity criteria for both carcinogenic and non-carcinogenic effects are based on lifetime average exposures and that the "average concentration is most representative of the concentration that would be contacted at a site over time" (*Supplemental Guidance to RAGS: Calculating the Concentration Term*, 1992). Other US EPA guidance states that "...in most situations, assuming long-term contact with the maximum concentration is not reasonable" (*Risk Assessment Guidance for Superfund, Part A*, 1989). US EPA Region 4 also states that, generally, it is reasonable to assume that soil data are distributed lognormally (1995). In keeping with these guidances, the lognormal 95% UCL was considered in the screening process where the data distribution for a compound could not be defined as specifically normal or lognormal.

If the 95% UCL (or lognormal 95% UCL where appropriate) of a constituent was less than the Tier 1 TRG, then that constituent was eliminated from further quantitative analysis. If the 95% UCL (or lognormal 95% UCL where appropriate) of a constituent in soil exceeded the Tier 1 TRG, then that constituent was retained for quantitative analysis in the Site-specific risk assessment (Tier III).

MCEQ guidance (1999) does not specify screening levels for constituents in sediment or surface water; therefore, Region 4 was referred to for guidance (1995). Sediment is only found on the Site in drainage ditches that contain little to no water most of the time. US EPA Region 4 guidance states that sediments in an intermittent stream (or ditch) should be considered as surface soil for the portion of the year the stream is without water. Based on these factors and comments provided by the MDEQ (2000), the maximum detected constituent concentrations in sediment was compared to MCEQ unrestricted Tier 1 TRGs. The screening process then followed the same procedure as mentioned above for other soils.

For surface water, the maximum detected concentration of a constituent in an EU was compared to the US EPA Human Health Water Quality Standard (WQS) for consumption of water and organisms in accordance with US EPA Region 4 guidance (1995). If the maximum

concentration of a constituent in surface water was less than the WQS, then that constituent was eliminated from quantitative analysis. If the maximum concentration of a constituent in surface water exceeded the WQS, then that constituent was retained for quantitative analysis.

At the request of MDEQ (2000), if any single carcinogenic polycyclic aromatic hydrocarbon (cPAH) was retained as a COPC in a medium, then all cPAHs were also retained as COPCs in that medium. This guidance refers to the following chemicals: benzo(a)anthracene, benzo(b)fluoroanthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. To establish an exposure point concentration for undetected cPAHs retained as COPCs in an EU, one-half the maximum detection limit was used.

The results of the screening process are presented on the statistical summary tables, Tables 1 through 18. The screening process eliminated detected constituents from the subsurface soil dataset down to 20 feet bgs and surface soil dataset down to 6 feet bgs in EU3 For this reason, construction worker and maintenance worker exposures to soils in EU3 were not evaluated quantitatively in this assessment.

4.0 Exposure Assessment

Currently, a majority of the Site is used for commercial and light industrial purposes and is paved for roads and parking lots. Unpaved areas are limited to Gordon's Creek (EU 1), the wooded portion in and around the Fill Area (EU2) and the grassy field outlined by EU 3, and the drainage ditches and surrounding area delineated by EU 4 (Figure 2). Since the developed and undeveloped areas of the Site vary considerably with respect to both residual chemical concentrations and land use, the Site was divided into five EUs for the exposure assessment. A sixth EU was created to assess off-Site residential exposures. Chemical data from each EU were combined with EU-specific exposure parameter values and receptor scenarios to determine the chemical intake for each receptor potentially accessing an EU for occupational, recreational, or residential purposes.

4.1 Receptor Identification

The following exposures pathways (indicated with an "X") have been selected for this risk assessment as reasonable and realistic scenarios under current and future land-use assumptions:

EU/Media:	EU1		EU2	EU3	EU4			EU5	EU6	
Receptor/Route:	Sed.	Surf. Water	Soil	Soil	Soil	Sed.	Surf. Water	Soil	Sed.	Surf. Water
Visitor										
Dermal	X	X	X	X	X	X	X	X		
Oral	X	X	X	X	X	X	X	X		
Inhalation										
Maint. Worker										
Dermal	X	X	X	X	X	X	X	X		
Oral	X	X	X	X	X	X	X	X		
Inhalation										
Const. Worker										
Dermal	X	X	X	X	X	X	X	X		
Oral	X	X	X	X	X	X	X	X		
Inhalation			X	X	X			X		

EU/Media:	EU1		EU2	EU3	EU4			EU5	EU6	
Receptor/Route:	Sed.	Surf. Water	Soil	Soil	Soil	Sed.	Surf. Water	Soil	Sed.	Surf. Water
Off-Site Resident										
Dermal									X	X
Oral										X
Inhalation										

Surface water present on-Site is either ephemeral or very shallow and is conducive only to wading-type activities. Ingestion of Site surface water was considered an insignificant exposure pathway since on-Site drainage ditches "contain little or no water most of the time" (MDEQ, 2000). In addition, US EPA IV guidance indicates that "In most cases, it is unnecessary to evaluate human exposures to sediments covered by surface water" (1995). At the request of MDEQ (2000), however, dermal and oral exposures to surface water were assessed for visitors, maintenance workers, and construction workers in EUs 1 and 4. Surface water exposures were also assessed for residents in off-Site EU 6.

Each of the potential receptors is discussed below.

4.1.1 Infrequent Site Visitor

Since the Site is not currently fenced or guarded, the general public has access to most areas of the Site at any given time. It is possible, though unlikely, that an individual may use some areas of the Site, such as EU1, EU2, or EU3, for recreational purposes. For this reason, sediment and surface water exposures to visitors in EU1, and surface soil exposures in EU2 and EU3 were assessed for the visitor scenario. The vast majority of the remainder of the Site (EU5) is covered with either buildings or pavement, precluding direct contact with surface soils; however, a small exposed area encompassing a drainage ditch exists along side of the former Process Area (EU4). Although this area is not attractive for recreational purposes, it is possible that an individual traversing the Site may contact surface soils, sediment, or surface water in this EU; therefore, these potential exposures were assessed. Sediment exposures in EU1 and EU4 were addressed in accordance with US EPA Region 4 guidance that recommends evaluating sediment exposures in intermittent streams. At the request of MDEQ (2000), soil exposures were assessed for visitors

in EU5 regardless of the existence of buildings and pavements precluding almost all potential direct contact with soils in this area.

4.1.2 Maintenance Worker

Currently, maintenance activities are most likely limited to the developed portions of the Site. Of these, the former Process Area and adjacent former drip track and treated wood storage areas (EU5) were most affected by historical wood preserving processes. Although these areas are mostly paved or built upon, it is possible that maintenance activities may require some shallow digging in unpaved areas; therefore, exposures to surface soils in EU5 were assessed. As a conservative measure, surface soil data from sample locations located in paved areas were evaluated in conjunction with surface soil data from exposed areas in EU5. If the currently undeveloped portions of the Site (EU2 and EU3) become developed in the future, similar maintenance activities may be required and, therefore, exposures to surface soils in EU2 and EU3 were also assessed. The drainage ditch encompassed by EU4 requires periodic maintenance; therefore, exposures to soil, sediment, and surface water in this area were assessed. At the request of MDEQ (2000), maintenance worker exposures to surface water and sediment in EU 1 were also assessed.

4.1.3 Construction Worker

Although there are currently no major construction activities at the Site, such activities may hypothetically occur in the future. Thus, exposures to surface water and sediment in EUs 1 and 4, and exposures to soil in EUs 2 through 5 were assessed herein. Construction workers may be exposed to both surface and subsurface soils during activities such as excavating. Subsurface soils, for purposes of this assessment, were defined as those soils at the water table and shallower. Since the depth to the water varies significantly across the Site, so does the definition of "subsurface" soils. Accordingly, subsurface soils were evaluated down to 10 feet for EU2 and 20 feet for EUs 3, 4, and 5.

4.1.4 Future On-Site Residents

The affected areas of the Property (the Site) are currently zoned for industrial or light-commercial use, and, at the time of this report, there were no plans to develop the Site for residential housing. In fact, deed restrictions preventing residential development are in the process of being implemented for the impacted areas on Site. Because of these deed restrictions, it is reasonable and realistic to assume that the Site will remain commercial/industrial in the future; therefore, on-Site residential exposures were not addressed in this risk assessment.

4.1.5 Off-Site Residential Exposures

The northeast drainage ditch extends from the former Process Area to the northeast into a nearby residential community. Surface water and sediment data from areas along the northeast drainage ditch (EU6, Figure 3) were evaluated for off-Site residential exposures. For purposes of exposure assessment, a child resident between the ages of 1 and 6 years and an adolescent/adult resident between the ages of 7 and 30 years were evaluated. Hazards and risks for these two receptors were then combined (summed) to reflect the exposures incurred by a single individual living off-Site in the vicinity of the northeast drainage ditch for 30 years.

4.2 General Intake Equation

Chemical exposure/intake is expressed as the amount of the agent at the exchange boundaries of an organism (*i.e.*, skin, lungs, gut) that is available for systemic absorption. An applied dose is defined as the amount of a chemical at the absorption barriers such as skin, lung, digestive tract, available for absorption and is (usually expressed in milligrams, or mg) absorbed per unit of body weight of the receptor (usually expressed in units of kilogram, or kg). Absorbed dose can be defined as the amount of chemical that penetrates the exchange boundaries. If the exposure occurs over time, the total exposure can be divided by the time period of interest to obtain an average exposure rate (*e.g.*, mg/kg-day). The general equation, as defined by US EPA, for estimating a time-weighted average intake is:

$$\text{Intake (mg/kg - day)} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$ **[Equation 1]**

where:

C	=	chemical concentration at the exposure point (*e.g.*, mg/m^3 air);
IR	=	intake rate (*e.g.*, m^3/hr);
EF	=	exposure frequency (days/year);
ED	=	exposure duration (years);
BW	=	body weight of exposed individual (kg); and
AT	=	averaging time (period over which exposure is averaged, usually measured in days).

Additional parameters (*e.g.*, skin surface area) were incorporated into the above general equation to evaluate the different potential exposure routes (dermal, oral, inhalation).

Table 19 presents the general and pathway-specific exposure parameters utilized for the intake equations in this assessment.

4.2.1 General Exposure Parameters

Although some of the parameters used to calculate potential exposure are pathway- or route-specific, exposure frequency (EF), exposure duration (ED), averaging time (AT; determined separately for carcinogenic and non-carcinogenic exposures), and body weight (BW) are present in each intake model. These general parameters remain consistent throughout the intake calculations for each specific receptor.

4.2.1.1 Exposure Frequency

The exposure frequency (EF) describes the number of times per year an event is likely to occur. It is most often expressed in units of days/year or events/year, depending on the scenario. Variables such as weather, vacations, sick days, and institutional controls often aid in determining reasonable and realistic exposure frequencies.

The EF for an adolescent visitor was extracted from US EPA *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) Interim Final* (1989). This EF value of 12 days/year per EU is a reasonable estimate that assumes an adolescent would most likely be engaged in outdoor activity on the unpaved areas of the Site for one day a week during

the three warmest months of the year. This value was used for soil, sediment, and surface water exposures.

Typical construction projects, especially at industrial complexes, generally involve several phases of activity prior to completion. The EF parameter used for oral exposure in construction workers, therefore, was subdivided into two exposure events. The first event hypothetically lasts for 10 days (used in relevant exposure model calculations under "Exposure Level A") and would involve earth-moving activities such as foundation. The second exposure event to the same individual hypothetically lasts for 70 days (for a total of 80 days at the Site for an individual; this value was used in relevant exposure model calculations under "Exposure Level B") and included remaining construction activities such as building framing, plumbing installation, electrical installation, and roofing. Generally, to complete each of these phases, a different team of specialized contractors is employed to perform the tasks for which they are most qualified. As a result, an individual may only remain at the construction site for a few days or weeks until his/her task has been completed and the next phase has begun. This is especially true for those activities involving direct contact with soil such as excavating and foundation pouring. Individuals performing these tasks are not usually qualified or employed to continue with the actual building processes. For dermal and inhalation exposures, however, an 80-day EF was used and accounted for an individual to be involved in construction activities for four entire months of the year (assuming five-day work weeks).

For surface water and sediment exposures to construction workers, an EF value of 8 days/year was used. This value represents $1/10^{th}$ of the time a worker may be on-Site for construction-type activities and is conservative in that it is unlikely that construction workers would be exposed at all to Site surface water or sediment.

The EF value used for the maintenance worker scenario was 150 days/year for surface soil exposures in EUs 2, 3, and 5. This is also a conservative assumption in that the currently developed areas of the Site are covered with buildings or pavement. Maintenance activities in

these areas would require little contact with the obscured surface soils. The undeveloped areas of the Site currently require little or no maintenance as they are only occasionally mowed or allowed to grow naturally. Should these areas become developed, they will most likely take on the appearance of the remainder of the Site, including industrial/commercial buildings and paved roads or parking lots. Once again, extensive direct contact with surface soils would be minimal for a maintenance worker.

For maintenance worker sediment and surface water exposures in EUs 1 and 4 and surface soil exposures in EU 4, an EF value of 30 days/year was used. Historically, the northeast drainage ditch has been maintained on an as-needed basis (less than annually). Maintenance worker exposures to sediment and surface water in these areas were assessed at the request of the MDEQ (2000). An EF value of 30 days/year is amply conservative in that both Gordon's Creek (EU 1) and the northeast drainage ditch (EU 4) are currently maintained less than annually.

For residential soil exposures, an exposure frequency of 350 days/year was used in accordance with Region IV guidance. This value assumes that 15 days/year are spent away from home (US EPA, 1991).

Sediments along the bank of the northeast drainage ditch are not comparable to surface soils comprising a yard with respect to exposure. Typically, yard soils include relatively large areas where children frequently play and where surface soils are tracked into the home to become part of the household dust that can be ingested, particularly by crawling infants, on a daily basis. These are the assumptions that underlie the standard residential soil exposure algorithm and parameter values. However, it is not realistic to assume that infants, children, or adults will directly contact a relatively small area of sediments on the banks of a drainage ditch on a daily basis. A more realistic exposure scenario for this unique area under an assumption of residential land use is for a resident child to play on occasion in the drainage ditch that traverses the residential property. An exposure frequency of 40 days/year, two hours per exploring event, is conservatively plausible.

4.2.1.2 Exposure Duration

The ED parameter represents the number of years during which an event is likely to occur. Factors affecting this parameter include variables such as age of receptor, population mobility, and occupational mobility. Exposure durations of less than seven years typically correspond to subchronic exposures while those greater than seven years are typically considered chronic exposures (US EPA, 1989). Toxicity indices are selected based on subchronic or chronic exposure durations.

The future construction worker scenario used an ED of one year because it is highly unlikely that a future construction worker would remain on one site for more than a year. Often, two months is considered the maximum amount of time a construction worker may reasonably remain at the same site.

The future maintenance worker ED, on the other hand, is based on occupational mobility studies. The ED of 25 years was obtained from US EPA (1991) which recommends a 95th percentile value of 25 years based on a study by the Bureau of Labor Statistics as of 1987. US EPA Region 4 also recommends a default value of 25 years for worker scenarios (1995).

The adolescent visitor scenario used an ED of 10 years. An adolescent was defined in this assessment as an individual aged seven to 16 years in accordance with US EPA Region 4 (1995); therefore, an exposure duration of 10 years was most appropriate.

An ED of 30 years (US EPA Region 4, 1995) was used for off-Site residents. This value assumes an individual spends 6 years as a child and 24 years as an adolescent/adult in the same location.

4.2.1.3 Averaging Time

The averaging time (AT) parameter is the time period over which exposure is averaged. For human health cancer risk calculations, the AT_c value prorates a total cumulative dose over a

lifetime. As a conservative approach, the AT_c value for each receptor is the product of a 365-day year and a 70-year life span, equaling 25,550 days.

The AT_n used for non-carcinogenic effects is the product of a 365-day year and the exposure duration (*i.e.*, AT_n = 365 days × ED). Because the ED parameter changes for each receptor, the AT_n changes as well. The AT_n values used for each receptor are summarized below:

Future Construction Worker - 365 days
Maintenance Worker - 9125 days
Adolescent Visitor - 3650 days
Off-Site Child Resident – 2,190 days
Off-Site Adult Resident – 8,760 days

4.2.1.4 Body Weight

The body weight used for the adult exposures (future construction worker and maintenance worker) analyzed in this assessment was the current US EPA default value of 70 kg (US EPA, 1989; US EPA Region 4, 1995). This value was also used for the adolescent/adult off-Site resident scenario. The adolescent body weight used for the visitor scenarios was 45 kg. This value was extracted from US EPA Region 4 guidance (1995). For the child resident scenario, a body weight of 15 kg was used as recommended by US EPA (1991).

4.2.2 Route-Specific Exposure Parameters

The general intake equation discussed above (Equation 1) was modified by including route-specific exposure parameters in order to calculate route-specific intake values. For dermal exposures, skin surface area, adherence factor, exposure time (surface water exposures only), and absorption factor parameters were included in the intake equation. For ingestion exposures, an ingestion rate and a matrix effect were included in the intake calculation. For inhalation exposures, an inhalation rate and a retention factor for fugitive dusts were included in the intake equation. Also, for inhalation exposures, an additional paradigm was necessary to convert soil concentrations to concentrations in air available for intake.

4.2.2.1 Dermal Exposure Parameters

Skin Surface Area

The total skin surface area used for adult receptors in this assessment was 20,000 cm^2. This is a US EPA default value extracted from the *Exposure Factors Handbook* (1997). For adolescent exposures, a value of 12,768.3 cm^2 was used for total skin surface area. This was a mean value calculated based on the distributions of total skin surface areas for males and females between the ages of 7 and 16 as presented in *Exposure Factors Handbook* (1997). For the off-Site child resident scenario, a skin surface area of 7,213 cm^2 was used. This value was based on skin surface area data for male and female children provided in *Exposure Factors Handbook* (1997).

For purposes of exposure, it was assumed that only portions of the body would be exposed to the affected media on the Site. For the construction worker scenario, it was assumed that the hands, forearms, lower legs, and face would be exposed to Site soils. These body parts comprise 27.8% of the total skin surface area, or 5560 cm^2.

For maintenance worker exposures to Site soils, it was assumed that the hands, forearms, and face would be exposed. These body parts comprise 15 percent of the total skin surface area, or 3000 cm^2.

For surface water and sediment exposures, exposed body parts for construction and maintenance workers included hands, forearms, and face or 3000 cm^2 (15% of the total skin surface area).

The visitor and off-Site resident scenarios assumed that the hands, forearms, and lower legs would be exposed for contact with Site soils. These body parts comprise 23.9% of the total skin surface area, or 3052 cm^2 for adolescent visitors, 1724 cm^2 for child residents, and 4780 cm^2 for adult residents. For exposures to surface water and sediment, hands, forearms, lower legs, and feet were assumed exposed for adolescent visitor and off-Site resident scenarios. These body parts comprise 30.9 % of the total skin surface area or 3945 cm^2 for adolescent visitors, 2229 cm^2 for child residents, and 6180 cm^2 for adult residents.

Soil Adherence Factor

Until recently, the US EPA-recommended default for soil adherence on skin ranged from 0.2 to 1.0 mg/cm^2 for the entire exposed surface area, without consideration of the type of activity (US EPA, 1992). However, the data from which that range was derived were primarily the result of indirect measurements, artificial activities, and sampling of hands only. A more recent study has presented the results of direct measurement of soil loading on skin surfaces before and after normal occupational and recreational activities that might result in soil contact (Kissel *et al.*, 1996). A five-order of magnitude range (roughly 10^{-3} to 10^{+2} mg/cm^2) was reported for observed activity-related hand loadings. That report indicated that hand loadings within the range of 0.2 to 1.0 mg/cm^2 were produced by activities in which there was vigorous soil contact (*e.g.*, rugby, farming); but for activities in which there was less soil contact (*e.g.*, soccer, professional grounds maintenance), loadings substantially less than 0.2 mg/cm^2 were found on hands and other body parts. Kissel *et al.* (1996) concluded that, because non-hand loadings attributable to higher contact activities exceeded hand loadings resulting from lower contact activities, hand data from limited activities cannot be used as a conservative predictor of loadings that might occur on other body surfaces without regard to activity. Furthermore, because exposures are activity-dependent, dermal exposure to soil should be quantified using data describing human behavior (*e.g.*, type of activity, frequency, duration, including interval before bathing, clothing worn, etc.).

The most recent version of the *Exposure Factors Handbook* (1997) states:

> In consideration, of these general observations and the recent data from Kissel *et al.* (1996, 1997), this document recommends a new approach for estimating soil adherence to skin. First use Table 6-12 [Summary of Field Studies, Kissel *et al.*, 1996a] to select the activity which best approximates the exposure scenario of concern. Next, use Table 6-13 [Mean Soil Adherence by Activity and Body Region, Kissel *et al.*, 1996a] to select soil loadings on exposed skin surfaces which correspond to the activity of interest. This table contains soil loading estimates for various body parts. The estimates were derived from soil adherence measurements of body parts of individuals engaged in specific activities described in Table 6-12. These results provide the best estimate of central loadings, but are

based on limited data. Therefore, they have a high degree of uncertainty such that considerable judgment must be used when selecting them for an assessment.

In another study that assessed the percentage of skin coverage in several soil contact trials in a greenhouse and an irrigation pipe laying trial, Kissel *et al.* (1996) concluded that adjusted loadings may be two to three orders of magnitude larger than average loadings if average loadings are small.

The activity-specific soil adherence factor for exposures to a maintenance worker was calculated based on data presented by Kissel *et al.* (1996) for grounds keepers, as presented below:

		Soil Adherence Factor by Body Part (mg/cm²)			
Receptor	**Representative Activity**	**Hands**	**Arms**	**Lower Legs**	**Face**
Maintenance Worker	Grounds Keepers	0.030 - 0.15	0.0021 - 0.023	0.0008 - 0.0012	0.0021 - 0.01

Data for the grounds keepers were used for the maintenance worker estimates because the activities of a grounds keeper best mimic those of a maintenance worker.

Soil adherence factors were calculated by normalizing each body part-specific soil adherence value (using the mid-points of the ranges tabulated above) with regard to the percentage of total body surface area represented by the respective body part (extracted from the US EPA *Dermal Exposure Assessment: Principles and Applications* [US EPA, 1992]). The maintenance worker adherence factor for soil was calculated based upon exposure to the hands, forearms and face. Surface area percentages for the hands, forearms, and face are 5.2, 5.9, and 3.9 percent, respectively (US EPA, 1997). Those body parts comprise 15 percent of the total body surface area. The normalized values for all body parts of interest were added, and the sum was divided by the total percentage of body surface area occupied by the parts. For example, the soil and sediment adherence factors for maintenance worker soil exposures (0.038 mg/cm²) were calculated as follows:

$$AF\ (mg/cm^2) = \frac{(0.09 \times 0.052) + (0.0126 \times 0.059) + (0.006 \times 0.039)}{0.15} = 0.038$$

The construction worker adherence factor was also calculated in this fashion. This exposure scenario assumed that the hands, forearms, lower legs, and face would be exposed to Site soils. Soil loadings for the upper torso (chest and back) were not measured by Kissel *et al.* (1996) for construction workers because this body area is generally covered. However, to account for exposure to the upper torso during the very hot months of the year, the total area of the forearms, legs, hands, and face were assumed to be completely exposed. The hands, forearms, legs, and face comprise 5.2%, 5.9%, 12.8%, and 3.9% of the total skin surface area, respectively (with the face comprising one-third the surface area of the head), for a total of 27.8% exposed surface area. The construction worker soil adherence factor was based on data from Kissel *et al.* (1996) for construction workers as follows:

		Soil Adherence Factor by Body Part (mg/cm^2)			
Receptor	**Representative Activity**	**Hands**	**Arms**	**Lower Legs**	**Face**
Construction Worker	Construction Worker	0.24	0.098	0.066	0.029

The soil adherence factor for the construction worker scenario was calculated as follows:

$$AF\ (mg/cm^2) = \frac{(0.24 \times 0.052) + (0.098 \times 0.059) + (0.066 \times 0.128) + (0.029 \times 0.039)}{0.278} = 0.1$$

For sediment exposures, the soil adherence factor was calculated for the construction worker scenario using adherence data from Kissel *et al.* (1996) for construction workers (as tabulated above) for the hands, forearms, and face. The hands, forearms, and face comprise 5.2, 5.9, and

3.9 percent of the total skin surface area, respectively (totaling 15 percent). Thus, the adherence factor for construction workers exposed to sediment (0.13 mg /cm²) was calculated as follows:

$$\text{AF (mg/cm}^2) = \frac{(0.24 \times 0.052) + (0.098 \times 0.059) + (0.029 \times 0.039)}{0.15} = 0.13$$

The adherence factor for visitor and off-Site resident exposures to soil assumed that the forearms, hands, and lower legs would be exposed to soil or sediment. The data used in these calculation were based on data by Kissel *et al.* (1996) for soccer players (exposed to a playing field of roughly one-half grass and one-half bare earth in a light mist) as presented below:

		Soil Adherence Factor by Body Part (mg/cm²)		
Receptor	**Representative Activity**	**Arms**	**Hands**	**Lower Legs**
Visitor and Off-Site Resident	Soccer Players	0.0029 – 0.011	0.019 – 0.11	0.0081 – 0.031

The forearms, hands, and lower legs comprise 5.9%, 5.2%, and 12.8% of the total skin surface area, respectively, for a total of 23.9% (US EPA *Exposure Factors Handbook*, 1997). The adherence factor was then calculated for visitor and off-Site resident dermal exposures to soil as follows:

$$\text{AF (mg/cm}^2) = \frac{(0.00695 \times 0.059) + (0.0645 \times 0.052) + (0.0196 \times 0.128)}{0.239} = 0.026$$

A value of 0.026 mg/cm² was used as the soil adherence factor for visitors to the Site and off-Site residents.

Soil adherence factors for sediment exposures to Site visitors and off-Site residents were calculated using adherence data for the hands, forearms, lower legs, and feet. Adherence data for

reed gatherers were used for these exposures to best mimic activities that may incur sediment exposures. The reed gatherers studied by Kissel *et al.* (1996) periodically visited tidal flats to collect raw materials for basket weaving. The data from Kissel *et al.* (1996) presented in *Exposure Factors Handbook* (US EPA, 1997) were as follows:

		Soil Adherence Factor by Body Part (mg/cm²)			
Receptor	**Representative Activity**	**Hands**	**Arms**	**Lower Legs**	**Feet**
Visitors and Off-Site Residents	Reed Gatherers	0.66	0.036	0.128	0.63

The hands, forearms, lower legs, and feet comprises 5.2, 5.9, 12.8 and 7.0 percent of the total skin surface area, respectively (totaling 30.9 percent). Thus, the adherence factor for visitors and off-Site residents exposed to sediment (0.33 mg /cm^2) was calculated as follows:

$$AF\ (mg/cm^2) = \frac{(0.66 \times 0.052) + (0.036 \times 0.059) + (0.16 \times 0.128) + (0.63 \times 0.07)}{0.309} = 0.33$$

Exposure Time

To estimate intakes as a result of dermal exposure to surface water, an exposure time (ET) parameter was included in the intake formula for Site visitors and off-Site residents. The parameter value of 1.0 hour/day was estimated using best professional judgement. This value represents the amount of time a Site visitor or off-Site resident may spend exposed to surface water in any one EU.

Dermal Permeability Constant

The permeability constant, Kp, accounts for the movement of a constituent dissolved in water through the skin, across the stratum corneum, and into the blood stream. Kp values for the constituents examined in this assessment for surface water exposures were obtained from US EPA *Dermal Exposure Assessment: Principles and Applications* (1992). For values not available in

US EPA *Dermal Exposure Assessment* (1992), the Kp value were calculated using the equations provided by the US EPA in the same document.

Dermal Absorption Factor

The final parameter included in the dermal intake paradigm was a dermal absorption factor. In general, the skin provides an effective barrier to environmental toxins. For example, certain hair-coloring formulations which are vigorously rubbed onto the scalp on a daily basis contain lead acetate at concentrations up to 200,000 ppm, yet lead toxicity does not appear to result. Moore *et al.* (1980) determined that the rate of lead absorption from 203^{Pb} labeled lead acetate in cosmetic preparations containing six mmol Pb acetate/L in male volunteers over 12 hours was 0.06% during normal use of such preparations. For most inorganic salts, percutaneous (skin) absorption is considered insignificant relative to incidental ingestion (for example, US EPA, 1986). On the other hand, some drugs (*e.g.*, nicotine) are effectively administered and absorbed into the blood stream from dermal "patches."

Most dermal bioavailability data for impacted soil have been obtained in laboratory animals or in vitro test systems. This introduces a significant source of uncertainty for predicting the human response. Safety factors have sometimes been applied to dermal absorption data obtained in animals to conservatively estimate the upper-bound of likely human percutaneous uptake of a certain constituent from skin exposure. This is usually unnecessary because human skin has generally been shown, for a diverse group of constituents, to be about 10-fold less permeable than the skin of typical animal species, such as rabbits and rats (Bartek and LaBudde, 1975; Shu *et al.*, 1988).

US EPA Region III evaluated available data concerning the dermal absorption of specific constituents and classes of constituents and provided several recommendations (US EPA Region 3, 1995). For semivolatile compounds, such as *bis*(2-ethylhexyl)phthalate, the US EPA recommends a range of 1% to 10% (US EPA, 1995). Kao *et al.* (1985) reported 2.7 percent for absorption of topically applied pure benzo(a)pyrene by human skin *in vitro*. The US EPA

Region 3 recommends using 10% as a conservative assumption based on the Ryan *et al.* study (1987). In addition, US EPA Region 4 guidance (1995) states that a soil dermal absorption factor "of 1.0% for organics and 0.1% for inorganics should be used as defaults in determining the uptake associated with dermal exposure" (see the Dermal Contact subsection of Exposure Assessment section of the 1995 guidance). For the purpose of this risk assessment, an ABS of 3% for cPAHs and of 10% for other SVOCs were conservatively assumed for dermal absorption, in keeping with US EPA Region 3's and MDEQ's recommendations.

4.2.2.2 Ingestion Exposure Parameters

Ingestion Rate

US EPA's *Exposure Factors Handbook* (1997) discusses three adult soil ingestion studies with results ranging from 10 mg/day to 480 mg/day. Hawley's (1985) value of 480 mg/day (as recommended by the MDEQ) was "derived from assumptions about soil/dust levels on hands and mouthing behavior" (US EPA, 1997). Since no supporting measurements were made for Hawley's study, the US EPA states that Hawley's estimate "must be considered conjectural" (1997). As such, the US EPA goes on to suggest adult soil ingestion rates of 50 mg/day for industrial settings and 100 mg/day for residential and agricultural settings, although "50 mg/day still represents a reasonable central estimate of adult soil ingestion and is the recommended value…" (1997). Accordingly, a value of 100 mg/day for the maintenance worker and adult off-Site resident is amply conservative and was used in this assessment. In conjunction with the use of a two-tiered EF to reflect the different stages of potential future construction activities (see Section 4.2.1.1), the soil ingestion s for the construction worker scenario was also divided into two exposure levels for a single individual. A highly conservative ingestion rate of 480 mg/day (used in relevant exposure model calculations under "Exposure Level A") was used for construction workers for the first 10 days of exposure to address direct contact with soil during earth-moving activities such as foundation excavating. A soil ingestion rate of 100 mg/day (used in relevant exposure model calculations under "Exposure Level B") was used for the remainder of the construction worker exposure (70 days). Risks were then summed for both exposure levels to estimate the total potential risk posed to an individual construction worker

The ingestion rate used for the adolescent visitor scenario was 100 mg/day. The US EPA Region IV (1995) recommends a value of 200 mg/day as a mean ingestion rate for children under six years of age. This value was conservatively used in this assessment to estimate soil and sediment ingestion exposures for an off-Site resident child aged one to six years.

Gastrointestinal Matrix Effects of Soil

Incidental ingestion incorporates the matrix effect (ME; sometimes called the absorption adjustment factor [AAF]) into the general intake equation. When constituents are administered in solid vehicles such as food and soil, only a fraction of the ingested dose is extracted from the vehicle and subsequently absorbed through the gastrointestinal tract (US EPA *Estimated Exposure to Dioxin-like Compounds*, 1992). Gastrointestinal absorption of constituents sorbed onto such a medium is inhibited by physical-constituent bonding to the matrix (Hawley, 1985). This phenomenon is referred to as the gastrointestinal matrix effect of soil. Several studies referenced in the US EPA's *Estimated Exposure to Dioxin-like Compounds* (1992) have been performed to estimate the oral absorption factors of constituents from soil. At the request of MDEQ (2001), however, a gastrointestinal matrix effect of 1.0 was used in accordance with US EPA Region IV guidance (1995), although this approach is highly conservative and does not account for scientific studies that indicate the absorption of chemical constituents through the gastrointestinal tract is less than 100%.

4.2.2.3 Inhalation Exposure Parameters and Paradigms

Inhalation Rate

The inhalation rate used for the construction worker scenario was 20 m^3/day. This is a common US EPA default value and was recommended by US EPA Region 4 (1995).

Retention Factor

According to the International Commission on Radiological Protection (ICRP), 75 percent of respirable dust particles (PM_{10}, or particles less than 10 microns in aerodynamic diameter) are retained when inhaled, the vast majority of which is potentially subsequently swallowed (ICRP,

1968). This 75% was included in the inhalation intake equation as the retention factor parameter (RF). This parameter applies only to non-VOC constituents entrained onto dust particles.

Concentration in Air

To estimate airborne dust levels during hypothetical construction activities, an emission rate of suspendible particles of less than 15 microns in aerodynamic diameter (PM_{15}) was calculated (grams/second); particles less than 10 microns were considered to be respirable. Considering particles of 15 microns or less in diameter in the emission rate calculation is a conservative assumption, inasmuch as only particles with an aerodynamic diameter of less than five to seven microns are inhaled into the lung.

The two types of construction activities at the Site that have the potential to emit fugitive dusts are vehicular movement over bare (unpaved or unvegetated) surfaces and the excavation of soil. Estimation of fugitive dust emissions caused by each activity were examined separately, as follows, and were derived from existing estimates of general construction exposure. The sum of the emissions from these two activities was multiplied by the concentration of constituent in the soil (Cs) in order to derive the total emission rate (Ei) for non-VOCs as follows:

$$Ei = C_s \times (PERv + PERe) \qquad \textbf{[Equation 2]}$$

where:

Ei	=	Emission rate (mg/sec);
C_s	=	Concentration in soil (mg/kg);
PERv	=	Particulate emission rate for vehicular movement (lb/vehicle mile); and
PERe	=	Particulate emission rate for excavation (lb/vehicle mile).

The following empirical expression (US EPA, 1988) was used to estimate the fugitive dust generated by vehicles during construction activities:

$$\text{PERv (lbs/vehicle mile)} = k \times 5.9 \times (s/12)(S/30) \times (mvw/3)^{0.7} \times (ww/4)^{0.5} \times ((365 - p)/365)$$

[Equation 3]

where:

PERv	=	Vehicle particle emission rate (lb/vehicle mile traveled);
s	=	Percent silt content (unitless);
k	=	Particle size multiplier (unitless);
S	=	Mean vehicle speed (mph);
mvw	=	Mean vehicle weight (ton);
ww	=	Mean number of wheels per vehicle (unitless); and
p	=	Mean number of days with ≥ 0.01 inches of precipitation per year (unitless).

It was assumed that the vehicle travels during 40% of the 80-day exposure duration and 0.5 miles per day. The result is a value of 16 miles per construction event. Percent silt content was estimated to have a mean value of 50%, based on geotechnical data provided in the *Remedial Investigation Report* (Pisani & Assoc., 1997). US EPA default values were utilized and referenced for all other parameters. The particle size multiplier was assumed to be 0.50, corresponding to particles less than 15 microns (US EPA, 1996). Vehicle characteristics consist of the following: mean vehicle speed was assumed to be 15 mph, with mean vehicle weight assumed to be approximately 12.5 tons, for 8-wheeled vehicles (US EPA, 1988). The estimated mean number of days with precipitation equal to or greater than 0.01 inches per year is 110 (US EPA, 1988). Total resultant dust emissions for constituents during vehicular movement activities were estimated to be approximately 16.5 lbs/vehicle mile traveled, or 0.0001 kg/sec. Calculations are summarized in Table 20.

Future excavation may be performed by bulldozers, a backhoe, or other heavy construction equipment. The following estimate of particulate emissions, less than 15 μm in diameter resulting from bulldozing activity, was based on the approach described in the US EPA *Compilation of Air Pollution Emission Factors* (1996), as developed from studies of emissions from uncontrolled open dust sources resulting from bulldozing at western surface coal mines.

$$\text{PERe (lb/hour)} = \frac{1.0 \times s^{1.5}}{M^{1.4}}$$ **[Equation 4]**

where:

PERe	=	Excavation particle emission rate (lb/hr);
s	=	Percent silt content (unitless); and
M	=	Soil moisture content (unitless).

Percent soil moisture content was assumed to be 15.1%, an average of Site-specific soil moisture data and percent silt content 50%, as described above.

The resultant fugitive dust emission rate during excavation activities was 7.9 lbs/hr or 0.001 kg/sec. Table 20 summarizes these calculations.

Once the emission rate (Ei in Equation 2) was calculated, it was converted to a concentration in ambient air. Gaussian models are conventionally used to determine downwind ambient air concentrations, Ca, from the emission rate, Ei, estimated. However, in this scenario, such models have limited applicability when the receptor(s) is at or very near the source of emission. In this case, a bulldozer operator, for example, is situated directly within the area of ground emissions of vapors and dusts. Average ambient air concentrations in this circumstance are best estimated by use of a near-field box model (US EPA, 1988).

The near-field box model assumes uniform wind speed and uniform mixing throughout the box. The release and mixing of VOCs or respirable dusts in ambient air is estimated as follows:

$$\text{Ca (mg/m}^3\text{)} = \frac{\text{Ei}}{W_b \times H_b \times V}$$ **[Equation 5]**

where:

Ca	=	Concentration of constituent in ambient air (mg/m^3);
Ei	=	Emission rate of constituent (mg/sec);
W_b	=	Width of box in crosswind dimension within the area of residual constituent in soil (m);
H_b	=	Downwind height of box (m); and
V	=	Average wind speed through the box (m/sec).

The value of H_b in this calculation is determined by the downwind distance and the atmospheric turbulence at ground level, which determines the trajectory of a release from the upwind edge of the source of vapor or dust emissions. For neutral atmospheric conditions, the height at the downwind boundary (H_b) may be expressed by the following function (Pasquill 1975, Horst 1979):

$$z = 6.25\, r\, [H_b/r \times \ln (H_b/r) - 1.58\, H_b/r + 1.58]$$ **[Equation 6]**

where:

H_b	=	Downwind height of box (m);
z	=	Downwind distance to boundary (m); and
r	=	A terrain-dependent roughness height (m)

H_b (defined in Equation 5) is adjusted until the z parameter is equal to W_b (defined in Equation 5). The resulting H_b value is the height of the box. On any given workday, it is estimated that grading or excavation activities occur over the entire "workable" Site area (exposure unit) from which dusts are generated. This area is estimated to be 2,500 m^2, with length of the box estimated to be 50 meters (downwind distance) and the width of the box (W) estimated to be 50 meters. The greater the roughness height, the greater the wind turbulence and constituent dilution (*i.e.*, the height of the box increases). For the purposes of this risk assessment, it is conservatively assumed that the roughness height is 0.20 meters, which corresponds to a terrain with grass, some small bushes, and occasional trees (US EPA *Rapid Assessment of Exposure to Particulate Emission from Surface Contamination Sites,* 1985). This

assumption is appropriate for the actual Site conditions. An annual average wind speed (4.69 m/sec) is obtained from the STAR data set, accessed through the Personal Computer Graphical Exposure Modeling System (PCGEMS), for STAR station 03940, Jackson/Thompson, MS for the period 1974-1978 (Table 21).

5.0 Toxicity Assessment

The toxicity assessment involves the evaluation of available toxicity information to be utilized in the risk assessment process. Toxicity values derived from a dose-response relationship can be used to estimate the potential for the occurrence of adverse effects in individuals exposed to various constituent levels.

Exposure to a constituent does not necessarily result in adverse effects. The relationship between dose and response defines the quantitative indices of toxicity required to evaluate the potential health risks associated with a given level of exposure. If the nature of the dose-response relationship is such that no effects can be demonstrated below a certain level of exposure, a threshold can be defined and an acceptable exposure level derived. Humans are routinely exposed to naturally-occurring constituents and man-made constituents through the typical diet, air, and water, with no apparent adverse effects. However, the potential for adverse effects may occur if the exposure level exceeds the threshold in a variably sensitive population. This threshold applies primarily to constituents which produce non-carcinogenic (systemic) effects, although there is a growing body of scientific evidence which suggests that exposure thresholds may exist for certain carcinogenic constituents as well.

Adverse effects can be caused by acute exposure, which is a single or short-term exposure to a toxic substance, or by chronic exposure on a continuous or repeated basis over an extended period of time. "Acceptable" acute or chronic levels of exposure are considered to be without any anticipated adverse effects. Such exposure levels are commonly expressed as reference doses (RfDs), health advisories, etc. An acceptable exposure level is calculated to provide an "adequate margin of safety."

Chronic RfDs, which have been derived by the US EPA for a large number of constituents, were utilized to evaluate exposures lasting seven to 70 years (US EPA, 1989). Activities involving exposures of shorter duration to COPCs at the Site are anticipated to result in hazard and risk estimates that are lower than those associated with the long-term exposures. Identification of

subchronic toxicity values corresponding to shorter-term exposure scenarios (*i.e.*, less than seven years) are included in the risk assessment to ensure that both short-term and long-term risks can be addressed.

Currently, the US EPA has not developed toxicity values to be utilized in dermal exposure scenarios; however, the US EPA does provide the following guidance for dermal exposure:

> No RfDs or slope factors are available for the dermal route of exposure. In some cases, however, non-carcinogenic or carcinogenic risks associated with dermal exposure can be evaluated using an oral RfD or oral slope factor, respectively. (US EPA, 1989).

Provisional dermal toxicity values were developed and utilized in the dermal exposure pathways considered in the human health risk assessment to provide a more accurate Site-specific risk assessment. These dermal RfD values were developed by multiplying the published oral RfD for a given constituent by the fraction of that constituent that can be absorbed through the gastrointestinal tract (stomach/intestine lining). The absorption fraction utilized was 50% for semivolatiles as extracted from US EPA Region 4 guidance (1995).

A number of sources of toxicity information exists, and these sources vary with regard to the availability and strength of supporting evidence. The following protocol has been established for the determination of toxicity indices; it defines a hierarchy of sources to be consulted and the methodology for the determination of toxicity values. This protocol has been developed in accordance with current US EPA methodology. Toxicity values for the COPCs at the Site were obtained with reference to the following hierarchy of sources developed in accordance with MCEQ guidance (1999):

1) Toxicity values were obtained from the *Integrated Risk Information System* (IRIS, 1999) database. This database contains the RfDs and Cancer Slope Factors (CSFs), which have been verified by the US EPA's RfD and Carcinogen Risk Assessment Verification Endeavor (CRAVE) workgroups, and is, thus, the

agency's preferred source for toxicity values. IRIS supersedes all other information sources.

2) For toxicity values which are unavailable on IRIS, the most current source of information is the Health Effects Assessment Summary Tables (HEAST, US EPA, 1997), published by the US EPA. HEAST contains interim, as well as verified RfDs and CSFs. Supporting toxicity information for verified values is provided in an extensive reference section of HEAST.

3) In cases where IRIS or HEAST could not provide toxicity values, US EPA Region III's Risk-Based Concentration (RBC) Tables were visited. These tables often provide toxicity values generated by reliable sources other than IRIS or HEAST. For example, in response to specific requests from risk assessors, the US EPA National Center for Environmental Assessment (NCEA) develops provisional RfDs or CSFs for chemicals not listed in IRIS or HEAST. Region III's RBC tables will list such provisional values. Also, RfDs or CSFs that have since been withdrawn from IRIS or HEAST may still be listed on the Region III RBC tables, although they are flagged with a "W." These toxicity values were no longer agreed upon by US EPA scientists; however, the Region III RBC tables continue to publish such values because risk assessors still need to quantify exposures to these chemicals. Lastly, the Region III RBC tables will list toxicity indices found in "other" US EPA documents. These values are flagged with an "O" on the tables.

The US EPA has derived carcinogenic slope factors for both oral and inhalation pathways, and these are utilized to quantitatively estimate risks. In the first step of the US EPA's evaluation, the available data are analyzed to determine the likelihood that the agent is a human carcinogen. The evidence is characterized separately for human studies and animal studies as sufficient, limited, inadequate, no data, or evidence of no effect. The characterizations of these two types of data are combined, and based on the extent to which the agent has been shown to be a carcinogen in experimental animals or humans, or both, the agent is given a provisional weight-of-evidence classification. The US EPA scientists then adjust the provisional classification upward or downward, based on other supporting evidence of carcinogenicity (see Section 7.1.3, US EPA, 1989). For a further description of the role of supporting evidence, see the US EPA guidelines (US EPA, 1986).

The US EPA classification system for weight of evidence is shown in the table below. This system is adapted from the approach taken by the International Agency for Research on Cancer.

US EPA WEIGHT-OF-EVIDENCE CLASSIFICATION SYSTEM FOR CARCINOGENICITY

Group	Description
A	Human carcinogen
B1 or B2	Probable human carcinogen B1 indicates that limited human data are available B2 indicates sufficient evidence in animals and inadequate or no evidence in humans
C	Possible human carcinogen
D	Not classifiable as to human carcinogenicity
E	Evidence of non-carcinogenicity for humans

(US EPA, 1989)

Table 22 summarizes the available toxicity values for the identified COPCs. COPCs lacking published toxicity values were not able to be quantitatively evaluated in this assessment in accordance with MCEQ guidance (1999). The MCEQ limits the use of toxicity values to those that have been published in IRIS, HEAST, ATSDR toxicity profiles, or other peer-reviewed reference sources or literature approved by the MCEQ (1999). The MDEQ (2001), however, requested that risks from dermal exposure to cPAHs be estimated using the oral cancer slope factor for benzo(a)pyrene, applying benzo(a)pyrene relative potency factors, and accounting for an absorption efficiency of 50%. This methodology was used accordingly.

6.0 Risk Characterization

The objective of the risk characterization is to determine potential risk to receptors by combining the results of the exposure and toxicity assessments. Non-carcinogenic effects and carcinogenic risks are summarized in Table 23. Tables 24 through 78 provide algorithms and parameters for each pathway.

The estimated intakes calculated for each exposure pathway considered and each COPC were compared to RfDs for non-carcinogenic effects. The following formula was used to estimate the potential for non-carcinogenic health effects for each COPC.

$$HQ = ADI/RfD \qquad \textbf{[Equation 7]}$$

where:

HQ	=	Hazard quotient - potential for noncancer health effects (unitless);
ADI	=	Average daily intake of COPC (mg/kg-day); and
RfD	=	Reference dose (mg/kg-day).

RfDs have been developed by the US EPA for chronic (*e.g.*, lifetime) and/or subchronic exposure to constituents based on the most sensitive non-carcinogenic effects. The chronic RfD for a constituent is an estimate of a lifetime daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects. The potential for noncancer health effects was evaluated by comparing the Site-specific exposure level with the RfD derived by the US EPA for a similar exposure period. This ratio of exposure to toxicity is called the hazard quotient (HQ). If the Site-specific exposure level exceeds the threshold (*i.e.*, the HQ exceeds a value greater than 1.0), there may be concern for potential noncancer effects.

To assess the overall potential for noncancer effects posed by multiple constituents, a hazard index (HI) is derived by summing the individual HQs. This approach assumes additivity of critical effects of multiple constituents. This is appropriate only for compounds that induce the

same effect by the same mechanism of action. This conservative approach significantly overestimates the actual potential for adverse health impacts.

In cancer risk assessment, the US EPA has required the use of the upper limit which produces an estimate of potential risk that has a 95% probability of exceeding the actual risk, which may, in fact, be zero. The following formula was utilized to estimate the upper bound excess cancer risk for each carcinogen (note that not all COPCs are carcinogens):

$$TR = CLDI \times SF \qquad \textbf{[Equation 8]}$$

where:

TR	=	Target risk - excess probability of an individual developing cancer (unitless);
CLDI	=	Calculated lifetime average daily intake of carcinogenic COPC (mg/kg-day); and
SF	=	Cancer slope factor $(mg/kg\text{-}day)^{-1}$.

For exposures to multiple carcinogens, the upper limits of cancer risks are summed to derive a total cancer risk. The US EPA recognizes that it is not technically appropriate to sum upper confidence limits of the risk to produce a realistic total probability, but requires this approach be used.

Carcinogenic risk refers to the probability of developing cancer as a result of exposure to known or suspected carcinogens. The National Contingency Plan (NCP) endorses an acceptable risk range of 10^{-4} to 10^{-6} for exposure to multiple carcinogens. This range represents an incremental increase of 1 in 10,000 to 1 in 1,000,000 in the chance of developing cancer over a lifetime. The MCEQ (1999) indicates that the target risk level is 1×10^{-6} per individual carcinogen and an acceptable cumulative risk level is 1×10^{-4}. As such, risk levels totaled across oral, dermal, and inhalation pathways may exceed 1×10^{-6} and still be in compliance with MCEQ requirements (1999) as long as no single carcinogen exceeds 1×10^{-6} and the cumulative risk for a single receptor does not exceed 1×10^{-4}.

Table 23 provides a summary of the non-carcinogenic effects and carcinogenic risks associated with each of the pathways evaluated in this assessment.

The overall hazard index across the assessed pathways and EUs was 0.1 for the Site visitor scenario. This value is below the acceptable benchmark of 1.0. The highest hazard index associated with the Site visitor scenario was 0.07 corresponding to dermal exposure to sediment in EU4. The overall cancer risk for exposures to Site visitors was estimated to be 9×10^{-5} and is primarily attributable to oral and dermal exposure to benzo(a)pyrene and associated cPAHs in EU4 soil and sediments. Oral exposure to the same constituents in EU4 and EU5 surface soils also contributed to the cancer risk estimate for the site visitor. Additional discussion regarding remediation goals for this scenario has been provided in section 8.0.

The overall hazard index for the maintenance worker scenarios was 0.08 and is below the acceptable benchmark of 1.0. The highest hazard index associated with the maintenance worker scenario was 0.05 corresponding to oral exposure to sediment in EU4. The overall cancer risk for the maintenance worker scenario was 4×10^{-4} and was primarily attributable to dermal and oral exposure to benzo(a)pyrene and other cPAHs in surface soils in EUs 2, 4, and 5. Additional discussion regarding remediation goals for this scenario has been provided in section 8.0.

The overall hazard index for the hypothetical future construction worker was 0.000001 and is well below the acceptable benchmark of 1.0. The highest hazard index associated with the construction worker scenario was 9×10^{-7} corresponding to dermal exposure to surface water in EU 4. The overall cancer risk for the hypothetical future construction worker scenario was 5×10^{-5} and is attributable to benzo(a)pyrene and associated cPAH oral exposure in EU4 sediment and oral and dermal exposure to EU4 and EU5 soils. Additional discussion regarding remediation goals for this scenario has been provided in section 8.0.

The off-Site resident scenario revealed a hazard index of 6×10^{-4}. This value is considerably below the acceptable benchmark of 1.0. The overall cancer risk for the resident exposure

scenario was estimated to be 2×10^{-4} and is attributable to oral and dermal exposure to benzo(a)pyrene and associated cPAHs in EU6.

7.0 Uncertainty Analysis

Risk assessment uses a wide array of information sources and techniques. Even in those rare circumstances where constituent intake for an exposed individual may be measured relatively precisely, assumptions will still be required to evaluate the associated risk. Generally, data are not available for critical aspects of the risk assessment, and the use of professional judgment, inferences based on analogy, the use of default values, model estimation techniques, etc., result in uncertainty of varying degrees.

The expressions of risk in this assessment are not probabilistic; the expressions of risk are conditional, based on the conditions represented by the single-point values selected for the analysis. This section is intended to identify and qualitatively evaluate the more salient Site-specific uncertainties and their potential influence on the credibility of the estimated Site risks.

7.1 Uncertainty of Data Evaluation Factors

Uncertainties in data analysis include analytical error, selection of COPCs, adequacy of sampling design, etc. Generally, there is far less uncertainty in this phase of the risk assessment process than other aspects contribute.

Laboratory analysis is extremely accurate relative to the potential error of "professional judgment" in exposure assessments. The uncertainty of analytical data is likely to be less than 25 percent, most of the time.

The adequacy of the sampling strategies to characterize Site conditions is a potentially large source of uncertainty. Because of the limited availability of resources, sample collection is generally limited. However, sampling (especially in multiple surveys) is not random, but is designed to locate the areas with the highest levels of constituents. Thus, test data are biased toward overestimation of average constituent levels. In addition, in most instances, the upper 95-percent confidence limit of the average concentration is utilized as an exposure-point

concentration in the risk assessment. The use of this value likely will result in an overestimation of risk, as the 95% UCL represents a value that will be greater than the true average 95% of the time.

Oftentimes, only a portion of detected constituents are carried through the risk assessment process because constituents are eliminated through COPC screening procedures (US EPA, 1989). This could result in an underestimation of risk, although the COPC selection process is intended to identify those constituents that account for the vast majority of potential risk. COPCs lacking published RfD values were not quantitatively evaluated and this may result in an underestimation of potential hazards (non-carcinogenic effects).

7.2 Uncertainty of Toxicity Values

The US EPA's IRIS states that the uncertainty associated with RfD values for non-carcinogenic endpoints of toxicity "span perhaps an order of magnitude." In fact, the uncertainty of extrapolating dose-response data from animals to humans with the application of multiple safety factors (100 to 10,000 or more) is likely to be several orders of magnitude. Current policies for deriving RfD values will often result in an overestimation of risk.

The uncertainty associated with the estimation of cancer risk contributes, by far, the major source of potential error and uncertainty. It is beyond the scope of this analysis to explore this toxicity assessment factor in any detail. However, a few salient points are noted below.

Some constituents classified as carcinogens have been shown to produce an increased incidence of cancer in mice but not rats, for example. If the mouse is not an adequate model for the rat, it may be wondered how reliable a model it is for human beings. The assumption of linearity and a non-threshold phenomenon in the dose versus risk relationship may not be valid and could result in a very large overestimation of actual cancer risk, if any even exist at low doses in humans.

The US EPA evaluated the uncertainty of cancer risk estimates from exposures to trichloroethene and several other related VOCs in public drinking water supplies (Cothern *et al.*, 1984). These US EPA scientists concluded the following:

- The largest uncertainty in the calculations is due to the choice of the model [Multistage, Weiball, Logit, Probit, etc.] used in extrapolating risk to low doses in humans, and is 5 to 6 orders of magnitude;

- If a single model were chosen [assumed to be valid], the overall uncertainty in risk estimates would be 2 to 3 orders of magnitude;

- The exposure estimates contribute, at most, an order of magnitude to the uncertainty; and

- It would appear that until a particular compound's mechanisms of cancer are better known, it is likely that the uncertainty in the toxicity will not be improved.

7.3 Uncertainties in Assessing Potential Exposure

Ideally, Site-specific exposure values should be used when assessing potential intakes of chemicals at a Site. Oftentimes, however, Site-specific data are not available; therefore, the risk assessor must estimate values that most accurately reflect Site conditions. In doing so, US EPA or other regulatory default values were utilized in place of Site-specific data. These values may over- or under-estimate risks, depending on Site conditions and the percentile range in which the default values fall (*e.g.*, 50^{th}, 95^{th}).

Although a considerable amount of published data is available on the most common exposure parameters (*e.g.*, body weight, skin surface area), even these data contain uncertainties. Studies conducted by different scientists often provide differing levels of detail, statistics, and accuracy based on sample size, study design, geographic area, etc. Such discrepancies can increase uncertainty when the data are combined to derive a single-point default value. These data may be the best available; however, the reflection of reality may still be imprecise.

Where published exposure parameters were not available, best professional judgment had to be used, thereby increasing uncertainty. The default or estimated exposure parameters used in this assessment likely resulted in a moderate over-estimation of risk.

The intakes estimated for dermal absorption of PAHs adsorbed into soils adhering to skin may overestimate risks for a host of reasons. Early studies conducted by Falk and coworkers indicated that the carcinogenic effect of B(a)P on subcutaneous injection in mice could be markedly inhibited by the simultaneous administration of various non-carcinogenic PAHs (Falk *et al.*, 1964, as cited in ATSDR, 1988. In other subcutaneous injection and skin-painting studies with mice, it was shown that a combination of several non-carcinogenic PAH compounds, mixed according to the proportion occurring in auto exhaust, did not enhance or inhibit the action of two potent PAH carcinogens, B(a)P and dibenz(a,h)anthracene- (ATSDR, 1988).

The carcinogenic potency of B(a)P and other carcinogenic PAHs is generally determined by injecting solutions under the skin, painting the skin with the carcinogenic PAH dissolved in a solvent, or dissolved in corn oil in feeding studies. This vehicle or matrix affords a high level of bioavailability of the carcinogenic PAH compound. Recently, Krueger *et al.* (1999) conducted *in vitro* percutaneous absorption studies with contaminated soils and organic solvent extracts of contaminated soils collected at former manufactured gas plant (MGP) sites. The MGP tar-contaminated soils contained PAHs at levels ranging from 10 to 2400 mg/kg. The dermal penetration rates of PAH from the MGP tar-contaminated soils and soil solvent extracts were determined experimentally through human skin using tritrum-labelled B(a)P as a surrogate. Results showed reductions of two to three orders of magnitude in PAH absorption through human skin from the most contaminated soils in comparison to the soil extracts. Reduction in PAH penetration was attributed to soil matrix properties. That is, PAH compounds adsorbed to organic carbon in a soil matrix are far less bioavailable for dermal flux than PAH compounds dissolved in a solvent. [No correction for such a profound soil matrix effect was applied in quantitatively estimating cancer risks due to dermal absorption of B(a)P and other carcinogenic PAHs in this assessment.]

8.0 Summary of Findings

The results of the baseline human health risk assessment indicate potentially unacceptable risk levels for the following exposure scenarios:

Potentially Exposed Population	Media	EU
Site Visitor	Sediment Surface Soil	4 4, 5
Maintenance Worker	Sediment Surface Soil	4 2, 4, 5
Construction Worker	Sediment Subsurface Soil	4 4, 5
Off-Site Resident	Sediment	6

The risk levels associated with the above scenarios were driven by cPAHs, particularly benzo(a)pyrene. To determine the extent of remediation necessary to reduce these risks to acceptable levels, sediment and soil data for cPAHs in EUs 2, 4, 5, and 6 were closely examined.

The benzo(a)pyrene exposure-point concentration used to evaluate maintenance worker exposures to surface soil in EU2 was 5.2 mg/kg (sample location GEO-13/0-1'). This was the maximum benzo(a)pyrene concentration found in surface soil in EU2. The next highest concentration of benzo(a)pyrene in surface soil was found at SS-10 (2.4 mg/kg). However, as previously noted, these samples were collected at locations within a densely wooded area. No remediation is planned to address surface soils at these locations for the following reasons:

- No maintenance activities are currently conducted in this area;
- Any remediation would require significant clearing; and
- Cancer risks associated with surface soils at these locations only slightly exceed 1×10^{-6} for two individual constituents, and the total cancer risk level is still less than 1×10^{-5}.

In EU4, the maximum concentration of benzo(a)pyrene was used as the exposure-point concentration for site visitor, maintenance worker, and construction worker exposure to sediment. The benzo(a)pyrene exposure-point concentration used to evaluate these in EU4 was 130 mg/kg (sample location SD-02, see Figure 2). The next two highest concentrations of benzo(a)pyrene in sediment were found at SD-12 (71 mg/kg) and SD-23 (5.57 mg/kg), respectively. Implementing a remedy to remove, treat, or preclude contact with sediment at sample locations SD-02, SD-12, and SD-23 would leave a concentration of 3.1 mg/kg (sample location SD-18) as the maximum concentration in sediment that could be potentially contacted by site visitors, maintenance workers, and/or construction workers in EU 4. Excluding samples SD-02, SD-12, and SD-23 and using 3.1 mg/kg as the exposure-point concentration drops the risk level for dermal and oral contact with sediment by a visitor and oral contact with sediment by a maintenance worker or construction worker to within acceptable levels (i.e., no risk level associated with a single carcinogen exceeds 1×10^{-6}; Tables 79 - 83).

In EU4, the maximum concentration of benzo(a)pyrene was also used as the exposure-point concentration for site visitor, maintenance worker, and construction worker soil exposures. Each of these receptors could potentially be exposed to soils at different depth ranges: visitor 0-1' bgs, maintenance worker 0-6' bgs, and construction worker 0-20' bgs. The sample locations and corresponding concentrations of benzo(a)pyrene that contributed to elevated risk estimates in the three exposure scenarios are presented in the table below:

Sample Location	Benzo(a)pyrene Concentration (mg/kg)
GEO-48/0-1'	500
GEO-21/0-1'	230
GEO-21/2-3'	190
GEO-19/0-1'	56
GEO-46/0-1'	16

Sample Location	Benzo(a)pyrene Concentration (mg/kg)
GEO-20/5-6'	11
GEO-47/5-6'	9.6
GEO-48/2-3'	6.1
GEO-20/0-1'	3.2
GEO-47/0-1'	3
GEO-19/2-3'	2.4

Implementing a remedy to remove, treat, or preclude contact with the surface (0-1' bgs) soil sample locations tabulated above would result in eliminating exposures for the site visitor scenario (*i.e.*, the 0-1' bgs samples listed above comprise the entire data set for visitor exposures to surface soils in EU4). In addition, implementation of a remedy addressing the sample locations tabulated above would leave a maximum benzo(a)pyrene soil concentration in the 0-6' horizon of 0.29 mg/kg (sample location GEO-19/5-6'). Using the concentration of 0.29 mg/kg as the exposure-point concentration for estimating risk to maintenance workers drops the risk levels to within acceptable levels (Tables 84 - 85). Implementation of this remedy would also reduce the benzo(a)pyrene exposure-point concentration in soils in the 0-20' horizon for construction workers to 5.2 mg/kg resulting in estimated risk values well below acceptable levels (Tables 86-88). In situ biological treatment is proposed to address impacted soils within EU4. This will include clearing, tilling, application of inorganic nutrients, and, once soils are remediated to the extent practicable, placement of concrete cover. The area to be remediated will extend at least from Courtesy Ford to the edge of the railroad right-of-way, and may extend onto the railroad right-of-way with the permission of the Southern railway.

In EU5, the surface soil sample locations contributing most to elevated risk levels for the maintenance worker, construction worker, and site visitor scenarios were GEO-33/0-1', GEO-33/2-3', GEO-30/0-1', GEO-59/0-1, GEO-29/0-1', and GEO-28/0-1' (see Figure 2). All sample locations, with the exception of GEO-59/0-1', are located underneath paved areas in a parcel of land extending from Courtesy Ford to the southeast (Figure 2). Pavement in this area precludes direct contact with surface and subsurface soils; therefore, it is not anticipated that current or future maintenance workers or site visitors will have access to soils in or around these sample locations. In addition, a deed restriction will be implemented requiring the maintenance of the paved areas to ensure protection of human health in the future. Sample location GEO-59/0-1', with a benzo(a)pyrene exposure point concentration is 6.1 mg/kg, however, is adjacent to West Pine Street in an unpaved area. Implementing a remedy to remove, treat, or preclude contact with surface soil at this location would leave a concentration of 0.37 mg/kg (GEO-60/0-1') as the maximum concentration in surface soil not covered by pavement that could potentially be contacted by any of the three receptors in this EU. Excluding sample GEO-59/0-1' and using 0.37 mg/kg as the exposure-point concentration drops the estimated exposures in EU5 to within acceptable levels (i.e., no risk level associated with a single carcinogen exceeds 1×10^{-6}; Tables 89 - 92).

The benzo(a)pyrene exposure-point concentration used to evaluate adult and child resident exposures to sediment in EU6 was 49 mg/kg (sample location SD-03, see Figure 3). This was the maximum benzo(a)pyrene concentration found in sediments in EU6. Sample locations SD-04, SD-14, SD-13, SD-16, SD-15, and SD-17 (33, 12.2, 3.27, 2.8, 2.42, and 2.26 mg/kg, respectively) also contributed to elevated cancer risk estimates for both receptors. Implementing a remedy to remove, treat, or preclude contact with sediment at these sample locations would leave a concentration of 0.97 mg/kg (sample location SD-05). Using the benzo(a)pyrene concentration of 0.97 mg/kg as the exposure-point concentration for sediment exposure to adult and child residents reduces the risk estimate to within acceptable limits (i.e., no risk level associated with a single carcinogen exceeds 1×10^{-6}; Tables 93 - 96). Remediation activities are proposed to remove impacted sediment and preclude contact with residuals in the northeast drainage ditch. These activities include removal and off-Site treatment and/or disposal of impacted sediments, installation of a storm water collection and conveyance pipe, backfilling around the culvert, and planting with native grass.

Table 23
Summary of Hazard and Risk Calculations
Kerr McGee, Hattiesburg, MS

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Cancer Risk	Driving Constituent	Table Referenced
Dermal Exposure to Sediment in EU1	Visitor	NA	4E-08		24
Oral Exposure to Sediment in EU1	Visitor	NA	5E-08		25
	Sub-Total	NA	8E-08		
Dermal Exposure to Surface Water in EU1	Visitor	NA	4E-07		26
Oral Exposure to Surface Water in EU1	Visitor	NA	9E-09		27
	Sub-Total	NA	4E-07		
Dermal Exposure to Surface Soil in EU2	Visitor	NA	3E-08		28
Oral Exposure to Surface Soil in EU2	Visitor	NA	6E-07		29
	Sub-Total	NA	6E-07		
Dermal Exposure to Surface Soil in EU3	Visitor	NA	4E-09		30
Oral Exposure to Surface Soil in EU3	Visitor	NA	9E-08		31
	Sub-Total	NA	9E-08		
Dermal Exposure to Sediment in EU4	Visitor	7E-02	1E-05	cPAHs	32
Oral Exposure to Sediment in EU4	Visitor	3E-02	2E-05	cPAHs	33
	Sub-Total	1E-01	3E-05		
Dermal Exposure to Surface Water in EU4	Visitor	2E-04	9E-07		34
Oral Exposure to Surface Water in EU4	Visitor	2E-05	2E-08		35
	Sub-Total	3E-04	9E-07		
Dermal Exposure to Surface Soil in EU4	Visitor	4E-03	3E-06	*	36
Oral Exposure to Surface Soil in EU4	Visitor	3E-02	6E-05	cPAHs	37
	Sub-Total	3E-02	6E-05		
Dermal Exposure to Surface Soil in EU5	Visitor	NA	3E-07		38
Oral Exposure to Surface Soil in EU5	Visitor	NA	6E-06	Benzo(a)pyrene	39
	Sub-Total	NA	6E-06		
	Visitor Total:	**1E-01**	**9E-05**		

Table 23
Summary of Hazard and Risk Calculations
Kerr McGee, Hattiesburg, MS

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Cancer Risk	Driving Constituent	Table Referenced
Dermal Exposure to Sediment in EU1	Maintenance Worker	NA	1E-08		40
Oral Exposure to Sediment in EU1	Maintenance Worker	NA	2E-07		41
	Sub-Total	NA	2E-07		
Dermal Exposure to Surface Water in EU1	Maintenance Worker	NA	1E-06	*	42
Oral Expposure to Surface Water in EU1	Maintenance Worker	NA	4E-08		43
	Sub-Total	NA	1E-06		
Dermal Exposure to Surface Soil in EU2	Maintenance Worker	NA	5E-07		44
Oral Exposure to Surface Soil in EU2	Maintenance Worker	NA	7E-06	cPAHs	45
	Sub-Total	NA	7E-06		
Dermal Exposure to Sediment in EU4	Maintenance Worker	1E-02	4E-06	Benzo(a)pyrene	46
Oral Exposure to Sediment in EU4	Maintenance Worker	5E-02	6E-05	cPAHs	47
	Sub-Total	6E-02	7E-05		
Dermal Exposure to Surface Water in EU4	Maintenance Worker	3E-04	3E-06	*	48
Oral Exposure to Surface Water in EU4	Maintenance Worker	3E-05	9E-08		49
	Sub-Total	3E-04	3E-06		
Dermal Exposure to Surface Soil in EU4	Maintenance Worker	5E-03	2E-05	cPAHs	50
Oral Exposure to Surface Soil in EU4	Maintenance Worker	2E-02	2E-04	cPAHs	51
	Sub-Total	3E-02	2E-04		
Dermal Exposure to Surface Soil in EU5	Maintenance Worker	NA	6E-06	Benzo(a)pyrene	52
Oral Exposure to Surface Soil in EU5	Maintenance Worker	NA	9E-05	cPAHs	53
	Sub-Total	NA	1E-04		
	Maintenance Worker Total:	**8E-02**	**4E-04**		

Table 23
Summary of Hazard and Risk Calculations
Kerr McGee, Hattiesburg, MS

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Cancer Risk	Driving Constituent	Table Referenced
Dermal Exposure to Sediment in EU1	Construction Worker	NA	5E-10		54
Oral Exposure to Sediment in EU1	Construction Worker	NA	9E-09		55
	Sub-Total	NA	1E-08		
Dermal Exposure to Surface Water in EU1	Construction Worker	NA	1E-08		56
Oral Exposure to Surface Water in EU1	Construction Worker	NA	4E-10		57
	Sub-Total	NA	1E-08		
Dermal Exposure to Soil in EU2	Construction Worker	NA	4E-07		58
Oral Exposure to Soil in EU2	Construction Worker	NA	2E-06	*	59
Inhalation of Fugitive Dust in EU2	Construction Worker	NA	7E-08		60
	Sub-Total	NA	2E-06		
Dermal Exposure to Sediment in EU4	Construction Worker	NA	2E-07		61
Oral Exposure to Sediment in EU4	Construction Worker	NA	3E-06	Benzo(a)pyrene	62
	Sub-Total	NA	3E-06		
Dermal Exposure to Surface Water in EU4	Construction Worker	9E-07	3E-08		63
Oral Exposure to Surface Water in EU4	Construction Worker	5E-07	9E-10		64
	Sub-Total	1E-06	3E-08		
Dermal Exposure to Soil in EU4	Construction Worker	NA	8E-06	Benzo(a)pyrene	65
Oral Exposure to Soil in EU4	Construction Worker	NA	4E-05	cPAHs	66
Inhalation of Fugitive Dust in EU4	Construction Worker	NA	1E-06	Benzo(a)pyrene	67
	Sub-Total	NA	5E-05		
Dermal Exposure to Soil in EU5	Construction Worker	NA	7E-07		68
Oral Exposure to Soil in EU5	Construction Worker	NA	3E-06	Benzo(a)pyrene	69
Inhalation of Fugitive Dust in EU5	Construction Worker	NA	1E-07		70
	Sub-Total	NA	4E-06		
	Construction Worker Total:	**1E-06**	**5E-05**		

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Cancer Risk	Driving Constituent	Table Referenced
Dermal Exposure to Sediment in EU6	Child Off-Site Resident	NA	2E-05	cPAHs	71
Oral Exposure to Sediment in EU6	Child Off-Site Resident	NA	7E-05	cPAHs	72
	Sub-Total	NA	9E-05		
Dermal Exposure to Sediment in EU6	Adult Off-Site Resident	5E-04	4E-05	cPAHs	73
Oral Exposure to Sediment in EU6	Adult Off-Site Resident	1E-04	3E-05	cPAHs	74
	Sub-Total	6E-04	7E-05		
Dermal Exposure to Surface Water in EU6	Child Off-Site Resident	NA	2E-06	*	75
Oral Exposure to Surface Water in EU6	Child Off-Site Resident	NA	5E-07		76
	Sub-Total	NA	3E-06		
Dermal Exposure to Surface Water in EU6	Adult Off-Site Resident	NA	5E-06	*	77
Oral Exposure to Surface Water in EU6	Adult Off-Site Resident	NA	8E-08		78
	Sub-Total	NA	5E-06		
	Off-Site Resident Total:	**6E-04**	**2E-04**		

*Estimated carcinogenic risk level is below *de minimis* level as no single constituent exceeded 1×10^{-6} and the cumulative site carcinogenic risk is below 1×10^{-4} (Section 501, MCEQ, 1999).

Table 60

Exposure to Construction Workers from Inhalation of Fugitive Dust in EU2

Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Ca*InhR*EF*ED*RF}{BW*AT}$

Parameter	Units	Value	Source
Ca - Concentration in air =	mg/m^3	chem.spec.	
InhR - Inhalation Rate =	m^3/shift	20	USEPA 1995, Region IV
EF - Exposure Frequency =	shifts/year	80	reasonable assumption
ED - Exposure Duration =	years	1	reasonable assumption
RF_s - Retention Factor - semivolatiles =		0.75	ICRP, 1968
AT_n - Averaging Time noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM
BW - Body Weight =	kg	70	USEPA 1995, Region IV

E_i - Emission Rate (mg/sec) = Cs*(PERv+PERe)

Cs - Concentration in soil = mg/kg chem.spec.

Ca = Concentration in Air (mg/m^3) = Ei / (Hb * W * V)

Ei - Emission Rate of Component (mg/sec) = see below

Hb - Downwind Ht (m) = 4.81

W - Width (m) = 50

V - Wind speed (m/sec) = 4.69

Length (downwind distance) (m) = 50

r - Roughness Ht. (m) = 0.20

z - downwind distance (m) = 50

z = 6.25r[Hb/r * Ln(Hb/r) - 1.58*Hb/r + 1.58]

Chemicals	Concentration in Soil mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles									
Benzo(a)anthracene	6.10E+01	6.67E-02	5.92E-05	2.78E-06	NA	NA	3.97E-08	3.10E-01	1.23E-08
Benzo(a)pyrene	2.17E+01	2.37E-02	2.10E-05	9.88E-07	NA	NA	1.41E-08	3.10E+00	4.37E-08
Benzo(b)fluoranthene	3.30E+01	3.61E-02	3.20E-05	1.50E-06	NA	NA	2.15E-08	3.10E-01	6.66E-09
Benzo(k)fluoranthene	1.10E+01	1.20E-02	1.07E-05	5.01E-07	NA	NA	7.16E-09	3.10E-02	2.22E-10
Chrysene	5.20E+01	5.69E-02	5.05E-05	2.37E-06	NA	NA	3.39E-08	3.10E-03	1.05E-10
Dibenz(a,h)anthracene	1.69E+00	1.85E-03	1.64E-06	7.70E-08	NA	NA	1.10E-09	3.10E+00	3.41E-09
Indeno(1,2,3-cd)pyrene	8.70E+00	9.51E-03	8.44E-06	3.96E-07	NA	NA	5.66E-09	3.10E-01	1.76E-09

NA - Not Available

Total Cancer Risk: 6.82E-08

Table 86
Dermal Exposure to EU4 Soil (0-20') by a Construction Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	5560	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		27.8%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.1	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	80	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.50E+01	7.83E-07	NA	NA	1.12E-08	1.46E+00	1.63E-08
Benzo(a)pyrene	5.20E+00	2.72E-07	NA	NA	3.88E-09	1.46E+01	5.66E-08
Benzo(b)fluoranthene	7.80E+00	4.07E-07	NA	NA	5.82E-09	1.46E+00	8.50E-09
Benzo(k)fluoranthene	3.70E+00	1.93E-07	NA	NA	2.76E-09	1.46E-01	4.03E-10
Carbazole	9.50E+00	1.65E-06	NA	NA	2.36E-08	NA	NA
Chrysene	1.20E+01	6.27E-07	NA	NA	8.95E-09	1.46E-02	1.31E-10
Dibenz(a,h)anthracene	5.00E-01	2.61E-08	NA	NA	3.73E-10	1.46E+01	5.45E-09
Indeno(1,2,3-cd)pyrene	2.00E+00	1.04E-07	NA	NA	1.49E-09	1.46E+00	2.18E-09
Naphthalene	1.50E+02	2.61E-05	NA	NA	3.73E-07	NA	NA

NA - Not Available

Total Cancer Risk = 8.96E-08

Table 87
Oral Exposure to EU4 Soil (0-20') by a Construction Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in soil =	mg/kg	see below	
$IngR_a$ - Ingestion rate for soil =	mg/day	480	USEPA 1997, EFH
$IngR_b$ - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF_a - Exposure frequency =	days/year	10	reasonable assumption
EF_b - Exposure frequency =	days/year	70	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Exposure Level A

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.50E+01	2.82E-06	NA	NA	4.03E-08	7.30E-01	2.94E-08
Benzo(a)pyrene	5.20E+00	9.77E-07	NA	NA	1.40E-08	7.30E+00	1.02E-07
Benzo(b)fluoranthene	7.80E+00	1.47E-06	NA	NA	2.09E-08	7.30E-01	1.53E-08
Benzo(k)fluoranthene	3.70E+00	6.95E-07	NA	NA	9.93E-09	7.30E-02	7.25E-10
Carbazole	9.50E+00	1.78E-06	NA	NA	2.55E-08	2.00E-02	5.10E-10
Chrysene	1.20E+01	2.25E-06	NA	NA	3.22E-08	7.30E-03	2.35E-10
Dibenz(a,h)anthracene	5.00E-01	9.39E-08	NA	NA	1.34E-09	7.30E+00	9.80E-09
Indeno(1,2,3-cd)pyrene	2.00E+00	3.76E-07	NA	NA	5.37E-09	7.30E-01	3.92E-09
Naphthalene	1.50E+02	2.82E-05	NA	NA	4.03E-07	NA	NA

NA - Not Available

Cancer Risk = 1.62E-07

Exposure Level B

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.50E+01	4.11E-06	NA	NA	5.87E-08	7.30E-01	4.29E-08
Benzo(a)pyrene	5.20E+00	1.42E-06	NA	NA	2.04E-08	7.30E+00	1.49E-07
Benzo(b)fluoranthene	7.80E+00	2.14E-06	NA	NA	3.05E-08	7.30E-01	2.23E-08
Benzo(k)fluoranthene	3.70E+00	1.01E-06	NA	NA	1.45E-08	7.30E-02	1.06E-09
Carbazole	9.50E+00	2.60E-06	NA	NA	3.72E-08	2.00E-02	7.44E-10
Chrysene	1.20E+01	3.29E-06	NA	NA	4.70E-08	7.30E-03	3.43E-10
Dibenz(a,h)anthracene	5.00E-01	1.37E-07	NA	NA	1.96E-09	7.30E+00	1.43E-08
Indeno(1,2,3-cd)pyrene	2.00E+00	5.48E-07	NA	NA	7.83E-09	7.30E-01	5.71E-09
Naphthalene	1.50E+02	4.11E-05	NA	NA	5.87E-07	NA	NA

NA - Not Available

Cancer Risk = 2.36E-07

Total Cancer Risk = 3.98E-07

Table 88

Exposure to Construction Workers from Inhalation of Fugitive Dust in EU4
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Ca*InhR*EF*ED*RF}{BW*AT}$$

Ca - Concentration in air =	mg/m^3	see below	
InhR - Inhalation Rate =	m^3/shift	20	USEPA 1995, Region IV
EF - Exposure Frequency =	shifts/year	80	reasonable assumption
ED - Exposure Duration =	years	1	reasonable assumption
RF_s - Retention Factor - semivolatiles =		0.75	ICRP, 1968
AT_n - Averaging Time noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM
BW - Body Weight =	kg	70	USEPA 1995, Region IV

E_i - Emission Rate (mg/sec) = Cs*(PERv+PERe)
Cs - Concentration in soil = mg/kg see below

Ca = Concentration in Air (mg/m^3) = Ei / (Hb * W * V)
Ei - Emission Rate of Component (mg/sec) = see below
Hb - Downwind Ht (m) = 4.81
W - Width (m) = 50
V - Wind speed (m/sec) = 4.69
Length (downwind distance) (m) = 50
r - Roughness Ht. (m) = 0.20
z - downwind distance (m) = 50
z = 6.25r[Hb/r * Ln(Hb/r) - 1.58*Hb/r + 1.58]

Chemicals	Concentration in Soil mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles									
Benzo(a)anthracene	1.50E+01	1.64E-02	1.46E-05	6.84E-07	NA	NA	9.77E-09	3.10E-01	3.03E-09
Benzo(a)pyrene	5.20E+00	5.69E-03	5.05E-06	2.37E-07	NA	NA	3.39E-09	3.10E+00	1.05E-08
Benzo(b)fluoranthene	7.80E+00	8.53E-03	7.57E-06	3.55E-07	NA	NA	5.08E-09	3.10E-01	1.57E-09
Benzo(k)fluoranthene	3.70E+00	4.05E-03	3.59E-06	1.69E-07	NA	NA	2.41E-09	3.10E-02	7.47E-11
Carbazole	9.50E+00	1.04E-02	9.22E-06	4.33E-07	NA	NA	6.19E-09	NA	NA
Chrysene	1.20E+01	1.31E-02	1.16E-05	5.47E-07	NA	NA	7.81E-09	3.10E-03	2.42E-11
Dibenz(a,h)anthracene	5.00E-01	5.47E-04	4.85E-07	2.28E-08	NA	NA	3.26E-10	3.10E+00	1.01E-09
Indeno(1,2,3-cd)pyrene	2.00E+00	2.19E-03	1.94E-06	9.11E-08	NA	NA	1.30E-09	3.10E-01	4.04E-10
Naphthalene	1.50E+02	1.64E-01	1.46E-04	6.84E-06	NA	NA	9.77E-08	NA	NA

NA - Not Available

Total Cancer Risk: 1.66E-08

HUMAN HEALTH RISK ASSESSMENT

FOR THE FORMER GULF STATES CREOSOTING FACILITY,

HATTIESBURG, MISSISSIPPI

April 3, 2001

Prepared for:

KERR-MCGEE CHEMICAL LLC
123 Robert S. Kerr Avenue
P.O. Box 25861
Oklahoma City, OK 73125-0861

Prepared by:

ENVIRONMENTAL STANDARDS, INC.
1140 Valley Forge Road
P.O. Box 810
Valley Forge, PA 19482-0810

Table of Contents

Page

Table of Contents (Cont.)

Executive Summary

A baseline human health risk assessment (HHRA) was conducted for the Former Gulf States Creosoting facility in Hattiesburg, Mississippi. The HHRA was performed in accordance with: Mississippi Commission on Environmental Quality's (MCEQ's) *Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi* (1999); US EPA's *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* (1989); US EPA Region 4 guidance entitled *Technical Services Supplemental Guidance to RAGS, Region 4 Bulletins* (1995); and other relevant US EPA guidance documents.

Creosoting constituents of potential health concern include polycyclic aromatic hydrocarbons (PAHs), of which benzo(a)pyrene is the predominant contributor to potential risks. Much of the former creosoting process area is currently covered with asphalt or large building structures. Potential future exposure scenarios included a construction worker, a maintenance worker, an infrequent Site visitor, and off-Site residents. Media of concern included soils, sediment, and surface water.

Hazards posed by chemical constituents in soils, sediment, and surface water for health effects other than an increased risk of cancer were well below a threshold of possible concern for each receptor evaluated in this risk assessment. Cancer risks for all exposure scenarios were within or below the US EPA's acceptable target risk range of 1×10^{-6} to 1×10^{-4} (*i.e.*, one in one million to one in ten thousand) with the exception of maintenance worker exposure to soils in EU4 and off-site resident exposure to sediments in EU6. The added lifetime cancer risk conservatively estimated for a maintenance worker was 4×10^{-4} for the entire Site, while that for the off-site resident was 2×10^{-4} for the entire Site. The potential risk for a construction worker was estimated to be 5×10^{-5} for the entire Site. The estimated potential risk for an adolescent Site visitor was 7×10^{-5} for the entire Site. For the Site visitor, maintenance worker, and construction worker scenarios, oral contact with carcinogenic PAHs in sediment and soils drove the cancer risk level. For the off-Site resident scenario, oral contact with carcinogenic PAHs in sediment drove the cancer risk level.

Risk levels are mainly attributable to residual concentrations of carcinogenic polycyclic aromatic hydrocarbons (cPAH) in EUs 4, 5, and 6. Remedial actions currently planned for these areas, including deed restrictions, will result in incomplete exposure pathways thereby resulting in acceptable levels of risks to potential receptors. Proposed remediation activities to address impacted media in EUs 4, 5, and 6 include the following:

- Conduct in-situ biological treatment of impacted soils in the unpaved area between the former Process Area and the Southern railroad tracks (EU4);
- Attempt to recover free product from targeted areas within the former Process Area to address continuing sources (EU5);

- Remove impacted sediments from the northeast drainage ditch and install a culvert to provide for surface drainage (EU6);
- Establish deed restrictions limiting the use of property to non-residential (i.e., "restricted") purposes (EU4 and EU5); and
- Include in the deed restrictions provisions for maintaining pavement to preclude contact with impacted media left in place (EU5).

Constituent concentrations in surface soils at two isolated locations within EU2 also resulted in maintenance worker risk levels slightly greater than 1×10^{-6}. Because these locations are within a densely wooded area where no maintenance activities currently occur and remediation would require significant clearing, no remediation activities are planned to address surface soils at these locations. Deed restrictions limiting the use of properties within EU2 to non-residential purposes will be established.

1.0 Introduction

Environmental Standards, Inc. (Environmental Standards) was retained by Kerr-McGee Chemical Corporation (Kerr-McGee) to perform a human health risk assessment (HHRA) to evaluate hazards and risks potentially posed by residual levels of chemicals present at the Former Gulf States Creosoting facility (Site). The Site, located near the intersection of US Highways 49 and 11 in Hattiesburg, Mississippi, was formerly a wood treating facility that operated between the early 1900s and 1960. In the early 1960s, the Site was redeveloped for commercial and light industrial uses (Michael Pisani & Assoc., 1997). The land on which the Site is located is a portion of the Sixteenth Section land owned by the Hattiesburg Public School District and leased to the current tenants under a 99-year lease, granted on July 7, 1947. At the time of this report, the Site, with the exception of the grassy and wooded areas in the south and southwest, respectively, was primarily used for automobile dealerships. There are no residential or institutional (*i.e.*, schools) uses of the Site (Michael Pisani & Assoc., 1997).

Operations at the Site consisted of a small-scale wood preserving process using creosote. The creosoting process was primarily confined to a 2.5-acre area in the northeast corner of the Site; this is known as the former Process Area and is currently occupied by Courtesy Ford. During the redevelopment of the Site in the early 1960s, construction debris (*e.g.*, broken concrete, asphalt, etc.) appears to have been relocated to the southwestern corner of the Site along Gordon's Creek. This area is known as the Fill Area and currently remains undeveloped.

This assessment has been conducted as a result of an agreement between Kerr-McGee, the Mississippi Department of Environmental Quality (MDEQ), and the Mississippi Commission on Environmental Quality (MCEQ) pursuant to the Uncontrolled Site Voluntary Evaluation Program. The MDEQ Office of Pollution Control, Uncontrolled Sites Section has been providing oversight and review of investigations and reports relating to the former Gulf States Creosoting facility.

This report will address the potential for on-Site exposures to human receptors and off-Site exposures to humans along the northeast drainage ditch.

The primary guidance used to develop this risk assessment was the MCEQ *Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi* (1999). US EPA Region 4's *Technical Services Supplemental Guidance to RAGS: Region 4 Bulletins* (1995) were also referred to for guidance. Additional US EPA guidance documents cited herein include:

- *Guidance for Remediation of Uncontrolled Hazardous Substance Sites in Mississippi (MDEQ, 1990);*
- *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual/ Part A (RAGS/Part A)* (US EPA, 1989);
- *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (US EPA, 1991);
- *Exposure Factors Handbook* (US EPA, 1997);
- *Guidelines for Exposure Assessment* (US EPA 1992);
- *Dermal Exposure Assessment: Principles and Applications* (US EPA, 1992);

These documents are not listed in a hierarchical manner; other US EPA guidance documents and peer-reviewed technical papers may have also been referenced in this risk assessment report.

2.0 Hazard Identification and Conceptual Site Model

As a result of the historical wood preservation process, residual levels of creosote-related chemicals are present in soils in the former Process Area. Sediment and surface water in a drainage ditch along the southeast border of the former Process Area also contain chemical residuals. These Site-related chemicals, mostly polycyclic aromatic hydrocarbons (PAHs) are also present in the Fill Area. Residual levels of PAHs have been found in soil in the Fill Area and in Gordon's Creek surface water and sediment.

PAH residuals have also been detected in shallow groundwater underlying the Site. Currently, there are no private water wells located on-Site that access this shallow groundwater for potable purposes. The results of a door-to-door survey conducted by Michael Pisani and Associates on October 3, 2000 indicated no private uses of shallow groundwater downgradient of the Site. For these reasons, the groundwater exposure pathway, both on- and off-Site, was considered incomplete and not evaluated in this assessment.

A conceptual site model (CSM) was developed for the Site to aid in determining the potential receptors and exposure units to be evaluated under current and future potential land use (Figure 1). These receptors were identified as infrequent Site visitors, maintenance workers, construction workers, and off-Site residents.

Under current land use assumptions, Site visitors may potentially contact residual chemicals in Gordon's Creek surface water and sediment, and/or surface soils in the Fill Area and surrounding woods, the grassy field southeast of the Fill Area, and/or the drainage ditch along side of the former Process Area. Visitors may also potentially contact surface soil, surface water, and sediment along the former Process Area drainage ditch. The remaining affected areas of the Site are covered with either buildings or pavement precluding casual direct contact with surface soils. As a conservative measure, however, visitor exposure to soils from these paved areas was also assessed.

Under both current and future land use assumptions, a maintenance worker may contact surface soils in the Fill Area and surrounding woods, the grassy field southeast of the Fill Area, and/or the former Process Area and surrounding affected areas, including the drainage ditch located to the southeast of the former Process Area. Although most of the former Process Area and vicinity are paved, maintenance activities may involve some shallow digging; therefore, direct contact with shallow soils in this area was assessed.. As a conservative measure, exposure to surface water and sediment in Gordon's Creek was assessed. The remainder of the Site was relatively unaffected by historical creosoting activities.

Although there are currently no major construction activities at the Site, these types of activities may occur at some time in the future. As with the maintenance worker scenario, construction activities could potentially occur in the Fill Area and vicinity, the grassy field southeast of the Fill Area, and the former Process Area and vicinity. Construction workers may be exposed to both surface and subsurface soils (down to the water table). Construction worker exposure to surface water and sediment in Gordon's Creek was assessed as a conservative measure. The remainder of the Site was relatively unaffected by historical creosoting activities.

Areas of the Site affected by historical creosoting activities will be deed restricted prohibiting future residential development. Off-Site areas along the northeast Drainage Ditch, currently a residential neighborhood, were assessed for residential exposures to soil, sediment, and surface water.

3.0 Data Evaluation

To characterize potential exposures to Site-related chemicals, the former Gulf States Creosoting facility was divided into six exposure units (EUs). Each exposure unit outlines potentially affected areas of the Site and adjacent on-Site locales that may be frequented by individuals accessing the Site for recreational or occupational purposes. The use of EUs is encouraged by the US EPA Region 4 (1995), which defines an EU as "an areal extent of a receptor's movements during a single day… ." Each of these exposure units is depicted on Figure 2 and is discussed below.

A sixth EU was created for off-Site residential exposures to surface water and sediment along the northeast Drainage Ditch. This EU is delineated on Figure 3.

3.1 Exposure Unit Delineation

The following EUs were delineated based upon the presence of residual chemicals and the potential for receptors to contact those chemicals. Areas of the Site most affected were included in at least one of the five EUs while areas with relatively low or non-detectable concentrations of residuals were not included in an EU. By limiting Site-wide exposures to the EUs most affected by historical activities at the Site, worst-case scenarios were created.

3.1.1 Exposure Unit 1

EU1 outlines the on-Site areas in, adjacent to, and downstream of the Fill Area along Gordon's Creek (Figure 2). EU1 includes exposures to surface water and sediment by an infrequent Site visitor, future maintenance worker, and future construction worker. Although US EPA Region IV guidance indicates that "In most cases it is unnecessary to evaluate human exposures to sediments covered by surface water," (US EPA, 1995) dermal and oral surface water exposures were conservatively assessed herein at the request of the MDEQ (2000). Sediment samples included in EU 1 were SD07 and SD08. Surface water samples included in were SW-07 and SW-08.

Soil samples from this area were considered part of EU2 and exposures were assessed accordingly.

3.1.2 Exposure Unit 2

EU2 delineates the upland areas of the Fill Area and adjacent woody and grassy areas (Figure 2). Surface soils from zero to one foot and zero to six feet below ground surface [bgs] in this area were evaluated for potential visitor and future hypothetical maintenance worker scenarios, respectively. Surface and subsurface soils were also evaluated for a hypothetical future construction worker scenario. Available data for subsurface soils for a construction scenario were evaluated from the surface to the water table (approximately 10 feet bgs) as recommended by the MDEQ (2000). Soil samples included in EU2 are presented in the table below:

Soils (0-1' bgs)	GEO-13/0-1'	SS-1	SS-2	SS-3	SS-4
	SS-5	SS-6	SS-7	SS-8	SS-9
	SS-10	SS-11	SS-12	SS-13	
Soils (0-6' bgs)	GEO-03/2-3'	GEO-03/5-6''	GEO-10/2-3	GEO-10/5-6	GEO-13/0-1'
	GEO-13/2-3'	GEO-13/5-6'	GEO-44/5-6'	SS-1	SS-2
	SS-3	SS-4	SS-5	SS-6	SS-7
	SS-8	SS-9	SS-10	SS-11	SS-12
	SS-13				
Soils (0-10' bgs)	GEO-03/2-3'	GEO-03/5-6'	GEO-10/2-3	GEO-10/5-6'	GEO-13/0-1'
	GEO-13/2-3'	GEO-13/5-6'	GEO-43/7-8'	GEO-44/5-6'	GEO-45/7-8'
	SB-03/8-9.3	SB-05/4-9	SB-07/5-7	SS-1	SS-2
	SS-3	SS-4	SS-5	SS-6	SS-7
	SS-8	SS-9	SS-10	SS-11	SS-12
	SS-13				

3.1.3 Exposure Unit 3

In the southwest corner of the Site there exists a grassy field east of West Pine Street between Henson Auto Sales and Eagan Cars and Trucks. This grassy area has been defined as EU3 for

purposes of this risk assessment (Figure 2). Similar to EU2, surface soil from zero to one foot and zero to six feet bgs were evaluated in EU2 for visitor and hypothetical future maintenance worker scenarios, respectively. Surface and subsurface soils in this EU were evaluated for a hypothetical future construction worker scenario. Available data for subsurface soils for a construction scenario were evaluated from the surface to the water table(approximately 20 feet bgs) as recommended by the MDEQ (2000). Soil samples included in EU3 are presented in the table below:

Soils (0-1' bgs)	SS-15	SS-16	SS-17		
Soils (0-6' and 0-20' bgs)	GEO-16/2-3'	GEO-16/5-6'	GEO-17/2-3'	GEO-17/5-6'	SS-15
	SS-16	SS-17			

3.1.4 Exposure Unit 4

EU 4 encompasses the grassy drainage ditch area along the fenceline behind Courtesy Ford in the northeast corner of the Site and continues parallel to the railroad tracks, and west through EU 3 and EU 2 (Figure 2). EU 4, along the southeast side of the former Process Area, has been widened to include soil data from that area. Receptors associated with EU 4 included Site visitor exposures via casual contact with surface soil, sediment, and surface water. Maintenance worker and construction worker scenarios were also evaluated for exposures to surface water and sediment in EU 4 as well as soils in EU 4 near the former Process Area. Soils down to six feet bgs were evaluated for maintenance workers while soils down to the water table (approximately20 feet bgs) were evaluated for construction workers in this EU as requested by the MDEQ (2000). Sediment, surface water, and soil samples included in EU4 are presented in the following table:

Sediment	SD-02	SD-12	SD-18	SD-19	SD-20
	SD-21	SD-22	SD-23		
Surface Water	SW-02				
Soils (0-1' bgs)	GEO-19/0-1'	GEO-20/0-1'	GEO-21/0-1'	GEO-46/0-1'	GEO-47/0-1'
	GEO-48/0-1'				
Soils (0-6' bgs)	GEO-19/0-1'	GEO-19/2-3'	GEO-19/5-6'	GEO-20/0-1'	GEO-20/2-3'
	GEO-20/5-6'	GEO-21/0-1'	GEO-21/2-3'	GEO-21/5-6'	GEO-46/0-1'
	GEO-46/2-3'	GEO-46/5-6'	GEO-47/0-1'	GEO-47/2-3'	GEO-47/5-6'
	GEO-48/0-1'	GEO-48/2-3'	GEO-48/5-6'		
Soils (0-20' bgs)	GEO-19/0-1'	GEO-19/2-3'	GEO-19/5-6'	GEO-20/0-1'	GEO-20/2-3'
	GEO-20/5-6'	GEO-20/9-10'	GEO-21/0-1'	GEO-21/2-3'	GEO-21/5-6'
	GEO-21/9-10'	GEO-46/0-1'	GEO-46/2-3'	GEO-46/5-6'	GEO-47/0-1'
	GEO-47/2-3'	GEO-47/5-6'	GEO-47/7-8'	GEO-48/0-1'	GEO-48/2-3'
	GEO-48/5-6'				

3.1.5 Exposure Unit 5

EU5 outlines the former Process Area and the historical drip track and treated wood storage areas of the former Gulf States Creosoting facility (Figure 2). Surface soils from zero to six feet bgs were evaluated in EU5 for a hypothetical maintenance worker scenario. Available data for soils down to the water table (approximately 20 feet bgs) were evaluated in EU5 for a hypothetical future construction worker scenario. Soil samples included in EU5 are presented in the table below:

Soils (0-1' bgs)	GEO-28/0-1'	GEO-29/0-1'	GEO-30/0-1'	GEO-31/0-1'	GEO-32/0-1'
	GEO-33/0-1'	GEO-59/0-1'	GEO-60/0-1'		
Soils (0-6' bgs)	GEO-28/0-1'	GEO-28/2-3'	GEO-28/5-6'	GEO-29/0-1'	GEO-29/2-3'
	GEO-29/5-6'	GEO-30/0-1'	GEO-30/2-3'	GEO-30/5-6'	GEO-31/0-1'
	GEO-31/2-3'	GEO-31/5-6'	GEO-32/0-1'	GEO-32/2-3'	GEO-32/5-6'
	GEO-33/0-1'	GEO-33/2-3'	GEO-33/5-6'	GEO-59/0-1'	GEO-59/2-3'
	GEO-59/5-6'	GEO-60/0-1'	GEO-60/2-3'	GEO-60/5-6'	
Soils (0-20' bgs)	GEO-28/0-1'	GEO-28/2-3'	GEO-28/5-6'	GEO-29/0-1'	GEO-29/2-3'
	GEO-29/5-6'	GEO-30/0-1'	GEO-30/2-3'	GEO-30/5-6'	GEO-31/0-1'
	GEO-31/2-3'	GEO-31/5-6'	GEO-32/0-1'	GEO-32/2-3'	GEO-32/5-6'
	GEO-33/0-1'	GEO-33/2-3'	GEO-33/5-6'	GEO-59/0-1'	GEO-59/2-3'
	GEO-59/5-6'	GEO-60/0-1'	GEO-60/2-3'	GEO-60/5-6'	GEO-60/7-8'
	SB-01/8-10	SB-02/9-11	SB-05/10.5-12.5	SB-06/6-10	SB-07/14-16

3.1.6 Exposure Unit 6

EU6 outlines a stretch (approximately 2700 feet in length) of the northeast drainage ditch that leads from the Site into the neighboring residential area. EU6 exposures include oral and dermal exposures by off-Site residents to sediment and surface water along the northeast drainage ditch. Soil exposures were not assessed in this area for lack of soil data. Also, it was anticipated that sediment exposures in this area represent a more conservative estimate of exposure in that chemical concentrations in the exposed sediment along the drainage ditch are likely to be greater than concentrations in the surrounding soils. Sediment and surface water samples included in EU6 are presented in the table below:

Sediment	SD-03	SD-04	SD-05	SD-13
	SD-14	SD-15	SD-16	SD-17
Surface Water	SW-03	SW-04		

3.2 Statistical Evaluation

Environmental samples undergo laboratory analyses that are designed to quantitate the concentrations of constituents in the various environmental media. As a result of the analytical procedures, a constituent may be detected and its concentration measured, detected but not able to be quantitated, or not detected at all in a sample. The data set for the Site contains a number of nondetections for some chemicals of potential concern (COPCs) in various samples. Assuming that the COPC is present in these samples at the achieved detection limit is biased because the chemical may be absent altogether. Assuming a concentration of zero is also flawed because the chemical could be present at a level below laboratory capabilities to detect and quantify the concentration. Consequently, in the event that an analyte identified at least once in a given medium was not detected in a given sample, it was conservatively assumed for the risk assessment purposes to be present at a concentration equivalent to one-half of the sample quantitation limit (SQL). In addition, samples labeled with an "R" (rejected) qualifier were not included in the data analysis because those data were deemed unreliable and, therefore, unusable. Constituents that were not detected in any sample from a particular medium were eliminated from further consideration in accordance with US EPA guidelines (1989).

Site analytical data used in this assessment were collected during the Phase I (1997) and Phase II (1998) remedial investigations as well as the additional investigation conducted in 2000 at the request of the MDEQ. These data were fully validated by qualified technical professionals using standard data validation protocols, as required by the MCEQ (1999).

Previous investigations at the Site have been conducted since 1990. These investigations included the following:

- 1990 soil gas and soil sampling by Roy F. Weston
- 1991 MDEQ Site inspections and Phase II report
- 1994 Phase II Site investigation by Environmental Protection Systems (EPS)
- 1994 Site investigation by Bonner Analytical Testing Company (BATCO)
- 1994 preliminary subsurface investigation by BATCO

- 1995 three-dimension resistivity surveys by American Remediation Technology
- 1996 investigation by McLaren/Hart
- 1996 investigation by Kerr McGee Chemical Corporation

Data acquired from these historical (pre-1997) investigatory activities were not used in this assessment as they were not validated by qualified chemists and sampling locations for some of the data could not be accurately established. These historical data were not considered valid and were, therefore, not appropriate to use in this assessment of risks. Only validated data that were considered to be representative of Site conditions with a reasonable level of confidence were used for this assessment.

The validated laboratory data from 1997, 1998, and 2000 investigations were compiled into data sets representing areas of potential exposure (EUs) for each potential receptor. Each data set was analyzed statistically using SiteStat®, a commercially available software package, to calculate the minimum, maximum, arithmetic mean, logarithmic mean, standard error of the mean, and the 95% upper confidence limit of the mean concentration (95% UCL) for each constituent based on distributional analysis of the data (*i.e.*, utilizing goodness-of-fit statistical tests to determine whether the data are distributed normally or lognormally). The data qualifier associated with the minimum and maximum detected concentrations as well as the location of the maximum detected concentration for each EU were also determined. Results of the quantitative and statistical analyses for each of the EUs discussed above are presented in Tables 1 through 18.

Standard sampling protocol requires the collection of duplicate field samples used to ensure the quality of a laboratory analysis (i.e., to ensure that analytical results can be replicated). As such, duplicate sample results were provided as part of the database for the Hattiesburg Site. In accordance with US EPA guidance (1989), duplicate sample results were averaged (for any sample containing duplicates) and the average concentration was used as a single concentration for that sample in the calculation of summary statistics as discussed below.

Soils down to one foot deep were assumed to be representative of surface soils at the Site for infrequent visitor exposures. A depth of 0 to 6 feet was used to define surface soils for maintenance worker exposures. These assumptions were recommended by the MDEQ (2000). The groundwater table was considered the extent of subsurface soils as recommended by MDEQ (2000). This value (depth-to-groundwater) varies significantly across the Site and, as such, the extent of subsurface soil was EU-specific as follows:

EU2 – soils down to 10 feet
EU3 – soils down to 20 feet
EU4 – soils down to 20 feet
EU5 – soils down to 20 feet

This risk assessment focuses mainly on environmental data collected from the former Process and Fill Areas and any other portions of the Site that were affected by former creosoting operations. Virtually unaffected areas (e.g., the developed area north of West Pine Street) as delineated using historical data were not considered to contribute significantly to risk levels and, therefore, were excluded from this risk assessment.

3.3 Determination of Exposure-Point Concentrations

Exposure-point concentrations were determined to be the 95% UCL or the maximum concentration of a COPC in an EU, whichever was lower. This methodology is in accordance with US EPA guidance (1989). If the distribution of the concentration data was determined to be lognormal, then the lognormal 95% UCL was compared to the maximum concentration to determine the exposure-point concentration. In the event that the distribution of a chemical in any given medium could not be confidently labeled as normal or lognormal, it is termed either "unknown" or "normal/lognormal." In these cases, the lognormal 95% UCL was compared to maximum concentration when determining the exposure-point concentration. It should be noted, however, that in cases where the distribution is "unknown," the normal and lognormal 95% UCLs could not be reliably predicted. Assuming a lognormal distribution of the data increases

the uncertainty associated with this step of the risk assessment process; however, hazard and risk estimates are likely to be less uncertain than if the maximum concentrations were used.

Exposure-point concentrations are provided on the statistical summary tables, Tables 1 through 18.

3.4 COPC Selection

Soils (both surface and subsurface) were screened according to MCEQ (1999) guidance. The first tier of the screening process compared maximum concentrations of a constituent in an EU with the Restricted Tier 1 target remediation goal (TRG) for maintenance worker and construction worker scenarios. Restricted TRGs were used because the Site is not currently used for residential purposes and the current commercial/industrial land-use is anticipated to remain into the future as a result of the implementation of deed restrictions on the impacted areas of the Site. If a maximum concentration of a constituent was less than the Restricted Tier 1 TRG, then that constituent was eliminated from further quantitative assessment.

Surface soil data (zero to one foot bgs) for the visitor scenario were screened using Unrestricted Tier 1 TRGs at the request of MDEQ (2000). If a maximum concentration of a constituent was less than the Unrestricted Tier 1 TRG, then that constituent was eliminated from further quantitative assessment. Conversely, if the maximum concentration of a constituent exceeded the Tier 1 TRG, that constituent was retained for quantitative analysis.

If the maximum concentration of a constituent in an EU exceeded the Tier 1 TRG, then the 95% UCL of the constituent was compared to the Tier 1 TRG (Restricted or Unrestricted, depending on the exposure scenarios as described above) as part of the Tier II screening process. In the event that the concentrations of a chemical were distributed lognormally, the lognormal 95% UCL of that constituent was compared to the Tier 1 TRG. If the distribution of data of a chemical could not be positively identified as either normal or lognormal, the lognormal 95% UCL was used in the screening process. In these cases, either the maximum concentration or the lognormal 95% UCL can be conservatively used. The US EPA, however, justifies the use of an

average concentration as the exposure-point concentration by explaining that toxicity criteria for both carcinogenic and non-carcinogenic effects are based on lifetime average exposures and that the "average concentration is most representative of the concentration that would be contacted at a site over time" (*Supplemental Guidance to RAGS: Calculating the Concentration Term*, 1992). Other US EPA guidance states that "...in most situations, assuming long-term contact with the maximum concentration is not reasonable" (*Risk Assessment Guidance for Superfund, Part A*, 1989). US EPA Region 4 also states that, generally, it is reasonable to assume that soil data are distributed lognormally (1995). In keeping with these guidances, the lognormal 95% UCL was considered in the screening process where the data distribution for a compound could not be defined as specifically normal or lognormal.

If the 95% UCL (or lognormal 95% UCL where appropriate) of a constituent was less than the Tier 1 TRG, then that constituent was eliminated from further quantitative analysis. If the 95% UCL (or lognormal 95% UCL where appropriate) of a constituent in soil exceeded the Tier 1 TRG, then that constituent was retained for quantitative analysis in the Site-specific risk assessment (Tier III).

MCEQ guidance (1999) does not specify screening levels for constituents in sediment or surface water; therefore, Region 4 was referred to for guidance (1995). Sediment is only found on the Site in drainage ditches that contain little to no water most of the time. US EPA Region 4 guidance states that sediments in an intermittent stream (or ditch) should be considered as surface soil for the portion of the year the stream is without water. Based on these factors and comments provided by the MDEQ (2000), the maximum detected constituent concentrations in sediment was compared to MCEQ unrestricted Tier 1 TRGs. The screening process then followed the same procedure as mentioned above for other soils.

For surface water, the maximum detected concentration of a constituent in an EU was compared to the US EPA Human Health Water Quality Standard (WQS) for consumption of water and organisms in accordance with US EPA Region 4 guidance (1995). If the maximum

concentration of a constituent in surface water was less than the WQS, then that constituent was eliminated from quantitative analysis. If the maximum concentration of a constituent in surface water exceeded the WQS, then that constituent was retained for quantitative analysis.

At the request of MDEQ (2000), if any single carcinogenic polycyclic aromatic hydrocarbon (cPAH) was retained as a COPC in a medium, then all cPAHs were also retained as COPCs in that medium. This guidance refers to the following chemicals: benzo(a)anthracene, benzo(b)fluoroanthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. To establish an exposure point concentration for undetected cPAHs retained as COPCs in an EU, one-half the maximum detection limit was used.

The results of the screening process are presented on the statistical summary tables, Tables 1 through 18. The screening process eliminated detected constituents from the subsurface soil dataset down to 20 feet bgs and surface soil dataset down to 6 feet bgs in EU3 For this reason, construction worker and maintenance worker exposures to soils in EU3 were not evaluated quantitatively in this assessment.

4.0 Exposure Assessment

Currently, a majority of the Site is used for commercial and light industrial purposes and is paved for roads and parking lots. Unpaved areas are limited to Gordon's Creek (EU 1), the wooded portion in and around the Fill Area (EU2) and the grassy field outlined by EU 3, and the drainage ditches and surrounding area delineated by EU 4 (Figure 2). Since the developed and undeveloped areas of the Site vary considerably with respect to both residual chemical concentrations and land use, the Site was divided into five EUs for the exposure assessment. A sixth EU was created to assess off-Site residential exposures. Chemical data from each EU were combined with EU-specific exposure parameter values and receptor scenarios to determine the chemical intake for each receptor potentially accessing an EU for occupational, recreational, or residential purposes.

4.1 Receptor Identification

The following exposures pathways (indicated with an "X") have been selected for this risk assessment as reasonable and realistic scenarios under current and future land-use assumptions:

EU/Media:	EU1		EU2	EU3	EU4			EU5	EU6	
Receptor/Route:	Sed.	Surf. Water	Soil	Soil	Soil	Sed.	Surf. Water	Soil	Sed.	Surf. Water
Visitor										
Dermal	X	X	X	X	X	X	X	X		
Oral	X	X	X	X	X	X	X	X		
Inhalation										
Maint. Worker										
Dermal	X	X	X	X	X	X	X	X		
Oral	X	X	X	X	X	X	X	X		
Inhalation										
Const. Worker										
Dermal	X	X	X	X	X	X	X	X		
Oral	X	X	X	X	X	X	X	X		
Inhalation			X	X	X			X		
Off-Site Resident										
Dermal									X	X

EU/Media:	EU1		EU2	EU3	EU4			EU5	EU6	
Receptor/Route:	Sed.	Surf. Water	Soil	Soil	Soil	Sed.	Surf. Water	Soil	Sed.	Surf. Water
Oral										X
Inhalation										

Surface water present on-Site is either ephemeral or very shallow and is conducive only to wading-type activities. Ingestion of Site surface water was considered an insignificant exposure pathway since on-Site drainage ditches "contain little or no water most of the time" (MDEQ, 2000). In addition, US EPA IV guidance indicates that "In most cases, it is unnecessary to evaluate human exposures to sediments covered by surface water" (1995). At the request of MDEQ (2000), however, dermal and oral exposures to surface water were assessed for visitors, maintenance workers, and construction workers in EUs 1 and 4. Surface water exposures were also assessed for residents in off-Site EU 6.

Each of the potential receptors is discussed below.

4.1.1 Infrequent Site Visitor

Since the Site is not currently fenced or guarded, the general public has access to most areas of the Site at any given time. It is possible, though unlikely, that an individual may use some areas of the Site, such as EU1, EU2, or EU3, for recreational purposes. For this reason, sediment and surface water exposures to visitors in EU1, and surface soil exposures in EU2 and EU3 were assessed for the visitor scenario. The vast majority of the remainder of the Site (EU5) is covered with either buildings or pavement, precluding direct contact with surface soils; however, a small exposed area encompassing a drainage ditch exists along side of the former Process Area (EU4). Although this area is not attractive for recreational purposes, it is possible that an individual traversing the Site may contact surface soils, sediment, or surface water in this EU; therefore, these potential exposures were assessed. Sediment exposures in EU1 and EU4 were addressed in accordance with US EPA Region 4 guidance that recommends evaluating sediment exposures in intermittent streams. At the request of MDEQ (2000), soil exposures were assessed for visitors

in EU5 regardless of the existence of buildings and pavements precluding almost all potential direct contact with soils in this area.

4.1.2 Maintenance Worker

Currently, maintenance activities are most likely limited to the developed portions of the Site. Of these, the former Process Area and adjacent former drip track and treated wood storage areas (EU5) were most affected by historical wood preserving processes. Although these areas are mostly paved or built upon, it is possible that maintenance activities may require some shallow digging in unpaved areas; therefore, exposures to surface soils in EU5 were assessed. As a conservative measure, surface soil data from sample locations located in paved areas were evaluated in conjunction with surface soil data from exposed areas in EU5. If the currently undeveloped portions of the Site (EU2 and EU3) become developed in the future, similar maintenance activities may be required and, therefore, exposures to surface soils in EU2 and EU3 were also assessed. The drainage ditch encompassed by EU4 requires periodic maintenance; therefore, exposures to soil, sediment, and surface water in this area were assessed. At the request of MDEQ (2000), maintenance worker exposures to surface water and sediment in EU 1 were also assessed.

4.1.3 Construction Worker

Although there are currently no major construction activities at the Site, such activities may hypothetically occur in the future. Thus, exposures to surface water and sediment in EUs 1 and 4, and exposures to soil in EUs 2 through 5 were assessed herein. Construction workers may be exposed to both surface and subsurface soils during activities such as excavating. Subsurface soils, for purposes of this assessment, were defined as those soils at the water table and shallower. Since the depth to the water varies significantly across the Site, so does the definition of "subsurface" soils. Accordingly, subsurface soils were evaluated down to 10 feet for EU2 and 20 feet for EUs 3, 4, and 5.

4.1.4 Future On-Site Residents

The affected areas of the Property (the Site) are currently zoned for industrial or light-commercial use, and, at the time of this report, there were no plans to develop the Site for residential housing. In fact, deed restrictions preventing residential development are in the process of being implemented for the impacted areas on Site. Because of these deed restrictions, it is reasonable and realistic to assume that the Site will remain commercial/industrial in the future; therefore, on-Site residential exposures were not addressed in this risk assessment.

4.1.5 Off-Site Residential Exposures

The northeast drainage ditch extends from the former Process Area to the northeast into a nearby residential community. Surface water and sediment data from areas along the northeast drainage ditch (EU6, Figure 3) were evaluated for off-Site residential exposures. For purposes of exposure assessment, a child resident between the ages of 1 and 6 years and an adolescent/adult resident between the ages of 7 and 30 years were evaluated. Hazards and risks for these two receptors were then combined (summed) to reflect the exposures incurred by a single individual living off-Site in the vicinity of the northeast drainage ditch for 30 years.

4.2 General Intake Equation

Chemical exposure/intake is expressed as the amount of the agent at the exchange boundaries of an organism (*i.e.*, skin, lungs, gut) that is available for systemic absorption. An applied dose is defined as the amount of a chemical at the absorption barriers such as skin, lung, digestive tract, available for absorption and is (usually expressed in milligrams, or mg) absorbed per unit of body weight of the receptor (usually expressed in units of kilogram, or kg). Absorbed dose can be defined as the amount of chemical that penetrates the exchange boundaries. If the exposure occurs over time, the total exposure can be divided by the time period of interest to obtain an average exposure rate (*e.g.*, mg/kg-day). The general equation, as defined by US EPA, for estimating a time-weighted average intake is:

$$\text{Intake (mg/kg - day)} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$ **[Equation 1]**

where:

C	=	chemical concentration at the exposure point (*e.g.*, mg/m^3 air);
IR	=	intake rate (*e.g.*, m^3/hr);
EF	=	exposure frequency (days/year);
ED	=	exposure duration (years);
BW	=	body weight of exposed individual (kg); and
AT	=	averaging time (period over which exposure is averaged, usually measured in days).

Additional parameters (*e.g.*, skin surface area) were incorporated into the above general equation to evaluate the different potential exposure routes (dermal, oral, inhalation).

Table 19 presents the general and pathway-specific exposure parameters utilized for the intake equations in this assessment.

4.2.1 General Exposure Parameters

Although some of the parameters used to calculate potential exposure are pathway- or route-specific, exposure frequency (EF), exposure duration (ED), averaging time (AT; determined separately for carcinogenic and non-carcinogenic exposures), and body weight (BW) are present in each intake model. These general parameters remain consistent throughout the intake calculations for each specific receptor.

4.2.1.1 Exposure Frequency

The exposure frequency (EF) describes the number of times per year an event is likely to occur. It is most often expressed in units of days/year or events/year, depending on the scenario. Variables such as weather, vacations, sick days, and institutional controls often aid in determining reasonable and realistic exposure frequencies.

The EF for an adolescent visitor was extracted from US EPA *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) Interim Final* (1989). This EF value of 12 days/year per EU is a reasonable estimate that assumes an adolescent would most likely be engaged in outdoor activity on the unpaved areas of the Site for one day a week during

the three warmest months of the year. This value was used for soil, sediment, and surface water exposures.

Typical construction projects, especially at industrial complexes, generally involve several phases of activity prior to completion. The EF parameter used for oral exposure in construction workers, therefore, was subdivided into two exposure events. The first event hypothetically lasts for 10 days (used in relevant exposure model calculations under "Exposure Level A") and would involve earth-moving activities such as foundation. The second exposure event to the same individual hypothetically lasts for 70 days (for a total of 80 days at the Site for an individual; this value was used in relevant exposure model calculations under "Exposure Level B") and included remaining construction activities such as building framing, plumbing installation, electrical installation, and roofing. Generally, to complete each of these phases, a different team of specialized contractors is employed to perform the tasks for which they are most qualified. As a result, an individual may only remain at the construction site for a few days or weeks until his/her task has been completed and the next phase has begun. This is especially true for those activities involving direct contact with soil such as excavating and foundation pouring. Individuals performing these tasks are not usually qualified or employed to continue with the actual building processes. For dermal and inhalation exposures, however, an 80-day EF was used and accounted for an individual to be involved in construction activities for four entire months of the year (assuming five-day work weeks).

For surface water and sediment exposures to construction workers, an EF value of 8 days/year was used. This value represents 1/10th of the time a worker may be on-Site for construction-type activities and is conservative in that it is unlikely that construction workers would be exposed at all to Site surface water or sediment.

The EF value used for the maintenance worker scenario was 150 days/year for surface soil exposures in EUs 2, 3, and 5. This is also a conservative assumption in that the currently developed areas of the Site are covered with buildings or pavement. Maintenance activities in

these areas would require little contact with the obscured surface soils. The undeveloped areas of the Site currently require little or no maintenance as they are only occasionally mowed or allowed to grow naturally. Should these areas become developed, they will most likely take on the appearance of the remainder of the Site, including industrial/commercial buildings and paved roads or parking lots. Once again, extensive direct contact with surface soils would be minimal for a maintenance worker.

For maintenance worker sediment and surface water exposures in EUs 1 and 4 and surface soil exposures in EU 4, an EF value of 30 days/year was used. Historically, the northeast drainage ditch has been maintained on an as-needed basis (less than annually). Maintenance worker exposures to sediment and surface water in these areas were assessed at the request of the MDEQ (2000). An EF value of 30 days/year is amply conservative in that both Gordon's Creek (EU 1) and the northeast drainage ditch (EU 4) are currently maintained less than annually.

For residential soil exposures, an exposure frequency of 350 days/year was used in accordance with Region IV guidance. This value assumes that 15 days/year are spent away from home (US EPA, 1991).

Sediments along the bank of the northeast drainage ditch are not comparable to surface soils comprising a yard with respect to exposure. Typically, yard soils include relatively large areas where children frequently play and where surface soils are tracked into the home to become part of the household dust that can be ingested, particularly by crawling infants, on a daily basis. These are the assumptions that underlie the standard residential soil exposure algorithm and parameter values. However, it is not realistic to assume that infants, children, or adults will directly contact a relatively small area of sediments on the banks of a drainage ditch on a daily basis. A more realistic exposure scenario for this unique area under an assumption of residential land use is for a resident child to play on occasion in the drainage ditch that traverses the residential property. An exposure frequency of 40 days/year, two hours per exploring event, is conservatively plausible.

4.2.1.2 Exposure Duration

The ED parameter represents the number of years during which an event is likely to occur. Factors affecting this parameter include variables such as age of receptor, population mobility, and occupational mobility. Exposure durations of less than seven years typically correspond to subchronic exposures while those greater than seven years are typically considered chronic exposures (US EPA, 1989). Toxicity indices are selected based on subchronic or chronic exposure durations.

The future construction worker scenario used an ED of one year because it is highly unlikely that a future construction worker would remain on one site for more than a year. Often, two months is considered the maximum amount of time a construction worker may reasonably remain at the same site.

The future maintenance worker ED, on the other hand, is based on occupational mobility studies. The ED of 25 years was obtained from US EPA (1991) which recommends a 95th percentile value of 25 years based on a study by the Bureau of Labor Statistics as of 1987. US EPA Region 4 also recommends a default value of 25 years for worker scenarios (1995).

The adolescent visitor scenario used an ED of 10 years. An adolescent was defined in this assessment as an individual aged seven to 16 years in accordance with US EPA Region 4 (1995); therefore, an exposure duration of 10 years was most appropriate.

An ED of 30 years (US EPA Region 4, 1995) was used for off-Site residents. This value assumes an individual spends 6 years as a child and 24 years as an adolescent/adult in the same location.

4.2.1.3 Averaging Time

The averaging time (AT) parameter is the time period over which exposure is averaged. For human health cancer risk calculations, the AT_c value prorates a total cumulative dose over a

lifetime. As a conservative approach, the AT_c value for each receptor is the product of a 365-day year and a 70-year life span, equaling 25,550 days.

The AT_n used for non-carcinogenic effects is the product of a 365-day year and the exposure duration (*i.e.*, AT_n = 365 days × ED). Because the ED parameter changes for each receptor, the AT_n changes as well. The AT_n values used for each receptor are summarized below:

Future Construction Worker - 365 days
Maintenance Worker - 9125 days
Adolescent Visitor - 3650 days
Off-Site Child Resident – 2,190 days
Off-Site Adult Resident – 8,760 days

4.2.1.4 Body Weight

The body weight used for the adult exposures (future construction worker and maintenance worker) analyzed in this assessment was the current US EPA default value of 70 kg (US EPA, 1989; US EPA Region 4, 1995). This value was also used for the adolescent/adult off-Site resident scenario. The adolescent body weight used for the visitor scenarios was 45 kg. This value was extracted from US EPA Region 4 guidance (1995). For the child resident scenario, a body weight of 15 kg was used as recommended by US EPA (1991).

4.2.2 Route-Specific Exposure Parameters

The general intake equation discussed above (Equation 1) was modified by including route-specific exposure parameters in order to calculate route-specific intake values. For dermal exposures, skin surface area, adherence factor, exposure time (surface water exposures only), and absorption factor parameters were included in the intake equation. For ingestion exposures, an ingestion rate and a matrix effect were included in the intake calculation. For inhalation exposures, an inhalation rate and a retention factor for fugitive dusts were included in the intake equation. Also, for inhalation exposures, an additional paradigm was necessary to convert soil concentrations to concentrations in air available for intake.

4.2.2.1 Dermal Exposure Parameters

Skin Surface Area

The total skin surface area used for adult receptors in this assessment was 20,000 cm^2. This is a US EPA default value extracted from the *Exposure Factors Handbook* (1997). For adolescent exposures, a value of 12,768.3 cm^2 was used for total skin surface area. This was a mean value calculated based on the distributions of total skin surface areas for males and females between the ages of 7 and 16 as presented in *Exposure Factors Handbook* (1997). For the off-Site child resident scenario, a skin surface area of 7,213 cm^2 was used. This value was based on skin surface area data for male and female children provided in *Exposure Factors Handbook* (1997).

For purposes of exposure, it was assumed that only portions of the body would be exposed to the affected media on the Site. For the construction worker scenario, it was assumed that the hands, forearms, lower legs, and face would be exposed to Site soils. These body parts comprise 27.8% of the total skin surface area, or 5560 cm^2.

For maintenance worker exposures to Site soils, it was assumed that the hands, forearms, and face would be exposed. These body parts comprise 15 percent of the total skin surface area, or 3000 cm^2.

For surface water and sediment exposures, exposed body parts for construction and maintenance workers included hands, forearms, and face or 3000 cm^2 (15% of the total skin surface area).

The visitor and off-Site resident scenarios assumed that the hands, forearms, and lower legs would be exposed for contact with Site soils. These body parts comprise 23.9% of the total skin surface area, or 3052 cm^2 for adolescent visitors, 1724 cm^2 for child residents, and 4780 cm^2 for adult residents. For exposures to surface water and sediment, hands, forearms, lower legs, and feet were assumed exposed for adolescent visitor and off-Site resident scenarios. These body parts comprise 30.9 % of the total skin surface area or 3945 cm^2 for adolescent visitors, 2229 cm^2 for child residents, and 6180 cm^2 for adult residents.

Soil Adherence Factor

Until recently, the US EPA-recommended default for soil adherence on skin ranged from 0.2 to 1.0 mg/cm^2 for the entire exposed surface area, without consideration of the type of activity (US EPA, 1992). However, the data from which that range was derived were primarily the result of indirect measurements, artificial activities, and sampling of hands only. A more recent study has presented the results of direct measurement of soil loading on skin surfaces before and after normal occupational and recreational activities that might result in soil contact (Kissel *et al.*, 1996). A five-order of magnitude range (roughly 10^{-3} to 10^{+2} mg/cm^2) was reported for observed activity-related hand loadings. That report indicated that hand loadings within the range of 0.2 to 1.0 mg/cm^2 were produced by activities in which there was vigorous soil contact (*e.g.*, rugby, farming); but for activities in which there was less soil contact (*e.g.*, soccer, professional grounds maintenance), loadings substantially less than 0.2 mg/cm^2 were found on hands and other body parts. Kissel *et al.* (1996) concluded that, because non-hand loadings attributable to higher contact activities exceeded hand loadings resulting from lower contact activities, hand data from limited activities cannot be used as a conservative predictor of loadings that might occur on other body surfaces without regard to activity. Furthermore, because exposures are activity-dependent, dermal exposure to soil should be quantified using data describing human behavior (*e.g.*, type of activity, frequency, duration, including interval before bathing, clothing worn, etc.).

The most recent version of the *Exposure Factors Handbook* (1997) states:

> In consideration, of these general observations and the recent data from Kissel *et al.* (1996, 1997), this document recommends a new approach for estimating soil adherence to skin. First use Table 6-12 [Summary of Field Studies, Kissel *et al.*, 1996a] to select the activity which best approximates the exposure scenario of concern. Next, use Table 6-13 [Mean Soil Adherence by Activity and Body Region, Kissel *et al.*, 1996a] to select soil loadings on exposed skin surfaces which correspond to the activity of interest. This table contains soil loading estimates for various body parts. The estimates were derived from soil adherence measurements of body parts of individuals engaged in specific activities described in Table 6-12. These results provide the best estimate of central loadings, but are

based on limited data. Therefore, they have a high degree of uncertainty such that considerable judgment must be used when selecting them for an assessment.

In another study that assessed the percentage of skin coverage in several soil contact trials in a greenhouse and an irrigation pipe laying trial, Kissel *et al.* (1996) concluded that adjusted loadings may be two to three orders of magnitude larger than average loadings if average loadings are small.

The activity-specific soil adherence factor for exposures to a maintenance worker was calculated based on data presented by Kissel *et al.* (1996) for grounds keepers, as presented below:

		Soil Adherence Factor by Body Part (mg/cm^2)			
Receptor	**Representative Activity**	**Hands**	**Arms**	**Lower Legs**	**Face**
Maintenance Worker	Grounds Keepers	0.030 - 0.15	0.0021 - 0.023	0.0008 - 0.0012	0.0021 - 0.01

Data for the grounds keepers were used for the maintenance worker estimates because the activities of a grounds keeper best mimic those of a maintenance worker.

Soil adherence factors were calculated by normalizing each body part-specific soil adherence value (using the mid-points of the ranges tabulated above) with regard to the percentage of total body surface area represented by the respective body part (extracted from the US EPA *Dermal Exposure Assessment: Principles and Applications* [US EPA, 1992]). The maintenance worker adherence factor for soil was calculated based upon exposure to the hands, forearms and face. Surface area percentages for the hands, forearms, and face are 5.2, 5.9, and 3.9 percent, respectively (US EPA, 1997). Those body parts comprise 15 percent of the total body surface area. The normalized values for all body parts of interest were added, and the sum was divided by the total percentage of body surface area occupied by the parts. For example, the soil and sediment adherence factors for maintenance worker soil exposures (0.038 mg/cm^2) were calculated as follows:

$$AF\,(mg/cm^2) = \frac{(0.09 \times 0.052) + (0.0126 \times 0.059) + (0.006 \times 0.039)}{0.15} = 0.038$$

The construction worker adherence factor was also calculated in this fashion. This exposure scenario assumed that the hands, forearms, lower legs, and face would be exposed to Site soils. Soil loadings for the upper torso (chest and back) were not measured by Kissel *et al.* (1996) for construction workers because this body area is generally covered. However, to account for exposure to the upper torso during the very hot months of the year, the total area of the forearms, legs, hands, and face were assumed to be completely exposed. The hands, forearms, legs, and face comprise 5.2%, 5.9%, 12.8%, and 3.9% of the total skin surface area, respectively (with the face comprising one-third the surface area of the head), for a total of 27.8% exposed surface area. The construction worker soil adherence factor was based on data from Kissel *et al.* (1996) for construction workers as follows:

		Soil Adherence Factor by Body Part (mg/cm^2)			
Receptor	**Representative Activity**	**Hands**	**Arms**	**Lower Legs**	**Face**
Construction Worker	Construction Worker	0.24	0.098	0.066	0.029

The soil adherence factor for the construction worker scenario was calculated as follows:

$$AF\,(mg/cm^2) = \frac{(0.24 \times 0.052) + (0.098 \times 0.059) + (0.066 \times 0.128) + (0.029 \times 0.039)}{0.278} = 0.1$$

For sediment exposures, the soil adherence factor was calculated for the construction worker scenario using adherence data from Kissel *et al.* (1996) for construction workers (as tabulated above) for the hands, forearms, and face. The hands, forearms, and face comprise 5.2, 5.9, and

3.9 percent of the total skin surface area, respectively (totaling 15 percent). Thus, the adherence factor for construction workers exposed to sediment (0.13 mg /cm^2) was calculated as follows:

$$AF\,(mg/cm^2) = \frac{(0.24 \times 0.052) + (0.098 \times 0.059) + (0.029 \times 0.039)}{0.15} = 0.13$$

The adherence factor for visitor and off-Site resident exposures to soil assumed that the forearms, hands, and lower legs would be exposed to soil or sediment. The data used in these calculation were based on data by Kissel *et al.* (1996) for soccer players (exposed to a playing field of roughly one-half grass and one-half bare earth in a light mist) as presented below:

		Soil Adherence Factor by Body Part (mg/cm^2)		
Receptor	**Representative Activity**	**Arms**	**Hands**	**Lower Legs**
Visitor and Off-Site Resident	Soccer Players	0.0029 – 0.011	0.019 – 0.11	0.0081 – 0.031

The forearms, hands, and lower legs comprise 5.9%, 5.2%, and 12.8% of the total skin surface area, respectively, for a total of 23.9% (US EPA *Exposure Factors Handbook*, 1997). The adherence factor was then calculated for visitor and off-Site resident dermal exposures to soil as follows:

$$AF\,(mg/cm^2) = \frac{(0.00695 \times 0.059) + (0.0645 \times 0.052) + (0.0196 \times 0.128)}{0.239} = 0.026$$

A value of 0.026 mg/cm^2 was used as the soil adherence factor for visitors to the Site and off-Site residents.

Soil adherence factors for sediment exposures to Site visitors and off-Site residents were calculated using adherence data for the hands, forearms, lower legs, and feet. Adherence data for

reed gatherers were used for these exposures to best mimic activities that may incur sediment exposures. The reed gatherers studied by Kissel *et al.* (1996) periodically visited tidal flats to collect raw materials for basket weaving. The data from Kissel *et al.* (1996) presented in *Exposure Factors Handbook* (US EPA, 1997) were as follows:

		Soil Adherence Factor by Body Part (mg/cm^2)			
Receptor	**Representative Activity**	**Hands**	**Arms**	**Lower Legs**	**Feet**
Visitors and Off-Site Residents	Reed Gatherers	0.66	0.036	0.128	0.63

The hands, forearms, lower legs, and feet comprises 5.2, 5.9, 12.8 and 7.0 percent of the total skin surface area, respectively (totaling 30.9 percent). Thus, the adherence factor for visitors and off-Site residents exposed to sediment (0.33 mg /cm^2) was calculated as follows:

$$AF\,(mg/cm^2) = \frac{(0.66 \times 0.052) + (0.036 \times 0.059) + (0.16 \times 0.128) + (0.63 \times 0.07)}{0.309} = 0.33$$

Exposure Time

To estimate intakes as a result of dermal exposure to surface water, an exposure time (ET) parameter was included in the intake formula for Site visitors and off-Site residents. The parameter value of 1.0 hour/day was estimated using best professional judgement. This value represents the amount of time a Site visitor or off-Site resident may spend exposed to surface water in any one EU.

Dermal Permeability Constant

The permeability constant, Kp, accounts for the movement of a constituent dissolved in water through the skin, across the stratum corneum, and into the blood stream. Kp values for the constituents examined in this assessment for surface water exposures were obtained from US EPA *Dermal Exposure Assessment: Principles and Applications* (1992). For values not available in

US EPA *Dermal Exposure Assessment* (1992), the Kp value were calculated using the equations provided by the US EPA in the same document.

Dermal Absorption Factor

The final parameter included in the dermal intake paradigm was a dermal absorption factor. In general, the skin provides an effective barrier to environmental toxins. For example, certain hair-coloring formulations which are vigorously rubbed onto the scalp on a daily basis contain lead acetate at concentrations up to 200,000 ppm, yet lead toxicity does not appear to result. Moore *et al.* (1980) determined that the rate of lead absorption from 203^{Pb} labeled lead acetate in cosmetic preparations containing six mmol Pb acetate/L in male volunteers over 12 hours was 0.06% during normal use of such preparations. For most inorganic salts, percutaneous (skin) absorption is considered insignificant relative to incidental ingestion (for example, US EPA, 1986). On the other hand, some drugs (*e.g.*, nicotine) are effectively administered and absorbed into the blood stream from dermal "patches."

Most dermal bioavailability data for impacted soil have been obtained in laboratory animals or in vitro test systems. This introduces a significant source of uncertainty for predicting the human response. Safety factors have sometimes been applied to dermal absorption data obtained in animals to conservatively estimate the upper-bound of likely human percutaneous uptake of a certain constituent from skin exposure. This is usually unnecessary because human skin has generally been shown, for a diverse group of constituents, to be about 10-fold less permeable than the skin of typical animal species, such as rabbits and rats (Bartek and LaBudde, 1975; Shu *et al.*, 1988).

US EPA Region III evaluated available data concerning the dermal absorption of specific constituents and classes of constituents and provided several recommendations (US EPA Region 3, 1995). For semivolatile compounds, such as *bis*(2-ethylhexyl)phthalate, the US EPA recommends a range of 1% to 10% (US EPA, 1995). Kao *et al.* (1985) reported 2.7 percent for absorption of topically applied pure benzo(a)pyrene by human skin *in vitro*. The US EPA

Region 3 recommends using 10% as a conservative assumption based on the Ryan *et al.* study (1987). In addition, US EPA Region 4 guidance (1995) states that a soil dermal absorption factor "of 1.0% for organics and 0.1% for inorganics should be used as defaults in determining the uptake associated with dermal exposure" (see the Dermal Contact subsection of Exposure Assessment section of the 1995 guidance). For the purpose of this risk assessment, an ABS of 3% for cPAHs and of 10% for other SVOCs were conservatively assumed for dermal absorption, in keeping with US EPA Region 3's and MDEQ's recommendations.

4.2.2.2 Ingestion Exposure Parameters

Ingestion Rate

US EPA's *Exposure Factors Handbook* (1997) discusses three adult soil ingestion studies with results ranging from 10 mg/day to 480 mg/day. Hawley's (1985) value of 480 mg/day (as recommended by the MDEQ) was "derived from assumptions about soil/dust levels on hands and mouthing behavior" (US EPA, 1997). Since no supporting measurements were made for Hawley's study, the US EPA states that Hawley's estimate "must be considered conjectural" (1997). As such, the US EPA goes on to suggest adult soil ingestion rates of 50 mg/day for industrial settings and 100 mg/day for residential and agricultural settings, although "50 mg/day still represents a reasonable central estimate of adult soil ingestion and is the recommended value..." (1997). Accordingly, a value of 100 mg/day for the maintenance worker and adult off-Site resident is amply conservative and was used in this assessment. In conjunction with the use of a two-tiered EF to reflect the different stages of potential future construction activities (see Section 4.2.1.1), the soil ingestion s for the construction worker scenario was also divided into two exposure levels for a single individual. A highly conservative ingestion rate of 480 mg/day (used in relevant exposure model calculations under "Exposure Level A") was used for construction workers for the first 10 days of exposure to address direct contact with soil during earth-moving activities such as foundation excavating. A soil ingestion rate of 100 mg/day (used in relevant exposure model calculations under "Exposure Level B") was used for the remainder of the construction worker exposure (70 days). Risks were then summed for both exposure levels to estimate the total potential risk posed to an individual construction worker

The ingestion rate used for the adolescent visitor scenario was 100 mg/day. The US EPA Region IV (1995) recommends a value of 200 mg/day as a mean ingestion rate for children under six years of age. This value was conservatively used in this assessment to estimate soil and sediment ingestion exposures for an off-Site resident child aged one to six years.

Gastrointestinal Matrix Effects of Soil

Incidental ingestion incorporates the matrix effect (ME; sometimes called the absorption adjustment factor [AAF]) into the general intake equation. When constituents are administered in solid vehicles such as food and soil, only a fraction of the ingested dose is extracted from the vehicle and subsequently absorbed through the gastrointestinal tract (US EPA *Estimated Exposure to Dioxin-like Compounds*, 1992). Gastrointestinal absorption of constituents sorbed onto such a medium is inhibited by physical-constituent bonding to the matrix (Hawley, 1985). This phenomenon is referred to as the gastrointestinal matrix effect of soil. Several studies referenced in the US EPA's *Estimated Exposure to Dioxin-like Compounds* (1992) have been performed to estimate the oral absorption factors of constituents from soil. At the request of MDEQ (2001), however, a gastrointestinal matrix effect of 1.0 was used in accordance with US EPA Region IV guidance (1995), although this approach is highly conservative and does not account for scientific studies that indicate the absorption of chemical constituents through the gastrointestinal tract is less than 100%.

4.2.2.3 Inhalation Exposure Parameters and Paradigms

Inhalation Rate

The inhalation rate used for the construction worker scenario was 20 m^3/day. This is a common US EPA default value and was recommended by US EPA Region 4 (1995).

Retention Factor

According to the International Commission on Radiological Protection (ICRP), 75 percent of respirable dust particles (PM_{10}, or particles less than 10 microns in aerodynamic diameter) are retained when inhaled, the vast majority of which is potentially subsequently swallowed (ICRP,

1968). This 75% was included in the inhalation intake equation as the retention factor parameter (RF). This parameter applies only to non-VOC constituents entrained onto dust particles.

Concentration in Air

To estimate airborne dust levels during hypothetical construction activities, an emission rate of suspendible particles of less than 15 microns in aerodynamic diameter (PM_{15}) was calculated (grams/second); particles less than 10 microns were considered to be respirable. Considering particles of 15 microns or less in diameter in the emission rate calculation is a conservative assumption, inasmuch as only particles with an aerodynamic diameter of less than five to seven microns are inhaled into the lung.

The two types of construction activities at the Site that have the potential to emit fugitive dusts are vehicular movement over bare (unpaved or unvegetated) surfaces and the excavation of soil. Estimation of fugitive dust emissions caused by each activity were examined separately, as follows, and were derived from existing estimates of general construction exposure. The sum of the emissions from these two activities was multiplied by the concentration of constituent in the soil (Cs) in order to derive the total emission rate (Ei) for non-VOCs as follows:

$$Ei = C_s \times (PERv + PERe) \qquad \textbf{[Equation 2]}$$

where:

Ei	=	Emission rate (mg/sec);
C_s	=	Concentration in soil (mg/kg);
PERv	=	Particulate emission rate for vehicular movement (lb/vehicle mile); and
PERe	=	Particulate emission rate for excavation (lb/vehicle mile).

The following empirical expression (US EPA, 1988) was used to estimate the fugitive dust generated by vehicles during construction activities:

$$\text{PERv (lbs/vehicle mile)} = k \times 5.9 \times (s/12)(S/30) \times (mvw/3)^{0.7} \times (ww/4)^{0.5} \times ((365 - p)/365)$$

[Equation 3]

where:

PERv	=	Vehicle particle emission rate (lb/vehicle mile traveled);
s	=	Percent silt content (unitless);
k	=	Particle size multiplier (unitless);
S	=	Mean vehicle speed (mph);
mvw	=	Mean vehicle weight (ton);
ww	=	Mean number of wheels per vehicle (unitless); and
p	=	Mean number of days with ≥ 0.01 inches of precipitation per year (unitless).

It was assumed that the vehicle travels during 40% of the 80-day exposure duration and 0.5 miles per day. The result is a value of 16 miles per construction event. Percent silt content was estimated to have a mean value of 50%, based on geotechnical data provided in the *Remedial Investigation Report* (Pisani & Assoc., 1997). US EPA default values were utilized and referenced for all other parameters. The particle size multiplier was assumed to be 0.50, corresponding to particles less than 15 microns (US EPA, 1996). Vehicle characteristics consist of the following: mean vehicle speed was assumed to be 15 mph, with mean vehicle weight assumed to be approximately 12.5 tons, for 8-wheeled vehicles (US EPA, 1988). The estimated mean number of days with precipitation equal to or greater than 0.01 inches per year is 110 (US EPA, 1988). Total resultant dust emissions for constituents during vehicular movement activities were estimated to be approximately 16.5 lbs/vehicle mile traveled, or 0.0001 kg/sec. Calculations are summarized in Table 20.

Future excavation may be performed by bulldozers, a backhoe, or other heavy construction equipment. The following estimate of particulate emissions, less than 15 μm in diameter resulting from bulldozing activity, was based on the approach described in the US EPA *Compilation of Air Pollution Emission Factors* (1996), as developed from studies of emissions from uncontrolled open dust sources resulting from bulldozing at western surface coal mines.

$$PERe\ (lb/hour) = \frac{1.0 \times s^{1.5}}{M^{1.4}}$$ **[Equation 4]**

where:

PERe	=	Excavation particle emission rate (lb/hr);
s	=	Percent silt content (unitless); and
M	=	Soil moisture content (unitless).

Percent soil moisture content was assumed to be 15.1%, an average of Site-specific soil moisture data and percent silt content 50%, as described above.

The resultant fugitive dust emission rate during excavation activities was 7.9 lbs/hr or 0.001 kg/sec. Table 20 summarizes these calculations.

Once the emission rate (Ei in Equation 2) was calculated, it was converted to a concentration in ambient air. Gaussian models are conventionally used to determine downwind ambient air concentrations, Ca, from the emission rate, Ei, estimated. However, in this scenario, such models have limited applicability when the receptor(s) is at or very near the source of emission. In this case, a bulldozer operator, for example, is situated directly within the area of ground emissions of vapors and dusts. Average ambient air concentrations in this circumstance are best estimated by use of a near-field box model (US EPA, 1988).

The near-field box model assumes uniform wind speed and uniform mixing throughout the box. The release and mixing of VOCs or respirable dusts in ambient air is estimated as follows:

$$Ca\ (mg/m^3) = \frac{Ei}{W_b \times H_b \times V}$$ **[Equation 5]**

where:

Ca	=	Concentration of constituent in ambient air (mg/m^3);
Ei	=	Emission rate of constituent (mg/sec);
W_b	=	Width of box in crosswind dimension within the area of residual constituent in soil (m);
H_b	=	Downwind height of box (m); and
V	=	Average wind speed through the box (m/sec).

The value of H_b in this calculation is determined by the downwind distance and the atmospheric turbulence at ground level, which determines the trajectory of a release from the upwind edge of the source of vapor or dust emissions. For neutral atmospheric conditions, the height at the downwind boundary (H_b) may be expressed by the following function (Pasquill 1975, Horst 1979):

$$z = 6.25\, r\, [H_b/r \times \ln(H_b/r) - 1.58\, H_b/r + 1.58] \quad \textbf{[Equation 6]}$$

where:

H_b	=	Downwind height of box (m);
z	=	Downwind distance to boundary (m); and
r	=	A terrain-dependent roughness height (m)

H_b (defined in Equation 5) is adjusted until the z parameter is equal to W_b (defined in Equation 5). The resulting H_b value is the height of the box. On any given workday, it is estimated that grading or excavation activities occur over the entire "workable" Site area (exposure unit) from which dusts are generated. This area is estimated to be 2,500 m^2, with length of the box estimated to be 50 meters (downwind distance) and the width of the box (W) estimated to be 50 meters. The greater the roughness height, the greater the wind turbulence and constituent dilution (*i.e.*, the height of the box increases). For the purposes of this risk assessment, it is conservatively assumed that the roughness height is 0.20 meters, which corresponds to a terrain with grass, some small bushes, and occasional trees (US EPA *Rapid Assessment of Exposure to Particulate Emission from Surface Contamination Sites,* 1985). This

assumption is appropriate for the actual Site conditions. An annual average wind speed (4.69 m/sec) is obtained from the STAR data set, accessed through the Personal Computer Graphical Exposure Modeling System (PCGEMS), for STAR station 03940, Jackson/Thompson, MS for the period 1974-1978 (Table 21).

5.0 Toxicity Assessment

The toxicity assessment involves the evaluation of available toxicity information to be utilized in the risk assessment process. Toxicity values derived from a dose-response relationship can be used to estimate the potential for the occurrence of adverse effects in individuals exposed to various constituent levels.

Exposure to a constituent does not necessarily result in adverse effects. The relationship between dose and response defines the quantitative indices of toxicity required to evaluate the potential health risks associated with a given level of exposure. If the nature of the dose-response relationship is such that no effects can be demonstrated below a certain level of exposure, a threshold can be defined and an acceptable exposure level derived. Humans are routinely exposed to naturally-occurring constituents and man-made constituents through the typical diet, air, and water, with no apparent adverse effects. However, the potential for adverse effects may occur if the exposure level exceeds the threshold in a variably sensitive population. This threshold applies primarily to constituents which produce non-carcinogenic (systemic) effects, although there is a growing body of scientific evidence which suggests that exposure thresholds may exist for certain carcinogenic constituents as well.

Adverse effects can be caused by acute exposure, which is a single or short-term exposure to a toxic substance, or by chronic exposure on a continuous or repeated basis over an extended period of time. "Acceptable" acute or chronic levels of exposure are considered to be without any anticipated adverse effects. Such exposure levels are commonly expressed as reference doses (RfDs), health advisories, etc. An acceptable exposure level is calculated to provide an "adequate margin of safety."

Chronic RfDs, which have been derived by the US EPA for a large number of constituents, were utilized to evaluate exposures lasting seven to 70 years (US EPA, 1989). Activities involving exposures of shorter duration to COPCs at the Site are anticipated to result in hazard and risk estimates that are lower than those associated with the long-term exposures. Identification of

subchronic toxicity values corresponding to shorter-term exposure scenarios (*i.e.*, less than seven years) are included in the risk assessment to ensure that both short-term and long-term risks can be addressed.

Currently, the US EPA has not developed toxicity values to be utilized in dermal exposure scenarios; however, the US EPA does provide the following guidance for dermal exposure:

> No RfDs or slope factors are available for the dermal route of exposure. In some cases, however, non-carcinogenic or carcinogenic risks associated with dermal exposure can be evaluated using an oral RfD or oral slope factor, respectively. (US EPA, 1989).

Provisional dermal toxicity values were developed and utilized in the dermal exposure pathways considered in the human health risk assessment to provide a more accurate Site-specific risk assessment. These dermal RfD values were developed by multiplying the published oral RfD for a given constituent by the fraction of that constituent that can be absorbed through the gastrointestinal tract (stomach/intestine lining). The absorption fraction utilized was 50% for semivolatiles as extracted from US EPA Region 4 guidance (1995).

A number of sources of toxicity information exists, and these sources vary with regard to the availability and strength of supporting evidence. The following protocol has been established for the determination of toxicity indices; it defines a hierarchy of sources to be consulted and the methodology for the determination of toxicity values. This protocol has been developed in accordance with current US EPA methodology. Toxicity values for the COPCs at the Site were obtained with reference to the following hierarchy of sources developed in accordance with MCEQ guidance (1999):

1) Toxicity values were obtained from the *Integrated Risk Information System* (IRIS, 1999) database. This database contains the RfDs and Cancer Slope Factors (CSFs), which have been verified by the US EPA's RfD and Carcinogen Risk Assessment Verification Endeavor (CRAVE) workgroups, and is, thus, the

agency's preferred source for toxicity values. IRIS supersedes all other information sources.

2) For toxicity values which are unavailable on IRIS, the most current source of information is the Health Effects Assessment Summary Tables (HEAST, US EPA, 1997), published by the US EPA. HEAST contains interim, as well as verified RfDs and CSFs. Supporting toxicity information for verified values is provided in an extensive reference section of HEAST.

3) In cases where IRIS or HEAST could not provide toxicity values, US EPA Region III's Risk-Based Concentration (RBC) Tables were visited. These tables often provide toxicity values generated by reliable sources other than IRIS or HEAST. For example, in response to specific requests from risk assessors, the US EPA National Center for Environmental Assessment (NCEA) develops provisional RfDs or CSFs for chemicals not listed in IRIS or HEAST. Region III's RBC tables will list such provisional values. Also, RfDs or CSFs that have since been withdrawn from IRIS or HEAST may still be listed on the Region III RBC tables, although they are flagged with a "W." These toxicity values were no longer agreed upon by US EPA scientists; however, the Region III RBC tables continue to publish such values because risk assessors still need to quantify exposures to these chemicals. Lastly, the Region III RBC tables will list toxicity indices found in "other" US EPA documents. These values are flagged with an "O" on the tables.

The US EPA has derived carcinogenic slope factors for both oral and inhalation pathways, and these are utilized to quantitatively estimate risks. In the first step of the US EPA's evaluation, the available data are analyzed to determine the likelihood that the agent is a human carcinogen. The evidence is characterized separately for human studies and animal studies as sufficient, limited, inadequate, no data, or evidence of no effect. The characterizations of these two types of data are combined, and based on the extent to which the agent has been shown to be a carcinogen in experimental animals or humans, or both, the agent is given a provisional weight-of-evidence classification. The US EPA scientists then adjust the provisional classification upward or downward, based on other supporting evidence of carcinogenicity (see Section 7.1.3, US EPA, 1989). For a further description of the role of supporting evidence, see the US EPA guidelines (US EPA, 1986).

The US EPA classification system for weight of evidence is shown in the table below. This system is adapted from the approach taken by the International Agency for Research on Cancer.

US EPA WEIGHT-OF-EVIDENCE CLASSIFICATION SYSTEM FOR CARCINOGENICITY

Group	Description
A	Human carcinogen
B1 or B2	Probable human carcinogen B1 indicates that limited human data are available B2 indicates sufficient evidence in animals and inadequate or no evidence in humans
C	Possible human carcinogen
D	Not classifiable as to human carcinogenicity
E	Evidence of non-carcinogenicity for humans

(US EPA, 1989)

Table 22 summarizes the available toxicity values for the identified COPCs. COPCs lacking published toxicity values were not able to be quantitatively evaluated in this assessment in accordance with MCEQ guidance (1999). The MCEQ limits the use of toxicity values to those that have been published in IRIS, HEAST, ATSDR toxicity profiles, or other peer-reviewed reference sources or literature approved by the MCEQ (1999). The MDEQ (2001), however, requested that risks from dermal exposure to cPAHs be estimated using the oral cancer slope factor for benzo(a)pyrene, applying benzo(a)pyrene relative potency factors, and accounting for an absorption efficiency of 50%. This methodology was used accordingly.

6.0 Risk Characterization

The objective of the risk characterization is to determine potential risk to receptors by combining the results of the exposure and toxicity assessments. Non-carcinogenic effects and carcinogenic risks are summarized in Table 23. Tables 24 through 78 provide algorithms and parameters for each pathway.

The estimated intakes calculated for each exposure pathway considered and each COPC were compared to RfDs for non-carcinogenic effects. The following formula was used to estimate the potential for non-carcinogenic health effects for each COPC.

$$HQ = ADI/RfD \qquad \textbf{[Equation 7]}$$

where:

HQ	=	Hazard quotient - potential for noncancer health effects (unitless);
ADI	=	Average daily intake of COPC (mg/kg-day); and
RfD	=	Reference dose (mg/kg-day).

RfDs have been developed by the US EPA for chronic (*e.g.*, lifetime) and/or subchronic exposure to constituents based on the most sensitive non-carcinogenic effects. The chronic RfD for a constituent is an estimate of a lifetime daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects. The potential for noncancer health effects was evaluated by comparing the Site-specific exposure level with the RfD derived by the US EPA for a similar exposure period. This ratio of exposure to toxicity is called the hazard quotient (HQ). If the Site-specific exposure level exceeds the threshold (*i.e.*, the HQ exceeds a value greater than 1.0), there may be concern for potential noncancer effects.

To assess the overall potential for noncancer effects posed by multiple constituents, a hazard index (HI) is derived by summing the individual HQs. This approach assumes additivity of critical effects of multiple constituents. This is appropriate only for compounds that induce the

same effect by the same mechanism of action. This conservative approach significantly overestimates the actual potential for adverse health impacts.

In cancer risk assessment, the US EPA has required the use of the upper limit which produces an estimate of potential risk that has a 95% probability of exceeding the actual risk, which may, in fact, be zero. The following formula was utilized to estimate the upper bound excess cancer risk for each carcinogen (note that not all COPCs are carcinogens):

$$TR = CLDI \times SF \qquad \textbf{[Equation 8]}$$

where:

TR	=	Target risk - excess probability of an individual developing cancer (unitless);
CLDI	=	Calculated lifetime average daily intake of carcinogenic COPC (mg/kg-day); and
SF	=	Cancer slope factor $(mg/kg\text{-}day)^{-1}$.

For exposures to multiple carcinogens, the upper limits of cancer risks are summed to derive a total cancer risk. The US EPA recognizes that it is not technically appropriate to sum upper confidence limits of the risk to produce a realistic total probability, but requires this approach be used.

Carcinogenic risk refers to the probability of developing cancer as a result of exposure to known or suspected carcinogens. The National Contingency Plan (NCP) endorses an acceptable risk range of 10^{-4} to 10^{-6} for exposure to multiple carcinogens. This range represents an incremental increase of 1 in 10,000 to 1 in 1,000,000 in the chance of developing cancer over a lifetime. The MCEQ (1999) indicates that the target risk level is 1×10^{-6} per individual carcinogen and an acceptable cumulative risk level is 1×10^{-4}. As such, risk levels totaled across oral, dermal, and inhalation pathways may exceed 1×10^{-6} and still be in compliance with MCEQ requirements (1999) as long as no single carcinogen exceeds 1×10^{-6} and the cumulative risk for a single receptor does not exceed 1×10^{-4}.

Table 23 provides a summary of the non-carcinogenic effects and carcinogenic risks associated with each of the pathways evaluated in this assessment.

The overall hazard index across the assessed pathways and EUs was 0.1 for the Site visitor scenario. This value is below the acceptable benchmark of 1.0. The highest hazard index associated with the Site visitor scenario was 0.07 corresponding to dermal exposure to sediment in EU4. The overall cancer risk for exposures to Site visitors was estimated to be 7×10^{-5} and is primarily attributable to oral and dermal exposure to benzo(a)pyrene and associated cPAHs in EU4 soil and sediments. Oral exposure to the same constituents in EU4 and EU5 surface soils also contributed to the cancer risk estimate for the site visitor. Additional discussion regarding remediation goals for this scenario has been provided in section 8.0.

The overall hazard index for the maintenance worker scenarios was 0.08 and is below the acceptable benchmark of 1.0. The highest hazard index associated with the maintenance worker scenario was 0.05 corresponding to oral exposure to sediment in EU4. The overall cancer risk for the maintenance worker scenario was 4×10^{-4} and was primarily attributable to dermal and oral exposure to benzo(a)pyrene and other cPAHs in surface soils in EUs 2, 4, and 5. Additional discussion regarding remediation goals for this scenario has been provided in section 8.0.

The overall hazard index for the hypothetical future construction worker was 0.000006 and is well below the acceptable benchmark of 1.0. The highest hazard index associated with the construction worker scenario was 9×10^{-7} corresponding to dermal exposure to surface water in EU 4. The overall cancer risk for the hypothetical future construction worker scenario was 5×10^{-5} and is attributable to benzo(a)pyrene and associated cPAH oral exposure in EU4 sediment and oral and dermal exposure to EU4 and EU5 soils. Additional discussion regarding remediation goals for this scenario has been provided in section 8.0.

The off-Site resident scenario revealed a hazard index of 6×10^{-4}. This value is considerably below the acceptable benchmark of 1.0. The overall cancer risk for the resident exposure

scenario was estimated to be 2×10^{-4} and is attributable to oral and dermal exposure to benzo(a)pyrene and associated cPAHs in EU6.

7.0 Uncertainty Analysis

Risk assessment uses a wide array of information sources and techniques. Even in those rare circumstances where constituent intake for an exposed individual may be measured relatively precisely, assumptions will still be required to evaluate the associated risk. Generally, data are not available for critical aspects of the risk assessment, and the use of professional judgment, inferences based on analogy, the use of default values, model estimation techniques, etc., result in uncertainty of varying degrees.

The expressions of risk in this assessment are not probabilistic; the expressions of risk are conditional, based on the conditions represented by the single-point values selected for the analysis. This section is intended to identify and qualitatively evaluate the more salient Site-specific uncertainties and their potential influence on the credibility of the estimated Site risks.

7.1 Uncertainty of Data Evaluation Factors

Uncertainties in data analysis include analytical error, selection of COPCs, adequacy of sampling design, etc. Generally, there is far less uncertainty in this phase of the risk assessment process than other aspects contribute.

Laboratory analysis is extremely accurate relative to the potential error of "professional judgment" in exposure assessments. The uncertainty of analytical data is likely to be less than 25 percent, most of the time.

The adequacy of the sampling strategies to characterize Site conditions is a potentially large source of uncertainty. Because of the limited availability of resources, sample collection is generally limited. However, sampling (especially in multiple surveys) is not random, but is designed to locate the areas with the highest levels of constituents. Thus, test data are biased toward overestimation of average constituent levels. In addition, in most instances, the upper 95-percent confidence limit of the average concentration is utilized as an exposure-point

concentration in the risk assessment. The use of this value likely will result in an overestimation of risk, as the 95% UCL represents a value that will be greater than the true average 95% of the time.

Oftentimes, only a portion of detected constituents are carried through the risk assessment process because constituents are eliminated through COPC screening procedures (US EPA, 1989). This could result in an underestimation of risk, although the COPC selection process is intended to identify those constituents that account for the vast majority of potential risk. COPCs lacking published RfD values were not quantitatively evaluated and this may result in an underestimation of potential hazards (non-carcinogenic effects).

7.2 Uncertainty of Toxicity Values

The US EPA's IRIS states that the uncertainty associated with RfD values for non-carcinogenic endpoints of toxicity "span perhaps an order of magnitude." In fact, the uncertainty of extrapolating dose-response data from animals to humans with the application of multiple safety factors (100 to 10,000 or more) is likely to be several orders of magnitude. Current policies for deriving RfD values will often result in an overestimation of risk.

The uncertainty associated with the estimation of cancer risk contributes, by far, the major source of potential error and uncertainty. It is beyond the scope of this analysis to explore this toxicity assessment factor in any detail. However, a few salient points are noted below.

Some constituents classified as carcinogens have been shown to produce an increased incidence of cancer in mice but not rats, for example. If the mouse is not an adequate model for the rat, it may be wondered how reliable a model it is for human beings. The assumption of linearity and a non-threshold phenomenon in the dose versus risk relationship may not be valid and could result in a very large overestimation of actual cancer risk, if any even exist at low doses in humans.

The US EPA evaluated the uncertainty of cancer risk estimates from exposures to trichloroethene and several other related VOCs in public drinking water supplies (Cothern *et al.*, 1984). These US EPA scientists concluded the following:

- The largest uncertainty in the calculations is due to the choice of the model [Multistage, Weiball, Logit, Probit, etc.] used in extrapolating risk to low doses in humans, and is 5 to 6 orders of magnitude;

- If a single model were chosen [assumed to be valid], the overall uncertainty in risk estimates would be 2 to 3 orders of magnitude;

- The exposure estimates contribute, at most, an order of magnitude to the uncertainty; and

- It would appear that until a particular compound's mechanisms of cancer are better known, it is likely that the uncertainty in the toxicity will not be improved.

7.3 Uncertainties in Assessing Potential Exposure

Ideally, Site-specific exposure values should be used when assessing potential intakes of chemicals at a Site. Oftentimes, however, Site-specific data are not available; therefore, the risk assessor must estimate values that most accurately reflect Site conditions. In doing so, US EPA or other regulatory default values were utilized in place of Site-specific data. These values may over- or under-estimate risks, depending on Site conditions and the percentile range in which the default values fall (*e.g.*, 50^{th}, 95^{th}).

Although a considerable amount of published data is available on the most common exposure parameters (*e.g.*, body weight, skin surface area), even these data contain uncertainties. Studies conducted by different scientists often provide differing levels of detail, statistics, and accuracy based on sample size, study design, geographic area, etc. Such discrepancies can increase uncertainty when the data are combined to derive a single-point default value. These data may be the best available; however, the reflection of reality may still be imprecise.

Where published exposure parameters were not available, best professional judgment had to be used, thereby increasing uncertainty. The default or estimated exposure parameters used in this assessment likely resulted in a moderate over-estimation of risk.

The intakes estimated for dermal absorption of PAHs adsorbed into soils adhering to skin may overestimate risks for a host of reasons. Early studies conducted by Falk and coworkers indicated that the carcinogenic effect of B(a)P on subcutaneous injection in mice could be markedly inhibited by the simultaneous administration of various non-carcinogenic PAHs (Falk *et al.*, 1964, as cited in ATSDR, 1988. In other subcutaneous injection and skin-painting studies with mice, it was shown that a combination of several non-carcinogenic PAH compounds, mixed according to the proportion occurring in auto exhaust, did not enhance or inhibit the action of two potent PAH carcinogens, B(a)P and dibenz(a,h)anthracene- (ATSDR, 1988).

The carcinogenic potency of B(a)P and other carcinogenic PAHs is generally determined by injecting solutions under the skin, painting the skin with the carcinogenic PAH dissolved in a solvent, or dissolved in corn oil in feeding studies. This vehicle or matrix affords a high level of bioavailability of the carcinogenic PAH compound. Recently, Krueger *et al.* (1999) conducted *in vitro* percutaneous absorption studies with contaminated soils and organic solvent extracts of contaminated soils collected at former manufactured gas plant (MGP) sites. The MGP tar-contaminated soils contained PAHs at levels ranging from 10 to 2400 mg/kg. The dermal penetration rates of PAH from the MGP tar-contaminated soils and soil solvent extracts were determined experimentally through human skin using tritrum-labelled B(a)P as a surrogate. Results showed reductions of two to three orders of magnitude in PAH absorption through human skin from the most contaminated soils in comparison to the soil extracts. Reduction in PAH penetration was attributed to soil matrix properties. That is, PAH compounds adsorbed to organic carbon in a soil matrix are far less bioavailable for dermal flux than PAH compounds dissolved in a solvent. [No correction for such a profound soil matrix effect was applied in quantitatively estimating cancer risks due to dermal absorption of B(a)P and other carcinogenic PAHs in this assessment.]

8.0 Summary of Findings

The results of the baseline human health risk assessment indicate potentially unacceptable risk levels for the following exposure scenarios:

Potentially Exposed Population	Media	EU
Site Visitor	Sediment	4
	Surface Soil	4, 5
Maintenance Worker	Sediment	4
	Surface Soil	2, 4, 5
Construction Worker	Sediment	4
	Subsurface Soil	4, 5
Off-Site Resident	Sediment	6

The risk levels associated with the above scenarios were driven by cPAHs, particularly benzo(a)pyrene. To determine the extent of remediation necessary to reduce these risks to acceptable levels, sediment and soil data for cPAHs in EUs 2, 4, 5, and 6 were closely examined.

The benzo(a)pyrene exposure-point concentration used to evaluate maintenance worker exposures to surface soil in EU2 was 5.2 mg/kg (sample location GEO-13/0-1'). This was the maximum benzo(a)pyrene concentration found in surface soil in EU2. The next highest concentration of benzo(a)pyrene in sediment was found at SS-10 (2.4 mg/kg). However, as previously noted, these samples were collected at locations within a densely wooded area. No remediation is planned to address surface soils at these locations for the following reasons:

- No maintenance activities are currently conducted in this area;
- Any remediation would require significant clearing; and
- Cancer risks associated with surface soils at these locations only slightly exceed 1×10^{-6} for two individual constituents, and the total cancer risk level is still less than 1×10^{-5}.

In EU4, the maximum concentration of benzo(a)pyrene was used as the exposure-point concentration for site visitor, maintenance worker, and construction worker exposure to sediment. The benzo(a)pyrene exposure-point concentration used to evaluate these in EU4 was 130 mg/kg (sample location SD-02, see Figure 2). The next two highest concentrations of benzo(a)pyrene in sediment were found at SD-12 (71 mg/kg) and SD-23 (5.57 mg/kg), respectively. Implementing a remedy to remove, treat, or preclude contact with sediment at sample locations SD-02, SD-12, and SD-23 would leave a concentration of 3.1 mg/kg (sample location SD-18) as the maximum concentration in sediment that could be potentially contacted by site visitors, maintenance workers, and/or construction workers in EU 4. Excluding samples SD-02, SD-12, and SD-23 and using 3.1 mg/kg as the exposure-point concentration drops the risk level for dermal and oral contact with sediment by a visitor and oral contact with sediment by a maintenance worker or construction worker to within acceptable levels (i.e., no risk level associated with a single carcinogen exceeds 1×10^{-6}; Tables 79 - 83).

In EU4, the maximum concentration of benzo(a)pyrene was also used as the exposure-point concentration for site visitor, maintenance worker, and construction worker soil exposures. Each of these receptors could potentially be exposed to soils at different depth ranges: visitor 0-1' bgs, maintenance worker 0-6' bgs, and construction worker 0-20' bgs. The sample locations and corresponding concentrations of benzo(a)pyrene that contributed to elevated risk estimates in the three exposure scenarios are presented in the table below:

Sample Location	Benzo(a)pyrene Concentration (mg/kg)
GEO-48/0-1'	500
GEO-21/0-1'	230
GEO-21/2-3'	190
GEO-19/0-1'	56
GEO-46/0-1'	16

Sample Location	Benzo(a)pyrene Concentration (mg/kg)
GEO-20/5-6'	11
GEO-47/5-6'	9.6
GEO-48/2-3'	6.1
GEO-20/0-1'	3.2
GEO-47/0-1'	3
GEO-19/2-3'	2.4

Implementing a remedy to remove, treat, or preclude contact with the surface (0-1' bgs) soil sample locations tabulated above would result in eliminating exposures for the site visitor scenario (*i.e.*, the 0-1' bgs samples listed above comprise the entire data set for visitor exposures to surface soils in EU4). In addition, implementation of a remedy addressing the sample locations tabulated above would leave a maximum subsurface soil benzo(a)pyrene concentration of 0.29 mg/kg (sample location GEO-19/5-6'). Using the concentration of 0.29 mg/kg as the exposure-point concentration for estimating risk to maintenance workers and construction workers drops the risk levels to within acceptable levels (Tables 84 - 88). In situ biological treatment is proposed to address impacted soils within EU4. This will include clearing, tilling, application of inorganic nutrients, and, once soils are remediated to the extent practicable, placement of concrete cover. The area to be remediated will extend at least from Courtesy Ford to the edge of the railroad right-of-way, and may extend onto the railroad right-of-way with the permission of the Southern railway.

In EU5, the surface soil sample locations contributing most to elevated risk levels for the maintenance worker, construction worker, and site visitor scenarios were GEO-33/0-1', GEO-33/2-3', GEO-30/0-1', GEO-59/0-1, GEO-29/0-1', and GEO-28/0-1' (see Figure 2). All sample locations, with the exception of GEO-59/0-1', are located underneath paved areas in a parcel of land extending from Courtesy Ford to the southeast (Figure 2). Pavement in this area precludes direct contact with surface and subsurface soils; therefore, it is not anticipated that current or future maintenance workers or site visitors will have access to soils in or around these sample locations. In addition, a deed restriction will be implemented requiring the maintenance of the paved areas to ensure protection of human health in the future. Sample location GEO-59/0-1', with a benzo(a)pyrene exposure point concentration is 6.1 mg/kg, however, is adjacent to West Pine Street in an unpaved area. Implementing a remedy to remove, treat, or preclude contact with surface soil at this location would leave a concentration of 0.37 mg/kg (GEO-60/0-1') as the maximum concentration in surface soil not covered by pavement that could potentially be contacted by any of the three receptors in this EU. Excluding sample GEO-59/0-1' and using 0.37 mg/kg as the exposure-point concentration drops the estimated exposures in EU5 to within acceptable levels (i.e., no risk level associated with a single carcinogen exceeds 1×10^{-6}; Tables 89 - 92).

The benzo(a)pyrene exposure-point concentration used to evaluate adult and child resident exposures to sediment in EU6 was 49 mg/kg (sample location SD-03, see Figure 3). This was the maximum benzo(a)pyrene concentration found in sediments in EU6. Sample locations SD-04, SD-14, SD-13, SD-16, SD-15, and SD-17 (33, 12.2, 3.27, 2.8, 2.42, and 2.26 mg/kg, respectively) also contributed to elevated cancer risk estimates for both receptors. Implementing a remedy to remove, treat, or preclude contact with sediment at these sample locations would leave a concentration of 0.97 mg/kg (sample location SD-05). Using the benzo(a)pyrene concentration of 0.97 mg/kg as the exposure-point concentration for sediment exposure to adult and child residents reduces the risk estimate to within acceptable limits (i.e., no risk level associated with a single carcinogen exceeds 1×10^{-6}; Tables 93 - 96). Remediation activities are proposed to remove impacted sediment and preclude contact with residuals in the northeast drainage ditch. These activities include removal and off-Site treatment and/or disposal of impacted sediments, installation of a storm water collection and conveyance pipe, backfilling around the culvert, and planting with native grass.

Bibliography

Andelman, J. B., and M. J. Suess. 1980. Polynuclear aromatic hydrocarbons in the water environment. Bull. WHO 43:479-508.

Alexander, M. Aging, Bioavailability, and Overestimation of Risk from Environmental Pollutants. Environ. Sci. Technol, 2000, 34(20):4259.

ATSDR (Agency for Toxic Substances and Disease Registry). Toxicological Profile for Benzo(a)Pyrene. Oak Ridge National Laboratory. 1988.

ATSDR (Agency for Toxic Substances and Disease Registry). ATSDR's Toxicological Profiles on CD-ROM. Polycyclic Aromatic Hydrocarbons (PAHs), Update. CRC Press, 1999.

Audere, A. K., Z. Y. Lindberg, G. A. Smirnov, and L. M. Shabad. 1973. Experiment in studying the influence of an airport located within the limits of a city on the level of environmental pollution by benzo(a)pyrene. Gig. Sanit. 38(9): 90-92.

Bartek, M.J. and J.A. LaBudde. Percutaneous Absorption *in vitro*, in Animal Models in Dermatology. Ed. H.I. Maibach. New York: Churchill Livingstone, 1975. p. 103.

Blumer, M. 1961. Benzopyrenes in soil. Science 134, 474-475.

Blumer, M., W. Blumer, and T. Relch. 1977. Polycyclic aromatic hydrocarbons in soils of a mountain valley; correlation with highway traffic and cancer incidence. Environ. Sci. Technol. 11 (12), 1082-1084.

Butler, J. D., V. Butterworth, C. Kellow, and H. G. Robinson. 1984. Some observations on the polycyclic aromatic hydrocarbon (PAH) content of surface soils in urban areas. Sci. Total Environ. 38, 75-85.

Chu, M. M. L. and G. W. Chem. 1984. Evaluation and estimation of potential carcinogenic risks of polynuclear aromatic hydrocarbons. Paper presented at the Pacific Rim Risk Conference.

Chung, N. and Alexander, M. Differences in Sequestration and Bioavailability of Organic Compounds Aged in Dissimilar Soils. Environ Sci. Technol. 32: 855.

Coomes, R. M. 1981. Carcinogenic testing of oil shale materials. Twelfth Oil Shale Symposium Proceedings. Colorado School of Mines Pres.

Cothern, C. R., W. Conniglio, W. Marcus. Techniques for the Assessment of the Carcinogenic Risk to the US Population due to Exposure from Selected Volatile Organic Compounds from Drinking Water via the Ingestion, Inhalation and Dermal Routes. NTIS PB84-213941. Office of Drinking Water. Washington DC: Environmental Protection Agency, 1984.

Edwards, C.A., Beck, S.D. and Lichtenstein, E.P., J. Econ. Entomol. 1957, 50: 622.

Edwards, N. T. 1983. Polycyclic aromatic hydrocarbons (PAHs) in the terrestrial environment – a review. J. Environ. Qual. 12 (4), 427-441.

Falk, H. L., and P. T. S. Kotin. Inhibition of carcinogenesis: The effects of polycyclic hydrocarbons and related compounds. Arch. Environ. Health Vol. 9 (1964):169-179.

Fritz, W. 1971. Extent and sources of contamination of our food with carcinogenic hydrocarbons. Ernaehrungsforschung 16(4), 547-557.

Health & Welfare Canada. Polycyclic Aromatic Hydrocarbons, Report No. 80-EHD-50, (1979) p. 38.

Horst, T. W. Langrangian Similarity Modeling of Vertical Diffusion for a Ground Level Source. Int. Applied Met, Vol. 18 (1979): 733-740.

HSDB (Hazardous Substances Data Bank), 1999. National Library of Medicine (NLM) On-Line Toxicological Network (TOXNET). Bethesda, MD.

ICRP (International Commission on Radiological Protection). Report of Committee IV on Evaluation of Radiation Doses to Body Tissues from Internal Contamination due to Occupational Exposure. ICRP Publication 10. New York: Pergamon Press, 1968.

Kao, J.K., F.K. Patterson, and J. Hall. Skin Penetration and Metabolism of Topically Applied Chemicals in Six Mammalian Species, Including Man: an in vitro Study with Benzo(a)pyrene and Testcaterone. Toxicol. Appl. Pharmacol, Vol. 81 (1985): 502-516.

Kelsey, J.W. and Alexander, M. Declining Bioavailability and Inappropriate Estimation of Risk of Persistent Compounds. Environ. Toxicol. Chem. 1997. 16(3): 582

Kelsey, J.W., Kottler, B.D. and Alexander, M. Environ. Sci. Technol. 1997, 31: 214.

Kissel, J., K. Richter, and R. Fenske. Field Measurements of Dermal Soil Loading Attributable to Various Activities: Implications for Exposure Assessment. Risk Analysis, Vol. 16, No. 1 (1996): 115-125.

Magee, B., P. Anderson, and D. Burmaster. Absorption Adjustment Factor (AAF) Distributions for Polycyclic Aromatic Hydrocarbons (PAHs). Human and Ecological Assessment: An International Journal. Vol. 2, No. 4 (December 1996): 841-873.

Menzi, C.A., B.B. Potocki and J. Santodonato. Exposure to Carcinogenic PAHs in the Environment. Environ. Sci. Technol. Vol. 26, No. 7, 1992.

Michael Pisani & Associates. Remedial Investigation Report, Former Gulf States Creosoting Site, Hattiesburg, Mississippi. New Orleans, Louisiana. 1997.

Michael Pisani & Associates. Phase II Remedial Investigation Report, Former Gulf States Creosoting Site, Hattiesburg, Mississippi. New Orleans, Louisiana. 1998.

Mississippi Commission on Environmental Quality (MCEQ). Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi. 1999.

Mississippi Department of Environmental Quality (MDEQ). Guidance for Remediation of Uncontrolled Hazardous Substance Sites in Mississippi. Office of Pollution Control. 1990.

Mississippi Department of Environmental Quality (MDEQ). Letter to Glen Pilie, Adams and Reese, from Tony Russell, MDEQ. August 2, 2000.

Mississippi Department of Environmental Quality (MDEQ). Letter to Glen Pilie, Adams and Reese, from Tony Russell, MDEQ. February 6, 2001.

Morrison, DE., Robertson, B.K. and Alexander, M. Bioavailability to Earthworms of Aged DDT, DDE, DDD, and Dieldrin in Soil. Environ. Sci. Technol. 2000 34: 709.

Moore, M.R., P.A. Meredith, W.S. Watson, D.J. Sumner, M.K. Taylor, and A. Goldberg. "The Percutaneous Absorption of Lead-203 in Humans From Cosmetic Preparations Containing Lead Acetate, as Assessed by Whole-Body Counting and Other Techniques." Food Cosmet. Toxicol. 18. (1980): 399.

Pancirov, R. J. and R. A. Brown. 1975. Analytical methods for polynuclear aromatic hydrocarbons in crude oil, heating oils, and marine tissues. In: Conference on prevention and control or oil pollution, San Francisco, CA, March, 1975. American Petroleum Institute, Wash., DC. pp 103-13.

Pao, E. M. *et al.* Home Economics Research Report No. 44. United States Department of Agriculture, Washington, DC. 1982.

Pasquill, I.. The Dispersion of Material in the Atmospheric Boundary Layer - The Basis for Generalization. In: Lectures on Air Pollution and Environmental Impact Analysis. Boston, MA: American Meteorological Society, 1975.

Ryan, E.A., E.T. Hawkins *et al.* "Assessing Risk From Dermal Exposure at Hazardous Waste Sites. in Bennett." Ed. G. and J. Bennett. Superfund '87: Proceedings of the Eighth National Conference. Washington, DC, 16-18 November 1987. The Hazardous Material Control Research Institute. p.166-168.

Santodonato, J., P. Howard, and D. Basu. Health and Ecological Assessment of Polynuclear Aromatic Hydrocarbons. Pathotox Publishers, Inc., Park Forest South, IL. 1981.

Shabad, L. M. 1980. Circulation of carcinogenic polycyclic aromatic hydrocarbons in the human environment and cancer prevention. J. Natl. Cancer Inst. 64(3): 405-410.

Shu, H.P., P. Teitelbaum, A.S. Webb, L. Marple, B. Brunck, D. Dei Rossi, F.J. Murray, and D.J. Paustenbach. "Bioavailability of Soil Bound TCDD: Dermal Bioavailability in the Rat." Fundam. Appl. Toxicol., Vol. 10 (1988): 648-654.

Smirnov, G. A. 1970. The study of benzo(a)pyrene content in soil and vegetation in the airfield region. Vopr. Onkol. 16(5): 83-86.

State of Mississippi. Mississippi Code 1972 Annotated. Title 29 Public Lands, Buildings, and Property, Chapter 3, Sixteenth Section and Lieu Lands in General. 1998.

Suess, M. J. 1976. The environmental load and cycle of polycyclic aromatic hydrocarbons. Sci. Total Environ. 6:239-250.

Ta, Roy *et al.*, Studies Estimating the Dermal Bioavailability of Polynuclear Aromatic Hydrocarbons from Manufactured Gas Plan Tar-Contaminated Soils. Env. Sci. Tech. 32(20). 1998. 3113-3117.

Tang, W.C., White, J.C., and Alexander, M. Appl. Microbiol. Biotechnol. 1998, 49: 117.

Tang, J and Alexander, M. Environ. Toxicol. Chem. 1999, 18: 2711.

Thomas, J.F., M. Mukai, and B.D. Teggens. Fate of airborne benzo(a)pyrene. Environ. Sci. Technol. 2:33-39, 1968.

United States Department of Agriculture (USDA). Nationwide Food Consumption Survey: Continuing Survey of Food Intakes by Individuals, Men 19-50 years, 1 Day, 1985; United States Department of Agriculture. Human Nutrition Information Service. Nutrition Monitoring Division; Washington, DC, Report No. 86-1. 1986.

US EPA (United States Environmental Protection Agency). Rapid Assessment of Exposure to Particulate Emission from Surface Contamination Sites. EPA/OHEA/EPA. 600/8-85/002. Cowherd, C., Jr., G.E. Muleski, P.J. Engelhart and D.A. Gillett, Ed. Washington DC: Midwest Research Inst.. 1985.

US EPA (United States Environmental Protection Agency). "Guidelines for Carcinogenic Risk Assessment." Federal Register 51:33992-34003. 1986.

US EPA (United States Environmental Protection Agency). Superfund Exposure Assessment Manual (SEAM). EPA 540/1-88/001. Office of Remedial Response. Washington, DC, 1988.

US EPA (United States Environmental Protection Agency). Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Interim Final. EPA/540/1-89/002. Office of Emergency and Remedial Response. Washington, DC, 1989.

US EPA (United States Environmental Protection Agency). Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive. 9285.6-03. Office of Solid Waste and Emergency Response. Washington, DC, 1991.

US EPA (United States Environmental Protection Agency). Dermal Exposure Assessment: Principles and Applications. Office of Research and Development. EPA/600/8-91/011B. Washington, DC, 1992.

US EPA (United States Environmental Protection Agency). Estimating Exposure to Dioxin-Like Compounds. Office of Research and Development. EPA/600/6-88/005B. Washington, DC, 1992.

US EPA (United States Environmental Protection Agency). Provisional Guidance for Quantitative Risk Assessment of Polynuclear Aromatic Hydrocarbons. Office of Solid Waste and Environmental Remediation. EPA/600/R-93/089, July 1993

US EPA (United States Environmental Protection Agency). Land Use Directive in the CERCLA Remedy Selection Process. OSWER Directive 9355.7-04. Office of Solid Waste and Emergency Response. Washington, DC, May 1995.

US EPA (United States Environmental Protection Agency) Region 3. Technical Guidance Manual: Risk Assessment, Assessing Dermal Exposure From Soil. EPA/903-K-95-003. Office of Superfund Programs, Hazardous Waste Management Division. Washington, DC, 1995.

US EPA (United States Environmental Protection Agency) Region 4. Technical Services Supplemental Guidance to RAGS: Region 4 Bulletins. Waste Management Division, Atlanta, GA. 1995.

US EPA (United States Environmental Protection Agency). Supplement B to Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources. AP-42, Fifth Edition, Supplement B. Office of Air Quality Planning and Standards, Office of Air and Radiation. Research Triangle Park, NC, 1996

US EPA (United States Environmental Protection Agency). Exposure Factors Handbook,. EPA/600/P-95/002F. Office of Research and Development, Washington, DC, August 1997.

US EPA (United States Environmental Protection Agency). Health Effects Assessment Summary Tables (HEAST). Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office (ECAO). Cincinnati OH, 1997.

US EPA (United States Environmental Protection Agency). IRIS (Integrated Risk Information System). A Continuously Updated Electronic Database Maintained by the US Environmental Protection Agency. Bethesda, Maryland: National Library of Medicine, 1999.

US EPA (United States Environmental Protection Agency) Region 3. Updated Risk-Based Concentration Tables. Office of RCRA Technical & Program Support Branch. Philadelphia, PA, April, 1999.

Wallcave, L., H. Garcia, R. Fedlman, W. Linjinsky, and P. Shubik. 1971. Skin tumorigenesis in mice by petroleum asphalts and coal-tar pitches of known po9lynuclear aromatic hydrocarbon content. Toxicol. Appl. Pharmacol. 18, 41-52.

Weissenfels, W.D., Klewer, H.J. and Langhoff, J., J. Appl. Microbiol. Biotechnol. 1992, 36: 689.

White, J.C., Kelsey, J.W., Hatzinger, P.B and Alexander, M. Factors Affecting Sequestration and Bioavailability of Phenanthrene in Soils. Environ. Toxicol. Chem. 1997, 16(10): 2040.

Youngblood, W. W., and M. Blumer. 1975. Polycyclic aromatic hydrocarbons in the environment: homologous series in soils and recent marine sediments. Geochim. Cosmochim. Acta 39:1303-1315.

Table 5
Statistical Summary and Selection of COPCs in EU2 Soil (0-10' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Pesticides														
Endosulfan I	959-98-8	1	1	100	0.00E+00	0.00E+00	4.00E-03	J	4.00E-03	4.00E-03	4.00E-03	J	SB-05	--
Heptachlor	76-44-8	1	1	100	0.00E+00	0.00E+00	1.00E-02		1.00E-02	1.00E-02	1.00E-02		SB-05	--
Semivolatiles														
2,4-dimethylphenol	105-67-9	23	1	4.35	6.70E-02	3.30E-01	1.10E+00	J	8.68E-02	4.33E-02	1.10E+00	J	SB-05	2.23E-01
2-methylnaphthalene	91-57-6	23	4	17.39	3.30E-02	3.90E-02	7.00E-02	J	1.87E+01	4.58E-02	2.30E+02		SB-07	6.21E+01
Acenaphthene	83-32-9	26	3	11.54	2.80E-02	3.10E-01	4.90E-02	J	1.14E+01	4.20E-02	2.00E+02		SB-07	4.29E+01
Acenaphthylene	208-96-8	26	8	30.77	2.80E-02	3.10E-01	3.70E-02	J	6.65E-01	5.37E-02	7.70E+00		SB-07	1.97E+00
Anthracene	120-12-7	26	10	38.46	7.90E-04	3.90E-02	4.10E-02	J	8.11E+00	5.28E-02	1.20E+02		SB-07	2.86E+01
Benzo(a)anthracene	56-55-3	26	16	61.54	8.60E-04	3.80E-02	4.10E-02	J	4.69E+00	1.16E-01	6.10E+01		SB-07	1.48E+01
Benzo(a)pyrene	50-32-8	26	16	61.54	3.70E-02	6.70E-02	1.69E-03	J	2.09E+00	1.33E-01	2.20E+01		SB-07	5.75E+00
Benzo(b)fluoranthene	205-99-2	26	20	76.92	3.70E-02	6.70E-02	7.60E-04	J	3.49E+00	2.74E-01	3.30E+01	J	SB-07	8.58E+00
Benzo(ghi)perylene	191-24-2	26	14	53.85	1.70E-02	6.70E-02	1.80E-03	J	7.49E-01	1.06E-01	6.40E+00		SB-07	1.65E+00
Benzo(k)fluoranthene	207-08-9	26	17	65.38	3.70E-02	1.30E-01	5.10E-04	J	1.18E+00	1.62E-01	1.10E+01		SB-07	2.70E+00
Bis(2-ethylhexyl)phthalate	117-81-7	23	1	4.35	6.70E-02	5.00E-01	3.70E-01	J	6.43E-02	4.48E-02	3.70E-01	J	GEO-13	8.41E-02
Carbazole	86-74-8	23	6	26.09	3.30E-02	3.90E-02	4.30E-02	J	3.39E+00	4.75E-02	5.00E+01		SB-05	1.16E+01
Chrysene	218-01-9	26	15	57.69	2.50E-03	7.40E-02	5.10E-02	J	4.36E+00	1.44E-01	5.20E+01		SB-07	1.31E+01
Dibenz(a,h)anthracene	53-70-3	26	10	38.46	5.30E-04	6.70E-02	1.88E-02	J	3.23E-01	5.14E-02	3.40E+00		SB-07	7.82E-01
Dibenzofuran	132-64-9	23	4	17.39	3.30E-02	3.90E-02	7.20E-02	J	1.33E+01	4.35E-02	1.80E+02		SB-07	4.47E+01
Di-n-butylphthalate	84-74-2	23	9	39.13	3.30E-02	2.50E-01	3.60E-02	J	4.59E-02	3.91E-02	1.10E-01	J	SS-10	2.80E-02
Fluoranthene	206-44-0	26	16	61.54	2.00E-03	3.80E-02	5.00E-02	J	1.73E+01	1.63E-01	2.50E+02		SB-07	5.91E+01
Fluorene	86-73-7	26	6	23.08	2.60E-03	3.80E-02	2.90E-02	J	1.48E+01	4.19E-02	2.50E+02		SB-07	5.48E+01
Indeno(1,2,3-cd)pyrene	193-39-5	26	14	53.85	1.10E-02	6.70E-02	1.40E-03	J	1.01E+00	1.11E-01	8.70E+00		SB-07	2.30E+00
Naphthalene	91-20-3	26	5	19.23	2.80E-02	3.10E-01	8.80E-02	J	2.31E+01	5.46E-02	3.90E+02		SB-05	8.54E+01
Phenanthrene	85-01-8	26	11	42.31	2.10E-03	3.90E-02	3.70E-02	J	3.34E+01	6.64E-02	5.10E+02		SB-07	1.20E+02
Phenol	108-95-2	23	2	8.7	3.30E-02	2.50E-01	1.10E-01	J	4.04E-02	2.79E-02	1.90E-01	J	GEO-03	4.49E-02
Pyrene	129-00-0	26	16	61.54	4.50E-03	6.70E-02	6.80E-02	J	1.59E+01	2.33E-01	2.30E+02		SB-07	5.37E+01
Volatiles														
Acetone	67-64-1	3	1	33.33	7.00E-03	3.50E-02	6.30E-02	J	2.80E-02	1.57E-02	6.30E-02	J	SB-05	3.11E-02
Ethylbenzene	100-41-4	3	2	66.67	1.00E-03	1.00E-03	6.80E-02		9.62E-02	1.96E-02	2.20E-01		SB-05	1.12E-01
Toluene	108-88-3	3	2	66.67	1.00E-03	1.00E-03	1.40E-02	J	2.07E-02	6.93E-03	4.75E-02		SB-05	2.42E-02
Xylene (total)	1330-20-7	3	2	66.67	1.00E-03	1.00E-03	4.90E-01		5.64E-01	6.65E-02	1.20E+00		SB-05	6.03E-01

Table 5
Statistical Summary and Selection of COPCs in EU2 Soil (0-10' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier I Restricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
Pesticides							
Endosulfan I	--	--	Unknown	4.00E-03	1.23E+03	no	
Heptachlor	--	--	Unknown	1.00E-02	1.95E-01	no	
Semivolatiles							
2,4-dimethylphenol	1.66E-01	8.51E-02	Unknown	8.51E-02	4.08E+04	no	
2-methylnaphthalene	4.10E+01	3.97E+01	Unknown	3.97E+01	8.18E+04	no	
Acenaphthene	2.58E+01	8.98E+00	Unknown	8.98E+00	1.23E+05	no	
Acenaphthylene	1.33E+00	1.26E+00	Unknown	1.26E+00	1.23E+05	no	
Anthracene	1.77E+01	3.27E+01	Unknown	3.27E+01	6.13E+05	no	
Benzo(a)anthracene	9.66E+00	9.96E+01	Lognormal	6.10E+01	7.84E+00	YES	YES-COPC
Benzo(a)pyrene	4.02E+00	2.17E+01	Lognormal	2.17E+01	7.84E-01	YES	YES-COPC
Benzo(b)fluoranthene	6.36E+00	1.42E+02	Lognormal	3.30E+01	7.84E+00	YES	YES-COPC
Benzo(ghi)perylene	1.30E+00	5.31E+00	Lognormal	5.31E+00	6.13E+04	no	
Benzo(k)fluoranthene	2.08E+00	1.71E+01	Lognormal	1.10E+01	7.84E+01	no	COPC*
Bis(2-ethylhexyl)phthalate	9.44E-02	7.81E-02	Unknown	7.81E-02	4.09E+02	no	
Carbazole	7.55E+00	5.44E+00	Unknown	5.44E+00	2.86E+02	no	
Chrysene	8.74E+00	7.90E+01	Lognormal	5.20E+01	7.84E+02	no	COPC*
Dibenz(a,h)anthracene	5.85E-01	1.69E+00	Lognormal	1.69E+00	7.84E-01	YES	YES-COPC
Dibenzofuran	2.93E+01	2.24E+01	Unknown	2.24E+01	8.18E+03	no	
Di-n-butylphthalate	5.59E-02	5.95E-02	Lognormal	5.95E-02	2.28E+03	no	
Fluoranthene	3.71E+01	4.36E+02	Lognormal	2.50E+02	8.17E+04	no	
Fluorene	3.32E+01	2.15E+01	Unknown	2.15E+01	8.17E+04	no	
Indeno(1,2,3-cd)pyrene	1.78E+00	9.60E+00	Lognormal	8.70E+00	7.84E+00	YES	YES-COPC
Naphthalene	5.17E+01	2.83E+01	Unknown	2.83E+01	8.24E+02	no	
Phenanthrene	7.34E+01	1.11E+02	Unknown	1.11E+02	6.13E+04	no	
Phenol	5.65E-02	5.50E-02	Unknown	5.50E-02	1.23E+05	no	
Pyrene	3.39E+01	2.55E+02	Lognormal	2.30E+02	6.13E+04	no	
Volatiles							
Acetone	8.04E-02	1.17E+07	Normal/Lognormal	6.30E-02	1.04E+05	no	
Ethylbenzene	2.86E-01	2.68E+42	Normal/Lognormal	2.20E-01	3.95E+02	no	
Toluene	6.15E-02	2.26E+21	Normal/Lognormal	4.75E-02	3.80E+01	no	
Xylene (total)	1.58E+00	3.97E+75	Normal/Lognormal	1.20E+00	3.18E+02	no	

*Retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of a carcinogenic PAH family one of which has been retained as a COPC.

RECEIVED APR - 4 DEQ-OPC

Table 16
Statistical Summary and Selection of COPCs in EU5 Soil (0-20' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	CAS Number	Total Number of Samples	Hits	Hit Frequency %	Minimum Detection Limit mg/kg	Maximum Detection Limit mg/kg	Minimum Detected mg/kg	Minimum Detected Qualifier	Mean mg/kg	Logarithmic Mean mg/kg	Maximum Detected mg/kg	Maximum Detected Qualifier	Location of Maximum Concentration	Standard Deviation mg/kg
Semivolatiles														
2,4-dimethylphenol	105-67-9	23	1	4.35	6.70E-02	1.30E+00	1.10E-01	J	8.81E-02	5.57E-02	1.10E-01	J	GEO-30	1.34E-01
2-methylnaphthalene	91-57-6	23	8	34.78	3.30E-02	4.10E-02	5.10E-02	J	2.37E+01	1.19E-01	4.40E+02		SB-05	9.23E+01
2-methylphenol	95-48-7	23	1	4.35	3.80E-02	1.30E+00	4.20E-02	J	6.29E-02	3.18E-02	4.20E-02	J	GEO-30	1.33E-01
3- and 4-methylphenol	106-44-5	23	1	4.35	7.50E-02	2.00E+00	1.40E-01	J	1.10E-01	6.12E-02	1.40E-01	J	GEO-30	2.04E-01
Acenaphthene	83-32-9	30	7	23.33	2.90E-02	2.40E+00	1.10E-01	J	1.29E+01	1.15E-01	2.90E+02		SB-05	5.34E+01
Acenaphthylene	208-96-8	30	9	30	3.30E-02	2.40E+00	4.80E-02	J	1.15E+00	9.90E-02	1.60E+01		GEO-33	3.36E+00
Anthracene	120-12-7	30	9	30	5.40E-04	6.00E-02	1.30E-01	J	7.18E+00	6.99E-02	9.80E+01		SB-05	2.26E+01
Benzo(a)anthracene	56-55-3	30	17	56.67	3.30E-02	4.10E-02	6.80E-03	Z	6.52E+00	1.56E-01	8.35E+01		GEO-33	1.93E+01
Benzo(a)pyrene	50-32-8	30	17	56.67	3.80E-02	6.70E-02	8.30E-03	Z	3.56E+00	1.55E-01	5.25E+01	J	GEO-33	1.05E+01
Benzo(b)fluoranthene	205-99-2	30	18	60	3.80E-02	6.70E-02	9.00E-03	Z	5.47E+00	2.09E-01	7.95E+01		GEO-33	1.59E+01
Benzo(ghi)perylene	191-24-2	30	16	53.33	3.80E-02	6.70E-02	6.70E-03	J	1.51E+00	9.66E-02	2.55E+01		GEO-33	4.77E+00
Benzo(k)fluoranthene	207-08-9	30	18	60	3.80E-02	1.30E-01	4.70E-03	Z	1.99E+00	1.32E-01	2.85E+01		GEO-33	5.64E+00
Bis(2-ethylhexyl)phthalate	117-81-7	23	2	8.7	6.70E-02	1.30E+00	1.40E-01	J	9.40E-02	6.04E-02	1.50E-01	J	GEO-32	1.34E-01
Carbazole	86-74-8	23	7	30.43	3.30E-02	4.10E-02	5.30E-01	J	4.29E+00	9.66E-02	6.90E+01		SB-05	1.45E+01
Chrysene	218-01-9	30	18	60	3.30E-02	4.10E-02	2.40E-03	J	6.33E+00	1.59E-01	8.25E+01		GEO-33	1.85E+01
Dibenz(a,h)anthracene	53-70-3	30	15	50	3.80E-02	3.30E-01	1.70E-03	J	4.87E-01	5.48E-02	7.45E+00		GEO-33	1.42E+00
Dibenzofuran	132-64-9	23	9	39.13	3.30E-02	4.10E-02	3.90E-02	J	1.47E+01	1.23E-01	2.70E+02		SB-05	5.62E+01
Fluoranthene	206-44-0	30	18	60	3.30E-02	4.10E-02	1.30E-02	Z	3.13E+01	2.82E-01	4.30E+02		SB-05	9.95E+01
Fluorene	86-73-7	30	11	36.67	2.90E-03	5.20E-02	3.60E-03	J	1.52E+01	8.67E-02	3.30E+02		SB-05	6.11E+01
Indeno(1,2,3-cd)pyrene	193-39-5	30	17	56.67	3.80E-02	6.70E-02	7.80E-03	J	1.92E+00	1.22E-01	3.10E+01		GEO-33	5.84E+00
Naphthalene	91-20-3	30	9	30	2.90E-02	5.60E-01	7.50E-02	J	3.80E+01	1.33E-01	9.10E+02		SB-05	1.68E+02
Phenanthrene	85-01-8	30	17	56.67	3.30E-02	4.10E-02	6.80E-03	J	3.77E+01	2.06E-01	7.10E+02		SB-05	1.36E+02
Phenol	108-95-2	23	13	56.52	3.30E-02	6.70E-01	1.00E-01	J	1.36E-01	9.66E-02	3.80E-01		GEO-29	9.90E-02
Pyrene	129-00-0	30	18	60	3.80E-02	6.70E-02	1.60E-02	J	2.04E+01	2.85E-01	2.60E+02		GEO-33	6.43E+01
Volatiles														
Acetone	67-64-1	5	5	100	0.00E+00	0.00E+00	9.00E-03	J	4.40E-02	2.95E-02	1.00E-01	J	SB-05	3.79E-02
Benzene	71-43-2	5	2	40	1.00E-03	1.00E-03	5.00E-03	J	2.70E-03	1.34E-03	7.00E-03	J	SB-05	3.09E-03
Ethylbenzene	100-41-4	5	3	60	1.00E-03	1.00E-03	2.40E-02		3.82E-02	8.02E-03	1.20E-01		SB-05	4.95E-02
Styrene	100-42-5	5	1	20	1.00E-03	1.00E-03	1.00E-01		2.04E-02	1.44E-03	1.00E-01		SB-05	4.45E-02
Toluene	108-88-3	5	3	60	1.00E-03	1.00E-03	1.30E-02		3.38E-02	5.85E-03	1.40E-01		SB-05	5.98E-02
Xylene (total)	1330-20-7	5	3	60	1.00E-03	1.00E-03	7.50E-02		2.27E-01	2.10E-02	7.80E-01		SB-05	3.30E-01

Table 16
Statistical Summary and Selection of COPCs in EU5 Soil (0-20' bgs)
Kerr McGee, Hattiesburg, MS

Constituent	95% UCL mg/kg	Logarithmic 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Tier I Restricted Soil TRG mg/kg	Is the Maximum Detected > TRG?	Is the 95% UCL > TRG?
Semivolatiles							
2,4-dimethylphenol	1.36E-01	1.12E-01	Unknown	1.10E-01	4.08E+04	no	
2-methylnaphthalene	5.67E+01	6.89E+02	Unknown	4.40E+02	8.18E+04	no	
2-methylphenol	1.11E-01	7.64E-02	Unknown	4.20E-02	1.02E+05	no	
3- and 4-methylphenol	1.83E-01	1.37E-01	Unknown	1.37E-01	1.02E+04	no	
Acenaphthene	2.95E+01	8.04E+01	Unknown	8.04E+01	1.23E+05	no	
Acenaphthylene	2.19E+00	3.82E+00	Unknown	3.82E+00	1.23E+05	no	
Anthracene	1.42E+01	4.31E+02	Unknown	9.80E+01	6.13E+05	no	
Benzo(a)anthracene	1.25E+01	1.52E+02	Unknown	8.35E+01	7.84E+00	Yes	YES-COPC
Benzo(a)pyrene	6.82E+00	4.42E+01	Unknown	4.42E+01	7.84E-01	Yes	YES-COPC
Benzo(b)fluoranthene	1.04E+01	1.19E+02	Unknown	7.95E+01	7.84E+00	Yes	YES-COPC
Benzo(ghi)perylene	2.99E+00	7.40E+00	Unknown	7.40E+00	6.13E+04	no	
Benzo(k)fluoranthene	3.74E+00	1.68E+01	Unknown	1.68E+01	7.84E+01	no	COPC*
Bis(2-ethylhexyl)phthalate	1.42E-01	1.24E-01	Unknown	1.24E-01	4.09E+02	no	
Carbazole	9.49E+00	6.44E+01	Unknown	6.44E+01	2.86E+02	no	
Chrysene	1.21E+01	2.00E+02	Unknown	8.25E+01	7.84E+02	Yes	YES-COPC
Dibenz(a,h)anthracene	9.29E-01	1.53E+00	Unknown	1.53E+00	7.84E-01	no	COPC*
Dibenzofuran	3.48E+01	4.46E+02	Unknown	2.70E+02	8.18E+03	no	
Fluoranthene	6.22E+01	3.34E+03	Unknown	4.30E+02	8.17E+04	no	
Fluorene	3.42E+01	2.24E+02	Unknown	2.24E+02	8.17E+04	no	
Indeno(1,2,3-cd)pyrene	3.73E+00	1.32E+01	Unknown	1.32E+01	7.84E+00	no	COPC*
Naphthalene	9.01E+01	2.69E+02	Unknown	2.69E+02	8.24E+02	no	
Phenanthrene	7.98E+01	2.37E+03	Unknown	7.10E+02	6.13E+04	no	
Phenol	1.72E-01	2.53E-01	Normal/Lognormal	2.53E-01	1.23E+05	no	
Pyrene	4.03E+01	1.08E+03	Unknown	2.60E+02	6.13E+04	no	
Volatiles							
Acetone	8.01E-02	9.07E-01	Normal/Lognormal	1.00E-01	1.04E+05	no	
Benzene	5.65E-03	2.77E-01	Normal/Lognormal	7.00E-03	1.36E+00	no	
Ethylbenzene	8.54E-02	1.58E+06	Normal/Lognormal	1.20E-01	3.95E+02	no	
Styrene	6.28E-02	1.19E+04	Unknown	1.00E-01	3.84E+02	no	
Toluene	9.08E-02	1.16E+05	Lognormal	1.40E-01	3.80E+01	no	
Xylene (total)	5.41E-01	2.82E+13	Normal/Lognormal	7.80E-01	3.18E+02	no	

*Logarithmic 95% UCL is less than benchmark but retained as a COPC, as per MDEQ Comments (8/2/2000): constituent is a member of carcinogenic PAH family, one of which has been retained as a COPC.

RECEIVED
APR - 4 2001
DEQ-OPC

Table 19
Summary of Human Health Exposure Parameters
Kerr McGee, Hattiesburg, MS

Receptors:		Adolescent Visitor		Maintenance Worker		Construction Worker		Off-Site Resident Child		Off-Site Resident Adult	
Parameter	**Units**										
Surface area available for exposure - soil	cm^2/day	3052	1	3000	1	5560	1	1724	1	4780	1
Surface area available for exposure - sed. & sw	cm^2/day	3945	1	3000	1	3000	1	2229	1	6180	1
Total skin surface area	cm^2	12768.3	2	20000	2	20000	2	7213	2	20000	2
Skin surface area available for exposure - soil	%	23.9%	2	15%	2	27.8%	2	23.9%	2	23.9%	2
Skin surface area available for exposure - sed. & sw	%	30.9%	2	15.0%	2	15.0%	2	30.9%	2	30.9%	2
Adherence factor - soil	mg/cm^2	0.026	2	0.038	2	0.1	2	0.026	2	0.026	2
Adherence factor - sed.	mg/cm^3	0.33	2	0.038	2	0.13	2	0.33	2	0.33	2
Dermal absorption factor - cPAHs		0.03	3	0.03	3	0.03	3	0.03	3	0.03	3
Dermal absorption factor - other SVOCs		0.1	3	0.1	3	0.1	3	0.1	3	0.1	3
Exposure time	hours/day	1	5	1	5	1	5	1	5	1	5
Exposure frequency - soils	days/year	12	5	150	5	10/70*	5	NA		NA	
Exposure frequency - soils (EU4)	days/year	12	5	30	5	10/70*	5	NA		NA	
Exposure frequency - sed. & sw	days/year	12	5	30	5	8	5	40	5	40	5
Exposure duration	years	10	6	25	6	1	5	6	6	24	6
Body weight	kg	45	6	70	6	70	6	15	7	70	6
Averaging time - noncarcinogenic	days	3650	7	9125	7	365	7	2190	7	8760	7
Averaging time - carcinogenic	days	25550	7	25550	7	25550	7	25550	7	25550	7
Ingestion rate - soil	mg/day	100	2	100	2	480/100*	2	200	2	100	2
Ingestion rate - surface water	L/hour	0.01	6	0.01	6	0.01	5	0.05	6	0.01	6
Matrix effect - PAHs		1	5	1	5	1	5	1	5	1	5
Inhalation rate	m^3/day	NA		NA		20	6	NA		NA	
Retention factor - semivolatiles		NA		NA		0.75	8	NA		NA	

NA - Not Applicable
1 Calculated
2 USEPA 1997, Exposure Factors Handbook
3 USEPA 1995, Region III Technical Guidance Manual: Assessing Dermal Exposure to Soil
4 USEPA 1992, Dermal Exposure Assessment
5 *Reasonable Maximum*
6 USEPA 1995, Region IV
7 USEPA 1991, HHEM Supplemental Guidances
8 International Commission on Radiological Protection, 1968
*Exposure Scenario A/Exposure Scenario B

Table 22
Summary of Toxicity Values
Kerr McGee, Hattiesburg, MS

RECEIVED
APR - 4 2001
DEQ-OPC

Chemical	Oral Chronic RfD mg/kg-day	Source	Inhalation Chronic RfD mg/kg-day	Source	Range of Absorption by G.I. Tract	Source	Dermal Chronic RfD mg/kg-day	Oral Subchronic RfD mg/kg-day	Source	Inhalation Subchronic RfD mg/kg-day	Source	Dermal Subchronic RfD mg/kg-day	Oral CSF 1/(mg/kg-day)	Source	Dermal CSF 1/(mg/kg-day)	Source	Inhalation CSF 1/(mg/kg-day)	Source
Semivolatiles																		
2-Methylnaphthalene	2.00E-02	E			0.5	Region IV	1.00E-02											
2-Nitroaniline			5.70E-05	H	0.5	Region IV				5.70E-04	HE							
2-Nitrophenol					0.5	Region IV												
3-Nitroaniline					0.5	Region IV												
4-Bromophenylphenylether	5.80E-02	O			0.5	Region IV	2.90E-02											
4-Chloro-3-methylphenol					0.5	Region IV												
4-Chlorophenylphenylether					0.5	Region IV												
4-Nitroaniline					0.5	Region IV												
Acenaphthylene					0.5	Region IV												
Benzo(a)anthracene					0.5	Region IV							7.30E-01	E	1.46E+00	MDEQ	3.10E-01	E
Benzo(a)pyrene					0.5	Region IV							7.30E+00	IRIS	1.46E+01	MDEQ	3.10E+00	E
Benzo(b)fluoranthene					0.5	Region IV							7.30E-01	E	1.46E+00	MDEQ	3.10E-01	E
Benzo(g,h,i)perylene					0.5	Region IV												
Benzo(k)fluoranthene					0.5	Region IV							7.30E-02	E	1.46E-01	MDEQ	3.10E-02	E
Bis(2-chloroethoxy)methane					0.5	Region IV												
Bis(2-chloroethyl)ether					0.5	Region IV							1.10E+00	IRIS			1.10E+00	IRIS
Bis(2-ethylhexyl) phthalate	2.00E-02	IRIS			0.5	Region IV	1.00E-02	2.00E-02	W			1.00E-02	1.40E-02	IRIS			1.40E-02	E
Carbazole					0.5	Region IV							2.00E-02	H				
Chrysene					0.5	Region IV							7.30E-03	E	1.46E-02	MDEQ	3.10E-03	E
Dibenz(a,h)anthracene					0.5	Region IV							7.30E+00	E	1.46E+01	MDEQ	3.10E+00	E
Dibenzofuran	4.00E-03	E			0.5	Region IV	2.00E-03											
Fluoranthene	4.00E-02	IRIS			0.5	Region IV	2.00E-02	4.00E-01	H			2.00E-01						
Fluorene	4.00E-02	IRIS			0.5	Region IV	2.00E-02	4.00E-01	H			2.00E-01						
Hexachlorobenzene	8.00E-04	IRIS			0.5	Region IV	4.00E-04						1.60E+00	IRIS			1.60E+00	IRIS
Hexachlorocyclopentadiene	7.00E-03	IRIS	2.00E-05	H	0.5	Region IV	3.50E-03											
Indeno(1,2,3-cd)pyrene					0.5	Region IV							7.30E-01	E	1.46E+00	MDEQ	3.10E-01	E
N-nitrosodi-n-propylamine					0.5	Region IV							7.00E+00	IRIS				
Naphthalene	2.00E-02	IRIS	9.00E-04	IRIS	0.5	Region IV	1.00E-02											
Phenanthrene					0.5	Region IV												
Pyrene	3.00E-02	IRIS			0.5	Region IV	1.50E-02	3.00E-01	H			1.50E-01						

E - EPA-NCEA Regional Support provisional value from Region III RBC Tables, April 2000
H - Values are published in HEAST, 1997
IRIS - Values are available in IRIS, 2000
MDEQ - Based on MDEQ's recommendation of using the Oral CSF with an absorption efficiency of 50%.
O - Values are withdrawn from other EPA documents as presented in the Region III RBC Tables, April 1999
Region IV - Region IV default value, 1995
W - Withdrawn from IRIS or HEAST

Table 23
Summary of Hazard and Risk Calculations
Kerr McGee, Hattiesburg, MS

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Cancer Risk	Driving Constituent	Table Referenced
Dermal Exposure to Sediment in EU1	Visitor	NA	4E-08		24
Oral Exposure to Sediment in EU1	Visitor	NA	5E-08		25
	Sub-Total	NA	8E-08		
Dermal Exposure to Surface Water in EU1	Visitor	NA	4E-07		26
Oral Exposure to Surface Water in EU1	Visitor	NA	9E-09		27
	Sub-Total	NA	4E-07		
Dermal Exposure to Surface Soil in EU2	Visitor	NA	3E-08		28
Oral Exposure to Surface Soil in EU2	Visitor	NA	6E-07		29
	Sub-Total	NA	6E-07		
Dermal Exposure to Surface Soil in EU3	Visitor	NA	4E-09		30
Oral Exposure to Surface Soil in EU3	Visitor	NA	9E-08		31
	Sub-Total	NA	4E-09		
Dermal Exposure to Sediment in EU4	Visitor	7E-02	1E-05	cPAHs	32
Oral Exposure to Sediment in EU4	Visitor	3E-02	2E-05	cPAHs	33
	Sub-Total	1E-01	1E-05		
Dermal Exposure to Surface Water in EU4	Visitor	2E-04	9E-07		34
Oral Exposure to Surface Water in EU4	Visitor	2E-05	2E-08		35
	Sub-Total	3E-04	9E-07		
Dermal Exposure to Surface Soil in EU4	Visitor	4E-03	3E-06	*	36
Oral Exposure to Surface Soil in EU4	Visitor	3E-02	6E-05	cPAHs	37
	Sub-Total	3E-02	6E-05		
Dermal Exposure to Surface Soil in EU5	Visitor	NA	3E-07		38
Oral Exposure to Surface Soil in EU5	Visitor	NA	6E-06	Benzo(a)pyrene	39
	Sub-Total	NA	3E-07		
	Visitor Total:	**1E-01**	**7E-05**		

Table 23
Summary of Hazard and Risk Calculations
Kerr McGee, Hattiesburg, MS

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Cancer Risk	Driving Constituent	Table Referenced
Dermal Exposure to Sediment in EU1	Maintenance Worker	NA	1E-08		40
Oral Exposure to Sediment in EU1	Maintenance Worker	NA	2E-07		41
	Sub-Total	NA	2E-07		
Dermal Exposure to Surface Water in EU1	Maintenance Worker	NA	1E-06	*	42
Oral Expposure to Surface Water in EU1	Maintenance Worker	NA	4E-08		43
	Sub-Total	NA	1E-06		
Dermal Exposure to Surface Soil in EU2	Maintenance Worker	NA	5E-07		44
Oral Exposure to Surface Soil in EU2	Maintenance Worker	NA	7E-06	cPAHs	45
	Sub-Total	NA	7E-06		
Dermal Exposure to Sediment in EU4	Maintenance Worker	1E-02	4E-06	Benzo(a)pyrene	46
Oral Exposure to Sediment in EU4	Maintenance Worker	5E-02	6E-05	cPAHs	47
	Sub-Total	6E-02	7E-05		
Dermal Exposure to Surface Water in EU4	Maintenance Worker	3E-04	3E-06	*	48
Oral Exposure to Surface Water in EU4	Maintenance Worker	3E-05	9E-08		49
	Sub-Total	3E-04	3E-06		
Dermal Exposure to Surface Soil in EU4	Maintenance Worker	5E-03	2E-05	cPAHs	50
Oral Exposure to Surface Soil in EU4	Maintenance Worker	2E-02	2E-04	cPAHs	51
	Sub-Total	3E-02	2E-04		
Dermal Exposure to Surface Soil in EU5	Maintenance Worker	NA	6E-06	Benzo(a)pyrene	52
Oral Exposure to Surface Soil in EU5	Maintenance Worker	NA	9E-05	cPAHs	53
	Sub-Total	NA	1E-04		
	Maintenance Worker Total:	**8E-02**	**4E-04**		

Table 23
Summary of Hazard and Risk Calculations
Kerr McGee, Hattiesburg, MS

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Cancer Risk	Driving Constituent	Table Referenced
Dermal Exposure to Sediment in EU1	Construction Worker	NA	5E-10		54
Oral Exposure to Sediment in EU1	Construction Worker	NA	9E-09		55
	Sub-Total	NA	1E-08		
Dermal Exposure to Surface Water in EU1	Construction Worker	NA	1E-08		56
Oral Exposure to Surface Water in EU1	Construction Worker	NA	4E-10		57
	Sub-Total	NA	1E-08		
Dermal Exposure to Soil in EU2	Construction Worker	NA	4E-07		58
Oral Exposure to Soil in EU2	Construction Worker	NA	2E-06	*	59
Inhalation of Fugitive Dust in EU2	Construction Worker	NA	6E-08		60
	Sub-Total	NA	2E-06		
Dermal Exposure to Sediment in EU4	Construction Worker	NA	2E-07		61
Oral Exposure to Sediment in EU4	Construction Worker	NA	3E-06	Benzo(a)pyrene	62
	Sub-Total	NA	3E-06		
Dermal Exposure to Surface Water in EU4	Construction Worker	9E-07	3E-08		63
Oral Exposure to Surface Water in EU4	Construction Worker	5E-07	9E-10		64
	Sub-Total	1E-06	9E-10		
Dermal Exposure to Soil in EU4	Construction Worker	NA	8E-06	Benzo(a)pyrene	65
Oral Exposure to Soil in EU4	Construction Worker	NA	4E-05	cPAHs	66
Inhalation of Fugitive Dust in EU4	Construction Worker	NA	1E-06	Benzo(a)pyrene	67
	Sub-Total	NA	5E-05		
Dermal Exposure to Soil in EU5	Construction Worker	NA	7E-07		68
Oral Exposure to Soil in EU5	Construction Worker	NA	3E-06	Benzo(a)pyrene	69
Inhalation of Fugitive Dust in EU5	Construction Worker	NA	1E-07		70
	Sub-Total	NA	4E-06		
	Construction Worker Total:	**1E-06**	**5E-05**		

Dermal Exposure to Sediment in EU6	Child Off-Site Resident	NA	2E-05	cPAHs	71
Oral Exposure to Sediment in EU6	Child Off-Site Resident	NA	7E-05	cPAHs	72
	Sub-Total	NA	9E-05		
Dermal Exposure to Sediment in EU6	Adult Off-Site Resident	5E-04	4E-05	cPAHs	73
Oral Exposure to Sediment in EU6	Adult Off-Site Resident	1E-04	3E-05	cPAHs	74
	Sub-Total	6E-04	7E-05		
Dermal Exposure to Surface Water in EU6	Child Off-Site Resident	NA	2E-06	*	75
Oral Exposure to Surface Water in EU6	Child Off-Site Resident	NA	5E-07		76
	Sub-Total	NA	2E-06		
Dermal Exposure to Surface Water in EU6	Adult Off-Site Resident	NA	5E-06	*	77
Oral Exposure to Surface Water in EU6	Adult Off-Site Resident	NA	8E-08		78
	Sub-Total	NA	5E-06		
	Off-Site Resident Total:	**6E-04**	**2E-04**		

*Estimated carcinogenic risk level is below *de minimis* level as no single constituent exceeded $1x10^{-6}$ and the cumulative site carcinogenic risk is below $1x10^{-4}$ (Section 501, MCEQ, 1999).

Table 27
Oral Exposure to EU1 Surface Water by an Adolescent Visitor (aged 7-16 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Csw*IngR*EF*ED*ET}{BW*AT}$$

Csw - Concentration in surface water =	mg/L	see below	
IngR - Ingestion rate for surface water =	L/hour	0.01	USEPA 1995, Region IV
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.00E-03	7.31E-09	NA	NA	1.04E-09	7.30E-01	7.62E-10
Benzo(a)pyrene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E+00	3.81E-09
Benzo(b)fluoranthene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E-01	3.81E-10
Benzo(k)fluoranthene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E-02	3.81E-11
Chrysene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E-03	3.81E-12
Dibenz(a,h)anthracene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E+00	3.81E-09
Indeno(1,2,3-cd)pyrene	5.00E-04	3.65E-09	NA	NA	5.22E-10	7.30E-01	3.81E-10

NA - Not Available

Total Cancer Risk = 9.18E-09

Table 32
Dermal Exposure to EU4 Sediment by an Adolescent Visitor (Aged 7-16 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3945	calculated
SA_t - Total skin surface area =	cm^2	12768.3	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.33	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	3.30E+02	9.42E-06	NA	NA	1.35E-06	1.46E+00	1.96E-06
Benzo(a)pyrene	1.30E+02	3.71E-06	NA	NA	5.30E-07	1.46E+01	7.74E-06
Benzo(b)fluoranthene	1.80E+02	5.14E-06	NA	NA	7.34E-07	1.46E+00	1.07E-06
Benzo(k)fluoranthene	6.40E+01	1.83E-06	NA	NA	2.61E-07	1.46E-01	3.81E-08
Carbazole	5.90E+02	5.61E-05	NA	NA	8.02E-06	NA	NA
Chrysene	2.90E+02	8.28E-06	NA	NA	1.18E-06	1.46E-02	1.73E-08
Dibenz(a,h)anthracene	1.20E+01	3.42E-07	NA	NA	4.89E-08	1.46E+01	7.14E-07
Dibenzofuran	9.40E+02	8.94E-05	2.00E-03	4.47E-02	1.28E-05	NA	NA
Indeno(1,2,3-cd)pyrene	4.70E+01	1.34E-06	NA	NA	1.92E-07	1.46E+00	2.80E-07
Naphthalene	3.00E+03	2.85E-04	1.00E-02	2.85E-02	4.08E-05	NA	NA
Phenanthrene	3.20E+03	3.04E-04	NA	NA	4.35E-05	NA	NA

NA - Not Available

Total Hazard Index = 7.32E-02

Total Cancer Risk = 1.18E-05

ENVIRONMENTAL STANDARDS

Table 34
Dermal Exposure to EU4 Surface Water by an Adolescent Visitor (aged 7-16 years)
Kerr McGee, Hattiesburg, MS

RECEIVED
APR - 4 2001
DEQ-OPC

$$\text{Intake (mg/kg-day)} = \frac{Cw*SA*Kp*ABS*ET*EF*ED*CF}{BW*AT}$$

Cw - Concentration in surface water =	mg/L	see below	
SA - Surface area available for exposure =	cm^2	3945	calculated
SA_t - Total skin surface area =	cm^2	12768.3	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
Kp - Dermal permeability constant =	cm/hr	see below	
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPS 1995, Region IV
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Kp cm/hr	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles								
Benzo(a)anthracene	5.00E-03	8.10E-01	3.50E-07	NA	NA	5.00E-08	1.46E+00	7.30E-08
Benzo(a)pyrene	5.00E-04	1.20E+00	5.19E-08	NA	NA	7.41E-09	1.46E+01	1.08E-07
Benzo(b)fluoranthene	1.20E-02	1.20E+00	1.25E-06	NA	NA	1.78E-07	1.46E+00	2.60E-07
Benzo(k)fluoranthene	2.00E-03	4.48E+01	7.74E-06	NA	NA	1.11E-06	1.46E-01	1.62E-07
Bis(2-ethylhexyl)phthalate	3.00E-03	3.30E-02	2.85E-08	1.00E-02	2.85E-06	4.08E-09	NA	NA
Carbazole	1.00E-02	3.57E-02	1.03E-07	NA	NA	1.47E-08	NA	NA
Chrysene	6.00E-03	8.10E-01	4.20E-07	NA	NA	6.00E-08	1.46E-02	8.77E-10
Dibenz(a,h)anthracene	5.00E-04	2.70E+00	1.17E-07	NA	NA	1.67E-08	1.46E+01	2.43E-07
Dibenzofuran	1.10E-02	1.51E-01	4.79E-07	2.00E-03	2.40E-04	6.84E-08	NA	NA
Indeno(1,2,3-cd)pyrene	5.00E-04	1.90E+00	8.22E-08	NA	NA	1.17E-08	1.46E+00	1.71E-08
Phenanthrene	1.70E-02	2.30E-01	1.13E-06	NA	NA	1.61E-07	NA	NA

NA - Not Available

Total Hazard Index = 2.42E-04

Total Cancer Risk = 8.64E-07

Table 36
Dermal Exposure to EU4 Surface Soil (0-1') by an Adolescent Visitor (Aged 7-16 years)
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3052	calculated
SA_t - Total skin surface area =	cm^2	12768.3	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		23.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.026	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
ATc - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	**Concentration in Soil mg/kg**	**Average Daily Intake mg/kg-day**	**Dermal Chronic RfD mg/kg-day**	**Hazard Index**	**Average Lifetime Daily Intake mg/kg-day**	**Cancer Slope Factor 1/(mg/kg-day)**	**Cancer Risk**
Semivolatiles							
Benzo(a)anthracene	9.30E+02	1.62E-06	NA	NA	2.31E-07	1.46E+00	3.37E-07
Benzo(a)pyrene	5.00E+02	8.70E-07	NA	NA	1.24E-07	1.46E+01	1.81E-06
Benzo(b)fluoranthene	5.30E+02	9.22E-07	NA	NA	1.32E-07	1.46E+00	1.92E-07
Benzo(k)fluoranthene	2.90E+02	5.04E-07	NA	NA	7.20E-08	1.46E-01	1.05E-08
Carbazole	2.30E+02	1.33E-06	NA	NA	1.90E-07	NA	NA
Chrysene	6.90E+02	1.20E-06	NA	NA	1.71E-07	1.46E-02	2.50E-09
Dibenz(a,h)anthracene	6.40E+01	1.11E-07	NA	NA	1.59E-08	1.46E+01	2.32E-07
Fluoranthene	4.60E+03	2.67E-05	2.00E-02	1.33E-03	3.81E-06	NA	NA
Indeno(1,2,3-cd)pyrene	2.50E+02	4.35E-07	NA	NA	6.21E-08	1.46E+00	9.07E-08
Naphthalene	2.20E+03	1.28E-05	1.00E-02	1.28E-03	1.82E-06	NA	NA
Phenanthrene	6.40E+03	3.71E-05	NA	NA	5.30E-06	NA	NA
Pyrene	4.40E+03	2.55E-05	1.50E-02	1.70E-03	3.64E-06	NA	NA

NA - Not Available

Total Hazard Index = 4.31E-03

Total Cancer Risk = 2.68E-06

Table 40
Dermal Exposure to EU1 Sediment by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABSp - Absorption - cPAHs =		0.03	USEPA 1995, Region III
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.90E-01	2.37E-09	NA	NA	8.46E-10	1.46E+00	1.24E-09
Benzo(a)pyrene	3.90E-01	1.57E-09	NA	NA	5.59E-10	1.46E+01	8.17E-09
Benzo(b)fluoranthene	5.80E-01	2.33E-09	NA	NA	8.32E-10	1.46E+00	1.21E-09
Benzo(k)fluoranthene	1.90E-01	7.63E-10	NA	NA	2.72E-10	1.46E-01	3.98E-11
Chrysene	5.30E-01	2.13E-09	NA	NA	7.60E-10	1.46E-02	1.11E-11
Dibenz(a,h)anthracene	6.20E-02	2.49E-10	NA	NA	8.89E-11	1.46E+01	1.30E-09
Indeno(1,2,3-cd)pyrene	2.20E-01	8.83E-10	NA	NA	3.16E-10	1.46E+00	4.61E-10

NA - Not Available

Total Cancer Risk = 1.24E-08

Table 41
Oral Exposure to EU1 Sediment by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.90E-01	6.93E-08	NA	NA	2.47E-08	7.30E-01	1.81E-08
Benzo(a)pyrene	3.90E-01	4.58E-08	NA	NA	1.64E-08	7.30E+00	1.19E-07
Benzo(b)fluoranthene	5.80E-01	6.81E-08	NA	NA	2.43E-08	7.30E-01	1.78E-08
Benzo(k)fluoranthene	1.90E-01	2.23E-08	NA	NA	7.97E-09	7.30E-02	5.82E-10
Chrysene	5.30E-01	6.22E-08	NA	NA	2.22E-08	7.30E-03	1.62E-10
Dibenz(a,h)anthracene	6.20E-02	7.28E-09	NA	NA	2.60E-09	7.30E+00	1.90E-08
Indeno(1,2,3-cd)pyrene	2.20E-01	2.58E-08	NA	NA	9.23E-09	7.30E-01	6.73E-09

NA - Not Available

Total Cancer Risk = 1.82E-07

Table 42
Dermal Exposure to EU1 Surface Water by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cw*SA*Kp*ABS*ET*EF*ED*CF}{BW*AT}$$

Cw - Concentration in surface water =	mg/L	see below	
SA - Surface area available for exposure =	cm^2	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
Kp - Dermal permeability constant =	cm/hr	see below	
ABSp - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Kp cm/hr	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles								
Benzo(a)anthracene	1.00E-03	8.10E-01	8.56E-08	NA	NA	3.06E-08	1.46E+00	4.46E-08
Benzo(a)pyrene	5.00E-04	1.20E+00	6.34E-08	NA	NA	2.26E-08	1.46E+01	3.31E-07
Benzo(b)fluoranthene	5.00E-04	1.20E+00	6.34E-08	NA	NA	2.26E-08	1.46E+00	3.31E-08
Benzo(k)fluoranthene	5.00E-04	4.48E+01	2.37E-06	NA	NA	8.45E-07	1.46E-01	1.23E-07
Chrysene	5.00E-04	8.10E-01	4.28E-08	NA	NA	1.53E-08	1.46E-02	2.23E-10
Dibenz(a,h)anthracene	5.00E-04	2.70E+00	1.43E-07	NA	NA	5.10E-08	1.46E+01	7.44E-07
Indeno(1,2,3-cd)pyrene	5.00E-04	1.90E+00	1.00E-07	NA	NA	3.59E-08	1.46E+00	5.23E-08

NA - Not Available

Total Cancer Risk = 1.33E-06

Table 43
Oral Exposure to EU1 Surface Water by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Csw*IngR*EF*ED*ET}{BW*AT}$$

Csw - Concentration in surface water =	mg/L	see below	
IngR - Ingestion rate for surface water =	L/hour	0.01	USEPA 1995, Region IV
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.00E-03	1.17E-08	NA	NA	4.19E-09	7.30E-01	3.06E-09
Benzo(a)pyrene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E+00	1.53E-08
Benzo(b)fluoranthene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E-01	1.53E-09
Benzo(k)fluoranthene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E-02	1.53E-10
Chrysene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E-03	1.53E-11
Dibenz(a,h)anthracene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E+00	1.53E-08
Indeno(1,2,3-cd)pyrene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E-01	1.53E-09

NA - Not Available

Total Cancer Risk = 3.69E-08

RECEIVED APR - 4 2001 DEQ-OPC

Table 46
Dermal Exposure to EU4 Sediment by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	3.30E+02	1.33E-06	NA	NA	4.73E-07	1.46E+00	6.91E-07
Benzo(a)pyrene	1.30E+02	5.22E-07	NA	NA	1.86E-07	1.46E+01	2.72E-06
Benzo(b)fluoranthene	1.80E+02	7.23E-07	NA	NA	2.58E-07	1.46E+00	3.77E-07
Benzo(k)fluoranthene	6.40E+01	2.57E-07	NA	NA	9.18E-08	1.46E-01	1.34E-08
Carbazole	5.90E+02	7.90E-06	NA	NA	2.82E-06	NA	NA
Chrysene	2.90E+02	1.16E-06	NA	NA	4.16E-07	1.46E-02	6.07E-09
Dibenz(a,h)anthracene	1.20E+01	4.82E-08	NA	NA	1.72E-08	1.46E+01	2.51E-07
Dibenzofuran	9.40E+02	1.26E-05	2.00E-03	6.29E-03	4.49E-06	NA	NA
Indeno(1,2,3-cd)pyrene	4.70E+01	1.89E-07	NA	NA	6.74E-08	1.46E+00	9.84E-08
Naphthalene	3.00E+03	4.02E-05	1.00E-02	4.02E-03	1.43E-05	NA	NA
Phenanthrene	3.20E+03	4.28E-05	NA	NA	1.53E-05	NA	NA

NA - Not Available   Total Hazard Index = 1.03E-02   Total Cancer Risk = 4.16E-06

Table 47
Oral Exposure to EU4 Sediment by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	3.30E+02	3.87E-05	NA	NA	1.38E-05	7.30E-01	1.01E-05
Benzo(a)pyrene	1.30E+02	1.53E-05	NA	NA	5.45E-06	7.30E+00	3.98E-05
Benzo(b)fluoranthene	1.80E+02	2.11E-05	NA	NA	7.55E-06	7.30E-01	5.51E-06
Benzo(k)fluoranthene	6.40E+01	7.51E-06	NA	NA	2.68E-06	7.30E-02	1.96E-07
Carbazole	5.90E+02	6.93E-05	NA	NA	2.47E-05	2.00E-02	4.95E-07
Chrysene	2.90E+02	3.41E-05	NA	NA	1.22E-05	7.30E-03	8.88E-08
Dibenz(a,h)anthracene	1.20E+01	1.41E-06	NA	NA	5.03E-07	7.30E+00	3.67E-06
Dibenzofuran	9.40E+02	1.10E-04	4.00E-03	2.76E-02	3.94E-05	NA	NA
Indeno(1,2,3-cd)pyrene	4.70E+01	5.52E-06	NA	NA	1.97E-06	7.30E-01	1.44E-06
Naphthalene	3.00E+03	3.52E-04	2.00E-02	1.76E-02	1.26E-04	NA	NA
Phenanthrene	3.20E+03	3.76E-04	NA	NA	1.34E-04	NA	NA

NA - Not Available　　Total Hazard Index = 4.52E-02　　Total Cancer Risk = 6.13E-05

RECEIVED
APR - 4 2001
DEQ-OPC

Table 48
Dermal Exposure to EU4 Surface Water by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cw*SA*Kp*ABS*ET*EF*ED*CF}{BW*AT}$

Cw - Concentration in surface water =	mg/L	see below	
SA - Surface area available for exposure =	cm^2	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
Kp - Dermal permeability constant =	cm/hr	see below	
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Kp cm/hr	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles								
Benzo(a)anthracene	5.00E-03	8.10E-01	4.28E-07	NA	NA	1.53E-07	1.46E+00	2.23E-07
Benzo(a)pyrene	5.00E-04	1.20E+00	6.34E-08	NA	NA	2.26E-08	1.46E+01	3.31E-07
Benzo(b)fluoranthene	1.20E-02	1.20E+00	1.52E-06	NA	NA	5.43E-07	1.46E+00	7.93E-07
Benzo(k)fluoranthene	2.00E-03	4.48E+01	9.46E-06	NA	NA	3.38E-06	1.46E-01	4.93E-07
Bis(2-ethylhexyl)phthalate	3.00E-03	3.30E-02	3.49E-08	1.00E-02	3.49E-06	1.25E-08	NA	NA
Carbazole	1.00E-02	3.57E-02	1.26E-07	NA	NA	4.50E-08	NA	NA
Chrysene	6.00E-03	8.10E-01	5.14E-07	NA	NA	1.83E-07	1.46E-02	2.68E-09
Dibenz(a,h)anthracene	5.00E-04	2.70E+00	1.43E-07	NA	NA	5.10E-08	1.46E+01	7.44E-07
Dibenzofuran	1.10E-02	1.51E-01	5.85E-07	2.00E-03	2.93E-04	2.09E-07	NA	NA
Indeno(1,2,3-cd)pyrene	5.00E-04	1.90E+00	1.00E-07	NA	NA	3.59E-08	1.46E+00	5.23E-08
Phenanthrene	1.70E-02	2.30E-01	1.38E-06	NA	NA	4.92E-07	NA	NA

NA - Not Available   Total Hazard Index = 2.96E-04   Total Cancer Risk = 2.64E-06

RECEIVED
APR - 4 2001
DEQ-OPC

Table 49
Oral Exposure to EU4 Surface Water by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Csw*IngR*EF*ED*ET}{BW*AT}$

Csw - Concentration in surface water =	mg/L	see below	
IngR - Ingestion rate for surface water =	L/hour	0.01	USEPA 1995, Region IV
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	5.00E-03	5.87E-08	NA	NA	2.10E-08	7.30E-01	1.53E-08
Benzo(a)pyrene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E+00	1.53E-08
Benzo(b)fluoranthene	1.20E-02	1.41E-07	NA	NA	5.03E-08	7.30E-01	3.67E-08
Benzo(k)fluoranthene	2.00E-03	2.35E-08	NA	NA	8.39E-09	7.30E-02	6.12E-10
Bis(2-ethylhexyl)phthalate	3.00E-03	3.52E-08	2.00E-02	1.76E-06	1.26E-08	1.40E-02	1.76E-10
Carbazole	1.00E-02	1.17E-07	NA	NA	4.19E-08	2.00E-02	8.39E-10
Chrysene	6.00E-03	7.05E-08	NA	NA	2.52E-08	7.30E-03	1.84E-10
Dibenz(a,h)anthracene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E+00	1.53E-08
Dibenzofuran	1.10E-02	1.29E-07	4.00E-03	3.23E-05	4.61E-08	NA	NA
Indeno(1,2,3-cd)pyrene	5.00E-04	5.87E-09	NA	NA	2.10E-09	7.30E-01	1.53E-09
Phenanthrene	1.70E-02	2.00E-07	NA	NA	7.13E-08	NA	NA

NA - Not Available

Total Hazard Index = 3.41E-05

Total Cancer Risk = 8.60E-08

Table 50
Dermal Exposure to EU4 Surface Soil (0-6') by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.30E+02	3.73E-06	NA	NA	1.33E-06	1.46E+00	1.95E-06
Benzo(a)pyrene	5.00E+02	2.01E-06	NA	NA	7.17E-07	1.46E+01	1.05E-05
Benzo(b)fluoranthene	5.30E+02	2.13E-06	NA	NA	7.60E-07	1.46E+00	1.11E-06
Benzo(k)fluoranthene	2.90E+02	1.16E-06	NA	NA	4.16E-07	1.46E-01	6.07E-08
Carbazole	6.20E+02	8.30E-06	NA	NA	2.96E-06	NA	NA
Chrysene	6.90E+02	2.77E-06	NA	NA	9.90E-07	1.46E-02	1.44E-08
Dibenz(a,h)anthracene	6.40E+01	2.57E-07	NA	NA	9.18E-08	1.46E+01	1.34E-06
Indeno(1,2,3-cd)pyrene	2.50E+02	1.00E-06	NA	NA	3.59E-07	1.46E+00	5.23E-07
Naphthalene	3.50E+03	4.68E-05	1.00E-02	4.68E-03	1.67E-05	NA	NA

NA - Not Available   Total Hazard Index = 4.68E-03   Total Cancer Risk = 1.55E-05

Table 51
Oral Exposure to EU4 Surface Soil (0-6') by a Maintenance Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in soil =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.30E+02	1.09E-04	NA	NA	3.90E-05	7.30E-01	2.85E-05
Benzo(a)pyrene	5.00E+02	5.87E-05	NA	NA	2.10E-05	7.30E+00	1.53E-04
Benzo(b)fluoranthene	5.30E+02	6.22E-05	NA	NA	2.22E-05	7.30E-01	1.62E-05
Benzo(k)fluoranthene	2.90E+02	3.41E-05	NA	NA	1.22E-05	7.30E-02	8.88E-07
Carbazole	6.20E+02	7.28E-05	NA	NA	2.60E-05	2.00E-02	5.20E-07
Chrysene	6.90E+02	8.10E-05	NA	NA	2.89E-05	7.30E-03	2.11E-07
Dibenz(a,h)anthracene	6.40E+01	7.51E-06	NA	NA	2.68E-06	7.30E+00	1.96E-05
Indeno(1,2,3-cd)pyrene	2.50E+02	2.94E-05	NA	NA	1.05E-05	7.30E-01	7.65E-06
Naphthalene	3.50E+03	4.11E-04	2.00E-02	2.05E-02	1.47E-04	NA	NA

NA - Not Available　　Total Hazard Index = 2.05E-02　　Total Cancer Risk = 2.27E-04

Table 58
Dermal Exposure to EU2 Soil (0-10') by a Construction Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	5560	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		27.8%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.1	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
EF - Exposure frequency =	days/year	80	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	6.10E+01	3.19E-06	NA	NA	4.55E-08	1.46E+00	6.64E-08
Benzo(a)pyrene	2.17E+01	1.13E-06	NA	NA	1.62E-08	1.46E+01	2.36E-07
Benzo(b)fluoranthene	3.30E+01	1.72E-06	NA	NA	2.46E-08	1.46E+00	3.59E-08
Benzo(k)fluoranthene	1.10E+01	5.74E-07	NA	NA	8.21E-09	1.46E-01	1.20E-09
Chrysene	5.20E+01	2.72E-06	NA	NA	3.88E-08	1.46E-02	5.66E-10
Dibenz(a,h)anthracene	1.69E+00	8.82E-08	NA	NA	1.26E-09	1.46E+01	1.84E-08
Indeno(1,2,3-cd)pyrene	8.70E+00	4.54E-07	NA	NA	6.49E-09	1.46E+00	9.48E-09

NA - Not Available

Total Cancer Risk = 3.68E-07

Table 59
Oral Exposure to EU2 Soil (0-10') by a Construction Worker
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in soil =	mg/kg	see below	
$IngR_a$ - Ingestion rate for soil =	mg/day	480	USEPA 1997, EFH
$IngR_b$ - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF_a - Exposure frequency =	days/year	10	reasonable assumption
EF_b - Exposure frequency =	days/year	70	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Exposure Level A

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	6.10E+01	1.15E-05	NA	NA	1.64E-07	7.30E-01	1.20E-07
Benzo(a)pyrene	2.17E+01	4.07E-06	NA	NA	5.82E-08	7.30E+00	4.25E-07
Benzo(b)fluoranthene	3.30E+01	6.20E-06	NA	NA	8.86E-08	7.30E-01	6.47E-08
Benzo(k)fluoranthene	1.10E+01	2.07E-06	NA	NA	2.95E-08	7.30E-02	2.16E-09
Chrysene	5.20E+01	9.77E-06	NA	NA	1.40E-07	7.30E-03	1.02E-09
Dibenz(a,h)anthracene	1.69E+00	3.17E-07	NA	NA	4.53E-09	7.30E+00	3.31E-08
Indeno(1,2,3-cd)pyrene	8.70E+00	1.63E-06	NA	NA	2.33E-08	7.30E-01	1.70E-08

NA - Not Available

Cancer Risk = 6.62E-07

Exposure Level B

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	6.10E+01	1.67E-05	NA	NA	2.39E-07	7.30E-01	1.74E-07
Benzo(a)pyrene	2.17E+01	5.94E-06	NA	NA	8.48E-08	7.30E+00	6.19E-07
Benzo(b)fluoranthene	3.30E+01	9.04E-06	NA	NA	1.29E-07	7.30E-01	9.43E-08
Benzo(k)fluoranthene	1.10E+01	3.01E-06	NA	NA	4.31E-08	7.30E-02	3.14E-09
Chrysene	5.20E+01	1.42E-05	NA	NA	2.04E-07	7.30E-03	1.49E-09
Dibenz(a,h)anthracene	1.69E+00	4.63E-07	NA	NA	6.61E-09	7.30E+00	4.83E-08
Indeno(1,2,3-cd)pyrene	8.70E+00	2.38E-06	NA	NA	3.41E-08	7.30E-01	2.49E-08

NA - Not Available

Cancer Risk = 9.65E-07

Total Cancer Risk = 1.63E-06

RECEIVED
APR - 4 2001
DEQ-OPC

Table 60

Exposure to Construction Workers from Inhalation of Fugitive Dust in EU2

Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Ca*InhR*EF*ED*RF}{BW*AT}$

Ca - Concentration in air =	mg/m^3	chem.spec.	
InhR - Inhalation Rate =	m^3/shift	20	USEPA 1995, Region IV
EF - Exposure Frequency =	shifts/year	80	reasonable assumption
ED - Exposure Duration =	years	1	reasonable assumption
RF_s - Retention Factor - semivolatiles =		0.75	ICRP, 1968
AT_n - Averaging Time noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM
BW - Body Weight =	kg	70	USEPA 1995, Region IV

E_i - Emission Rate (mg/sec) = Cs*(PERv+PERe)

Cs - Concentration in soil = mg/kg chem.spec.

Ca = Concentration in Air (mg/m^3) = Ei / (Hb * W * V)

Ei - Emission Rate of Component (mg/sec) = see below

Hb - Downwind Ht (m) = 4.81

W - Width (m) = 50

V - Wind speed (m/sec) = 4.69

Length (downwind distance) (m) = 50

r - Roughness Ht. (m) = 0.20

z - downwind distance (m) = 50

z = 6.25r[Hb/r * Ln(Hb/r) - 1.58*Hb/r + 1.58]

Chemicals	Concentration in Soil mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles									
Benzo(a)anthracene	6.10E+01	6.67E-02	5.92E-05	2.78E-06	NA	NA	3.97E-08	3.10E-01	1.23E-08
Benzo(a)pyrene	2.17E+01	2.37E-02	2.10E-05	9.88E-07	NA	NA	1.41E-08	3.10E+00	4.37E-08
Benzo(b)fluoranthene	3.30E+01	3.61E-02	3.20E-05	1.50E-06	NA	NA	2.15E-08	3.10E-01	6.66E-09
Benzo(k)fluoranthene	1.10E+01	1.20E-02	1.07E-05	5.01E-07	NA	NA	7.16E-09	3.10E-02	2.22E-10
Chrysene	5.20E+01	5.69E-02	5.05E-05	2.37E-06	NA	NA	3.39E-08	3.10E-03	1.05E-10
Dibenz(a,h)anthracene	1.69E+00	1.85E-03	1.64E-06	7.70E-08	NA	NA	1.10E-09	3.10E+00	3.41E-09
Indeno(1,2,3-cd)pyrene	8.70E+00	9.51E-03	8.44E-06	3.96E-07	NA	NA	5.66E-09	3.10E-01	1.76E-09

NA - Not Available

Total Cancer Risk: 5.59E-08

RECEIVED
APR - 4 2001
DEQ-OPC

Table 61
Dermal Exposure to EU4 Sediment by a Construction Worker
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.13	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	8	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	3.30E+02	1.21E-06	NA	NA	1.73E-08	1.46E+00	2.52E-08
Benzo(a)pyrene	1.30E+02	4.76E-07	NA	NA	6.80E-09	1.46E+01	9.93E-08
Benzo(b)fluoranthene	1.80E+02	6.59E-07	NA	NA	9.42E-09	1.46E+00	1.38E-08
Benzo(k)fluoranthene	6.40E+01	2.34E-07	NA	NA	3.35E-09	1.46E-01	4.89E-10
Carbazole	5.90E+02	7.20E-06	NA	NA	1.03E-07	NA	NA
Chrysene	2.90E+02	1.06E-06	NA	NA	1.52E-08	1.46E-02	2.22E-10
Dibenz(a,h)anthracene	1.20E+01	4.40E-08	NA	NA	6.28E-10	1.46E+01	9.17E-09
Dibenzofuran	9.40E+02	1.15E-05	NA	NA	1.64E-07	NA	NA
Indeno(1,2,3-cd)pyrene	4.70E+01	1.72E-07	NA	NA	2.46E-09	1.46E+00	3.59E-09
Naphthalene	3.00E+03	3.66E-05	NA	NA	5.23E-07	NA	NA
Phenanthrene	3.20E+03	3.91E-05	NA	NA	5.58E-07	NA	NA

NA - Not Available

Total Cancer Risk = 1.52E-07

Table 63
ermal Exposure to EU4 Surface Water by a Construction Worker
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cw*SA*Kp*ABS*ET*EF*ED*CF}{BW*AT}$

Cw - Concentration in surface water =	mg/L	see below	
SA - Surface area available for exposure =	cm^2	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
Kp - Dermal permeability constant =	cm/hr	see below	
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
ET - Exposure time =	hrs/day	1	USEPA 1992, Dermal Exposure Assessment
EF - Exposure frequency =	days/year	8	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	L/cm^3	1.00E-03	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Surface Water mg/L	Kp cm/hr	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
nivolatiles								
enzo(a)anthracene	5.00E-03	8.10E-01	1.14E-07	NA	NA	1.63E-09	1.46E+00	2.38E-09
Benzo(a)pyrene	5.00E-04	1.20E+00	1.69E-08	NA	NA	2.42E-10	1.46E+01	3.53E-09
Benzo(b)fluoranthene	1.20E-02	1.20E+00	4.06E-07	NA	NA	5.80E-09	1.46E+00	8.46E-09
Benzo(k)fluoranthene	2.00E-03	4.48E+01	2.52E-06	NA	NA	3.60E-08	1.46E-01	5.26E-09
Bis(2-ethylhexyl)phthalate	3.00E-03	3.30E-02	9.30E-09	1.00E-02	9.30E-07	1.33E-10	NA	NA
Carbazole	1.00E-02	3.57E-02	3.36E-08	NA	NA	4.80E-10	NA	NA
Chrysene	6.00E-03	8.10E-01	1.37E-07	NA	NA	1.96E-09	1.46E-02	2.86E-11
Dibenz(a,h)anthracene	5.00E-04	2.70E+00	3.80E-08	NA	NA	5.43E-10	1.46E+01	7.93E-09
Dibenzofuran	1.10E-02	1.51E-01	1.56E-07	NA	NA	2.23E-09	NA	NA
Indeno(1,2,3-cd)pyrene	5.00E-04	1.90E+00	2.68E-08	NA	NA	3.82E-10	1.46E+00	5.58E-10
Phenanthrene	1.70E-02	2.30E-01	3.67E-07	NA	NA	5.25E-09	NA	NA

NA - Not Available

Total Hazard Index = 9.30E-07

Total Cancer Risk = 2.82E-08

Table 65
Dermal Exposure to EU4 Soil (0-20') by a Construction Worker
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	5560	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		27.8%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.1	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	80	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.30E+02	4.86E-05	NA	NA	6.94E-07	1.46E+00	1.01E-06
Benzo(a)pyrene	5.00E+02	2.61E-05	NA	NA	3.73E-07	1.46E+01	5.45E-06
Benzo(b)fluoranthene	5.30E+02	2.77E-05	NA	NA	3.95E-07	1.46E+00	5.77E-07
Benzo(k)fluoranthene	2.90E+02	1.51E-05	NA	NA	2.16E-07	1.46E-01	3.16E-08
Carbazole	6.20E+02	1.08E-04	NA	NA	1.54E-06	NA	NA
Chrysene	6.90E+02	3.60E-05	NA	NA	5.15E-07	1.46E-02	7.52E-09
Dibenz(a,h)anthracene	6.40E+01	3.34E-06	NA	NA	4.78E-08	1.46E+01	6.97E-07
Indeno(1,2,3-cd)pyrene	2.50E+02	1.31E-05	NA	NA	1.87E-07	1.46E+00	2.72E-07
Naphthalene	3.50E+03	6.09E-04	NA	NA	8.70E-06	NA	NA

NA - Not Available

Total Cancer Risk = 8.05E-06

Table 68
Dermal Exposure to EU5 Soil (0-20') by a Construction Worker
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = Cs*SA*AH*ABS*EF*ED*CF / BW*AT

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	5560	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		27.8%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.1	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	80	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	8.35E+01	4.36E-06	NA	NA	6.23E-08	1.46E+00	9.10E-08
Benzo(a)pyrene	4.42E+01	2.31E-06	NA	NA	3.30E-08	1.46E+01	4.81E-07
Benzo(b)fluoranthene	7.95E+01	4.15E-06	NA	NA	5.93E-08	1.46E+00	8.66E-08
Benzo(k)fluoranthene	1.68E+01	8.77E-07	NA	NA	1.25E-08	1.46E-01	1.83E-09
Chrysene	8.25E+01	4.31E-06	NA	NA	6.16E-08	1.46E-02	8.99E-10
Dibenz(a,h)anthracene	1.53E+00	7.99E-08	NA	NA	1.14E-09	1.46E+01	1.67E-08
Indeno(1,2,3-cd)pyrene	1.32E+01	6.89E-07	NA	NA	9.85E-09	1.46E+00	1.44E-08

NA - Not Available

Total Cancer Risk = 6.93E-07

Table 69
Oral Exposure to EU5 Soil (0-20') by a Construction Worker
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$

Cd - Concentration in sediment =	mg/kg	see below	
$IngR_a$ - Ingestion rate for soil =	mg/day	480	USEPA 1997, EFH
$IngR_b$ - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF_a - Exposure frequency =	days/year	10	reasonable assumption
EF_b - Exposure frequency =	days/year	70	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Exposure Level A

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	8.35E+01	1.57E-05	NA	NA	2.24E-07	7.30E-01	1.64E-07
Benzo(a)pyrene	4.42E+01	8.30E-06	NA	NA	1.19E-07	7.30E+00	8.66E-07
Benzo(b)fluoranthene	7.95E+01	1.49E-05	NA	NA	2.13E-07	7.30E-01	1.56E-07
Benzo(k)fluoranthene	1.68E+01	3.16E-06	NA	NA	4.51E-08	7.30E-02	3.29E-09
Chrysene	8.25E+01	1.55E-05	NA	NA	2.21E-07	7.30E-03	1.62E-09
Dibenz(a,h)anthracene	1.53E+00	2.87E-07	NA	NA	4.11E-09	7.30E+00	3.00E-08
Indeno(1,2,3-cd)pyrene	1.32E+01	2.48E-06	NA	NA	3.54E-08	7.30E-01	2.59E-08

NA - Not Available

Cancer Risk = 1.25E-06

Exposure Level B

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	8.35E+01	2.29E-05	NA	NA	3.27E-07	7.30E-01	2.39E-07
Benzo(a)pyrene	4.42E+01	1.21E-05	NA	NA	1.73E-07	7.30E+00	1.26E-06
Benzo(b)fluoranthene	7.95E+01	2.18E-05	NA	NA	3.11E-07	7.30E-01	2.27E-07
Benzo(k)fluoranthene	1.68E+01	4.60E-06	NA	NA	6.58E-08	7.30E-02	4.80E-09
Chrysene	8.25E+01	2.26E-05	NA	NA	3.23E-07	7.30E-03	2.36E-09
Dibenz(a,h)anthracene	1.53E+00	4.19E-07	NA	NA	5.99E-09	7.30E+00	4.37E-08
Indeno(1,2,3-cd)pyrene	1.32E+01	3.62E-06	NA	NA	5.17E-08	7.30E-01	3.77E-08

NA - Not Available

Cancer Risk = 1.82E-06

Total Cancer Risk = 3.06E-06

Table 70

Exposure to Construction Workers from Inhalation of Fugitive Dust in EU5

Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Ca*InhR*EF*ED*RF}{BW*AT}$

Ca - Concentration in air =	mg/m^3	see below		
InhR - Inhalation Rate =	m^3/shift	20	USEPA 1995, Region IV	
EF - Exposure Frequency =	shifts/year	80	reasonable assumption	
ED - Exposure Duration =	years	1	reasonable assumption	
RF_s - Retention Factor - semivolatiles =		0.75	ICRP, 1968	
AT_n - Averaging Time noncarcinogenic =	days	365	USEPA 1991, HHEM	
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM	
BW - Body Weight =	kg	70	USEPA 1995, Region IV	

E_i - Emission Rate (mg/sec) = Cs*(PERv+PERe)

Cs - Concentration in soil = mg/kg see below

Ca = Concentration in Air (mg/m^3) = Ei / (Hb * W * V)

Ei - Emission Rate of Component (mg/sec) = see below

Hb - Downwind Ht (m) = 4.81

W - Width (m) = 50

V - Wind speed (m/sec) = 4.69

Length (downwind distance) (m) = 50

r - Roughness Ht. (m) = 0.20

z - downwind distance (m) = 50

z = 6.25r[Hb/r * Ln(Hb/r) - 1.58*Hb/r + 1.58]

Chemicals	Concentration in Soil mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles									
Benzo(a)anthracene	8.35E+01	9.13E-02	8.10E-05	3.81E-06	NA	NA	5.44E-08	3.10E-01	1.69E-08
Benzo(a)pyrene	4.42E+01	4.83E-02	4.29E-05	2.01E-06	NA	NA	2.88E-08	3.10E+00	8.92E-08
Benzo(b)fluoranthene	7.95E+01	8.69E-02	7.71E-05	3.62E-06	NA	NA	5.18E-08	3.10E-01	1.60E-08
Benzo(k)fluoranthene	1.68E+01	1.84E-02	1.63E-05	7.66E-07	NA	NA	1.09E-08	3.10E-02	3.39E-10
Chrysene	8.25E+01	9.02E-02	8.01E-05	3.76E-06	NA	NA	5.37E-08	3.10E-03	1.67E-10
Dibenz(a,h)anthracene	1.53E+00	1.67E-03	1.48E-06	6.97E-08	NA	NA	9.96E-10	3.10E+00	3.09E-09
Indeno(1,2,3-cd)pyrene	1.32E+01	1.44E-02	1.28E-05	6.02E-07	NA	NA	8.59E-09	3.10E-01	2.66E-09

NA - Not Available

Total Cancer Risk: 1.28E-07

Table 71
Dermal Exposure to EU6 Sediment by a Child Resident (Aged 1 to 6 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	2229	calculated
SA_t - Total skin surface area =	cm^2	7213	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.33	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	6	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	15	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	2190	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.00E-01	2.15E-07	NA	NA	1.84E-08	NA	NA
2-Nitrophenol	8.00E-01	4.30E-07	NA	NA	3.68E-08	NA	NA
3-Nitroaniline	8.00E-01	4.30E-07	NA	NA	3.68E-08	NA	NA
4-Bromophenylphenylether	8.00E-01	4.30E-07	NA	NA	3.68E-08	NA	NA
4-Chloro-3-methylphenol	8.00E-01	4.30E-07	NA	NA	3.68E-08	NA	NA
4-Chlorophenylphenylether	4.00E-01	2.15E-07	NA	NA	1.84E-08	NA	NA
4-Nitroaniline	8.00E-01	4.30E-07	NA	NA	3.68E-08	NA	NA
Benzo(a)anthracene	1.00E+02	1.61E-05	NA	NA	1.38E-06	1.46E+00	2.02E-06
Benzo(a)pyrene	4.90E+01	7.90E-06	NA	NA	6.77E-07	1.46E+01	9.89E-06
Benzo(b)fluoranthene	7.80E+01	1.26E-05	NA	NA	1.08E-06	1.46E+00	1.57E-06
Benzo(k)fluroanthene	2.30E+01	3.71E-06	NA	NA	3.18E-07	1.46E-01	4.64E-08
Bis(2-chloroethoxy)methane	8.00E-01	4.30E-07	NA	NA	3.68E-08	NA	NA
Bis(2-chloroethyl)ether	4.00E-01	2.15E-07	NA	NA	1.84E-08	NA	NA
Carbazole	1.00E+02	5.37E-05	NA	NA	4.61E-06	NA	NA
Chrysene	7.60E+01	1.23E-05	NA	NA	1.05E-06	1.46E-02	1.53E-08
Dibenz(a,h)anthracene	9.60E+00	1.55E-06	NA	NA	1.33E-07	1.46E+01	1.94E-06
Hexachlorobenzene	4.00E-01	2.15E-07	NA	NA	1.84E-08	NA	NA
Hexachlorocyclopentadiene	2.00E+00	1.07E-06	NA	NA	9.21E-08	NA	NA
Indeno(1,2,3-cd)pyrene	3.90E+01	6.29E-06	NA	NA	5.39E-07	1.46E+00	7.87E-07
N-nitrosodi-n-propylamine	4.00E-01	2.15E-07	NA	NA	1.84E-08	NA	NA

NA - Not Available

Total Cancer Risk = 1.63E-05

Table 73
Dermal Exposure to EU6 Sediment by an Adult Resident (Aged 7 to 30 years)
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	6180	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.33	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	24	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	8760	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.00E-01	1.28E-07	NA	NA	4.38E-08	NA	NA
2-Nitrophenol	8.00E-01	2.55E-07	NA	NA	8.76E-08	NA	NA
3-Nitroaniline	8.00E-01	2.55E-07	NA	NA	8.76E-08	NA	NA
4-Bromophenylphenylether	8.00E-01	2.55E-07	NA	NA	8.76E-08	NA	NA
4-Chloro-3-methylphenol	8.00E-01	2.55E-07	NA	NA	8.76E-08	NA	NA
4-Chlorophenylphenylether	4.00E-01	1.28E-07	NA	NA	4.38E-08	NA	NA
4-Nitroaniline	8.00E-01	2.55E-07	NA	NA	8.76E-08	NA	NA
Benzo(a)anthracene	1.00E+02	9.58E-06	NA	NA	3.28E-06	1.46E+00	4.79E-06
Benzo(a)pyrene	4.90E+01	4.69E-06	NA	NA	1.61E-06	1.46E+01	2.35E-05
Benzo(b)fluoranthene	7.80E+01	7.47E-06	NA	NA	2.56E-06	1.46E+00	3.74E-06
Benzo(k)fluroanthene	2.30E+01	2.20E-06	NA	NA	7.55E-07	1.46E-01	1.10E-07
Bis(2-chloroethoxy)methane	8.00E-01	2.55E-07	NA	NA	8.76E-08	NA	NA
Bis(2-chloroethyl)ether	4.00E-01	1.28E-07	NA	NA	4.38E-08	NA	NA
Carbazole	1.00E+02	3.19E-05	NA	NA	1.09E-05	NA	NA
Chrysene	7.60E+01	7.28E-06	NA	NA	2.50E-06	1.46E-02	3.64E-08
Dibenz(a,h)anthracene	9.60E+00	9.20E-07	NA	NA	3.15E-07	1.46E+01	4.60E-06
Hexachlorobenzene	4.00E-01	1.28E-07	4.00E-04	3.19E-04	4.38E-08	NA	NA
Hexachlorocyclopentadiene	2.00E+00	6.39E-07	3.50E-03	1.82E-04	2.19E-07	NA	NA
Indeno(1,2,3-cd)pyrene	3.90E+01	3.74E-06	NA	NA	1.28E-06	1.46E+00	1.87E-06
N-nitrosodi-n-propylamine	4.00E-01	1.28E-07	NA	NA	4.38E-08	NA	NA

NA - Not Available

Total Hazard Index = 5.02E-04

Total Cancer Risk = 3.86E-05

Table 79
Dermal Exposure to EU4 Sediment by an Adolescent Visitor (Aged 7-16 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3945	calculated
SA_t - Total skin surface area =	cm^2	12768.3	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.33	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	2.56E+00	7.31E-08	NA	NA	1.04E-08	1.46E+00	1.52E-08
Benzo(a)pyrene	3.10E+00	8.85E-08	NA	NA	1.26E-08	1.46E+01	1.85E-07
Benzo(b)fluoranthene	4.78E+00	1.36E-07	NA	NA	1.95E-08	1.46E+00	2.85E-08
Benzo(k)fluoranthene	2.27E+00	6.48E-08	NA	NA	9.25E-09	1.46E-01	1.35E-09
Carbazole	*	NA	NA	NA	NA	NA	NA
Chrysene	*	NA	NA	NA	NA	1.46E-02	NA
Dibenz(a,h)anthracene	5.87E-01	1.68E-08	NA	NA	2.39E-09	1.46E+01	3.49E-08
Dibenzofuran	*	NA	2.00E-03	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.40E+00	6.85E-08	NA	NA	9.78E-09	1.46E+00	1.43E-08
Naphthalene	*	NA	1.00E-02	NA	NA	NA	NA
Phenanthrene	*	NA	NA	NA	NA	NA	NA

NA - Not Available/Not Applicable

Total Cancer Risk = 2.79E-07

*Constituent not present in remaining samples.

Table 80
Oral Exposure to EU4 Sediment by an Adolescent Visitor (Aged 7-16 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for sediment =	mg/day	*100*	*USEPA 1997, EFH*
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	*1.00E-06*	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	*3650*	*USEPA 1991, HHEM*
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	2.56E+00	1.87E-07	NA	NA	2.67E-08	7.30E-01	1.95E-08
Benzo(a)pyrene	3.10E+00	2.26E-07	NA	NA	3.24E-08	7.30E+00	2.36E-07
Benzo(b)fluoranthene	4.78E+00	3.49E-07	NA	NA	4.99E-08	7.30E-01	3.64E-08
Benzo(k)fluoranthene	2.27E+00	1.66E-07	NA	NA	2.37E-08	7.30E-02	1.73E-09
Carbazole	*	NA	NA	NA	NA	2.00E-02	NA
Chrysene	*	NA	NA	NA	NA	7.30E-03	NA
Dibenz(a,h)anthracene	5.87E-01	4.29E-08	NA	NA	6.13E-09	7.30E+00	4.47E-08
Dibenzofuran	*	NA	4.00E-03	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.40E+00	1.75E-07	NA	NA	2.50E-08	7.30E-01	1.83E-08
Naphthalene	*	NA	2.00E-02	NA	NA	NA	NA
Phenanthrene	*	NA	NA	NA	NA	NA	NA

NA - Not Available/Not Applicable

Total Cancer Risk = 3.57E-07

*Constituent not present in remaining samples.

ENVIRONMENTAL STANDARDS

Table 81
Dermal Exposure to EU4 Sediment by a Maintenance Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15.0%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	2.56E+00	1.03E-08	NA	NA	3.67E-09	1.46E+00	5.36E-09
Benzo(a)pyrene	3.10E+00	1.24E-08	NA	NA	4.45E-09	1.46E+01	6.49E-08
Benzo(b)fluoranthene	4.78E+00	1.92E-08	NA	NA	6.86E-09	1.46E+00	1.00E-08
Benzo(k)fluoranthene	2.27E+00	9.12E-09	NA	NA	3.26E-09	1.46E-01	4.75E-10
Carbazole	*	NA	NA	NA	NA	NA	NA
Chrysene	*	NA	NA	NA	NA	1.46E-02	NA
Dibenz(a,h)anthracene	5.87E-01	2.36E-09	NA	NA	8.42E-10	1.46E+01	1.23E-08
Dibenzofuran	*	NA	2.00E-03	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.40E+00	9.64E-09	NA	NA	3.44E-09	1.46E+00	5.03E-09
Naphthalene	*	NA	1.00E-02	NA	NA	NA	NA
Phenanthrene	*	NA	NA	NA	NA	NA	NA

NA - Not Available/Not Applicable — Total Cancer Risk = 9.81E-08
*Constituent not present in remaining samples.

Table 82
Oral Exposure to EU4 Sediment by a Maintenance Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	2.56E+00	3.01E-07	NA	NA	1.07E-07	7.30E-01	7.84E-08
Benzo(a)pyrene	3.10E+00	3.64E-07	NA	NA	1.30E-07	7.30E+00	9.49E-07
Benzo(b)fluoranthene	4.78E+00	5.61E-07	NA	NA	2.00E-07	7.30E-01	1.46E-07
Benzo(k)fluoranthene	2.27E+00	2.67E-07	NA	NA	9.52E-08	7.30E-02	6.95E-09
Carbazole	*	NA	NA	NA	NA	2.00E-02	NA
Chrysene	*	NA	NA	NA	NA	7.30E-03	NA
Dibenz(a,h)anthracene	5.87E-01	6.89E-08	NA	NA	2.46E-08	7.30E+00	1.80E-07
Dibenzofuran	*	NA	4.00E-03	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.40E+00	2.82E-07	NA	NA	1.01E-07	7.30E-01	7.35E-08
Naphthalene	*	NA	2.00E-02	NA	NA	NA	NA
Phenanthrene	*	NA	NA	NA	NA	NA	NA

NA - Not Available/Not Applicable — Total Cancer Risk = 1.43E-06

*Constituent not present in remaining samples.

Table 83
Oral Exposure to EU4 Sediment by a Construction Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for sediment =	mg/day	480	USEPA 1997, EFH
EF - Exposure frequency =	days/year	8	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	2.56E+00	3.85E-07	NA	NA	5.50E-09	7.30E-01	4.01E-09
Benzo(a)pyrene	3.10E+00	4.66E-07	NA	NA	6.66E-09	7.30E+00	4.86E-08
Benzo(b)fluoranthene	4.78E+00	7.18E-07	NA	NA	1.03E-08	7.30E-01	7.49E-09
Benzo(k)fluoranthene	2.27E+00	3.41E-07	NA	NA	4.87E-09	7.30E-02	3.56E-10
Carbazole	*	NA	NA	NA	NA	2.00E-02	NA
Chrysene	*	NA	NA	NA	NA	7.30E-03	NA
Dibenz(a,h)anthracene	5.87E-01	8.82E-08	NA	NA	1.26E-09	7.30E+00	9.20E-09
Dibenzofuran	*	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.40E+00	3.61E-07	NA	NA	5.15E-09	7.30E-01	3.76E-09
Naphthalene	*	NA	NA	NA	NA	NA	NA
Phenanthrene	*	NA	NA	NA	NA	NA	NA

NA - Not Available/Not Applicable

Total Cancer Risk = 7.34E-08

*Constituent not present in remaining samples.

ENVIRONMENTAL STANDARDS

Table 84
Dermal Exposure to EU4 Surface Soil (0-6') by a Maintenance Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	8.10E-01	3.25E-09	NA	NA	1.16E-09	1.46E+00	1.70E-09
Benzo(a)pyrene	2.90E-01	1.16E-09	NA	NA	4.16E-10	1.46E+01	6.07E-09
Benzo(b)fluoranthene	3.70E-01	1.49E-09	NA	NA	5.31E-10	1.46E+00	7.75E-10
Benzo(k)fluoranthene	1.60E-01	6.43E-10	NA	NA	2.29E-10	1.46E-01	3.35E-11
Carbazole	4.90E-01	6.56E-09	NA	NA	2.34E-09	NA	NA
Chrysene	6.10E-01	2.45E-09	NA	NA	8.75E-10	1.46E-02	1.28E-11
Dibenz(a,h)anthracene	1.10E-02	4.42E-11	NA	NA	1.58E-11	1.46E+01	2.30E-10
Indeno(1,2,3-cd)pyrene	9.40E-02	3.77E-10	NA	NA	1.35E-10	1.46E+00	1.97E-10
Naphthalene	4.00E-01	5.35E-09	1.00E-02	5.35E-07	1.91E-09	NA	NA

NA - Not Available   Total Hazard Index = 5.35E-07   Total Cancer Risk = 9.02E-09

Table 85
Oral Exposure to EU4 Surface Soil (0-6') by a Maintenance Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in soil =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	30	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	8.10E-01	9.51E-08	NA	NA	3.40E-08	7.30E-01	2.48E-08
Benzo(a)pyrene	2.90E-01	3.41E-08	NA	NA	1.22E-08	7.30E+00	8.88E-08
Benzo(b)fluoranthene	3.70E-01	4.34E-08	NA	NA	1.55E-08	7.30E-01	1.13E-08
Benzo(k)fluoranthene	1.60E-01	1.88E-08	NA	NA	6.71E-09	7.30E-02	4.90E-10
Carbazole	4.90E-01	5.75E-08	NA	NA	2.05E-08	2.00E-02	4.11E-10
Chrysene	6.10E-01	7.16E-08	NA	NA	2.56E-08	7.30E-03	1.87E-10
Dibenz(a,h)anthracene	1.10E-02	1.29E-09	NA	NA	4.61E-10	7.30E+00	3.37E-09
Indeno(1,2,3-cd)pyrene	9.40E-02	1.10E-08	NA	NA	3.94E-09	7.30E-01	2.88E-09
Naphthalene	4.00E-01	4.70E-08	2.00E-02	2.35E-06	1.68E-08	NA	NA

NA - Not Applicable | Total Hazard Index = 2.35E-06 | Total Cancer Risk = 1.32E-07

Table 86
Dermal Exposure to EU4 Soil (0-20') by a Construction Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	5560	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		27.8%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.1	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	80	reasonable assumption
ED - Exposure duration =	years	1	reasonable assumption
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	3.00E+01	1.57E-06	NA	NA	2.24E-08	1.46E+00	3.27E-08
Benzo(a)pyrene	1.10E+01	5.74E-07	NA	NA	8.21E-09	1.46E+01	1.20E-07
Benzo(b)fluoranthene	1.70E+01	8.88E-07	NA	NA	1.27E-08	1.46E+00	1.85E-08
Benzo(k)fluoranthene	6.00E+00	3.13E-07	NA	NA	4.48E-09	1.46E-01	6.54E-10
Carbazole	2.40E+01	4.18E-06	NA	NA	5.97E-08	NA	NA
Chrysene	2.30E+01	1.20E-06	NA	NA	1.72E-08	1.46E-02	2.51E-10
Dibenz(a,h)anthracene	1.40E+00	7.31E-08	NA	NA	1.04E-09	1.46E+01	1.53E-08
Indeno(1,2,3-cd)pyrene	4.90E+00	2.56E-07	NA	NA	3.66E-09	1.46E+00	5.34E-09
Naphthalene	2.40E+02	4.18E-05	NA	NA	5.97E-07	NA	NA

NA - Not Available

Total Cancer Risk = 1.93E-07

Table 87
Oral Exposure to EU4 Soil (0-20') by a Construction Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in soil =	mg/kg	see below	
$IngR_a$ - Ingestion rate for soil =	mg/day	480	USEPA 1997, EFH
$IngR_b$ - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF_a - Exposure frequency =	days/year	10	reasonable assumption
EF_b - Exposure frequency =	days/year	70	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Exposure Level A

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	3.00E+01	5.64E-06	NA	NA	8.05E-08	7.30E-01	5.88E-08
Benzo(a)pyrene	1.10E+01	2.07E-06	NA	NA	2.95E-08	7.30E+00	2.16E-07
Benzo(b)fluoranthene	1.70E+01	3.19E-06	NA	NA	4.56E-08	7.30E-01	3.33E-08
Benzo(k)fluoranthene	6.00E+00	1.13E-06	NA	NA	1.61E-08	7.30E-02	1.18E-09
Carbazole	2.40E+01	4.51E-06	NA	NA	6.44E-08	2.00E-02	1.29E-09
Chrysene	2.30E+01	4.32E-06	NA	NA	6.17E-08	7.30E-03	4.51E-10
Dibenz(a,h)anthracene	1.40E+00	2.63E-07	NA	NA	3.76E-09	7.30E+00	2.74E-08
Indeno(1,2,3-cd)pyrene	4.90E+00	9.21E-07	NA	NA	1.32E-08	7.30E-01	9.60E-09
Naphthalene	2.40E+02	4.51E-05	NA	NA	6.44E-07	NA	NA

NA - Not Available

Cancer Risk = 3.48E-07

Exposure Level B

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	3.00E+01	8.22E-06	NA	NA	1.17E-07	7.30E-01	8.57E-08
Benzo(a)pyrene	1.10E+01	3.01E-06	NA	NA	4.31E-08	7.30E+00	3.14E-07
Benzo(b)fluoranthene	1.70E+01	4.66E-06	NA	NA	6.65E-08	7.30E-01	4.86E-08
Benzo(k)fluoranthene	6.00E+00	1.64E-06	NA	NA	2.35E-08	7.30E-02	1.71E-09
Carbazole	2.40E+01	6.58E-06	NA	NA	9.39E-08	2.00E-02	1.88E-09
Chrysene	2.30E+01	6.30E-06	NA	NA	9.00E-08	7.30E-03	6.57E-10
Dibenz(a,h)anthracene	1.40E+00	3.84E-07	NA	NA	5.48E-09	7.30E+00	4.00E-08
Indeno(1,2,3-cd)pyrene	4.90E+00	1.34E-06	NA	NA	1.92E-08	7.30E-01	1.40E-08
Naphthalene	2.40E+02	6.58E-05	NA	NA	9.39E-07	NA	NA

NA - Not Available

Cancer Risk = 5.07E-07

Total Cancer Risk = 8.54E-07

ENVIRONMENTAL STANDARDS

Table 88

Exposure to Construction Workers from Inhalation of Fugitive Dust in EU4
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

Intake (mg/kg-day) = $\frac{Ca*InhR*EF*ED*RF}{BW*AT}$

Ca - Concentration in air =	mg/m^3	see below	
InhR - Inhalation Rate =	m^3/shift	20	USEPA 1995, Region IV
EF - Exposure Frequency =	shifts/year	80	reasonable assumption
ED - Exposure Duration =	years	1	reasonable assumption
RF_s - Retention Factor - semivolatiles =		0.75	ICRP, 1968
AT_n - Averaging Time noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM
BW - Body Weight =	kg	70	USEPA 1995, Region IV

Ca = Concentration in Air (mg/m^3) = Ei / (Hb * W * V)
Ei - Emission Rate of Component (mg/sec) = see below
Hb - Downwind Ht (m) = 4.81
W - Width (m) = 50
V - Wind speed (m/sec) = 4.69
Length (downwind distance) (m) = 50
r - Roughness Ht. (m) = 0.20
z - downwind distance (m) = 50
z = 6.25r[Hb/r * Ln(Hb/r) - 1.58*Hb/r + 1.58]

E_i - Emission Rate (mg/sec) = Cs*(PERv+PERe)
Cs - Concentration in soil = mg/kg see below

Chemicals	Concentration in Soil mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles									
Benzo(a)anthracene	3.00E+01	3.28E-02	2.91E-05	1.37E-06	NA	NA	1.95E-08	3.10E-01	6.05E-09
Benzo(a)pyrene	1.10E+01	1.20E-02	1.07E-05	5.01E-07	NA	NA	7.16E-09	3.10E+00	2.22E-08
Benzo(b)fluoranthene	1.70E+01	1.86E-02	1.65E-05	7.75E-07	NA	NA	1.11E-08	3.10E-01	3.43E-09
Benzo(k)fluoranthene	6.00E+00	6.56E-03	5.82E-06	2.73E-07	NA	NA	3.91E-09	3.10E-02	1.21E-10
Carbazole	2.40E+01	2.62E-02	2.33E-05	1.09E-06	NA	NA	1.56E-08	NA	NA
Chrysene	2.30E+01	2.51E-02	2.23E-05	1.05E-06	NA	NA	1.50E-08	3.10E-03	4.64E-11
Dibenz(a,h)anthracene	1.40E+00	1.53E-03	1.36E-06	6.38E-08	NA	NA	9.11E-10	3.10E+00	2.83E-09
Indeno(1,2,3-cd)pyrene	4.90E+00	5.36E-03	4.75E-06	2.23E-07	NA	NA	3.19E-09	3.10E-01	9.89E-10
Naphthalene	2.40E+02	2.62E-01	2.33E-04	1.09E-05	NA	NA	1.56E-07	NA	NA

NA - Not Available

Total Cancer Risk: 3.57E-08

Table 89
Oral Exposure to EU5 Surface Soil (0-1') by an Adolescent Visitor (Aged 7-16 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

RECEIVED APR - 4 2001 DEQ-OPC

Intake (mg/kg-day) = $\frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	12	reasonable assumption
ED - Exposure duration =	years	10	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	45	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	3650	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	2.90E-01	2.12E-08	NA	NA	3.03E-09	7.30E-01	2.21E-09
Benzo(a)pyrene	3.70E-01	2.70E-08	NA	NA	3.86E-09	7.30E+00	2.82E-08
Benzo(b)fluoranthene	7.60E-01	5.55E-08	NA	NA	7.93E-09	7.30E-01	5.79E-09
Benzo(k)fluoranthene	4.60E-01	3.36E-08	NA	NA	4.80E-09	7.30E-02	3.50E-10
Chrysene	3.70E-01	2.70E-08	NA	NA	3.86E-09	7.30E-03	2.82E-11
Dibenz(a,h)anthracene	6.60E-02	4.82E-09	NA	NA	6.89E-10	7.30E+00	5.03E-09
Indeno(1,2,3-cd)pyrene	2.90E-01	2.12E-08	NA	NA	3.03E-09	7.30E-01	2.21E-09

NA - Not Available

Total Cancer Risk = 4.38E-08

ENVIRONMENTAL STANDARDS

Table 90
Dermal Exposure to EU5 Surface Soil (0-6') by a Maintenance Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	3000	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		15%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.038	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
EF - Exposure frequency =	days/year	150	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.54E-02	1.91E-09	NA	NA	6.84E-10	1.46E+00	9.98E-10
Benzo(a)pyrene	1.18E-01	2.36E-09	NA	NA	8.43E-10	1.46E+01	1.23E-08
Benzo(b)fluoranthene	2.90E-01	5.82E-09	NA	NA	2.08E-09	1.46E+00	3.03E-09
Benzo(k)fluoranthene	1.55E-01	3.10E-09	NA	NA	1.11E-09	1.46E-01	1.62E-10
Chrysene	1.50E-01	3.01E-09	NA	NA	1.07E-09	1.46E-02	1.57E-11
Dibenz(a,h)anthracene	4.40E-02	8.83E-10	NA	NA	3.15E-10	1.46E+01	4.60E-09
Indeno(1,2,3-cd)pyrene	9.13E-02	1.83E-09	NA	NA	6.54E-10	1.46E+00	9.55E-10

NA - Not Available

Total Cancer Risk = 2.21E-08

Table 91
Oral Exposure to EU5 Surface Soil (0-6') by a Maintenance Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	150	reasonable assumption
ED - Exposure duration =	years	25	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	9.54E-02	5.60E-08	NA	NA	2.00E-08	7.30E-01	1.46E-08
Benzo(a)pyrene	1.18E-01	6.91E-08	NA	NA	2.47E-08	7.30E+00	1.80E-07
Benzo(b)fluoranthene	2.90E-01	1.70E-07	NA	NA	6.08E-08	7.30E-01	4.44E-08
Benzo(k)fluoranthene	1.55E-01	9.08E-08	NA	NA	3.24E-08	7.30E-02	2.37E-09
Chrysene	1.50E-01	8.79E-08	NA	NA	3.14E-08	7.30E-03	2.29E-10
Dibenz(a,h)anthracene	4.40E-02	2.58E-08	NA	NA	9.22E-09	7.30E+00	6.73E-08
Indeno(1,2,3-cd)pyrene	9.13E-02	5.36E-08	NA	NA	1.91E-08	7.30E-01	1.40E-08

NA - Not Available

Total Cancer Risk = 3.23E-07

RECEIVED
APR - 4 2001
DEQ-OPC

Table 92
Oral Exposure to EU5 Soil (0-20') by a Construction Worker
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
$IngR_a$ - Ingestion rate for soil =	mg/day	480	USEPA 1997, EFH
$IngR_b$ - Ingestion rate for soil =	mg/day	100	USEPA 1997, EFH
EF_a - Exposure frequency =	days/year	10	reasonable assumption
EF_b - Exposure frequency =	days/year	70	reasonable assumption
ED - Exposure duration =	years	1	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	365	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Exposure Level A

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.93E-01	3.62E-08	NA	NA	5.18E-10	7.30E-01	3.78E-10
Benzo(a)pyrene	1.91E-01	3.59E-08	NA	NA	5.13E-10	7.30E+00	3.74E-09
Benzo(b)fluoranthene	3.89E-01	7.30E-08	NA	NA	1.04E-09	7.30E-01	7.61E-10
Benzo(k)fluoranthene	1.90E-01	3.58E-08	NA	NA	5.11E-10	7.30E-02	3.73E-11
Chrysene	2.64E-01	4.95E-08	NA	NA	7.07E-10	7.30E-03	5.16E-12
Dibenz(a,h)anthracene	5.15E-02	9.68E-09	NA	NA	1.38E-10	7.30E+00	1.01E-09
Indeno(1,2,3-cd)pyrene	1.30E-01	2.45E-08	NA	NA	3.50E-10	7.30E-01	2.56E-10

NA - Not Available

Cancer Risk = 6.19E-09

Exposure Level B

Constituent	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
Benzo(a)anthracene	1.93E-01	5.28E-08	NA	NA	7.55E-10	7.30E-01	5.51E-10
Benzo(a)pyrene	1.91E-01	5.23E-08	NA	NA	7.47E-10	7.30E+00	5.46E-09
Benzo(b)fluoranthene	3.89E-01	1.06E-07	NA	NA	1.52E-09	7.30E-01	1.11E-09
Benzo(k)fluoranthene	1.90E-01	5.22E-08	NA	NA	7.45E-10	7.30E-02	5.44E-11
Chrysene	2.64E-01	7.22E-08	NA	NA	1.03E-09	7.30E-03	7.53E-12
Dibenz(a,h)anthracene	5.15E-02	1.41E-08	NA	NA	2.02E-10	7.30E+00	1.47E-09
Indeno(1,2,3-cd)pyrene	1.30E-01	3.57E-08	NA	NA	5.11E-10	7.30E-01	3.73E-10

NA - Not Available

Cancer Risk = 9.02E-09

Total Cancer Risk = 1.52E-08

Table 93
Dermal Exposure to EU6 Sediment by an Adult Resident (Aged 7 to 30 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	6180	calculated
SA_t - Total skin surface area =	cm^2	20000	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.33	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	24	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	8760	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.20E-02	1.34E-08	NA	NA	4.60E-09	NA	NA
2-Nitrophenol	8.40E-02	2.68E-08	NA	NA	9.20E-09	NA	NA
3-Nitroaniline	8.40E-02	2.68E-08	NA	NA	9.20E-09	NA	NA
4-Bromophenylphenylether	8.40E-02	2.68E-08	NA	NA	9.20E-09	NA	NA
4-Chloro-3-methylphenol	8.40E-02	2.68E-08	NA	NA	9.20E-09	NA	NA
4-Chlorophenylphenylether	4.20E-02	1.34E-08	NA	NA	4.60E-09	NA	NA
4-Nitroaniline	8.40E-02	2.68E-08	NA	NA	9.20E-09	NA	NA
Benzo(a)anthracene	9.30E-01	8.91E-08	NA	NA	3.05E-08	1.46E+00	4.46E-08
Benzo(a)pyrene	9.70E-01	9.29E-08	NA	NA	3.19E-08	1.46E+01	4.65E-07
Benzo(b)fluoranthene	1.40E+00	1.34E-07	NA	NA	4.60E-08	1.46E+00	6.71E-08
Benzo(k)fluroanthene	5.00E-01	4.79E-08	NA	NA	1.64E-08	1.46E-01	2.40E-09
Bis(2-chloroethoxy)methane	8.40E-02	2.68E-08	NA	NA	9.20E-09	NA	NA
Bis(2-chloroethyl)ether	4.20E-02	1.34E-08	NA	NA	4.60E-09	NA	NA
Carbazole	2.20E-01	7.02E-08	NA	NA	2.41E-08	NA	NA
Chrysene	1.30E+00	1.25E-07	NA	NA	4.27E-08	1.46E-02	6.23E-10
Dibenz(a,h)anthracene	1.50E-01	1.44E-08	NA	NA	4.93E-09	1.46E+01	7.19E-08
Hexachlorobenzene	4.20E-02	1.34E-08	4.00E-04	3.35E-05	4.60E-09	NA	NA
Hexachlorocyclopentadiene	2.10E-01	6.70E-08	3.50E-03	1.92E-05	2.30E-08	NA	NA
Indeno(1,2,3-cd)pyrene	5.40E-01	5.17E-08	NA	NA	1.77E-08	1.46E+00	2.59E-08
N-nitrosodi-n-propylamine	4.20E-02	1.34E-08	NA	NA	4.60E-09	NA	NA

NA - Not Available

Total Hazard Index = 5.27E-05

Total Cancer Risk = 6.78E-07

Table 94
Oral Exposure to EU6 Sediment by an Adult Resident (Aged 7 to 30 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for sediment =	mg/day	100	USEPA 1997, EFH
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	24	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	70	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	8760	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.20E-02	6.58E-09	NA	NA	2.25E-09	NA	NA
2-Nitrophenol	8.40E-02	1.32E-08	NA	NA	4.51E-09	NA	NA
3-Nitroaniline	8.40E-02	1.32E-08	NA	NA	4.51E-09	NA	NA
4-Bromophenylphenylether	8.40E-02	1.32E-08	NA	NA	4.51E-09	NA	NA
4-Chloro-3-methylphenol	8.40E-02	1.32E-08	NA	NA	4.51E-09	NA	NA
4-Chlorophenylphenylether	4.20E-02	6.58E-09	NA	NA	2.25E-09	NA	NA
4-Nitroaniline	8.40E-02	1.32E-08	NA	NA	4.51E-09	NA	NA
Benzo(a)anthracene	9.30E-01	1.46E-07	NA	NA	4.99E-08	7.30E-01	3.64E-08
Benzo(a)pyrene	9.70E-01	1.52E-07	NA	NA	5.21E-08	7.30E+00	3.80E-07
Benzo(b)fluoranthene	1.40E+00	2.19E-07	NA	NA	7.51E-08	7.30E-01	5.49E-08
Benzo(k)fluroanthene	5.00E-01	7.83E-08	NA	NA	2.68E-08	7.30E-02	1.96E-09
Bis(2-chloroethoxy)methane	8.40E-02	1.32E-08	NA	NA	4.51E-09	NA	NA
Bis(2-chloroethyl)ether	4.20E-02	6.58E-09	NA	NA	2.25E-09	1.10E+00	2.48E-09
Carbazole	2.20E-01	3.44E-08	NA	NA	1.18E-08	2.00E-02	2.36E-10
Chrysene	1.30E+00	2.04E-07	NA	NA	6.98E-08	7.30E-03	5.09E-10
Dibenz(a,h)anthracene	1.50E-01	2.35E-08	NA	NA	8.05E-09	7.30E+00	5.88E-08
Hexachlorobenzene	4.20E-02	6.58E-09	8.00E-04	8.22E-06	2.25E-09	1.60E+00	3.61E-09
Hexachlorocyclopentadiene	2.10E-01	3.29E-08	7.00E-03	4.70E-06	1.13E-08	NA	NA
Indeno(1,2,3-cd)pyrene	5.40E-01	8.45E-08	NA	NA	2.90E-08	7.30E-01	2.12E-08
N-nitrosodi-n-propylamine	4.20E-02	6.58E-09	NA	NA	2.25E-09	7.00E+00	1.58E-08

NA - Not Available

Total Hazard Index = 1.29E-05

Total Cancer Risk = 5.76E-07

Table 95
Dermal Exposure to EU6 Sediment by a Child Resident (Aged 1 to 6 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

RECEIVED APR - 4 2001 DEQ-OPC

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*AH*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in sediment =	mg/kg	chem. spec.	
SA - Surface area available for exposure =	cm^2/day	2229	calculated
SA_t - Total skin surface area =	cm^2	7213	USEPA 1997, EFH
Fs - Fraction of skin surface area available for exposure =		30.9%	USEPA 1997, EFH
AH - Adherence factor =	mg/cm^2	0.33	USEPA 1997, EFH
ABS_p - Absorption - cPAHs =		0.03	USEPA 1995, Region III
ABS_s - Absorption - other SVOCs =		0.1	USEPA 1995, Region III
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	6	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
BW - Body weight =	kg	15	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	2190	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.20E-02	2.26E-08	NA	NA	1.93E-09	NA	NA
2-Nitrophenol	8.40E-02	4.51E-08	NA	NA	3.87E-09	NA	NA
3-Nitroaniline	8.40E-02	4.51E-08	NA	NA	3.87E-09	NA	NA
4-Bromophenylphenylether	8.40E-02	4.51E-08	NA	NA	3.87E-09	NA	NA
4-Chloro-3-methylphenol	8.40E-02	4.51E-08	NA	NA	3.87E-09	NA	NA
4-Chlorophenylphenylether	4.20E-02	2.26E-08	NA	NA	1.93E-09	NA	NA
4-Nitroaniline	8.40E-02	4.51E-08	NA	NA	3.87E-09	NA	NA
Benzo(a)anthracene	9.30E-01	1.50E-07	NA	NA	1.29E-08	1.46E+00	1.88E-08
Benzo(a)pyrene	9.70E-01	1.56E-07	NA	NA	1.34E-08	1.46E+01	1.96E-07
Benzo(b)fluoranthene	1.40E+00	2.26E-07	NA	NA	1.93E-08	1.46E+00	2.82E-08
Benzo(k)fluroanthene	5.00E-01	8.06E-08	NA	NA	6.91E-09	1.46E-01	1.01E-09
Bis(2-chloroethoxy)methane	8.40E-02	4.51E-08	NA	NA	3.87E-09	NA	NA
Bis(2-chloroethyl)ether	4.20E-02	2.26E-08	NA	NA	1.93E-09	NA	NA
Carbazole	2.20E-01	1.18E-07	NA	NA	1.01E-08	NA	NA
Chrysene	1.30E+00	2.10E-07	NA	NA	1.80E-08	1.46E-02	2.62E-10
Dibenz(a,h)anthracene	1.50E-01	2.42E-08	NA	NA	2.07E-09	1.46E+01	3.03E-08
Hexachlorobenzene	4.20E-02	2.26E-08	NA	NA	1.93E-09	NA	NA
Hexachlorocyclopentadiene	2.10E-01	1.13E-07	NA	NA	9.67E-09	NA	NA
Indeno(1,2,3-cd)pyrene	5.40E-01	8.71E-08	NA	NA	7.46E-09	1.46E+00	1.09E-08
N-nitrosodi-n-propylamine	4.20E-02	2.26E-08	NA	NA	1.93E-09	NA	NA

NA - Not Available

Total Cancer Risk = 2.85E-07

Table 96
Oral Exposure to EU6 Sediment by a Child Resident (Aged 1 to 6 years)
Preliminary Remediation Goal Calculation
Kerr McGee, Hattiesburg, MS

RECEIVED APR - 4 2001 DEQ-OPC

$$\text{Intake (mg/kg-day)} = \frac{Cd*IngR*EF*ED*CF*ME}{BW*AT}$$

Cd - Concentration in sediment =	mg/kg	see below	
IngR - Ingestion rate for sediment =	mg/day	200	USEPA 1997, EFH
EF - Exposure frequency =	days/year	40	reasonable assumption
ED - Exposure duration =	years	6	USEPA 1995, Region IV
CF - Conversion factor =	kg/mg	1.00E-06	
ME - Matrix effect =		1	Magee, et al., 1996
BW - Body weight =	kg	15	USEPA 1995, Region IV
AT_n - Averaging time - noncarcinogenic =	days	2190	USEPA 1991, HHEM
AT_c - Averaging time - carcinogenic =	days	25550	USEPA 1991, HHEM

Constituent	Concentration in Sediment mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles							
2-Nitroaniline	4.20E-02	6.14E-08	NA	NA	5.26E-09	NA	NA
2-Nitrophenol	8.40E-02	1.23E-07	NA	NA	1.05E-08	NA	NA
3-Nitroaniline	8.40E-02	1.23E-07	NA	NA	1.05E-08	NA	NA
4-Bromophenylphenylether	8.40E-02	1.23E-07	NA	NA	1.05E-08	NA	NA
4-Chloro-3-methylphenol	8.40E-02	1.23E-07	NA	NA	1.05E-08	NA	NA
4-Chlorophenylphenylether	4.20E-02	6.14E-08	NA	NA	5.26E-09	NA	NA
4-Nitroaniline	8.40E-02	1.23E-07	NA	NA	1.05E-08	NA	NA
Benzo(a)anthracene	9.30E-01	1.36E-06	NA	NA	1.16E-07	7.30E-01	8.50E-08
Benzo(a)pyrene	9.70E-01	1.42E-06	NA	NA	1.21E-07	7.30E+00	8.87E-07
Benzo(b)fluoranthene	1.40E+00	2.05E-06	NA	NA	1.75E-07	7.30E-01	1.28E-07
Benzo(k)fluroanthene	5.00E-01	7.31E-07	NA	NA	6.26E-08	7.30E-02	4.57E-09
Bis(2-chloroethoxy)methane	8.40E-02	1.23E-07	NA	NA	1.05E-08	NA	NA
Bis(2-chloroethyl)ether	4.20E-02	6.14E-08	NA	NA	5.26E-09	1.10E+00	5.79E-09
Carbazole	2.20E-01	3.21E-07	NA	NA	2.76E-08	2.00E-02	5.51E-10
Chrysene	1.30E+00	1.90E-06	NA	NA	1.63E-07	7.30E-03	1.19E-09
Dibenz(a,h)anthracene	1.50E-01	2.19E-07	NA	NA	1.88E-08	7.30E+00	1.37E-07
Hexachlorobenzene	4.20E-02	6.14E-08	NA	NA	5.26E-09	1.60E+00	8.42E-09
Hexachlorocyclopentadiene	2.10E-01	3.07E-07	NA	NA	2.63E-08	NA	NA
Indeno(1,2,3-cd)pyrene	5.40E-01	7.89E-07	NA	NA	6.76E-08	7.30E-01	4.94E-08
N-nitrosodi-n-propylamine	4.20E-02	6.14E-08	NA	NA	5.26E-09	7.00E+00	3.68E-08

NA - Not Available

Total Cancer Risk = 1.34E-06

ENVIRONMENTAL STANDARDS

kkoerber@envstd.com on 04/03/2001 09:09:51 AM

To: Gretchen_Zmitrovich@deq.state.ms.us
cc: m.pisani@ix.netcom.com

Subject: RE: gulf states risk assessment

Gretchen:
Attached is the text for the Hattiesburg Risk Assessment revised per your verbal comments from March 21. The revisions have been marked for ease of review and are limited to the Executive Summary, Section 6.8, and Section 8.0. Our conclusions and remediation plans do not change as a result of the revisions.

Hard copies of the revised tables are being sent to you for Wednesday AM delivery.
<<8Hattiesburg.doc>>
Thank you for your thorough review and we look forward to your approval of this report.

Kind regards,
Kathy Koerber
Senior Risk Assessor
Environmental Standards, Inc.
1140 Valley Forge Road
P.O. Box 810
Valley Forge, PA 19482-0810
610-935-5577 Phone
610-935-5583 Fax
KKoerber@EnvStd.com
www.EnvStd.com

-----Original Message-----
From: Gretchen_Zmitrovich@deq.state.ms.us [SMTP:Gretchen_Zmitrovich@deq.state.ms.us]
Sent: Wednesday, March 21, 2001 10:44 AM
To: kkoerber@envstd.com
Subject: gulf states risk assessment

(See attached file: Gulf State risk assessment.xls)(See attached file: Gulf State Creosote data.xls) << File: Gulf State risk assessment.xls >> << File: Gulf State Creosote data.xls >>

- 8Hattiesburg.doc

HUMAN HEALTH RISK ASSESSMENT

FOR THE FORMER GULF STATES CREOSOTING FACILITY,

HATTIESBURG, MISSISSIPPI

~~March 1, 2001~~April 3, 2001

Prepared for:

KERR-MCGEE CHEMICAL LLC
123 Robert S. Kerr Avenue
P.O. Box 25861
Oklahoma City, OK 73125-0861

Prepared by:

ENVIRONMENTAL STANDARDS, INC.
1140 Valley Forge Road
P.O. Box 810
Valley Forge, PA 19482-0810

Table of Contents

Page

Table of Contents (Cont.)

Executive Summary

A baseline human health risk assessment (HHRA) was conducted for the Former Gulf States Creosoting facility in Hattiesburg, Mississippi. The HHRA was performed in accordance with: Mississippi Commission on Environmental Quality's (MCEQ's) *Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi* (1999); US EPA's *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* (1989); US EPA Region 4 guidance entitled *Technical Services Supplemental Guidance to RAGS, Region 4 Bulletins* (1995); and other relevant US EPA guidance documents.

Creosoting constituents of potential health concern include polycyclic aromatic hydrocarbons (PAHs), of which benzo(a)pyrene is the predominant contributor to potential risks. Much of the former creosoting process area is currently covered with asphalt or large building structures. Potential future exposure scenarios included a construction worker, a maintenance worker, an infrequent Site visitor, and off-Site residents. Media of concern included soils, sediment, and surface water.

Hazards posed by chemical constituents in soils, sediment, and surface water for health effects other than an increased risk of cancer were well below a threshold of possible concern for each receptor evaluated in this risk assessment. Cancer risks for all exposure scenarios were within or below the US EPA's acceptable target risk range of 1×10^{-6} to 1×10^{-4} (*i.e.*, one in one million to one in ten thousand) with the exception of maintenance worker exposure to soils in EU4 and off-site resident exposure to sediments in EU6. The added lifetime cancer risk conservatively estimated for a maintenance worker was ~~1~~4 × 10^{-34} for the entire Site, while that for the off-site resident was 2×10^{-4} for the entire Site. The potential risk for a construction worker was estimated to be 5×10^{-5} for the entire Site. The estimated potential risk for an adolescent Site visitor was ~~2~~7 × 10^{-5} for the entire Site. For the Site visitor, maintenance worker, and construction worker scenarios, oral contact with ~~benzo(a)pyrene~~carcinogenic PAHs in sediment and soils drove the cancer risk level. For the off-Site resident scenario, oral contact with ~~benzo(a)pyrene~~carcinogenic PAHs in sediment drove the cancer risk level.

Risk levels are mainly attributable to residual concentrations of carcinogenic polycyclic aromatic hydrocarbons (cPAH) in EUs 4, 5, and 6. Remedial actions currently planned for these areas, including deed restrictions, will result in incomplete exposure pathways thereby resulting in acceptable levels of risks to potential receptors. Proposed remediation activities to address impacted media in EUs 4, 5, and 6 include the following:

- Conduct in-situ biological treatment of impacted soils in the unpaved area between the former Process Area and the Southern railroad tracks (EU4);
- Attempt to recover free product from targeted areas within the former Process Area to address continuing sources (EU5);

- Remove impacted sediments from the northeast drainage ditch and install a culvert to provide for surface drainage (EU6);
- Establish deed restrictions limiting the use of property to non-residential (i.e., "restricted") purposes (EU4 and EU5); and
- Include in the deed restrictions provisions for maintaining pavement to preclude contact with impacted media left in place (EU5).

Constituent concentrations in surface soils at two isolated locations within EU2 also resulted in maintenance worker risk levels slightly greater than 1×10^{-6}. Because these locations are within a densely wooded area where no maintenance activities currently occur and remediation would require significant clearing, no remediation activities are planned to address surface soils at these locations. Deed restrictions limiting the use of properties within EU2 to non-residential purposes will be established.

1.0 Introduction

Environmental Standards, Inc. (Environmental Standards) was retained by Kerr-McGee Chemical Corporation (Kerr-McGee) to perform a human health risk assessment (HHRA) to evaluate hazards and risks potentially posed by residual levels of chemicals present at the Former Gulf States Creosoting facility (Site). The Site, located near the intersection of US Highways 49 and 11 in Hattiesburg, Mississippi, was formerly a wood treating facility that operated between the early 1900s and 1960. In the early 1960s, the Site was redeveloped for commercial and light industrial uses (Michael Pisani & Assoc., 1997). The land on which the Site is located is a portion of the Sixteenth Section land owned by the Hattiesburg Public School District and leased to the current tenants under a 99-year lease, granted on July 7, 1947. At the time of this report, the Site, with the exception of the grassy and wooded areas in the south and southwest, respectively, was primarily used for automobile dealerships. There are no residential or institutional (*i.e.*, schools) uses of the Site (Michael Pisani & Assoc., 1997).

Operations at the Site consisted of a small-scale wood preserving process using creosote. The creosoting process was primarily confined to a 2.5-acre area in the northeast corner of the Site; this is known as the former Process Area and is currently occupied by Courtesy Ford. During the redevelopment of the Site in the early 1960s, construction debris (*e.g.*, broken concrete, asphalt, etc.) appears to have been relocated to the southwestern corner of the Site along Gordon's Creek. This area is known as the Fill Area and currently remains undeveloped.

This assessment has been conducted as a result of an agreement between Kerr-McGee, the Mississippi Department of Environmental Quality (MDEQ), and the Mississippi Commission on Environmental Quality (MCEQ) pursuant to the Uncontrolled Site Voluntary Evaluation Program. The MDEQ Office of Pollution Control, Uncontrolled Sites Section has been providing oversight and review of investigations and reports relating to the former Gulf States Creosoting facility.

This report will address the potential for on-Site exposures to human receptors and off-Site exposures to humans along the northeast drainage ditch.

The primary guidance used to develop this risk assessment was the MCEQ *Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi* (1999). US EPA Region 4's *Technical Services Supplemental Guidance to RAGS: Region 4 Bulletins* (1995) were also referred to for guidance. Additional US EPA guidance documents cited herein include:

- *Guidance for Remediation of Uncontrolled Hazardous Substance Sites in Mississippi (MDEQ, 1990);*
- *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual/ Part A (RAGS/Part A)* (US EPA, 1989);
- *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (US EPA, 1991);
- *Exposure Factors Handbook* (US EPA, 1997);
- *Guidelines for Exposure Assessment* (US EPA 1992);
- *Dermal Exposure Assessment: Principles and Applications* (US EPA, 1992);

These documents are not listed in a hierarchical manner; other US EPA guidance documents and peer-reviewed technical papers may have also been referenced in this risk assessment report.

2.0 Hazard Identification and Conceptual Site Model

As a result of the historical wood preservation process, residual levels of creosote-related chemicals are present in soils in the former Process Area. Sediment and surface water in a drainage ditch along the southeast border of the former Process Area also contain chemical residuals. These Site-related chemicals, mostly polycyclic aromatic hydrocarbons (PAHs) are also present in the Fill Area. Residual levels of PAHs have been found in soil in the Fill Area and in Gordon's Creek surface water and sediment.

PAH residuals have also been detected in shallow groundwater underlying the Site. Currently, there are no private water wells located on-Site that access this shallow groundwater for potable purposes. The results of a door-to-door survey conducted by Michael Pisani and Associates on October 3, 2000 indicated no private uses of shallow groundwater downgradient of the Site. For these reasons, the groundwater exposure pathway, both on- and off-Site, was considered incomplete and not evaluated in this assessment.

A conceptual site model (CSM) was developed for the Site to aid in determining the potential receptors and exposure units to be evaluated under current and future potential land use (Figure 1). These receptors were identified as infrequent Site visitors, maintenance workers, construction workers, and off-Site residents.

Under current land use assumptions, Site visitors may potentially contact residual chemicals in Gordon's Creek surface water and sediment, and/or surface soils in the Fill Area and surrounding woods, the grassy field southeast of the Fill Area, and/or the drainage ditch along side of the former Process Area. Visitors may also potentially contact surface soil, surface water, and sediment along the former Process Area drainage ditch. The remaining affected areas of the Site are covered with either buildings or pavement precluding casual direct contact with surface soils. As a conservative measure, however, visitor exposure to soils from these paved areas was also assessed.

Under both current and future land use assumptions, a maintenance worker may contact surface soils in the Fill Area and surrounding woods, the grassy field southeast of the Fill Area, and/or the former Process Area and surrounding affected areas, including the drainage ditch located to the southeast of the former Process Area. Although most of the former Process Area and vicinity are paved, maintenance activities may involve some shallow digging; therefore, direct contact with shallow soils in this area was assessed.. As a conservative measure, exposure to surface water and sediment in Gordon's Creek was assessed. The remainder of the Site was relatively unaffected by historical creosoting activities.

Although there are currently no major construction activities at the Site, these types of activities may occur at some time in the future. As with the maintenance worker scenario, construction activities could potentially occur in the Fill Area and vicinity, the grassy field southeast of the Fill Area, and the former Process Area and vicinity. Construction workers may be exposed to both surface and subsurface soils (down to the water table). Construction worker exposure to surface water and sediment in Gordon's Creek was assessed as a conservative measure. The remainder of the Site was relatively unaffected by historical creosoting activities.

Areas of the Site affected by historical creosoting activities will be deed restricted prohibiting future residential development. Off-Site areas along the northeast Drainage Ditch, currently a residential neighborhood, were assessed for residential exposures to soil, sediment, and surface water.

3.0 Data Evaluation

To characterize potential exposures to Site-related chemicals, the former Gulf States Creosoting facility was divided into six exposure units (EUs). Each exposure unit outlines potentially affected areas of the Site and adjacent on-Site locales that may be frequented by individuals accessing the Site for recreational or occupational purposes. The use of EUs is encouraged by the US EPA Region 4 (1995), which defines an EU as "an areal extent of a receptor's movements during a single day… ." Each of these exposure units is depicted on Figure 2 and is discussed below.

A sixth EU was created for off-Site residential exposures to surface water and sediment along the northeast Drainage Ditch. This EU is delineated on Figure 3.

3.1 Exposure Unit Delineation

The following EUs were delineated based upon the presence of residual chemicals and the potential for receptors to contact those chemicals. Areas of the Site most affected were included in at least one of the five EUs while areas with relatively low or non-detectable concentrations of residuals were not included in an EU. By limiting Site-wide exposures to the EUs most affected by historical activities at the Site, worst-case scenarios were created.

3.1.1 Exposure Unit 1

EU1 outlines the on-Site areas in, adjacent to, and downstream of the Fill Area along Gordon's Creek (Figure 2). EU1 includes exposures to surface water and sediment by an infrequent Site visitor, future maintenance worker, and future construction worker. Although US EPA Region IV guidance indicates that "In most cases it is unnecessary to evaluate human exposures to sediments covered by surface water," (US EPA, 1995) dermal and oral surface water exposures were conservatively assessed herein at the request of the MDEQ (2000). Sediment samples included in EU 1 were SD07 and SD08. Surface water samples included in were SW-07 and SW-08.

Soil samples from this area were considered part of EU2 and exposures were assessed accordingly.

3.1.2 Exposure Unit 2

EU2 delineates the upland areas of the Fill Area and adjacent woody and grassy areas (Figure 2). Surface soils from zero to one foot and zero to six feet below ground surface [bgs] in this area were evaluated for potential visitor and future hypothetical maintenance worker scenarios, respectively. Surface and subsurface soils were also evaluated for a hypothetical future construction worker scenario. Available data for subsurface soils for a construction scenario were evaluated from the surface to the water table (approximately 10 feet bgs) as recommended by the MDEQ (2000). Soil samples included in EU2 are presented in the table below:

Soils (0-1' bgs)	GEO-13/0-1'	SS-1	SS-2	SS-3	SS-4
	SS-5	SS-6	SS-7	SS-8	SS-9
	SS-10	SS-11	SS-12	SS-13	
Soils (0-6' bgs)	GEO-03/2-3'	GEO-03/5-6''	GEO-10/2-3	GEO-10/5-6	GEO-13/0-1'
	GEO-13/2-3'	GEO-13/5-6'	GEO-44/5-6'	SS-1	SS-2
	SS-3	SS-4	SS-5	SS-6	SS-7
	SS-8	SS-9	SS-10	SS-11	SS-12
	SS-13				
Soils (0-10' bgs)	GEO-03/2-3'	GEO-03/5-6'	GEO-10/2-3	GEO-10/5-6'	GEO-13/0-1'
	GEO-13/2-3'	GEO-13/5-6'	GEO-43/7-8'	GEO-44/5-6'	GEO-45/7-8'
	SB-03/8-9.3	SB-05/4-9	SB-07/5-7	SS-1	SS-2
	SS-3	SS-4	SS-5	SS-6	SS-7
	SS-8	SS-9	SS-10	SS-11	SS-12
	SS-13				

3.1.3 Exposure Unit 3

In the southwest corner of the Site there exists a grassy field east of West Pine Street between Henson Auto Sales and Eagan Cars and Trucks. This grassy area has been defined as EU3 for purposes of this risk assessment (Figure 2). Similar to EU2, surface soil from zero to one foot and zero to six feet bgs were evaluated in EU2 for visitor and hypothetical future maintenance worker scenarios, respectively. Surface and subsurface soils in this EU were evaluated for a hypothetical future construction worker scenario. Available data for subsurface soils for a construction scenario were evaluated from the surface to the water table(approximately 20 feet bgs) as recommended by the MDEQ (2000). Soil samples included in EU3 are presented in the table below:

Soils (0-1' bgs)	SS-15	SS-16	SS-17		
Soils (0-6' and 0-20' bgs)	GEO-16/2-3'	GEO-16/5-6'	GEO-17/2-3'	GEO-17/5-6'	SS-15
	SS-16	SS-17			

3.1.4 Exposure Unit 4

EU 4 encompasses the grassy drainage ditch area along the fenceline behind Courtesy Ford in the northeast corner of the Site and continues parallel to the railroad tracks, and west through EU 3 and EU 2 (Figure 2). EU 4, along the southeast side of the former Process Area, has been widened to include soil data from that area. Receptors associated with EU 4 included Site visitor exposures via casual contact with surface soil, sediment, and surface water. Maintenance worker and construction worker scenarios were also evaluated for exposures to surface water and sediment in EU 4 as well as soils in EU 4 near the former Process Area. Soils down to six feet bgs were evaluated for maintenance workers while soils down to the water table (approximately20 feet bgs) were evaluated for construction workers in this EU as requested by the MDEQ (2000). Sediment, surface water, and soil samples included in EU4 are presented in the following table:

Sediment	SD-02	SD-12	SD-18	SD-19	SD-20
	SD-21	SD-22	SD-23		
Surface Water	SW-02				
Soils (0-1' bgs)	GEO-19/0-1'	GEO-20/0-1'	GEO-21/0-1'	GEO-46/0-1'	GEO-47/0-1'
	GEO-48/0-1'				
Soils (0-6' bgs)	GEO-19/0-1'	GEO-19/2-3'	GEO-19/5-6'	GEO-20/0-1'	GEO-20/2-3'
	GEO-20/5-6'	GEO-21/0-1'	GEO-21/2-3'	GEO-21/5-6'	GEO-46/0-1'
	GEO-46/2-3'	GEO-46/5-6'	GEO-47/0-1'	GEO-47/2-3'	GEO-47/5-6'
	GEO-48/0-1'	GEO-48/2-3'	GEO-48/5-6'		
Soils (0-20' bgs)	GEO-19/0-1'	GEO-19/2-3'	GEO-19/5-6'	GEO-20/0-1'	GEO-20/2-3'
	GEO-20/5-6'	GEO-20/9-10'	GEO-21/0-1'	GEO-21/2-3'	GEO-21/5-6'
	GEO-21/9-10'	GEO-46/0-1'	GEO-46/2-3'	GEO-46/5-6'	GEO-47/0-1'
	GEO-47/2-3'	GEO-47/5-6'	GEO-47/7-8'	GEO-48/0-1'	GEO-48/2-3'
	GEO-48/5-6'				

3.1.5 Exposure Unit 5

EU5 outlines the former Process Area and the historical drip track and treated wood storage areas of the former Gulf States Creosoting facility (Figure 2). Surface soils from zero to six feet bgs were evaluated in EU5 for a hypothetical maintenance worker scenario. Available data for soils down to the water table (approximately 20 feet bgs) were evaluated in EU5 for a hypothetical future construction worker scenario. Soil samples included in EU5 are presented in the table below:

Soils (0-1' bgs)	GEO-28/0-1'	GEO-29/0-1'	GEO-30/0-1'	GEO-31/0-1'	GEO-32/0-1'
	GEO-33/0-1'	GEO-59/0-1'	GEO-60/0-1'		
Soils (0-6' bgs)	GEO-28/0-1'	GEO-28/2-3'	GEO-28/5-6'	GEO-29/0-1'	GEO-29/2-3'
	GEO-29/5-6'	GEO-30/0-1'	GEO-30/2-3'	GEO-30/5-6'	GEO-31/0-1'
	GEO-31/2-3'	GEO-31/5-6'	GEO-32/0-1'	GEO-32/2-3'	GEO-32/5-6'
	GEO-33/0-1'	GEO-33/2-3'	GEO-33/5-6'	GEO-59/0-1'	GEO-59/2-3'
	GEO-59/5-6'	GEO-60/0-1'	GEO-60/2-3'	GEO-60/5-6'	
Soils (0-20' bgs)	GEO-28/0-1'	GEO-28/2-3'	GEO-28/5-6'	GEO-29/0-1'	GEO-29/2-3'
	GEO-29/5-6'	GEO-30/0-1'	GEO-30/2-3'	GEO-30/5-6'	GEO-31/0-1'
	GEO-31/2-3'	GEO-31/5-6'	GEO-32/0-1'	GEO-32/2-3'	GEO-32/5-6'
	GEO-33/0-1'	GEO-33/2-3'	GEO-33/5-6'	GEO-59/0-1'	GEO-59/2-3'
	GEO-59/5-6'	GEO-60/0-1'	GEO-60/2-3'	GEO-60/5-6'	GEO-60/7-8'
	SB-01/8-10	SB-02/9-11	SB-05/10.5-12.5	SB-06/6-10	SB-07/14-16

3.1.6 Exposure Unit 6

EU6 outlines a stretch (approximately 2700 feet in length) of the northeast drainage ditch that leads from the Site into the neighboring residential area. EU6 exposures include oral and dermal exposures by off-Site residents to sediment and surface water along the northeast drainage ditch. Soil exposures were not assessed in this area for lack of soil data. Also, it was anticipated that sediment exposures in this area represent a more conservative estimate of exposure in that chemical concentrations in the exposed sediment along the drainage ditch are likely to be greater than concentrations in the surrounding soils. Sediment and surface water samples included in EU6 are presented in the table below:

Sediment	SD-03	SD-04	SD-05	SD-13
	SD-14	SD-15	SD-16	SD-17
Surface Water	SW-03	SW-04		

3.2 Statistical Evaluation

Environmental samples undergo laboratory analyses that are designed to quantitate the concentrations of constituents in the various environmental media. As a result of the analytical procedures, a constituent may be detected and its concentration measured, detected but not able to be quantitated, or not detected at all in a sample. The data set for the Site contains a number of nondetections for some chemicals of potential concern (COPCs) in various samples. Assuming that the COPC is present in these samples at the achieved detection limit is biased because the chemical may be absent altogether. Assuming a concentration of zero is also flawed because the chemical could be present at a level below laboratory capabilities to detect and quantify the concentration. Consequently, in the event that an analyte identified at least once in a given medium was not detected in a given sample, it was conservatively assumed for the risk assessment purposes to be present at a concentration equivalent to one-half of the sample quantitation limit (SQL). In addition, samples labeled with an "R" (rejected) qualifier were not included in the data analysis because those data were deemed unreliable and, therefore, unusable. Constituents that were not detected in any sample from a particular medium were eliminated from further consideration in accordance with US EPA guidelines (1989).

Site analytical data used in this assessment were collected during the Phase I (1997) and Phase II (1998) remedial investigations as well as the additional investigation conducted in 2000 at the request of the MDEQ. These data were fully validated by qualified technical professionals using standard data validation protocols, as required by the MCEQ (1999).

Previous investigations at the Site have been conducted since 1990. These investigations included the following:

- 1990 soil gas and soil sampling by Roy F. Weston
- 1991 MDEQ Site inspections and Phase II report
- 1994 Phase II Site investigation by Environmental Protection Systems (EPS)
- 1994 Site investigation by Bonner Analytical Testing Company (BATCO)

- 1994 preliminary subsurface investigation by BATCO
- 1995 three-dimension resistivity surveys by American Remediation Technology
- 1996 investigation by McLaren/Hart
- 1996 investigation by Kerr McGee Chemical Corporation

Data acquired from these historical (pre-1997) investigatory activities were not used in this assessment as they were not validated by qualified chemists and sampling locations for some of the data could not be accurately established. These historical data were not considered valid and were, therefore, not appropriate to use in this assessment of risks. Only validated data that were considered to be representative of Site conditions with a reasonable level of confidence were used for this assessment.

The validated laboratory data from 1997, 1998, and 2000 investigations were compiled into data sets representing areas of potential exposure (EUs) for each potential receptor. Each data set was analyzed statistically using SiteStat®, a commercially available software package, to calculate the minimum, maximum, arithmetic mean, logarithmic mean, standard error of the mean, and the 95% upper confidence limit of the mean concentration (95% UCL) for each constituent based on distributional analysis of the data (*i.e.*, utilizing goodness-of-fit statistical tests to determine whether the data are distributed normally or lognormally). The data qualifier associated with the minimum and maximum detected concentrations as well as the location of the maximum detected concentration for each EU were also determined. Results of the quantitative and statistical analyses for each of the EUs discussed above are presented in Tables 1 through 18.

Standard sampling protocol requires the collection of duplicate field samples used to ensure the quality of a laboratory analysis (i.e., to ensure that analytical results can be replicated). As such, duplicate sample results were provided as part of the database for the Hattiesburg Site. In accordance with US EPA guidance (1989), duplicate sample results were averaged (for any sample containing duplicates) and the average concentration was used as a single concentration for that sample in the calculation of summary statistics as discussed below.

Soils down to one foot deep were assumed to be representative of surface soils at the Site for infrequent visitor exposures. A depth of 0 to 6 feet was used to define surface soils for maintenance worker exposures. These assumptions were recommended by the MDEQ (2000). The groundwater table was considered the extent of subsurface soils as recommended by MDEQ (2000). This value (depth-to-groundwater) varies significantly across the Site and, as such, the extent of subsurface soil was EU-specific as follows:

EU2 – soils down to 10 feet
EU3 – soils down to 20 feet
EU4 – soils down to 20 feet
EU5 – soils down to 20 feet

This risk assessment focuses mainly on environmental data collected from the former Process and Fill Areas and any other portions of the Site that were affected by former creosoting operations. Virtually unaffected areas (e.g., the developed area north of West Pine Street) as delineated using historical data were not considered to contribute significantly to risk levels and, therefore, were excluded from this risk assessment.

3.3 Determination of Exposure-Point Concentrations

Exposure-point concentrations were determined to be the 95% UCL or the maximum concentration of a COPC in an EU, whichever was lower. This methodology is in accordance with US EPA guidance (1989). If the distribution of the concentration data was determined to be lognormal, then the lognormal 95% UCL was compared to the maximum concentration to determine the exposure-point concentration. In the event that the distribution of a chemical in any given medium could not be confidently labeled as normal or lognormal, it is termed either "unknown" or "normal/lognormal." In these cases, the lognormal 95% UCL was compared to maximum concentration when determining the exposure-point concentration. It should be noted, however, that in cases where the distribution is "unknown," the normal and lognormal 95% UCLs could not be reliably predicted. Assuming a lognormal distribution of the data increases the uncertainty associated with this step of the risk assessment process; however, hazard and risk estimates are likely to be less uncertain than if the maximum concentrations were used.

Exposure-point concentrations are provided on the statistical summary tables, Tables 1 through 18.

3.4 COPC Selection

Soils (both surface and subsurface) were screened according to MCEQ (1999) guidance. The first tier of the screening process compared maximum concentrations of a constituent in an EU with the Restricted Tier 1 target remediation goal (TRG) for maintenance worker and construction worker scenarios. Restricted TRGs were used because the Site is not currently used for residential purposes and the current commercial/industrial land-use is anticipated to remain into the future as a result of the implementation of deed restrictions on the impacted areas of the Site. If a maximum concentration of a constituent was less than the Restricted Tier 1 TRG, then that constituent was eliminated from further quantitative assessment.

Surface soil data (zero to one foot bgs) for the visitor scenario were screened using Unrestricted Tier 1 TRGs at the request of MDEQ (2000). If a maximum concentration of a constituent was less than the Unrestricted Tier 1 TRG, then that constituent was eliminated from further quantitative assessment. Conversely, if the maximum concentration of a constituent exceeded the Tier 1 TRG, that constituent was retained for quantitative analysis.

If the maximum concentration of a constituent in an EU exceeded the Tier 1 TRG, then the 95% UCL of the constituent was compared to the Tier 1 TRG (Restricted or Unrestricted, depending on the exposure scenarios as described above) as part of the Tier II screening process. In the event that the concentrations of a chemical were distributed lognormally, the lognormal 95%

UCL of that constituent was compared to the Tier 1 TRG. If the distribution of data of a chemical could not be positively identified as either normal or lognormal, the lognormal 95% UCL was used in the screening process. In these cases, either the maximum concentration or the lognormal 95% UCL can be conservatively used. The US EPA, however, justifies the use of an average concentration as the exposure-point concentration by explaining that toxicity criteria for both carcinogenic and non-carcinogenic effects are based on lifetime average exposures and that the "average concentration is most representative of the concentration that would be contacted at a site over time" (*Supplemental Guidance to RAGS: Calculating the Concentration Term*, 1992). Other US EPA guidance states that "...in most situations, assuming long-term contact with the maximum concentration is not reasonable" (*Risk Assessment Guidance for Superfund, Part A*, 1989). US EPA Region 4 also states that, generally, it is reasonable to assume that soil data are distributed lognormally (1995). In keeping with these guidances, the lognormal 95% UCL was considered in the screening process where the data distribution for a compound could not be defined as specifically normal or lognormal.

If the 95% UCL (or lognormal 95% UCL where appropriate) of a constituent was less than the Tier 1 TRG, then that constituent was eliminated from further quantitative analysis. If the 95% UCL (or lognormal 95% UCL where appropriate) of a constituent in soil exceeded the Tier 1 TRG, then that constituent was retained for quantitative analysis in the Site-specific risk assessment (Tier III).

MCEQ guidance (1999) does not specify screening levels for constituents in sediment or surface water; therefore, Region 4 was referred to for guidance (1995). Sediment is only found on the Site in drainage ditches that contain little to no water most of the time. US EPA Region 4 guidance states that sediments in an intermittent stream (or ditch) should be considered as surface soil for the portion of the year the stream is without water. Based on these factors and comments provided by the MDEQ (2000), the maximum detected constituent concentrations in sediment was compared to MCEQ unrestricted Tier 1 TRGs. The screening process then followed the same procedure as mentioned above for other soils.

For surface water, the maximum detected concentration of a constituent in an EU was compared to the US EPA Human Health Water Quality Standard (WQS) for consumption of water and organisms in accordance with US EPA Region 4 guidance (1995). If the maximum concentration of a constituent in surface water was less than the WQS, then that constituent was eliminated from quantitative analysis. If the maximum concentration of a constituent in surface water exceeded the WQS, then that constituent was retained for quantitative analysis.

At the request of MDEQ (2000), if any single carcinogenic polycyclic aromatic hydrocarbon (cPAH) was retained as a COPC in a medium, then all cPAHs were also retained as COPCs in that medium. This guidance refers to the following chemicals: benzo(a)anthracene, benzo(b)fluoroanthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. To establish an exposure point concentration for undetected cPAHs retained as COPCs in an EU, one-half the maximum detection limit was used.

The results of the screening process are presented on the statistical summary tables, Tables 1 through 18. The screening process eliminated detected constituents from the subsurface soil dataset down to 20 feet bgs and surface soil dataset down to 6 feet bgs in EU3 For this reason, construction worker and maintenance worker exposures to soils in EU3 were not evaluated quantitatively in this assessment.

4.0 Exposure Assessment

Currently, a majority of the Site is used for commercial and light industrial purposes and is paved for roads and parking lots. Unpaved areas are limited to Gordon's Creek (EU 1), the wooded portion in and around the Fill Area (EU2) and the grassy field outlined by EU 3, and the drainage ditches and surrounding area delineated by EU 4 (Figure 2). Since the developed and undeveloped areas of the Site vary considerably with respect to both residual chemical concentrations and land use, the Site was divided into five EUs for the exposure assessment. A sixth EU was created to assess off-Site residential exposures. Chemical data from each EU were combined with EU-specific exposure parameter values and receptor scenarios to determine the chemical intake for each receptor potentially accessing an EU for occupational, recreational, or residential purposes.

4.1 Receptor Identification

The following exposures pathways (indicated with an "X") have been selected for this risk assessment as reasonable and realistic scenarios under current and future land-use assumptions:

EU/Media:	**EU1**		**EU2**	**EU3**	**EU4**			**EU5**	**EU6**	
Receptor/Route:	Sed.	Surf. Water	Soil	Soil	Soil	Sed.	Surf. Water	Soil	Sed.	Surf. Water
Visitor										
Dermal	X	X	X	X	X	X	X	X		
Oral	X	X	X	X	X	X	X	X		
Inhalation										
Maint. Worker										
Dermal	X	X	X	X	X	X	X	X		
Oral	X	X	X	X	X	X	X	X		
Inhalation										
Const. Worker										
Dermal	X	X	X	X	X	X	X	X		
Oral	X	X	X	X	X	X	X	X		
Inhalation			X	X	X			X		
Off-Site Resident										

EU/Media:	EU1		EU2	EU3	EU4			EU5	EU6	
Receptor/Route:	Sed.	Surf. Water	Soil	Soil	Soil	Sed.	Surf. Water	Soil	Sed.	Surf. Water
Dermal									X	X
Oral										X
Inhalation										

Surface water present on-Site is either ephemeral or very shallow and is conducive only to wading-type activities. Ingestion of Site surface water was considered an insignificant exposure pathway since on-Site drainage ditches "contain little or no water most of the time" (MDEQ, 2000). In addition, US EPA IV guidance indicates that "In most cases, it is unnecessary to evaluate human exposures to sediments covered by surface water" (1995). At the request of MDEQ (2000), however, dermal and oral exposures to surface water were assessed for visitors, maintenance workers, and construction workers in EUs 1 and 4. Surface water exposures were also assessed for residents in off-Site EU 6.

Each of the potential receptors is discussed below.

4.1.1 Infrequent Site Visitor

Since the Site is not currently fenced or guarded, the general public has access to most areas of the Site at any given time. It is possible, though unlikely, that an individual may use some areas of the Site, such as EU1, EU2, or EU3, for recreational purposes. For this reason, sediment and surface water exposures to visitors in EU1, and surface soil exposures in EU2 and EU3 were assessed for the visitor scenario. The vast majority of the remainder of the Site (EU5) is covered with either buildings or pavement, precluding direct contact with surface soils; however, a small exposed area encompassing a drainage ditch exists along side of the former Process Area (EU4). Although this area is not attractive for recreational purposes, it is possible that an individual traversing the Site may contact surface soils, sediment, or surface water in this EU; therefore, these potential exposures were assessed. Sediment exposures in EU1 and EU4 were addressed in accordance with US EPA Region 4 guidance that recommends evaluating sediment exposures in intermittent streams. At the request of MDEQ (2000), soil exposures were assessed for visitors

in EU5 regardless of the existence of buildings and pavements precluding almost all potential direct contact with soils in this area.

4.1.2 Maintenance Worker

Currently, maintenance activities are most likely limited to the developed portions of the Site. Of these, the former Process Area and adjacent former drip track and treated wood storage areas (EU5) were most affected by historical wood preserving processes. Although these areas are mostly paved or built upon, it is possible that maintenance activities may require some shallow digging in unpaved areas; therefore, exposures to surface soils in EU5 were assessed. As a conservative measure, surface soil data from sample locations located in paved areas were evaluated in conjunction with surface soil data from exposed areas in EU5. If the currently undeveloped portions of the Site (EU2 and EU3) become developed in the future, similar maintenance activities may be required and, therefore, exposures to surface soils in EU2 and EU3 were also assessed. The drainage ditch encompassed by EU4 requires periodic maintenance; therefore, exposures to soil, sediment, and surface water in this area were assessed. At the request of MDEQ (2000), maintenance worker exposures to surface water and sediment in EU 1 were also assessed.

4.1.3 Construction Worker

Although there are currently no major construction activities at the Site, such activities may hypothetically occur in the future. Thus, exposures to surface water and sediment in EUs 1 and 4, and exposures to soil in EUs 2 through 5 were assessed herein. Construction workers may be exposed to both surface and subsurface soils during activities such as excavating. Subsurface soils, for purposes of this assessment, were defined as those soils at the water table and shallower. Since the depth to the water varies significantly across the Site, so does the definition of "subsurface" soils. Accordingly, subsurface soils were evaluated down to 10 feet for EU2 and 20 feet for EUs 3, 4, and 5.

4.1.4 Future On-Site Residents

The affected areas of the Property (the Site) are currently zoned for industrial or light-commercial use, and, at the time of this report, there were no plans to develop the Site for residential housing. In fact, deed restrictions preventing residential development are in the process of being implemented for the impacted areas on Site. Because of these deed restrictions, it is reasonable and realistic to assume that the Site will remain commercial/industrial in the future; therefore, on-Site residential exposures were not addressed in this risk assessment.

4.1.5 Off-Site Residential Exposures

The northeast drainage ditch extends from the former Process Area to the northeast into a nearby residential community. Surface water and sediment data from areas along the northeast drainage ditch (EU6, Figure 3) were evaluated for off-Site residential exposures. For purposes of exposure assessment, a child resident between the ages of 1 and 6 years and an adolescent/adult resident between the ages of 7 and 30 years were evaluated. Hazards and risks for these two receptors were then combined (summed) to reflect the exposures incurred by a single individual living off-Site in the vicinity of the northeast drainage ditch for 30 years.

4.2 General Intake Equation

Chemical exposure/intake is expressed as the amount of the agent at the exchange boundaries of an organism (*i.e.*, skin, lungs, gut) that is available for systemic absorption. An applied dose is defined as the amount of a chemical at the absorption barriers such as skin, lung, digestive tract, available for absorption and is (usually expressed in milligrams, or mg) absorbed per unit of body weight of the receptor (usually expressed in units of kilogram, or kg). Absorbed dose can be defined as the amount of chemical that penetrates the exchange boundaries. If the exposure occurs over time, the total exposure can be divided by the time period of interest to obtain an average exposure rate (*e.g.*, mg/kg-day). The general equation, as defined by US EPA, for estimating a time-weighted average intake is:

$$\text{Intake (mg/kg - day)} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$ **[Equation 1]**

where:

C	=	chemical concentration at the exposure point (*e.g.*, mg/m^3 air);
IR	=	intake rate (*e.g.*, m^3/hr);
EF	=	exposure frequency (days/year);
ED	=	exposure duration (years);
BW	=	body weight of exposed individual (kg); and
AT	=	averaging time (period over which exposure is averaged, usually measured in days).

Additional parameters (*e.g.*, skin surface area) were incorporated into the above general equation to evaluate the different potential exposure routes (dermal, oral, inhalation).

Table 19 presents the general and pathway-specific exposure parameters utilized for the intake equations in this assessment.

4.2.1 General Exposure Parameters

Although some of the parameters used to calculate potential exposure are pathway- or route-specific, exposure frequency (EF), exposure duration (ED), averaging time (AT; determined separately for carcinogenic and non-carcinogenic exposures), and body weight (BW) are present in each intake model. These general parameters remain consistent throughout the intake calculations for each specific receptor.

4.2.1.1 Exposure Frequency

The exposure frequency (EF) describes the number of times per year an event is likely to occur. It is most often expressed in units of days/year or events/year, depending on the scenario. Variables such as weather, vacations, sick days, and institutional controls often aid in determining reasonable and realistic exposure frequencies.

The EF for an adolescent visitor was extracted from US EPA *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) Interim Final* (1989). This EF value of 12 days/year per EU is a reasonable estimate that assumes an adolescent would most likely be engaged in outdoor activity on the unpaved areas of the Site for one day a week during the three warmest months of the year. This value was used for soil, sediment, and surface water exposures.

Typical construction projects, especially at industrial complexes, generally involve several phases of activity prior to completion. The EF parameter used for oral exposure in construction workers, therefore, was subdivided into two exposure events. The first event hypothetically lasts for 10 days (used in relevant exposure model calculations under "Exposure Level A") and would involve earth-moving activities such as foundation. The second exposure event to the same individual hypothetically lasts for 70 days (for a total of 80 days at the Site for an individual; this value was used in relevant exposure model calculations under "Exposure Level B") and included remaining construction activities such as building framing, plumbing installation, electrical installation, and roofing. Generally, to complete each of these phases, a different team of specialized contractors is employed to perform the tasks for which they are most qualified. As a result, an individual may only remain at the construction site for a few days or weeks until his/her task has been completed and the next phase has begun. This is especially true for those activities involving direct contact with soil such as excavating and foundation pouring. Individuals performing these tasks are not usually qualified or employed to continue with the actual building processes. For dermal and inhalation exposures, however, an 80-day EF was used and accounted for an individual to be involved in construction activities for four entire months of the year (assuming five-day work weeks).

For surface water and sediment exposures to construction workers, an EF value of 8 days/year was used. This value represents $1/10^{th}$ of the time a worker may be on-Site for construction-type activities and is conservative in that it is unlikely that construction workers would be exposed at all to Site surface water or sediment.

The EF value used for the maintenance worker scenario was 150 days/year for surface soil exposures in EUs 2, 3, and 5. This is also a conservative assumption in that the currently developed areas of the Site are covered with buildings or pavement. Maintenance activities in these areas would require little contact with the obscured surface soils. The undeveloped areas of the Site currently require little or no maintenance as they are only occasionally mowed or allowed to grow naturally. Should these areas become developed, they will most likely take on the appearance of the remainder of the Site, including industrial/commercial buildings and paved roads or parking lots. Once again, extensive direct contact with surface soils would be minimal for a maintenance worker.

For maintenance worker sediment and surface water exposures in EUs 1 and 4 and surface soil exposures in EU 4, an EF value of 30 days/year was used. Historically, the northeast drainage ditch has been maintained on an as-needed basis (less than annually). Maintenance worker exposures to sediment and surface water in these areas were assessed at the request of the MDEQ (2000). An EF value of 30 days/year is amply conservative in that both Gordon's Creek (EU 1) and the northeast drainage ditch (EU 4) are currently maintained less than annually.

For residential soil exposures, an exposure frequency of 350 days/year was used in accordance with Region IV guidance. This value assumes that 15 days/year are spent away from home (US EPA, 1991).

Sediments along the bank of the northeast drainage ditch are not comparable to surface soils comprising a yard with respect to exposure. Typically, yard soils include relatively large areas where children frequently play and where surface soils are tracked into the home to become part of the household dust that can be ingested, particularly by crawling infants, on a daily basis. These are the assumptions that underlie the standard residential soil exposure algorithm and parameter values. However, it is not realistic to assume that infants, children, or adults will directly contact a relatively small area of sediments on the banks of a drainage ditch on a daily basis. A more realistic exposure scenario for this unique area under an assumption of residential land use is for a resident child to play on occasion in the drainage ditch that traverses the residential property. An exposure frequency of 40 days/year, two hours per exploring event, is conservatively plausible.

4.2.1.2 Exposure Duration

The ED parameter represents the number of years during which an event is likely to occur. Factors affecting this parameter include variables such as age of receptor, population mobility, and occupational mobility. Exposure durations of less than seven years typically correspond to subchronic exposures while those greater than seven years are typically considered chronic exposures (US EPA, 1989). Toxicity indices are selected based on subchronic or chronic exposure durations.

The future construction worker scenario used an ED of one year because it is highly unlikely that a future construction worker would remain on one site for more than a year. Often, two months is considered the maximum amount of time a construction worker may reasonably remain at the same site.

The future maintenance worker ED, on the other hand, is based on occupational mobility studies. The ED of 25 years was obtained from US EPA (1991) which recommends a 95th percentile value of 25 years based on a study by the Bureau of Labor Statistics as of 1987. US EPA Region 4 also recommends a default value of 25 years for worker scenarios (1995).

The adolescent visitor scenario used an ED of 10 years. An adolescent was defined in this assessment as an individual aged seven to 16 years in accordance with US EPA Region 4 (1995); therefore, an exposure duration of 10 years was most appropriate.

An ED of 30 years (US EPA Region 4, 1995) was used for off-Site residents. This value assumes an individual spends 6 years as a child and 24 years as an adolescent/adult in the same location.

4.2.1.3 Averaging Time

The averaging time (AT) parameter is the time period over which exposure is averaged. For human health cancer risk calculations, the AT_c value prorates a total cumulative dose over a lifetime. As a conservative approach, the AT_c value for each receptor is the product of a 365-day year and a 70-year life span, equaling 25,550 days.

The AT_n used for non-carcinogenic effects is the product of a 365-day year and the exposure duration (*i.e.*, AT_n = 365 days × ED). Because the ED parameter changes for each receptor, the AT_n changes as well. The AT_n values used for each receptor are summarized below:

Future Construction Worker - 365 days
Maintenance Worker - 9125 days
Adolescent Visitor - 3650 days
Off-Site Child Resident – 2,190 days
Off-Site Adult Resident – 8,760 days

4.2.1.4 Body Weight

The body weight used for the adult exposures (future construction worker and maintenance worker) analyzed in this assessment was the current US EPA default value of 70 kg (US EPA, 1989; US EPA Region 4, 1995). This value was also used for the adolescent/adult off-Site resident scenario. The adolescent body weight used for the visitor scenarios was 45 kg. This value was extracted from US EPA Region 4 guidance (1995). For the child resident scenario, a body weight of 15 kg was used as recommended by US EPA (1991).

4.2.2 Route-Specific Exposure Parameters

The general intake equation discussed above (Equation 1) was modified by including route-specific exposure parameters in order to calculate route-specific intake values. For dermal exposures, skin surface area, adherence factor, exposure time (surface water exposures only), and absorption factor parameters were included in the intake equation. For ingestion exposures, an ingestion rate and a matrix effect were included in the intake calculation. For inhalation exposures, an inhalation rate and a retention factor for fugitive dusts were included in the intake equation. Also, for inhalation exposures, an additional paradigm was necessary to convert soil concentrations to concentrations in air available for intake.

4.2.2.1 Dermal Exposure Parameters

Skin Surface Area

The total skin surface area used for adult receptors in this assessment was 20,000 cm^2. This is a US EPA default value extracted from the *Exposure Factors Handbook* (1997). For adolescent exposures, a value of 12,768.3 cm^2 was used for total skin surface area. This was a mean value calculated based on the distributions of total skin surface areas for males and females between the ages of 7 and 16 as presented in *Exposure Factors Handbook* (1997). For the off-Site child resident scenario, a skin surface area of 7,213 cm^2 was used. This value was based on skin surface area data for male and female children provided in *Exposure Factors Handbook* (1997).

For purposes of exposure, it was assumed that only portions of the body would be exposed to the affected media on the Site. For the construction worker scenario, it was assumed that the hands, forearms, lower legs, and face would be exposed to Site soils. These body parts comprise 27.8% of the total skin surface area, or 5560 cm^2.

For maintenance worker exposures to Site soils, it was assumed that the hands, forearms, and face would be exposed. These body parts comprise 15 percent of the total skin surface area, or 3000 cm^2.

For surface water and sediment exposures, exposed body parts for construction and maintenance workers included hands, forearms, and face or 3000 cm^2 (15% of the total skin surface area).

The visitor and off-Site resident scenarios assumed that the hands, forearms, and lower legs would be exposed for contact with Site soils. These body parts comprise 23.9% of the total skin surface area, or 3052 cm^2 for adolescent visitors, 1724 cm^2 for child residents, and 4780 cm^2 for adult residents. For exposures to surface water and sediment, hands, forearms, lower legs, and feet were assumed exposed for adolescent visitor and off-Site resident scenarios. These body parts comprise 30.9 % of the total skin surface area or 3945 cm^2 for adolescent visitors, 2229 cm^2 for child residents, and 6180 cm^2 for adult residents.

Soil Adherence Factor

Until recently, the US EPA-recommended default for soil adherence on skin ranged from 0.2 to 1.0 mg/cm^2 for the entire exposed surface area, without consideration of the type of activity (US EPA, 1992). However, the data from which that range was derived were primarily the result of indirect measurements, artificial activities, and sampling of hands only. A more recent study has presented the results of direct measurement of soil loading on skin surfaces before and after normal occupational and recreational activities that might result in soil contact (Kissel *et al.*, 1996). A five-order of magnitude range (roughly 10^{-3} to 10^{+2} mg/cm^2) was reported for observed activity-related hand loadings. That report indicated that hand loadings within the range of 0.2 to 1.0 mg/cm^2 were produced by activities in which there was vigorous soil contact (*e.g.*, rugby, farming); but for activities in which there was less soil contact (*e.g.*, soccer, professional grounds maintenance), loadings substantially less than 0.2 mg/cm^2 were found on hands and other body parts. Kissel *et al.* (1996) concluded that, because non-hand loadings attributable to higher contact activities exceeded hand loadings resulting from lower contact activities, hand data from limited activities cannot be used as a conservative predictor of loadings that might occur on other body surfaces without regard to activity. Furthermore, because exposures are activity-dependent, dermal exposure to soil should be quantified using data describing human behavior (*e.g.*, type of activity, frequency, duration, including interval before bathing, clothing worn, etc.).

The most recent version of the *Exposure Factors Handbook* (1997) states:

In consideration, of these general observations and the recent data from Kissel *et al.* (1996, 1997), this document recommends a new approach for estimating soil adherence to skin. First use Table 6-12 [Summary of Field Studies, Kissel *et al.*, 1996a] to select the activity which best approximates the exposure scenario of concern. Next, use Table 6-13 [Mean Soil Adherence by Activity and Body Region, Kissel *et al.*, 1996a] to select soil loadings on exposed skin surfaces which correspond to the activity of interest. This table contains soil loading estimates for various body parts. The estimates were derived from soil adherence measurements of body parts of individuals engaged in specific activities described in Table 6-12. These results provide the best estimate of central loadings, but are based on limited data. Therefore, they have a high degree of uncertainty such that considerable judgment must be used when selecting them for an assessment.

In another study that assessed the percentage of skin coverage in several soil contact trials in a greenhouse and an irrigation pipe laying trial, Kissel *et al.* (1996) concluded that adjusted loadings may be two to three orders of magnitude larger than average loadings if average loadings are small.

The activity-specific soil adherence factor for exposures to a maintenance worker was calculated based on data presented by Kissel *et al.* (1996) for grounds keepers, as presented below:

		Soil Adherence Factor by Body Part (mg/cm^2)			
Receptor	**Representative Activity**	**Hands**	**Arms**	**Lower Legs**	**Face**
Maintenance Worker	Grounds Keepers	0.030 - 0.15	0.0021 - 0.023	0.0008 - 0.0012	0.0021 - 0.01

Data for the grounds keepers were used for the maintenance worker estimates because the activities of a grounds keeper best mimic those of a maintenance worker.

Soil adherence factors were calculated by normalizing each body part-specific soil adherence value (using the mid-points of the ranges tabulated above) with regard to the percentage of total body surface area represented by the respective body part (extracted from the US EPA *Dermal*

Exposure Assessment: Principles and Applications [US EPA, 1992]). The maintenance worker adherence factor for soil was calculated based upon exposure to the hands, forearms and face. Surface area percentages for the hands, forearms, and face are 5.2, 5.9, and 3.9 percent, respectively (US EPA, 1997). Those body parts comprise 15 percent of the total body surface area. The normalized values for all body parts of interest were added, and the sum was divided by the total percentage of body surface area occupied by the parts. For example, the soil and sediment adherence factors for maintenance worker soil exposures (0.038 mg/cm^2) were calculated as follows:

$$AF\,(mg/cm^2) = \frac{(0.09 \times 0.052) + (0.0126 \times 0.059) + (0.006 \times 0.039)}{0.15} = 0.038$$

The construction worker adherence factor was also calculated in this fashion. This exposure scenario assumed that the hands, forearms, lower legs, and face would be exposed to Site soils. Soil loadings for the upper torso (chest and back) were not measured by Kissel *et al.* (1996) for construction workers because this body area is generally covered. However, to account for exposure to the upper torso during the very hot months of the year, the total area of the forearms, legs, hands, and face were assumed to be completely exposed. The hands, forearms, legs, and face comprise 5.2%, 5.9%, 12.8%, and 3.9% of the total skin surface area, respectively (with the face comprising one-third the surface area of the head), for a total of 27.8% exposed surface area. The construction worker soil adherence factor was based on data from Kissel *et al.* (1996) for construction workers as follows:

		Soil Adherence Factor by Body Part (mg/cm^2)			
Receptor	**Representative Activity**	**Hands**	**Arms**	**Lower Legs**	**Face**
Construction Worker	Construction Worker	0.24	0.098	0.066	0.029

The soil adherence factor for the construction worker scenario was calculated as follows:

$$AF\,(mg/cm^2) = \frac{(0.24\times 0.052)+(0.098\times 0.059)+(0.066\times 0.128)+(0.029\times 0.039)}{0.278} = 0.1$$

For sediment exposures, the soil adherence factor was calculated for the construction worker scenario using adherence data from Kissel *et al.* (1996) for construction workers (as tabulated above) for the hands, forearms, and face. The hands, forearms, and face comprise 5.2, 5.9, and 3.9 percent of the total skin surface area, respectively (totaling 15 percent). Thus, the adherence factor for construction workers exposed to sediment (0.13 mg /cm^2) was calculated as follows:

$$AF\,(mg/cm^2) = \frac{(0.24\times 0.052)+(0.098\times 0.059)+(0.029\times 0.039)}{0.15} = 0.13$$

The adherence factor for visitor and off-Site resident exposures to soil assumed that the forearms, hands, and lower legs would be exposed to soil or sediment. The data used in these calculation were based on data by Kissel *et al.* (1996) for soccer players (exposed to a playing field of roughly one-half grass and one-half bare earth in a light mist) as presented below:

		Soil Adherence Factor by Body Part (mg/cm^2)		
Receptor	**Representative Activity**	**Arms**	**Hands**	**Lower Legs**
Visitor and Off-Site Resident	Soccer Players	0.0029 – 0.011	0.019 – 0.11	0.0081 – 0.031

The forearms, hands, and lower legs comprise 5.9%, 5.2%, and 12.8% of the total skin surface area, respectively, for a total of 23.9% (US EPA *Exposure Factors Handbook*, 1997). The adherence factor was then calculated for visitor and off-Site resident dermal exposures to soil as follows:

$$AF\,(mg/cm^2) = \frac{(0.00695 \times 0.059) + (0.0645 \times 0.052) + (0.0196 \times 0.128)}{0.239} = 0.026$$

A value of 0.026 mg/cm^2 was used as the soil adherence factor for visitors to the Site and off-Site residents.

Soil adherence factors for sediment exposures to Site visitors and off-Site residents were calculated using adherence data for the hands, forearms, lower legs, and feet. Adherence data for reed gatherers were used for these exposures to best mimic activities that may incur sediment exposures. The reed gatherers studied by Kissel *et al.* (1996) periodically visited tidal flats to collect raw materials for basket weaving. The data from Kissel *et al.* (1996) presented in *Exposure Factors Handbook* (US EPA, 1997) were as follows:

		Soil Adherence Factor by Body Part (mg/cm^2)			
Receptor	**Representative Activity**	**Hands**	**Arms**	**Lower Legs**	**Feet**
Visitors and Off-Site Residents	Reed Gatherers	0.66	0.036	0.128	0.63

The hands, forearms, lower legs, and feet comprises 5.2, 5.9, 12.8 and 7.0 percent of the total skin surface area, respectively (totaling 30.9 percent). Thus, the adherence factor for visitors and off-Site residents exposed to sediment (0.33 mg /cm^2) was calculated as follows:

$$AF\,(mg/cm^2) = \frac{(0.66 \times 0.052) + (0.036 \times 0.059) + (0.16 \times 0.128) + (0.63 \times 0.07)}{0.309} = 0.33$$

Exposure Time

To estimate intakes as a result of dermal exposure to surface water, an exposure time (ET) parameter was included in the intake formula for Site visitors and off-Site residents. The parameter value of 1.0 hour/day was estimated using best professional judgement. This value represents the amount of time a Site visitor or off-Site resident may spend exposed to surface water in any one EU.

Dermal Permeability Constant

The permeability constant, Kp, accounts for the movement of a constituent dissolved in water through the skin, across the stratum corneum, and into the blood stream. Kp values for the constituents examined in this assessment for surface water exposures were obtained from US EPA *Dermal Exposure Assessment: Principles and Applications* (1992). For values not available in US EPA *Dermal Exposure Assessment* (1992*)*, the Kp value were calculated using the equations provided by the US EPA in the same document.

Dermal Absorption Factor

The final parameter included in the dermal intake paradigm was a dermal absorption factor. In general, the skin provides an effective barrier to environmental toxins. For example, certain hair-coloring formulations which are vigorously rubbed onto the scalp on a daily basis contain lead acetate at concentrations up to 200,000 ppm, yet lead toxicity does not appear to result. Moore *et al.* (1980) determined that the rate of lead absorption from 203^{Pb} labeled lead acetate in cosmetic preparations containing six mmol Pb acetate/L in male volunteers over 12 hours was 0.06% during normal use of such preparations. For most inorganic salts, percutaneous (skin) absorption is considered insignificant relative to incidental ingestion (for example, US EPA, 1986). On the other hand, some drugs (*e.g.*, nicotine) are effectively administered and absorbed into the blood stream from dermal "patches."

Most dermal bioavailability data for impacted soil have been obtained in laboratory animals or in vitro test systems. This introduces a significant source of uncertainty for predicting the human response. Safety factors have sometimes been applied to dermal absorption data obtained in animals to conservatively estimate the upper-bound of likely human percutaneous uptake of a certain constituent from skin exposure. This is usually unnecessary because human skin has generally been shown, for a diverse group of constituents, to be about 10-fold less permeable than the skin of typical animal species, such as rabbits and rats (Bartek and LaBudde, 1975; Shu *et al.*, 1988).

US EPA Region III evaluated available data concerning the dermal absorption of specific constituents and classes of constituents and provided several recommendations (US EPA Region 3, 1995). For semivolatile compounds, such as *bis*(2-ethylhexyl)phthalate, the US EPA recommends a range of 1% to 10% (US EPA, 1995). Kao *et al.* (1985) reported 2.7 percent for absorption of topically applied pure benzo(a)pyrene by human skin *in vitro*. The US EPA Region 3 recommends using 10% as a conservative assumption based on the Ryan *et al.* study (1987). In addition, US EPA Region 4 guidance (1995) states that a soil dermal absorption factor "of 1.0% for organics and 0.1% for inorganics should be used as defaults in determining the uptake associated with dermal exposure" (see the Dermal Contact subsection of Exposure Assessment section of the 1995 guidance). For the purpose of this risk assessment, an ABS of 3% for cPAHs and of 10% for other SVOCs were conservatively assumed for dermal absorption, in keeping with US EPA Region 3's and MDEQ's recommendations.

4.2.2.2 Ingestion Exposure Parameters

Ingestion Rate

US EPA's *Exposure Factors Handbook* (1997) discusses three adult soil ingestion studies with results ranging from 10 mg/day to 480 mg/day. Hawley's (1985) value of 480 mg/day (as recommended by the MDEQ) was "derived from assumptions about soil/dust levels on hands and mouthing behavior" (US EPA, 1997). Since no supporting measurements were made for Hawley's study, the US EPA states that Hawley's estimate "must be considered conjectural" (1997). As such, the US EPA goes on to suggest adult soil ingestion rates of 50 mg/day for industrial settings and 100 mg/day for residential and agricultural settings, although "50 mg/day still represents a reasonable central estimate of adult soil ingestion and is the recommended value..." (1997). Accordingly, a value of 100 mg/day for the maintenance worker and adult off-Site resident is amply conservative and was used in this assessment. In conjunction with the use of a two-tiered EF to reflect the different stages of potential future construction activities (see Section 4.2.1.1), the soil ingestion s for the construction worker scenario was also divided into two exposure levels for a single individual. A highly conservative ingestion rate of 480 mg/day (used in relevant exposure model calculations under "Exposure Level A") was used for construction workers for the first 10 days of exposure to address direct contact with soil during earth-moving activities such as foundation excavating. A soil ingestion rate of 100 mg/day (used in relevant exposure model calculations under "Exposure Level B") was used for the remainder of the construction worker exposure (70 days). Risks were then summed for both exposure levels to estimate the total potential risk posed to an individual construction worker

The ingestion rate used for the adolescent visitor scenario was 100 mg/day. The US EPA Region IV (1995) recommends a value of 200 mg/day as a mean ingestion rate for children under six years of age. This value was conservatively used in this assessment to estimate soil and sediment ingestion exposures for an off-Site resident child aged one to six years.

Gastrointestinal Matrix Effects of Soil

Incidental ingestion incorporates the matrix effect (ME; sometimes called the absorption adjustment factor [AAF]) into the general intake equation. When constituents are administered in solid vehicles such as food and soil, only a fraction of the ingested dose is extracted from the vehicle and subsequently absorbed through the gastrointestinal tract (US EPA *Estimated Exposure to Dioxin-like Compounds*, 1992). Gastrointestinal absorption of constituents sorbed onto such a medium is inhibited by physical-constituent bonding to the matrix (Hawley, 1985). This phenomenon is referred to as the gastrointestinal matrix effect of soil. Several studies referenced in the US EPA's *Estimated Exposure to Dioxin-like Compounds* (1992) have been performed to estimate the oral absorption factors of constituents from soil. At the request of MDEQ (2001), however, a gastrointestinal matrix effect of 1.0 was used in accordance with US EPA Region IV guidance (1995), although this approach is highly conservative and does not account for scientific studies that indicate the absorption of chemical constituents through the gastrointestinal tract is less than 100%.

4.2.2.3 Inhalation Exposure Parameters and Paradigms

Inhalation Rate

The inhalation rate used for the construction worker scenario was 20 m^3/day. This is a common US EPA default value and was recommended by US EPA Region 4 (1995).

Retention Factor

According to the International Commission on Radiological Protection (ICRP), 75 percent of respirable dust particles (PM_{10}, or particles less than 10 microns in aerodynamic diameter) are retained when inhaled, the vast majority of which is potentially subsequently swallowed (ICRP, 1968). This 75% was included in the inhalation intake equation as the retention factor parameter (RF). This parameter applies only to non-VOC constituents entrained onto dust particles.

Concentration in Air

To estimate airborne dust levels during hypothetical construction activities, an emission rate of suspendible particles of less than 15 microns in aerodynamic diameter (PM_{15}) was calculated (grams/second); particles less than 10 microns were considered to be respirable. Considering particles of 15 microns or less in diameter in the emission rate calculation is a conservative assumption, inasmuch as only particles with an aerodynamic diameter of less than five to seven microns are inhaled into the lung.

The two types of construction activities at the Site that have the potential to emit fugitive dusts are vehicular movement over bare (unpaved or unvegetated) surfaces and the excavation of soil. Estimation of fugitive dust emissions caused by each activity were examined separately, as follows, and were derived from existing estimates of general construction exposure. The sum of the emissions from these two activities was multiplied by the concentration of constituent in the soil (Cs) in order to derive the total emission rate (Ei) for non-VOCs as follows:

$$Ei = C_s \times (PERv + PERe)$$ **[Equation 2]**

where:

Ei	=	Emission rate (mg/sec);
C_s	=	Concentration in soil (mg/kg);
PERv	=	Particulate emission rate for vehicular movement (lb/vehicle mile); and
PERe	=	Particulate emission rate for excavation (lb/vehicle mile).

The following empirical expression (US EPA, 1988) was used to estimate the fugitive dust generated by vehicles during construction activities:

$$PERv\ (lbs/vehicle\ mile) = k \times 5.9 \times (s/12)(S/30) \times (mvw/3)^{0.7} \times (ww/4)^{0.5} \times ((365 - p)/365)$$

[Equation 3]

where:

PERv	=	Vehicle particle emission rate (lb/vehicle mile traveled);
s	=	Percent silt content (unitless);
k	=	Particle size multiplier (unitless);
S	=	Mean vehicle speed (mph);
mvw	=	Mean vehicle weight (ton);
ww	=	Mean number of wheels per vehicle (unitless); and
p	=	Mean number of days with ≥ 0.01 inches of precipitation per year (unitless).

It was assumed that the vehicle travels during 40% of the 80-day exposure duration and 0.5 miles per day. The result is a value of 16 miles per construction event. Percent silt content was estimated to have a mean value of 50%, based on geotechnical data provided in the *Remedial Investigation Report* (Pisani & Assoc., 1997). US EPA default values were utilized and referenced for all other parameters. The particle size multiplier was assumed to be 0.50, corresponding to particles less than 15 microns (US EPA, 1996). Vehicle characteristics consist of the following: mean vehicle speed was assumed to be 15 mph, with mean vehicle weight assumed to be approximately 12.5 tons, for 8-wheeled vehicles (US EPA, 1988). The estimated mean number of days with precipitation equal to or greater than 0.01 inches per year is 110 (US EPA, 1988). Total resultant dust emissions for constituents during vehicular movement activities were estimated to be approximately 16.5 lbs/vehicle mile traveled, or 0.0001 kg/sec. Calculations are summarized in Table 20.

Future excavation may be performed by bulldozers, a backhoe, or other heavy construction equipment. The following estimate of particulate emissions, less than 15 μm in diameter resulting from bulldozing activity, was based on the approach described in the US EPA *Compilation of Air Pollution Emission Factors* (1996), as developed from studies of emissions from uncontrolled open dust sources resulting from bulldozing at western surface coal mines.

$$\text{PERe (lb/hour)} = \frac{1.0 \times s^{1.5}}{M^{1.4}} \qquad \textbf{[Equation 4]}$$

where:

PERe	=	Excavation particle emission rate (lb/hr);
s	=	Percent silt content (unitless); and
M	=	Soil moisture content (unitless).

Percent soil moisture content was assumed to be 15.1%, an average of Site-specific soil moisture data and percent silt content 50%, as described above.

The resultant fugitive dust emission rate during excavation activities was 7.9 lbs/hr or 0.001 kg/sec. Table 20 summarizes these calculations.

Once the emission rate (Ei in Equation 2) was calculated, it was converted to a concentration in ambient air. Gaussian models are conventionally used to determine downwind ambient air concentrations, Ca, from the emission rate, Ei, estimated. However, in this scenario, such models have limited applicability when the receptor(s) is at or very near the source of emission. In this case, a bulldozer operator, for example, is situated directly within the area of ground emissions of vapors and dusts. Average ambient air concentrations in this circumstance are best estimated by use of a near-field box model (US EPA, 1988).

The near-field box model assumes uniform wind speed and uniform mixing throughout the box. The release and mixing of VOCs or respirable dusts in ambient air is estimated as follows:

$$\text{Ca (mg/m}^3\text{)} = \frac{Ei}{W_b \times H_b \times V} \qquad \textbf{[Equation 5]}$$

where:

Ca	=	Concentration of constituent in ambient air (mg/m^3);
Ei	=	Emission rate of constituent (mg/sec);
W_b	=	Width of box in crosswind dimension within the area of residual constituent in soil (m);
H_b	=	Downwind height of box (m); and
V	=	Average wind speed through the box (m/sec).

The value of H_b in this calculation is determined by the downwind distance and the atmospheric turbulence at ground level, which determines the trajectory of a release from the upwind edge of the source of vapor or dust emissions. For neutral atmospheric conditions, the height at the downwind boundary (H_b) may be expressed by the following function (Pasquill 1975, Horst 1979):

$$z = 6.25\, r\, [H_b/r \times \ln (H_b/r) - 1.58\, H_b/r + 1.58]$$ **[Equation 6]**

where:

H_b	=	Downwind height of box (m);
z	=	Downwind distance to boundary (m); and
r	=	A terrain-dependent roughness height (m)

H_b (defined in Equation 5) is adjusted until the z parameter is equal to W_b (defined in Equation 5). The resulting H_b value is the height of the box. On any given workday, it is estimated that grading or excavation activities occur over the entire "workable" Site area (exposure unit) from which dusts are generated. This area is estimated to be 2,500 m^2, with length of the box estimated to be 50 meters (downwind distance) and the width of the box (W) estimated to be 50 meters. The greater the roughness height, the greater the wind turbulence and constituent dilution (*i.e.*, the height of the box increases). For the purposes of this risk assessment, it is conservatively assumed that the roughness height is 0.20 meters, which corresponds to a terrain with grass, some small bushes, and occasional trees (US EPA *Rapid Assessment of Exposure to Particulate Emission from Surface Contamination Sites,* 1985). This

assumption is appropriate for the actual Site conditions. An annual average wind speed (4.69 m/sec) is obtained from the STAR data set, accessed through the Personal Computer Graphical Exposure Modeling System (PCGEMS), for STAR station 03940, Jackson/Thompson, MS for the period 1974-1978 (Table 21).

5.0 Toxicity Assessment

The toxicity assessment involves the evaluation of available toxicity information to be utilized in the risk assessment process. Toxicity values derived from a dose-response relationship can be used to estimate the potential for the occurrence of adverse effects in individuals exposed to various constituent levels.

Exposure to a constituent does not necessarily result in adverse effects. The relationship between dose and response defines the quantitative indices of toxicity required to evaluate the potential health risks associated with a given level of exposure. If the nature of the dose-response relationship is such that no effects can be demonstrated below a certain level of exposure, a threshold can be defined and an acceptable exposure level derived. Humans are routinely exposed to naturally-occurring constituents and man-made constituents through the typical diet, air, and water, with no apparent adverse effects. However, the potential for adverse effects may occur if the exposure level exceeds the threshold in a variably sensitive population. This threshold applies primarily to constituents which produce non-carcinogenic (systemic) effects, although there is a growing body of scientific evidence which suggests that exposure thresholds may exist for certain carcinogenic constituents as well.

Adverse effects can be caused by acute exposure, which is a single or short-term exposure to a toxic substance, or by chronic exposure on a continuous or repeated basis over an extended period of time. "Acceptable" acute or chronic levels of exposure are considered to be without any anticipated adverse effects. Such exposure levels are commonly expressed as reference doses (RfDs), health advisories, etc. An acceptable exposure level is calculated to provide an "adequate margin of safety."

Chronic RfDs, which have been derived by the US EPA for a large number of constituents, were utilized to evaluate exposures lasting seven to 70 years (US EPA, 1989). Activities involving exposures of shorter duration to COPCs at the Site are anticipated to result in hazard and risk estimates that are lower than those associated with the long-term exposures. Identification of subchronic toxicity values corresponding to shorter-term exposure scenarios (*i.e.*, less than seven years) are included in the risk assessment to ensure that both short-term and long-term risks can be addressed.

Currently, the US EPA has not developed toxicity values to be utilized in dermal exposure scenarios; however, the US EPA does provide the following guidance for dermal exposure:

> No RfDs or slope factors are available for the dermal route of exposure. In some cases, however, non-carcinogenic or carcinogenic risks associated with dermal exposure can be evaluated using an oral RfD or oral slope factor, respectively. (US EPA, 1989).

Provisional dermal toxicity values were developed and utilized in the dermal exposure pathways considered in the human health risk assessment to provide a more accurate Site-specific risk assessment. These dermal RfD values were developed by multiplying the published oral RfD for a given constituent by the fraction of that constituent that can be absorbed through the gastrointestinal tract (stomach/intestine lining). The absorption fraction utilized was 50% for semivolatiles as extracted from US EPA Region 4 guidance (1995).

A number of sources of toxicity information exists, and these sources vary with regard to the availability and strength of supporting evidence. The following protocol has been established for the determination of toxicity indices; it defines a hierarchy of sources to be consulted and the methodology for the determination of toxicity values. This protocol has been developed in accordance with current US EPA methodology. Toxicity values for the COPCs at the Site were obtained with reference to the following hierarchy of sources developed in accordance with MCEQ guidance (1999):

1) Toxicity values were obtained from the *Integrated Risk Information System* (IRIS, 1999) database. This database contains the RfDs and Cancer Slope Factors (CSFs), which have been verified by the US EPA's RfD and Carcinogen Risk

Assessment Verification Endeavor (CRAVE) workgroups, and is, thus, the agency's preferred source for toxicity values. IRIS supersedes all other information sources.

2) For toxicity values which are unavailable on IRIS, the most current source of information is the Health Effects Assessment Summary Tables (HEAST, US EPA, 1997), published by the US EPA. HEAST contains interim, as well as verified RfDs and CSFs. Supporting toxicity information for verified values is provided in an extensive reference section of HEAST.

3) In cases where IRIS or HEAST could not provide toxicity values, US EPA Region III's Risk-Based Concentration (RBC) Tables were visited. These tables often provide toxicity values generated by reliable sources other than IRIS or HEAST. For example, in response to specific requests from risk assessors, the US EPA National Center for Environmental Assessment (NCEA) develops provisional RfDs or CSFs for chemicals not listed in IRIS or HEAST. Region III's RBC tables will list such provisional values. Also, RfDs or CSFs that have since been withdrawn from IRIS or HEAST may still be listed on the Region III RBC tables, although they are flagged with a "W." These toxicity values were no longer agreed upon by US EPA scientists; however, the Region III RBC tables continue to publish such values because risk assessors still need to quantify exposures to these chemicals. Lastly, the Region III RBC tables will list toxicity indices found in "other" US EPA documents. These values are flagged with an "O" on the tables.

The US EPA has derived carcinogenic slope factors for both oral and inhalation pathways, and these are utilized to quantitatively estimate risks. In the first step of the US EPA's evaluation, the available data are analyzed to determine the likelihood that the agent is a human carcinogen. The evidence is characterized separately for human studies and animal studies as sufficient, limited, inadequate, no data, or evidence of no effect. The characterizations of these two types of data are combined, and based on the extent to which the agent has been shown to be a carcinogen in experimental animals or humans, or both, the agent is given a provisional weight-of-evidence classification. The US EPA scientists then adjust the provisional classification upward or downward, based on other supporting evidence of carcinogenicity (see Section 7.1.3, US EPA, 1989). For a further description of the role of supporting evidence, see the US EPA guidelines (US EPA, 1986).

The US EPA classification system for weight of evidence is shown in the table below. This system is adapted from the approach taken by the International Agency for Research on Cancer.

US EPA WEIGHT-OF-EVIDENCE CLASSIFICATION SYSTEM FOR CARCINOGENICITY	
Group	**Description**
A	Human carcinogen
B1 or B2	Probable human carcinogen B1 indicates that limited human data are available B2 indicates sufficient evidence in animals and inadequate or no evidence in humans
C	Possible human carcinogen
D	Not classifiable as to human carcinogenicity
E	Evidence of non-carcinogenicity for humans

(US EPA, 1989)

Table 22 summarizes the available toxicity values for the identified COPCs. COPCs lacking published toxicity values were not able to be quantitatively evaluated in this assessment in accordance with MCEQ guidance (1999). The MCEQ limits the use of toxicity values to those that have been published in IRIS, HEAST, ATSDR toxicity profiles, or other peer-reviewed reference sources or literature approved by the MCEQ (1999). The MDEQ (2001), however, requested that risks from dermal exposure to cPAHs be estimated using the oral cancer slope factor for benzo(a)pyrene, applying benzo(a)pyrene relative potency factors, and accounting for an absorption efficiency of 50%. This methodology was used accordingly.

6.0 Risk Characterization

The objective of the risk characterization is to determine potential risk to receptors by combining the results of the exposure and toxicity assessments. Non-carcinogenic effects and carcinogenic risks are summarized in Table 23. Tables 24 through 78 provide algorithms and parameters for each pathway.

The estimated intakes calculated for each exposure pathway considered and each COPC were compared to RfDs for non-carcinogenic effects. The following formula was used to estimate the potential for non-carcinogenic health effects for each COPC.

$$HQ = ADI/RfD \qquad \textbf{[Equation 7]}$$

where:

HQ	=	Hazard quotient - potential for noncancer health effects (unitless);
ADI	=	Average daily intake of COPC (mg/kg-day); and
RfD	=	Reference dose (mg/kg-day).

RfDs have been developed by the US EPA for chronic (*e.g.*, lifetime) and/or subchronic exposure to constituents based on the most sensitive non-carcinogenic effects. The chronic RfD for a constituent is an estimate of a lifetime daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects. The potential for noncancer health effects was evaluated by comparing the Site-specific exposure level with the RfD derived by the US EPA for a similar exposure period. This ratio of exposure to toxicity is called the hazard quotient (HQ). If the Site-specific exposure level exceeds the threshold (*i.e.*, the HQ exceeds a value greater than 1.0), there may be concern for potential noncancer effects.

To assess the overall potential for noncancer effects posed by multiple constituents, a hazard index (HI) is derived by summing the individual HQs. This approach assumes additivity of critical effects of multiple constituents. This is appropriate only for compounds that induce the

same effect by the same mechanism of action. This conservative approach significantly overestimates the actual potential for adverse health impacts.

In cancer risk assessment, the US EPA has required the use of the upper limit which produces an estimate of potential risk that has a 95% probability of exceeding the actual risk, which may, in fact, be zero. The following formula was utilized to estimate the upper bound excess cancer risk for each carcinogen (note that not all COPCs are carcinogens):

$$TR = CLDI \times SF \quad \textbf{[Equation 8]}$$

where:

TR	=	Target risk - excess probability of an individual developing cancer (unitless);
CLDI	=	Calculated lifetime average daily intake of carcinogenic COPC (mg/kg-day); and
SF	=	Cancer slope factor $(mg/kg\text{-}day)^{-1}$.

For exposures to multiple carcinogens, the upper limits of cancer risks are summed to derive a total cancer risk. The US EPA recognizes that it is not technically appropriate to sum upper confidence limits of the risk to produce a realistic total probability, but requires this approach be used.

Carcinogenic risk refers to the probability of developing cancer as a result of exposure to known or suspected carcinogens. The National Contingency Plan (NCP) endorses an acceptable risk range of 10^{-4} to 10^{-6} for exposure to multiple carcinogens. This range represents an incremental increase of 1 in 10,000 to 1 in 1,000,000 in the chance of developing cancer over a lifetime. The MCEQ (1999) indicates that the target risk level is 1×10^{-6} per individual carcinogen and an acceptable cumulative risk level is 1×10^{-4}. As such, risk levels totaled across oral, dermal, and inhalation pathways may exceed 1×10^{-6} and still be in compliance with MCEQ requirements (1999) as long as no single carcinogen exceeds 1×10^{-6} and the cumulative risk for a single receptor does not exceed 1×10^{-4}.

Table 23 provides a summary of the non-carcinogenic effects and carcinogenic risks associated with each of the pathways evaluated in this assessment.

The overall hazard index across the assessed pathways and EUs was 0.1 for the Site visitor scenario. This value is below the acceptable benchmark of 1.0. The highest hazard index associated with the Site visitor scenario was 0.07 corresponding to dermal exposure to sediment in EU4. The overall cancer risk for exposures to Site visitors was estimated to be 2 7 $\times 10^{-5}$ and is primarily attributable to oral and dermal exposure to benzo(a)pyrene and associated cPAHs in EU4 soil and sediments. Oral exposure to the same constituents in EU4 and EU5 surface soils also contributed to the cancer risk estimate for the site visitor. Additional discussion regarding remediation goals for this scenario has been provided in section 8.0.

The overall hazard index for the maintenance worker scenarios was 0.108 and is below the acceptable benchmark of 1.0. The highest hazard index associated with the maintenance worker scenario was 0.1.05 corresponding to oral exposure to surface soilsediment in EU4. The overall cancer risk for the maintenance worker scenario was 1 4 $\times 10^{-3}$-4 and was primarily attributable to dermal and oral exposure to benzo(a)pyrene and other cPAHs in surface soils in EUs 2, 4, and 5. Additional discussion regarding remediation goals for this scenario has been provided in section 8.0.

The overall hazard index for the hypothetical future construction worker was 0.0000036 and is well below the acceptable benchmark of 1.0. The highest hazard index associated with the construction worker scenario was 0.0039 $\times 10^{-7}$ corresponding to oral dermal exposure to soils surface water in EU 54. The overall cancer risk for the hypothetical future construction worker scenario was -was 5 $\times 10^{-5}$ and is attributable to benzo(a)pyrene and associated cPAH oral exposure in EU4 sediment and oral and dermal exposure to EU4 and EU5 soils. Additional discussion regarding remediation goals for this scenario has been provided in section 8.0.

The off-Site resident scenario revealed a hazard index of ~~1~~ 6 × 10^{-4}. This value is considerably below the acceptable benchmark of 1.0. The overall cancer risk for the resident exposure scenario was estimated to be 2 × 10^{-4} and is attributable to oral and dermal exposure to benzo(a)pyrene and associated cPAHs in EU6.

7.0 Uncertainty Analysis

Risk assessment uses a wide array of information sources and techniques. Even in those rare circumstances where constituent intake for an exposed individual may be measured relatively precisely, assumptions will still be required to evaluate the associated risk. Generally, data are not available for critical aspects of the risk assessment, and the use of professional judgment, inferences based on analogy, the use of default values, model estimation techniques, etc., result in uncertainty of varying degrees.

The expressions of risk in this assessment are not probabilistic; the expressions of risk are conditional, based on the conditions represented by the single-point values selected for the analysis. This section is intended to identify and qualitatively evaluate the more salient Site-specific uncertainties and their potential influence on the credibility of the estimated Site risks.

7.1 Uncertainty of Data Evaluation Factors

Uncertainties in data analysis include analytical error, selection of COPCs, adequacy of sampling design, etc. Generally, there is far less uncertainty in this phase of the risk assessment process than other aspects contribute.

Laboratory analysis is extremely accurate relative to the potential error of "professional judgment" in exposure assessments. The uncertainty of analytical data is likely to be less than 25 percent, most of the time.

The adequacy of the sampling strategies to characterize Site conditions is a potentially large source of uncertainty. Because of the limited availability of resources, sample collection is generally limited. However, sampling (especially in multiple surveys) is not random, but is designed to locate the areas with the highest levels of constituents. Thus, test data are biased toward overestimation of average constituent levels. In addition, in most instances, the upper

95-percent confidence limit of the average concentration is utilized as an exposure-point concentration in the risk assessment. The use of this value likely will result in an overestimation of risk, as the 95% UCL represents a value that will be greater than the true average 95% of the time.

Oftentimes, only a portion of detected constituents are carried through the risk assessment process because constituents are eliminated through COPC screening procedures (US EPA, 1989). This could result in an underestimation of risk, although the COPC selection process is intended to identify those constituents that account for the vast majority of potential risk. COPCs lacking published RfD values were not quantitatively evaluated and this may result in an underestimation of potential hazards (non-carcinogenic effects).

7.2 Uncertainty of Toxicity Values

The US EPA's IRIS states that the uncertainty associated with RfD values for non-carcinogenic endpoints of toxicity "span perhaps an order of magnitude." In fact, the uncertainty of extrapolating dose-response data from animals to humans with the application of multiple safety factors (100 to 10,000 or more) is likely to be several orders of magnitude. Current policies for deriving RfD values will often result in an overestimation of risk.

The uncertainty associated with the estimation of cancer risk contributes, by far, the major source of potential error and uncertainty. It is beyond the scope of this analysis to explore this toxicity assessment factor in any detail. However, a few salient points are noted below.

Some constituents classified as carcinogens have been shown to produce an increased incidence of cancer in mice but not rats, for example. If the mouse is not an adequate model for the rat, it may be wondered how reliable a model it is for human beings. The assumption of linearity and a non-threshold phenomenon in the dose versus risk relationship may not be valid and could result in a very large overestimation of actual cancer risk, if any even exist at low doses in humans.

The US EPA evaluated the uncertainty of cancer risk estimates from exposures to trichloroethene and several other related VOCs in public drinking water supplies (Cothern *et al.*, 1984). These US EPA scientists concluded the following:

- The largest uncertainty in the calculations is due to the choice of the model [Multistage, Weiball, Logit, Probit, etc.] used in extrapolating risk to low doses in humans, and is 5 to 6 orders of magnitude;
- If a single model were chosen [assumed to be valid], the overall uncertainty in risk estimates would be 2 to 3 orders of magnitude;
- The exposure estimates contribute, at most, an order of magnitude to the uncertainty; and
- It would appear that until a particular compound's mechanisms of cancer are better known, it is likely that the uncertainty in the toxicity will not be improved.

7.3 Uncertainties in Assessing Potential Exposure

Ideally, Site-specific exposure values should be used when assessing potential intakes of chemicals at a Site. Oftentimes, however, Site-specific data are not available; therefore, the risk assessor must estimate values that most accurately reflect Site conditions. In doing so, US EPA or other regulatory default values were utilized in place of Site-specific data. These values may over- or under-estimate risks, depending on Site conditions and the percentile range in which the default values fall (*e.g.*, 50^{th}, 95^{th}).

Although a considerable amount of published data is available on the most common exposure parameters (*e.g.*, body weight, skin surface area), even these data contain uncertainties. Studies conducted by different scientists often provide differing levels of detail, statistics, and accuracy based on sample size, study design, geographic area, etc. Such discrepancies can increase uncertainty when the data are combined to derive a single-point default value. These data may be the best available; however, the reflection of reality may still be imprecise.

Where published exposure parameters were not available, best professional judgment had to be used, thereby increasing uncertainty. The default or estimated exposure parameters used in this assessment likely resulted in a moderate over-estimation of risk.

The intakes estimated for dermal absorption of PAHs adsorbed into soils adhering to skin may overestimate risks for a host of reasons. Early studies conducted by Falk and coworkers indicated that the carcinogenic effect of B(a)P on subcutaneous injection in mice could be markedly inhibited by the simultaneous administration of various non-carcinogenic PAHs (Falk *et al.*, 1964, as cited in ATSDR, 1988. In other subcutaneous injection and skin-painting studies with mice, it was shown that a combination of several non-carcinogenic PAH compounds, mixed according to the proportion occurring in auto exhaust, did not enhance or inhibit the action of two potent PAH carcinogens, B(a)P and dibenz(a,h)anthracene- (ATSDR, 1988).

The carcinogenic potency of B(a)P and other carcinogenic PAHs is generally determined by injecting solutions under the skin, painting the skin with the carcinogenic PAH dissolved in a solvent, or dissolved in corn oil in feeding studies. This vehicle or matrix affords a high level of bioavailability of the carcinogenic PAH compound. Recently, Krueger *et al.* (1999) conducted *in vitro* percutaneous absorption studies with contaminated soils and organic solvent extracts of contaminated soils collected at former manufactured gas plant (MGP) sites. The MGP tar-contaminated soils contained PAHs at levels ranging from 10 to 2400 mg/kg. The dermal penetration rates of PAH from the MGP tar-contaminated soils and soil solvent extracts were determined experimentally through human skin using tritrum-labelled B(a)P as a surrogate. Results showed reductions of two to three orders of magnitude in PAH absorption through human skin from the most contaminated soils in comparison to the soil extracts. Reduction in PAH penetration was attributed to soil matrix properties. That is, PAH compounds adsorbed to organic carbon in a soil matrix are far less bioavailable for dermal flux than PAH compounds dissolved in a solvent. [No correction for such a profound soil matrix effect was applied in quantitatively estimating cancer risks due to dermal absorption of B(a)P and other carcinogenic PAHs in this assessment.]

8.0 Summary of Findings

The results of the baseline human health risk assessment indicate potentially unacceptable risk levels for the following exposure scenarios:

Potentially Exposed Population	Media	EU
Site Visitor	Sediment Surface Soil	4 4, 5
Maintenance Worker	Sediment Surface Soil	4 2, 4, 5
Construction Worker	Sediment Subsurface Soil	4 4, 5
Off-Site Resident	Sediment	6

The risk levels associated with the above scenarios were driven by cPAHs, particularly benzo(a)pyrene. To determine the extent of remediation necessary to reduce these risks to acceptable levels, sediment and soil data for cPAHs in EUs 2, 4, 5, and 6 were closely examined.

The benzo(a)pyrene exposure-point concentration used to evaluate maintenance worker exposures to surface soil in EU2 was 5.2 mg/kg (sample location GEO-13/0-1'). This was the maximum benzo(a)pyrene concentration found in surface soil in EU2. The next highest concentration of benzo(a)pyrene in sediment was found at SS-10 (2.4 mg/kg). However, as previously noted, these samples were collected at locations within a densely wooded area. No remediation is planned to address surface soils at these locations for the following reasons:

- No maintenance activities are currently conducted in this area;
- Any remediation would require significant clearing; and
- Cancer risks associated with surface soils at these locations only slightly exceed 1×10^{-6} for two individual constituents, and the total cancer risk level is still less than 1×10^{-5}.

In EU4, the maximum concentration of benzo(a)pyrene was used as the exposure-point concentration for site visitor, maintenance worker, and construction worker exposure to sediment. The benzo(a)pyrene exposure-point concentration used to evaluate these in EU4 was 130 mg/kg (sample location SD-02, see Figure 2). The next two highest concentrations of benzo(a)pyrene in sediment ~~was~~ were found at SD-12 (71 mg/kg) and SD-23 (5.57 mg/kg), respectively. Implementing a remedy to remove, treat, or preclude contact with sediment at sample locations SD-02 ~~and~~, SD-12, and SD-23 would leave a concentration of ~~5.57~~3.1 mg/kg (sample location SD-~~23~~18) as the maximum concentration in sediment that could be potentially contacted by site visitors, maintenance workers, and/or construction workers in EU 4. Excluding samples SD-02, SD-12, and SD-23~~SD-02 and SD-12~~ and using ~~5.57~~3.1 mg/kg as the exposure-point concentration drops the risk level for dermal and oral contact with sediment by a visitor and oral contact with sediment by a maintenance worker or construction worker to within acceptable levels (i.e., no risk level associated with a single carcinogen exceeds 1×10^{-6}; Tables 79 - ~~82~~83).

In EU4, the maximum concentration of benzo(a)pyrene was also used as the exposure-point concentration for site visitor, maintenance worker, and construction worker soil exposures. Each of these receptors could potentially be exposed to soils at different depth ranges: visitor 0-1' bgs, maintenance worker 0-6' bgs, and construction worker 0-20' bgs. The sample locations and corresponding concentrations of benzo(a)pyrene that contributed to elevated risk estimates in the three exposure scenarios are presented in the table below:

Sample Location	Benzo(a)pyrene Concentration (mg/kg)
GEO-48/0-1'	500
GEO-21/0-1'	230
GEO-21/2-3'	190

Sample Location	Benzo(a)pyrene Concentration (mg/kg)
GEO-19/0-1'	56
GEO-46/0-1'	16
GEO-20/5-6'	11
GEO-47/5-6'	9.6
GEO-48/2-3'	6.1
GEO-20/0-1'	3.2
GEO-47/0-1'	3
GEO-19/2-3'	2.4

Implementing a remedy to remove, treat, or preclude contact with the ~~soils~~surface (0-1' bgs) soil sample locations tabulated ~~above~~ above would result in eliminating exposures for the site visitor scenario (*i.e.*, the 0-1' bgs samples listed above comprise the entire data set for visitor exposures to surface soils in EU4). In addition, implementation of a remedy addressing the sample locations tabulated above would leave a maximum subsurface soil benzo(a)pyrene concentration of 0.29 mg/kg (sample location GEO-19/5-6'). Using the concentration of 0.29 mg/kg as the exposure-point concentration for estimating risk to [redacted], maintenance workers~~,~~ and construction workers drops the risk levels to within acceptable levels (Tables ~~83~~ 84 - ~~87~~88). In situ biological treatment is proposed to address impacted soils within EU4. This will include clearing, tilling, application of inorganic nutrients, and, once soils are remediated to the extent practicable, placement of concrete cover. The area to be remediated will extend at least from Courtesy Ford to the edge of the railroad right-of-way, and may extend onto the railroad right-of-way with the permission of the Southern railway.

In EU5, the surface soil sample locations contributing most to elevated risk levels for the maintenance worker, construction worker, and site visitor scenarios were GEO-33/0-1', GEO-33/2-3', GEO-30/0-1', GEO-59/0-1, GEO-29/0-1', and GEO-28/0-1' (see Figure 2). All sample locations, with the exception of GEO-59/0-1', are located underneath paved areas in a parcel of land extending from Courtesy Ford to the southeast (Figure 2). Pavement in this area precludes direct contact with surface and subsurface soils; therefore, it is not anticipated that current or future maintenance workers or site visitors will have access to soils in or around these sample locations. In addition, a deed restriction will be implemented requiring the maintenance of the paved areas to ensure protection of human health in the future. Sample location GEO-59/0-1', with a benzo(a)pyrene exposure point concentration is 6.1 mg/kg, however, is adjacent to West Pine Street in an unpaved area. Implementing a remedy to remove, treat, or preclude contact with surface soil at this location would leave a concentration of 0.37 mg/kg (GEO-60/0-1') as the maximum concentration in surface soil not covered by pavement that could potentially be contacted by any of the three receptors in this EU. Excluding sample GEO-59/0-1' and using 0.37 mg/kg as the exposure-point concentration drops the estimated exposures in EU5 to within acceptable levels (i.e., no risk level associated with a single carcinogen exceeds 1×10^{-6}; Tables ~~88~~ 89 - ~~91~~92).

The benzo(a)pyrene exposure-point concentration used to evaluate adult and child resident exposures to sediment in EU6 was 49 mg/kg (sample location SD-03, see Figure 3). This was the maximum benzo(a)pyrene concentration found in sediments in EU6. Sample locations SD-04, SD-14, SD-13, SD-16, SD-15, and SD-17 (33, 12.2, 3.27, 2.8, 2.42, and 2.26 mg/kg, respectively) also contributed to elevated cancer risk estimates for both receptors. Implementing a remedy to remove, treat, or preclude contact with sediment at these sample locations would leave a concentration of 0.97 mg/kg (sample location SD-05). Using the benzo(a)pyrene concentration of 0.97 mg/kg as the exposure-point concentration for sediment exposure to adult and child residents reduces the risk estimate to within acceptable limits (i.e., no risk level associated with a single carcinogen exceeds 1×10^{-6}; Tables ~~92~~ 93 - ~~95~~96). Remediation activities are proposed to remove impacted sediment and preclude contact with residuals in the northeast drainage ditch. These activities include removal and off-Site treatment and/or disposal of impacted sediments, installation of a storm water collection and conveyance pipe, backfilling around the culvert, and planting with native grass.

Bibliography

Andelman, J. B., and M. J. Suess. 1980. Polynuclear aromatic hydrocarbons in the water environment. Bull. WHO 43:479-508.

Alexander, M. Aging, Bioavailability, and Overestimation of Risk from Environmental Pollutants. Environ. Sci. Technol, 2000, 34(20):4259.

ATSDR (Agency for Toxic Substances and Disease Registry). Toxicological Profile for Benzo(a)Pyrene. Oak Ridge National Laboratory. 1988.

ATSDR (Agency for Toxic Substances and Disease Registry). ATSDR's Toxicological Profiles on CD-ROM. Polycyclic Aromatic Hydrocarbons (PAHs), Update. CRC Press, 1999.

Audere, A. K., Z. Y. Lindberg, G. A. Smirnov, and L. M. Shabad. 1973. Experiment in studying the influence of an airport located within the limits of a city on the level of environmental pollution by benzo(a)pyrene. Gig. Sanit. 38(9): 90-92.

Bartek, M.J. and J.A. LaBudde. Percutaneous Absorption *in vitro*, in Animal Models in Dermatology. Ed. H.I. Maibach. New York: Churchill Livingstone, 1975. p. 103.

Blumer, M. 1961. Benzopyrenes in soil. Science 134, 474-475.

Blumer, M., W. Blumer, and T. Relch. 1977. Polycyclic aromatic hydrocarbons in soils of a mountain valley; correlation with highway traffic and cancer incidence. Environ. Sci. Technol. 11 (12), 1082-1084.

Butler, J. D., V. Butterworth, C. Kellow, and H. G. Robinson. 1984. Some observations on the polycyclic aromatic hydrocarbon (PAH) content of surface soils in urban areas. Sci. Total Environ. 38, 75-85.

Chu, M. M. L. and G. W. Chem. 1984. Evaluation and estimation of potential carcinogenic risks of polynuclear aromatic hydrocarbons. Paper presented at the Pacific Rim Risk Conference.

Chung, N. and Alexander, M. *Differences in* Sequestration and Bioavailability of Organic Compounds Aged in Dissimilar Soils. Environ Sci. Technol. 32: 855.

Coomes, R. M. 1981. Carcinogenic testing of oil shale materials. Twelfth Oil Shale Symposium Proceedings. Colorado School of Mines Pres.

Cothern, C. R., W. Conniglio, W. Marcus. Techniques for the Assessment of the Carcinogenic Risk to the US Population due to Exposure from Selected Volatile Organic Compounds from Drinking Water via the Ingestion, Inhalation and Dermal Routes. NTIS PB84-213941. Office of Drinking Water. Washington DC: Environmental Protection Agency, 1984.

Edwards, C.A., Beck, S.D. and Lichtenstein, E.P., J. Econ. Entomol. 1957, 50: 622.

Edwards, N. T. 1983. Polycyclic aromatic hydrocarbons (PAHs) in the terrestrial environment – a review. J. Environ. Qual. 12 (4), 427-441.

Falk, H. L., and P. T. S. Kotin. Inhibition of carcinogenesis: The effects of polycyclic hydrocarbons and related compounds. Arch. Environ. Health Vol. 9 (1964):169-179.

Fritz, W. 1971. Extent and sources of contamination of our food with carcinogenic hydrocarbons. Ernaehrungsforschung 16(4), 547-557.

Health & Welfare Canada. Polycyclic Aromatic Hydrocarbons, Report No. 80-EHD-50, (1979) p. 38.

Horst, T. W. Langrangian Similarity Modeling of Vertical Diffusion for a Ground Level Source. Int. Applied Met, Vol. 18 (1979): 733-740.

HSDB (Hazardous Substances Data Bank), 1999. National Library of Medicine (NLM) On-Line Toxicological Network (TOXNET). Bethesda, MD.

ICRP (International Commission on Radiological Protection). Report of Committee IV on Evaluation of Radiation Doses to Body Tissues from Internal Contamination due to Occupational Exposure. ICRP Publication 10. New York: Pergamon Press, 1968.

Kao, J.K., F.K. Patterson, and J. Hall. Skin Penetration and Metabolism of Topically Applied Chemicals in Six Mammalian Species, Including Man: an in vitro Study with Benzo(a)pyrene and Testcaterone. Toxicol. Appl. Pharmacol, Vol. 81 (1985): 502-516.

Kelsey, J.W. and Alexander, M. Declining Bioavailability and Inappropriate Estimation of Risk of Persistent Compounds. Environ. Toxicol. Chem. 1997. 16(3): 582

Kelsey, J.W., Kottler, B.D. and Alexander, M. Environ. Sci. Technol. 1997, 31: 214.

Kissel, J., K. Richter, and R. Fenske. Field Measurements of Dermal Soil Loading Attributable to Various Activities: Implications for Exposure Assessment. Risk Analysis, Vol. 16, No. 1 (1996): 115-125.

Magee, B., P. Anderson, and D. Burmaster. Absorption Adjustment Factor (AAF) Distributions for Polycyclic Aromatic Hydrocarbons (PAHs). Human and Ecological Assessment: An International Journal. Vol. 2, No. 4 (December 1996): 841-873.

Menzi, C.A., B.B. Potocki and J. Santodonato. Exposure to Carcinogenic PAHs in the Environment. Environ. Sci. Technol. Vol. 26, No. 7, 1992.

Michael Pisani & Associates. Remedial Investigation Report, Former Gulf States Creosoting Site, Hattiesburg, Mississippi. New Orleans, Louisiana. 1997.

Michael Pisani & Associates. Phase II Remedial Investigation Report, Former Gulf States Creosoting Site, Hattiesburg, Mississippi. New Orleans, Louisiana. 1998.

Mississippi Commission on Environmental Quality (MCEQ). Final Regulations Governing Brownfields Voluntary Cleanup and Redevelopment in Mississippi. 1999.

Mississippi Department of Environmental Quality (MDEQ). Guidance for Remediation of Uncontrolled Hazardous Substance Sites in Mississippi. Office of Pollution Control. 1990.

Mississippi Department of Environmental Quality (MDEQ). Letter to Glen Pilie, Adams and Reese, from Tony Russell, MDEQ. August 2, 2000.

Mississippi Department of Environmental Quality (MDEQ). Letter to Glen Pilie, Adams and Reese, from Tony Russell, MDEQ. February 6, 2001.

Morrison, DE., Robertson, B.K. and Alexander, M. Bioavailability to Earthworms of Aged DDT, DDE, DDD, and Dieldrin in Soil. Environ. Sci. Technol. 2000 34: 709.

Moore, M.R., P.A. Meredith, W.S. Watson, D.J. Sumner, M.K. Taylor, and A. Goldberg. "The Percutaneous Absorption of Lead-203 in Humans From Cosmetic Preparations Containing Lead Acetate, as Assessed by Whole-Body Counting and Other Techniques." Food Cosmet. Toxicol. 18. (1980): 399.

Pancirov, R. J. and R. A. Brown. 1975. Analytical methods for polynuclear aromatic hydrocarbons in crude oil, heating oils, and marine tissues. In: Conference on prevention and control or oil pollution, San Francisco, CA, March, 1975. American Petroleum Institute, Wash., DC. pp 103-13.

Pao, E. M. *et al.* Home Economics Research Report No. 44. United States Department of Agriculture, Washington, DC. 1982.

Pasquill, I.. The Dispersion of Material in the Atmospheric Boundary Layer - The Basis for Generalization. In: Lectures on Air Pollution and Environmental Impact Analysis. Boston, MA: American Meteorological Society, 1975.

Ryan, E.A., E.T. Hawkins *et al.* "Assessing Risk From Dermal Exposure at Hazardous Waste Sites. in Bennett." Ed. G. and J. Bennett. Superfund '87: Proceedings of the Eighth National Conference. Washington, DC, 16-18 November 1987. The Hazardous Material Control Research Institute. p.166-168.

Santodonato, J., P. Howard, and D. Basu. Health and Ecological Assessment of Polynuclear Aromatic Hydrocarbons. Pathotox Publishers, Inc., Park Forest South, IL. 1981.

Shabad, L. M. 1980. Circulation of carcinogenic polycyclic aromatic hydrocarbons in the human environment and cancer prevention. J. Natl. Cancer Inst. 64(3): 405-410.

Shu, H.P., P. Teitelbaum, A.S. Webb, L. Marple, B. Brunck, D. Dei Rossi, F.J. Murray, and D.J. Paustenbach. "Bioavailability of Soil Bound TCDD: Dermal Bioavailability in the Rat." Fundam. Appl. Toxicol., Vol. 10 (1988): 648-654.

Smirnov, G. A. 1970. The study of benzo(a)pyrene content in soil and vegetation in the airfield region. Vopr. Onkol. 16(5): 83-86.

State of Mississippi. Mississippi Code 1972 Annotated. Title 29 Public Lands, Buildings, and Property, Chapter 3, Sixteenth Section and Lieu Lands in General. 1998.

Suess, M. J. 1976. The environmental load and cycle of polycyclic aromatic hydrocarbons. Sci. Total Environ. 6:239-250.

Ta, Roy *et al.*, Studies Estimating the Dermal Bioavailability of Polynuclear Aromatic Hydrocarbons from Manufactured Gas Plan Tar-Contaminated Soils. Env. Sci. Tech. 32(20). 1998. 3113-3117.

Tang, W.C., White, J.C., and Alexander, M. Appl. Microbiol. Biotechnol. 1998, 49: 117.

Tang, J and Alexander, M. Environ. Toxicol. Chem. 1999, 18: 2711.

Thomas, J.F., M. Mukai, and B.D. Teggens. Fate of airborne benzo(a)pyrene. Environ. Sci. Technol. 2:33-39, 1968.

United States Department of Agriculture (USDA). Nationwide Food Consumption Survey: Continuing Survey of Food Intakes by Individuals, Men 19-50 years, 1 Day, 1985; United States Department of Agriculture. Human Nutrition Information Service. Nutrition Monitoring Division; Washington, DC, Report No. 86-1. 1986.

US EPA (United States Environmental Protection Agency). Rapid Assessment of Exposure to Particulate Emission from Surface Contamination Sites. EPA/OHEA/EPA. 600/8-85/002. Cowherd, C., Jr., G.E. Muleski, P.J. Engelhart and D.A. Gillett, Ed. Washington DC: Midwest Research Inst.. 1985.

US EPA (United States Environmental Protection Agency). "Guidelines for Carcinogenic Risk Assessment." Federal Register 51:33992-34003. 1986.

US EPA (United States Environmental Protection Agency). Superfund Exposure Assessment Manual (SEAM). EPA 540/1-88/001. Office of Remedial Response. Washington, DC, 1988.

US EPA (United States Environmental Protection Agency). Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Interim Final. EPA/540/1-89/002. Office of Emergency and Remedial Response. Washington, DC, 1989.

US EPA (United States Environmental Protection Agency). Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive. 9285.6-03. Office of Solid Waste and Emergency Response. Washington, DC, 1991.

US EPA (United States Environmental Protection Agency). Dermal Exposure Assessment: Principles and Applications. Office of Research and Development. EPA/600/8-91/011B. Washington, DC, 1992.

US EPA (United States Environmental Protection Agency). Estimating Exposure to Dioxin-Like Compounds. Office of Research and Development. EPA/600/6-88/005B. Washington, DC, 1992.

US EPA (United States Environmental Protection Agency). Provisional Guidance for Quantitative Risk Assessment of Polynuclear Aromatic Hydrocarbons. Office of Solid Waste and Environmental Remediation. EPA/600/R-93/089, July 1993

US EPA (United States Environmental Protection Agency). Land Use Directive in the CERCLA Remedy Selection Process. OSWER Directive 9355.7-04. Office of Solid Waste and Emergency Response. Washington, DC, May 1995.

US EPA (United States Environmental Protection Agency) Region 3. Technical Guidance Manual: Risk Assessment, Assessing Dermal Exposure From Soil. EPA/903-K-95-003. Office of Superfund Programs, Hazardous Waste Management Division. Washington, DC, 1995.

US EPA (United States Environmental Protection Agency) Region 4. Technical Services Supplemental Guidance to RAGS: Region 4 Bulletins. Waste Management Division, Atlanta, GA. 1995.

US EPA (United States Environmental Protection Agency). Supplement B to Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources. AP-42, Fifth Edition, Supplement B. Office of Air Quality Planning and Standards, Office of Air and Radiation. Research Triangle Park, NC, 1996

US EPA (United States Environmental Protection Agency). Exposure Factors Handbook,. EPA/600/P-95/002F. Office of Research and Development, Washington, DC, August 1997.

US EPA (United States Environmental Protection Agency). Health Effects Assessment Summary Tables (HEAST). Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office (ECAO). Cincinnati OH, 1997.

US EPA (United States Environmental Protection Agency). IRIS (Integrated Risk Information System). A Continuously Updated Electronic Database Maintained by the US Environmental Protection Agency. Bethesda, Maryland: National Library of Medicine, 1999.

US EPA (United States Environmental Protection Agency) Region 3. Updated Risk-Based Concentration Tables. Office of RCRA Technical & Program Support Branch. Philadelphia, PA, April, 1999.

Wallcave, L., H. Garcia, R. Fedlman, W. Linjinsky, and P. Shubik. 1971. Skin tumorigenesis in mice by petroleum asphalts and coal-tar pitches of known po9lynuclear aromatic hydrocarbon content. Toxicol. Appl. Pharmacol. 18, 41-52.

Weissenfels, W.D., Klewer, H.J. and Langhoff, J., J. Appl. Microbiol. Biotechnol. 1992, 36: 689.

White, J.C., Kelsey, J.W., Hatzinger, P.B and Alexander, M. Factors Affecting Sequestration and Bioavailability of Phenanthrene in Soils. Environ. Toxicol. Chem. 1997, 16(10): 2040.

Youngblood, W. W., and M. Blumer. 1975. Polycyclic aromatic hydrocarbons in the environment: homologous series in soils and recent marine sediments. Geochim. Cosmochim. Acta 39:1303-1315.