# FINAL REPORT
# REMEDIAL INVESTIGATION
# SOUTH CAVALCADE SITE
# HOUSTON, TEXAS

## VOLUME 1
## REMEDIAL INVESTIGATION REPORT

006404

PREPARED
FOR

KOPPERS

KOPPERS COMPANY, INC.
PITTSBURGH, PENNSYLVANIA

SUBMITTED TO:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VI
DALLAS, TEXAS

BY

KEYSTONE
ENVIRONMENTAL RESOURCES, INC.

MONROEVILLE, PENNSYLVANIA
JULY 1988

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LIST OF ACRONYMS
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| | |
|---|---|
| AA | atomic absorption |
| ACGIH | American Conference of Governmental Industrial Hygienists |
| AOC | Administrative Order on Consent |
| ASCS | Agricultural Stabilization and Conservation Service |
| AVOC | Aromatic Volatile Organic Compound |
| BNA | base neutral/acid |
| BTX | benzene, toluene, and xylene |
| CDI | Chronic Daily Intake |
| CDM | Camp Dresser & McKee, Inc. |
| CEC | cation exchange capacity |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act (1980) |
| CLP | Contract Laboratory Program |
| CPT | cone penetrometer test |
| CT | Crosstimbers Site |
| DO | dissolved oxygen |
| DUP/SPIKE | Duplicate/Spike |
| EPA | Environmental Protection Agency |
| FEMA | Federal Emergency Management Agency |
| FOC | fractional organic carbon |
| FS | feasibility study |
| GC/MS | gas chromatography/mass spectrometry |
| GPR | ground penetrating radar |
| HB&T | Houston Belt and Terminal Railroad |
| HCFCD | Harris County Flood Control District |
| HNU | HNU photoionization detector |
| HPLC | high performance liquid chromatography |
| HSL | Hazardous Substance List |
| IARC | International Agency for Research on Cancer |
| ICAP | inductively coupled argon plasma |
| MCL | Maximum Contaminant Level |
| MEG | Multimedia Environmental Goals |
| MRA | McBride-Ratcliff and Associates, Inc. |
| MSL | mean sea level |
| MS/MSD | matrix spike/matrix spike duplicate |
| MTA | Metropolitan Transit Authority (METRO) |
| NAAQS | National Ambient Air Quality Standards |
| NAPL | non-aqueous phase liquids |
| NASA | National Aeronautics and Space Administration |
| NCP | National Oil and Hazardous Substance Contingency Plan |
| NPL | National Priorities List |
| OW | Observation Well |
| PAH | polynuclear aromatic hydrocarbon |
| PCB | polychlorinated biphenyl |
| PCOC | potential contaminants of concern |
| PCP | pentachlorophenol |
| PHEA | Public Health and Environmental Assessment |
| PEP | potential exposure pathways |
| PNA | polynuclear aromatic hydrocarbon |
| PPbV | part per billion by volume |
| PRC | Planning Research Corporation |
| PRP | Potentially Responsible Party |
| PVC | polyvinyl chloride |
| QA | quality assurance |
| QC | quality control |
| RI | remedial investigation |
| RRS | regional rail system |
| RSD | relative standard deviation |
| SARA | Superfund Amendments and Reauthorization Act (1986) |
| SB | soil boring |
| SCK | South Cavalcade Site |
| SDWA | Safe Drinking Water Act |
| SOP | Standard Operating Procedure |
| SPHEM | Superfund Public Health Evaluation Manual |
| SV | semivolatile |
| SW | surface water |
| TCL | Target Compounds List |
| TDH | Texas Department of Health |
| TDWR | Texas Department of Water Resources |
| TLV | Threshhold Limit Value |
| TPH | total petroleum hydrocarbons |
| TWA | Time Weighted Average |
| TWC | Texas Water Commission |
| USCS | Unified Soil Classification System |
| USDA | United States Department of Agriculture |
| USGS | United States Geological Survey |
| VOA | volatile organics analysis |
| VOC | volatile organic compound |

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"The use in this document of any citations or references to U.S. EPA, or other, formulae, studies, documents, classifications and/or conclusions (collectively, "writings") is not to be construed as approval of, or agreement with, such writings or the reasoning, rationale or methodology upon which they are based, by Keystone Environmental Resources, Inc., its employees, agents, representatives and/or clients, unless approval or agreement is specially stated."

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# EXECUTIVE SUMMARY

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# EXECUTIVE SUMMARY

## Introduction

Koppers Company, Inc., retained Keystone Environmental Resources, Inc. to perform a remedial investigation at the South Cavalcade Site located in Houston, Texas. The purpose of this investigation was to determine the presence, nature, and extent of possible contamination at this site in the ditch sediments and surface water, surficial soils, subsurface soils, groundwater, and air.

## Nature and Extent of Problem

The South Cavalcade Site was first recognized by regulatory agencies (EPA and TDWR) in 1984, as a result of a preliminary geotechnical and contaminant survey performed to assess the suitability of the site for a proposed METRO vehicle maintenance yard and transit station. Sampling and analysis of on-site soil, sediment, surface water, and groundwater during the preliminary survey indicated the presence of polynuclear aromatic hydrocarbons (PAH). As a result of property deed research, Koppers Company was identified as the former site owner and was listed as the Potentially Responsible Party (PRP). The site was subsequently incorporated into the National Priorities List (NPL) for investigation and possible remediation.

The Remedial Investigation revealed that the site has a 78-year history of industrial/commercial use. From 1910 to 1962, the site was operated as a wood treating plant. A coal tar distillation facility was operated from about 1944 to 1962. Since 1962, the site has been occupied by several trucking firms. The primary environmental concerns of the site are relative to the former wood treating and coal tar distillation operations, in which creosote and various metal salts were used in the wood preserving process.

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Creosote is a mixture composed primarily of PAH compounds, and generally is comprised of the middle fractions (e.g. naphthalene, acenaphthene, methylnaphthalene) and heavy fractions (e.g. pyrene, chrysene, benzo(a)pyrene) of coal tar distillates. Creosote is characterized by low vapor pressure, low solubility, and density greater than water, although the various PAH constituents range from less dense to denser than water.

The metals used in wood preserving processes typically consist of salts or oxides of copper, chromium, and arsenic (Wolman salts). Historical site maps indicated the presence of Wolman salt tanks and zinc chloride tanks at the South Cavalcade Site. Lead was incorporated into the list of indicator inorganics along with copper, chromium, arsenic, and zinc although soils analyses during the Remedial Investigation indicated that lead is ubiquitous to the site area. The salts and oxides of these metals are generally characterized by relatively high water solubility, and their health effects to human and animal life vary widely.

The Remedial Investigation did not identify major source areas of creosote or wood-preserving metals such as oil-filled dip pits, buried tanks, or creosote-saturated soils. Past sources of creosote and wood-preserving metals were apparently removed during subsequent construction of the current site buildings and paved areas. Residual creosote tars and oils remain in two primary areas of <u>surficial</u> soil (6-ft depth) staining, located in the northern and southern portions of the site. The total area of <u>surficial</u> soil staining at the site is about 5.5 acres,

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and includes about 1.5 acres of surface soil (0.5-ft depth) staining where tars are observable at the surface.

Combined evaluations of subsurface soil and groundwater quality indicated that the shallow soil and groundwater media have been potentially impacted by PAH constituents. The areal distributions of the impacted subsurface media were categorized into three distinct, conceptual distribution areas. The boundaries of the subsurface distribution areas generally corresponded to the locations of the surface and surficial soil staining areas but with larger areal extents. The northern PAH distribution area encompasses approximately 19.7 acres, and the southern distribution area encompasses approximately 65.8 acres, or a total of about 85.5 acres. Most of the potentially impacted subsurface media was limited to the site; but some off-site distribution was noted, primarily to the south and southwest. The average soil PAH attenuation depths for the northern and southern subsurface distribution areas were 51.5 ft and 58 ft, respectively. Groundwater quality assessment of the uppermost aquifer potentially useable as a public water supply did not disclose the presence of PAH constituents above the method detection limits or inorganic indicators, with the exception of zinc.

Potential future exposure of human and animal life to the creosote constituents and metals, designated potential contaminants of concern (PCOC), appears limited mainly to dermal contact during soil excavation and related construction activities. Ingestion of impacted subsurface media is considered unlikely, and inhalation is not considered a major concern due to the low volatility of the PCOC.

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However, a complete evaluation of potential exposure pathways and health risks was not performed during the Remedial Investigation and has been reserved for the Endangerment Assessment.

Site Location

The South Cavalcade Site is located in north Houston, Texas near the 2000 block of Cavalcade Street. The site is approximately 66 acres and is bounded by Cavalcade Street on the north, Collingsworth Street on the south, and Houston Belt & Terminal (HB&T) Railroad on the east and west.

Site History

In 1910, the National Lumber and Creosoting Company acquired ownership of approximately 55 acres to build and operate a wood treating facility. National Lumber and Creosoting Company apparently operated at the site until 1938 when they were acquired by the Wood Preserving Corporation, a subsidiary of Koppers Company. In 1940, the Wood Preserving Corporation became part of Koppers Company. In 1944, Koppers Company incorporated and became Koppers Company, Inc. Records indicate that the site was operated as a wood treating and coal tar distillation facility until 1962, when the plant was dismantled and the property was sold to Merchants Fast Motor Lines, Inc.

In 1962, Merchants Fast Motor Lines sold the 55-acre tract to Mr. Gene Whitehead who also purchased an additional 12 acres in 1963. Mr. Whitehead then subdivided the property and in 1965, 1969, and 1977 sold portions to the following current property owners:

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TABLE 1

SUMMARY OF CURRENT PROPERTY OWNERSHIP

| Property Owner | Purchase Date | Acreage |
|---|---|---|
| Meridian Transport Co. | 1965 | 24.5 |
| (Merchants Fast Motor Lines) | 1969 | 8.5 |
| Baptist Foundation of Texas (leased to Transcon Lines) | 1969 | 22.5 |
| Mr. Rex King (Palletized Trucking) | 1977 | 10.3 |
| | Total | 65.8 acres |

Investigation and Observation History

A contaminant survey was conducted in 1983 by Camp Dresser & McKee, Inc., (CDM) to evaluate the suitability of the site for use as a maintenance yard and transit station for the proposed METRO-Stage One, Regional Rail System (RRS). The contaminant survey included a preliminary evaluation of shallow soil and groundwater conditions, primarily located throughout the northern portion of the site, with limited analytical testing. Results from the study indicated the potential for localized areas of contamination.

As a result of the Cavalcade Contaminant Survey Report, the site was referred to the Texas Department of Water Resources (TDWR). On April 16, 1984, the TDWR recommended to the U.S. Environmental Protection Agency (EPA) Region VI that the South Cavalcade Site be placed on the updated National Priorities List (NPL). On March 28, 1985, Koppers Company, Inc., entered into an Administrative Order on Consent (AOC) with the U.S. Environmental Protection Agency, Region VI. On June 10, 1986, the South Cavalcade Site was included on the final NPL. The South Cavalcade Site ranks 415 out of 802 final sites included on the July 1987 NPL.

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Field Investigation

The Remedial Investigation for the South Cavalcade Site included the following tasks: Geophysical Surveying; Surface Water Characterization; Surface Sediment Characterization; Subsurface Soil Sampling; Shallow and Deep Groundwater Investigation; and an Air Quality Investigation.

Geophysical Survey. A geophysical feasibility survey was conducted at three test site locations to evaluate three potential geophysical applications: (1) surface resistivity; (2) electromagnetic profiling; and (3) ground-penetrating radar techniques. The electromagnetic profiling method was selected and a site survey was conducted throughout approximately one-quarter of the site area that was not wooded or concrete paved. Results of the geophysical site survey were used to develop a shallow subsurface geophysical anomalies map to assist in locating soil borings.

Surface Water and Sediment Characterization. Both surface water and sediment characterization tasks were combined. A total of seven surface water and sediment samples were collected during Round 1, and nine samples during Round 2. Two rounds of samples were obtained subsequent to rainfall events to evaluate potential surface contaminant transport. Analytical testing included HSL volatile and semivolatile organics, HSL metals, cyanide, and iron. Also included was surface film analysis for total petroleum hydrocarbons.

Subsurface Soil Sampling. The initial phase of soil sampling consisted of drilling a total of 139 auger borings to a depth of about 8 ft within the unsaturated zone (vadose zone). Recovered auger boring soil samples were

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analyzed using photoionization headspace measurements for total organic vapors and X-ray fluorescence for metals. Results of the auger boring sampling were used to construct a preliminary surficial soil anomalies map for evaluating the geophysical anomalies and to assist in locating subsurface (saturated zone) soil borings.

Following the initial auger boring phase, a total of 82 soil borings were continuously sampled to an average depth of 64 ft within the saturated zone. Selected soil samples from the soil borings were screened using photoionization headspace measurements for total organic vapors, X-ray fluorescence for metals, and fluorescence spectrophotometry for total aromatic hydrocarbons (surrogate testing). Selected soil samples from the soil boring surrogate testing program were assigned for semivolatile organic, metals, and cyanide testing. Results of soil boring sampling were used to evaluate subsurface soil quality and to assist in developing a comprehensive groundwater monitoring program.

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Groundwater Investigation. During the Remedial Investigation, 20 groundwater monitoring wells were installed. Nine groundwater monitoring wells were previously installed during the Cavalcade Contaminant Survey. Therefore, a total of 29 monitoring wells are screened into the shallow water-bearing zone to evaluate vertical and lateral extent of potentially impacted groundwater quality. A deep monitoring well was installed to evaluate groundwater quality in a water-bearing zone at a depth of approximately 200 ft. A deep monitoring well was also previously installed during the Cavalcade Contaminant Survey. In addition, two off-site piezometers were also installed to the deep zone

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to supplement the groundwater monitoring wells for evaluating deep groundwater gradients. Two rounds of groundwater samples were analyzed for volatile and semivolatile organics, pesticides and PCBs, iron, cyanide, and HSL metals.

Air Quality Investigation. Air quality samples were collected at one upwind and two downwind locations on three consecutive days. Both particulate phase and vapor phase organic compounds were evaluated for EPA Method 604 priority pollutant phenolics and EPA Method 610 polynuclear aromatic hydrocarbon (PAH) compounds.

A Model 2133 Windicator portable wind indicating system was utilized each day to aid in the selection of upwind and downwind sampling positions and to validate the alignment of the sampling stations with respect to the wind direction over the test period.

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Geology and Hydrogeology Site Summary

The South Cavalcade Site is situated on the Quaternary Gulf Coastal Plain of Texas. This region is comprised of a series of sedimentary depositional plains. The youngest of these plains is of recent, post-glacial deposition (Holocene deposits). Sediments of Holocene deposition are deposited along the coast and in alluvial flood plains of present river systems. Progressively older plains (Pleistocene deposits) are associated with the fluvial/deltaic depositional systems of the Beaumont Formation and the Lissie Formation. The depositional environments of the fluvial/deltaic systems consist of distributary channel fill, flood basin/bay fill, and delta fringe environments. Deposits of the Beaumont Formation onlap the older Lissie Formation. The site is situated within surface sediments of the Beaumont Formation.

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Soil boring data were utilized to evaluate site hydrogeologic water-bearing zones and aquitards and to characterize the lithology and geometry of the water-bearing zones and aquitards. The primary hydrogeologic aquitards encountered at the site are summarized as follows: shallow aquitard; intermediate aquitard; and deep aquitard. Hydrogeologic water-bearing zones encountered in the vicinity of the South Cavalcade Site are organized as follows: shallow zone; intermediate zone; and deep zone. These water-bearing zones and aquitard units have been explored within depths of about 200-ft below ground surface and are summarized as follows:

PRIMARY HYDROGEOLOGIC DEPOSITS

| Deposit | Geologic Unit Number | Classification | Average Depth (ft) |
|---|---|---|---|
| Shallow Aquitard | 1 | Aquitard | 0-10 |
| Shallow Zone | 1 | Water-bearing zone | 10-21 |
| Intermediate Aquitard | 2,3 | Aquitard | 21-115 |
| Intermediate Zone | 3 | Water-bearing zone | 115-127 |
| Deep Aquitard | 4 | Aquitard | 127-174 |
| Deep Zone | 4 | Water-bearing zone | 174-200 |

Shallow zone groundwater trends at the South Cavalcade Site generally slope to the west at a gradient averaging about 20 ft/mi.

Summary of Surface Water and Sediment Quality Evaluation

Surface Water Quality. A total of sixteen surface water samples were collected in drainage ditch areas during the course of two sampling rounds, including two off-site background samples. Surface water sample analytical data indicates concentrations less than 100 ug/l for both volatile and semivolatile HSL organic compounds. Round 1 and Round 2 surface water samples disclosed no detected polynuclear aromatic hydrocarbon (PAH) compounds. Volatile

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organics (acetone and methylene chloride) were detected at two sample locations. However, these compounds are considered common laboratory contaminants.

Arsenic was detected at all but one surface water sampling points for both rounds, and ranged from 16 ug/l to 56 ug/l. Zinc was detected at all sampling points for both rounds, ranging from 31 ug/l to 1[illegible]0 ug/l. Lead was detected at all sampling points but one and ranged from 6.4 ug/l to 31 ug/l. Iron was detected at all sampling points for both rounds, ranging from 170 ug/l to 3100 ug/l.

Copper was detected at one location in each round at 17 ug/l and 14 ug/l, respectively. Nickel was detected at two locations at 36 ug/l. Silver was detected at one location at 11 ug/l, and cyanide was not detected at any location for either round.

A review of the surface water sample analytical data suggests that on-site surface water runoff is not currently a significant contributor to potential contaminant transport.

Sediment Quality. A total of sixteen sediment samples were collected in drainage ditch areas during the course of two sampling rounds, including two offsite background samples. A total of five sediment sample locations disclosed detected HSL semivolatile (SV) compounds, with total PAH concentrations ranging from approximately 2.3 mg/kg to 236 mg/kg. The background samples showed no detected HSL semivolatile organic compounds.

HSL volatile organic compounds (VOA) were detected at all five of the sediment sample locations tested, including the background sample. However, acetone and methylene chloride were the only volatile organic compounds detected, and are considered common laboratory contaminants.

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Although, arsenic, iron, lead, and zinc were detected at most sediment sample locations for both rounds, iron, lead, and zinc were also detected at the two background sediment sample locations. Arsenic was detected at all six on-site sample locations, ranging from 6.2 to 34 mg/kg. Iron was detected at all five locations, ranging from 4400 mg/kg to 15000 mg/kg at the background location. Lead was detected at all seven sample locations, ranging from 10 mg/kg to 540 mg/kg, with the highest concentration of 540 mg/kg at the background location. Zinc was also detected at all seven sample locations, ranging from 58 to 3300 mg/kg, with a background concentration of 630 mg/kg.

Cadmium was detected at two locations ranging from 3.0 mg/kg to 4.5 mg/kg. Chromium was detected at six locations, ranging from 10 to 360 mg/kg, including a background concentration of 18 mg/kg. Copper was detected at six locations ranging from 14 to 39 mg/kg, including a background concentration of 40 mg/kg. Mercury was detected at three locations, ranging from 0.29 mg/kg to 1.25 mg/kg at the background location. Nickel was detected at four locations, ranging from 15 mg/kg at the background location to 19 mg/kg. Thallium was detected at one location at 9 mg/kg. Antimony, beryllium, cyanide, selenium, and silver were not detected at any location for either round.

The highest detected sediment PAH concentrations were measured at the southern end of the site (236 mg/kg). However, PAH concentrations were also detected at an upstream, off-site sample location and indicates possible minor contributions from off-site sources. The types detected sediment metals at all of the on-site sample locations were similar to background conditions. One

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exception was arsenic, which was not detected at the background location, but ranged from 6.2 to 34 mg/kg at on-site locations. However, the concentrations of detected on-site sediment metals appear greater relative to detected sediment background metals.

Soil Analytical Data

Evaluation of soil quality included separate assessments of surficial soils (vadose or unsaturated zone) to a depth of 6 ft and subsurface soils (saturated zone) below a depth of 6 ft.

Surficial Soil. Surficial soils are defined herein as soils from 0 ft to 6 ft deep, which approximately delineates the unsaturated soils of the vadose zone. Samples of the surficial soils were obtained during the shallow auger boring program and from selected shallow samples from the soil boring program.

A total of four surficial soil samples were analyzed for HSL semivolatile organic compounds and select inorganics. Total surficial soil PAH concentrations ranged from below method detection limits to 8567 mg/kg.

Surficial soil inorganic indicator (copper, chromium, arsenic, zinc, lead) concentration ranges are presented as follows and are compared with the results of an off-site background sample:

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Surficial Soil Inorganic Indicators

| Constituent | Range (mg/kg) | Background (mg/kg) |
|---|---|---|
| Copper | BDL to 5 | BDL |
| Chromium | BDL to 9.5 | BDL |
| Arsenic | BDL to 8.8 | BDL |
| Zinc | BDL to 3480 | 12.5 |
| Lead | BDL to 30.4 | BDL |

Results of both the auger boring and soil boring programs did not disclose evidence of potential surficial contaminant source areas, such as creosote-saturated soils or non-aqueous phase liquids (NAPL) commonly associated with sludge pits or dip ponds. Soil staining was noted at 15 auger boring locations and in surficial soils at 29 soil boring locations, and indicates potential residual PAH concentrations.

Based on observations of visual soil staining conducted during the auger boring and soil boring programs, and a general site reconnaissance, a surficial soils quality map was prepared showing the approximate areal distributions of both surface and surficial visual soil staining and is presented on Exhibit 1. Criteria used to prepare the surficial soils quality map are summarized as follows:

1. Surface soils with observable soil staining and discoloration located within unpaved areas.

2. Surficial soils with detected PAH compounds (two samples).

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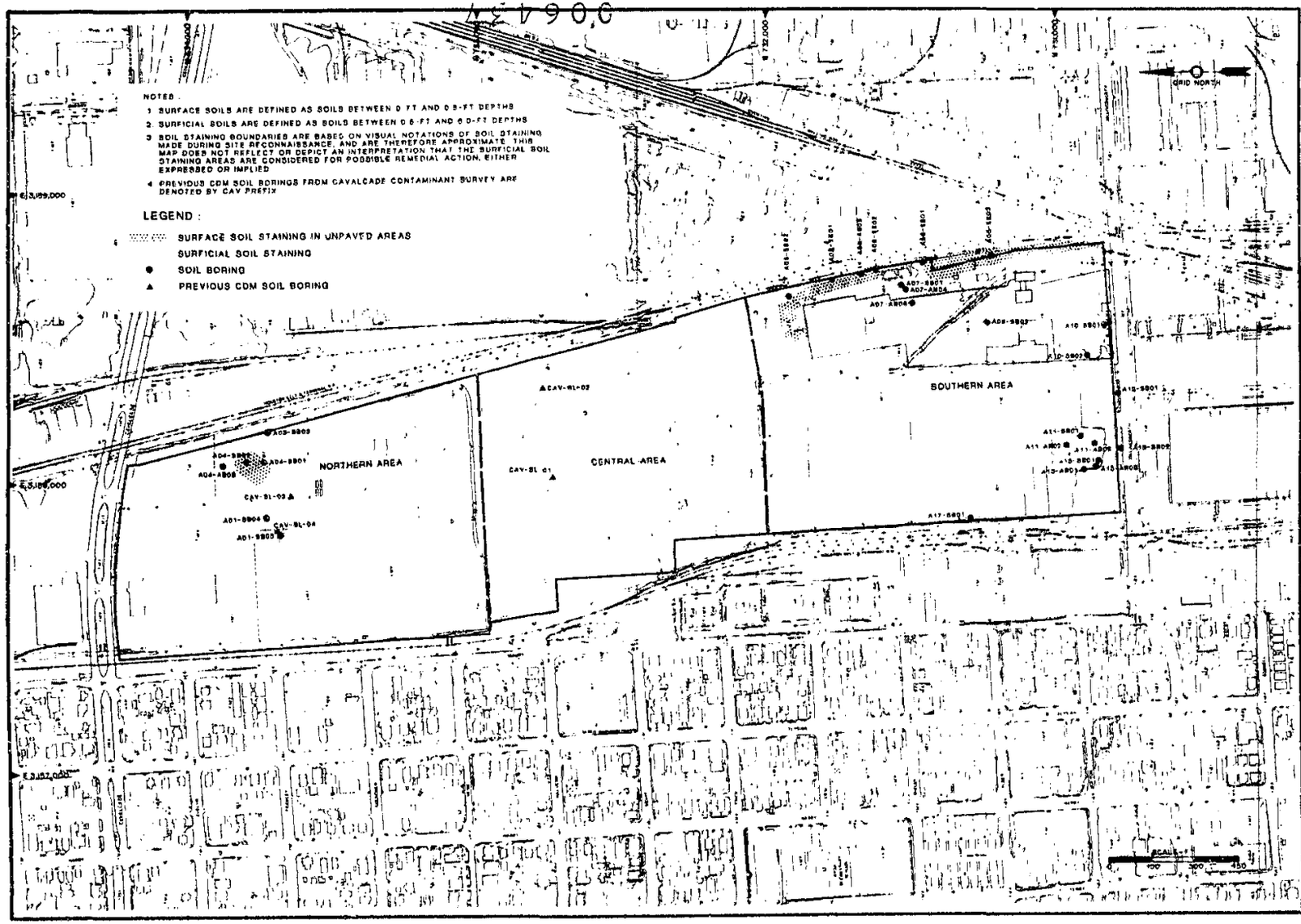


SURFICIAL SOILS QUALITY MAP
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

KOPPERS COMPANY, INC.

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| | |
|---|---|
| FIGURE NO | EXHIBIT 1 |
| PROJECT NO | 85-317 |
| DATE | 1-15-88 |
| ENGINEER | |
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3. Surficial soils with observable soil staining and positive surrogate test results (i.e., laboratory headspace measurements above 5 ppm or detected extractable fluorophores).

The soil quality distributions presented on Exhibit 1 are based on limited quantitative analytical test data, and therefore qualitative surrogate test data and visual observations were used to supplement the data base. The surficial soil quality areas shown on Exhibit 1 do not reflect or depict an interpretation that the areas are considered for possible remedial action, either expressed or implied.

Based on interpretations of the surficial soils quality map shown on Exhibit 1, the approximate areal extent of visually stained surface soils (less than 0.5 ft depth) is estimated to be approximately 1.5 acres in upaved areas. The approximate areal extent of visually stained surficial soils (0.5 ft to 6.0 ft) with positive surrogate test results is estimated to be 5.5 acres. It should be noted that these quantities are approximate and represent estimates of soil areas with visual soil staining. These quantities should not be misconstrued as estimates of soil volumes scheduled for potential remedial actions.

Subsurface Soils. A total of 88 soil samples including duplicates (excluding two samples analyzed for inorganics only) were analyzed for HSL semivolatile organic compounds and select inorganics. A summary of the total soil PAH concentration ranges for each geologic unit is presented as follows:

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Soil PAH Concentration Ranges

| Unit | Range (mg/kg) | Maximum Detected PAH Concentration Location |
|---|---|---|
| 1 | BDL to 5020 | A12-SB01 |
| 2 | BDL to 708 | A01-SB06 |
| 3 | BDL to 1416 | A10-SB01 |
| 4 | BDL | None Detected |

A composite evaluation of soil and groundwater analytical data was conducted to evaluate subsurface quality. Additional subsurface quality data from selected soil surrogate analytical testing was used in conjunction with the soil and groundwater analytical data to complete data gaps.

Groundwater Analytical Data. A total of 65 groundwater samples including duplicates were analyzed from the shallow and deep water-bearing zones for HSL volatile and semi-volatile organic compounds, pesticides and PCBs, and select inorganics. A summary of the total groundwater PAH concentration ranges for the upper-most water-bearing zone is presented as follows:

Groundwater PAH Concentration Ranges

| Zone | Total PAH Range (mg/l) | Maximum Detected PAH Concentration Location |
|---|---|---|
| Shallow Zone | BDL to 21950 | CAV-OW11 |

Non-aqueous phase liquids (NAPL) were noted at three monitoring well locations during sampling (CAV-OW11, SCK-P03, SCK-MW14). Denser than water hydrocarbons were reported at Monitoring Wells CAV-OW11 and SCK-P03 on June 16, 1988. A comparison of the shallow zone groundwater PAH distributions at paired monitoring well locations indicates that

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all shallow wells with detected PAH concentrations correspond to deeper shallow zone wells with detected PAH concentrations. It appears that total PAH concentrations are partially attenuated within the shallow zone with increasing depth.

Both soil and groundwater data were composited to provide an evaluation of subsurface soil and groundwater quality. Approximate delineations of subsurface distributions are presented on Exhibit 2 for organic compounds. Organic distributions are plotted separately for (1) Unit 1 soil and groundwater constituents; (2) Unit 2 soil and groundwater constituents, and (3) Unit 3 silt layer soil constituents. It should be noted that the distribution boundaries presented on Exhibit 2 are approximate and do not reflect or depict an interpretation that these areas are considered for possible remedial action, either expressed or implied.

As shown on Exhibit 2, the distribution of subsurface composite organic constituents appears to form two discrete areas, one at the northern portion of the site and the other in the southern portion of the site. The northern distribution area generally corresponds to the location of the 1964 aerial photograph anomaly. The Unit 1 northern area is interpolated to extend slightly off-site the northeast property boundary. The Unit 2 northern areas are very similar to the Unit 1 distributions. One localized area was noted in the silt layer, within the northern site area, as shown on Exhibit 2. The northern area includes approximately 19.7 acres. The average soil attenuation depth in the northern area is about 51.5 ft.

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The southern distribution area shown on Exhibit 2 encompasses the locations of the former process areas. The Unit 1 southern area appears to have relatively limited downgradient (shallow zone) distribution to the southwest. The Unit 2 southern area indicates possible off-site subsurface migration generally limited to the south and southwest. The silt layer soil distribution boundary in the southern area is shown to closely match the distributions in Unit 2. The southern area includes approximately 65.8 acres. The average soil attenuation depth in the southern area is about 58 ft.

Groundwater samples from Monitoring Wells CAV-OW06 and SCK-DW02 (deep zone) disclosed no concentrations of semi-volatile and volatile organics above the method detection limits. HPLC analyses of samples from the two deep zone monitoring wells for selected PAH compounds did not detect any constituents at a detection limit of 1.00 ng/l.

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Air Quality Investigation

As part of the South Cavalcade Site Remedial Investigation, an air quality investigation was conducted to characterize the nature and extent of potential air contaminants, if any, in the vicinity of the site. Field measurements made during the survey were compared to established Multimedia Environmental Goals (MEG), which set guideline concentrations of specific compounds in the ambient air based upon health effects (EPA-600/7-77-136, 1977). This investigation has shown that the majority of compounds identified at the site were well less than the MEG levels established by EPA.

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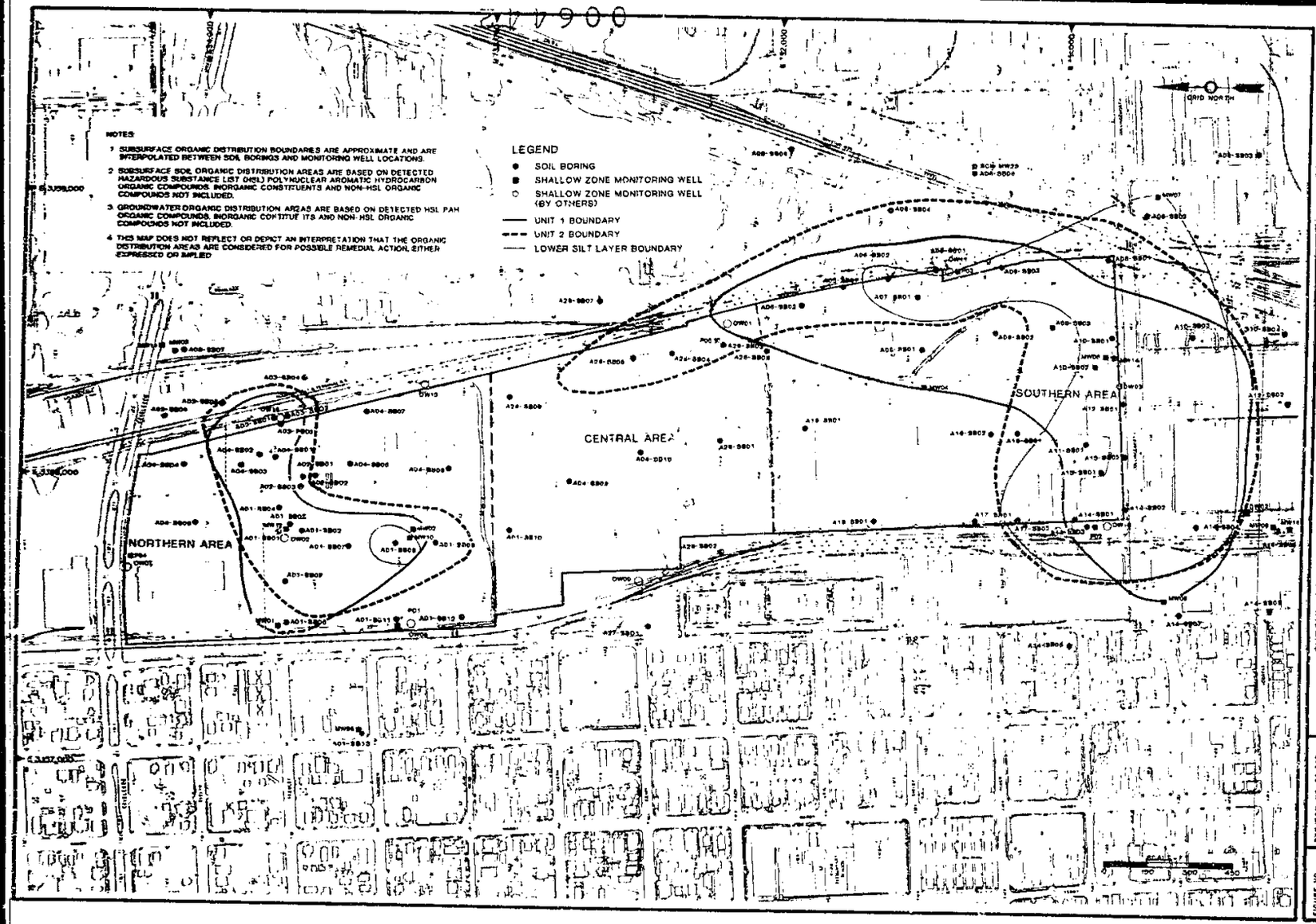


SUBSURFACE ORGANIC QUALITY MAP

SOUTH CAVALCADE SITE

HOUSTON, TEXAS

KOPPERS COMPANY, INC.

| | |
|---|---|
| FIGURE NO. | EXHIBIT 2 |
| PROJECT NO. | 85-317 |
| DATE | 8-28-87 |
| ENGINEER | |
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Of 17 phenolic and PAH compounds analyzed which have MEG, only two exceeded their respective limits. The two compounds, 2,4-dinitrophenol and 2-methyl-4,6-dinitrophenol, exhibited upwind concentrations equalling or exceeding downwind levels; thus, indicating a higher upwind background concentration for the compounds or possible contamination of the XAD-2 resin and filter.

A slight increase in the concentration of pentachlorophenol was noted at the downwind stations for Tests 1 and 3. The average net increase (4.7 ug/$M^3$), however, for the survey was 100 times less than the TLV-TWA for pentachlorophenol. Pentachlorophenol was also detected in the batch blank and field blank. Hence, it is thought that the presence of pentachlorophenol in the samples is not resultant from the site.

PAH compounds were not identified in air samples during the South Cavalcade Remedial Investigation.

Preliminary Public Health and Environmental Assessment

The Preliminary Public Health and Environmental Assessment (Preliminary PHEA) presented in the RI Report was organized into four major sections including identification of areas of interest, identification of potential contaminants of concern (PCOC), identification of potential exposure pathways, and identification of potential receptors. Emphasis was placed on identifying site specific, plausible exposure scenarios from a list of general scenarios. The scenarios which passed the initial screening during the preliminary PHEA will be considered further in the Final PHEA which will be presented in the Feasibility Study Report. The Final PHEA will attempt to quantify, within the limits of

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the specified procedures, potential risk associated with scenarios passing the screening process conducted in the Preliminary PHEA.

The PCOC identified for the South Cavalcade Site include: arsenic, chromium, copper, lead, mercury, zinc, light aromatics, and PAH. Some of these compounds may have a potential threat to human health. The selection of these PCOC was based upon site-specific factors such as prior use of the site and compounds present in the preservatives formerly used. Potential human exposure routes retained for evaluation in the Final PHEA were identified for sediments, soil, and groundwater. The specific potential exposure pathways and associated potential receptors which will be evaluated in the Final PHEA are shown on Exhibits 3 and 4.

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EXHIBIT 3
RETAINED POTENTIAL HUMAN EXPOSURE PATHWAYS

| Media | Current or Future | Potential Exposure Pathway | Potential Receptor | PCOC |
|---|---|---|---|---|
| SEDIMENTS | | | | |
| | Current and Future | inadvertant ingestion | trespassers | PAH, metals |
| | | dermal contact | trespassers | PAH, metals |
| SURFACE AND SURFICIAL SOILS | | | | |
| | Current | inadvertant ingestion, dermal contact, inhalation of dust | utility workers | PAH, metals |
| | Future | inadvertant ingestion, dermal contact, inhalation of dust | construction workers | PAH, metals |
| | | inadvertant ingestion, dermal contact | hypothetical residential occupants | PAH, metals |
| | | inadvertant ingestion, dermal contact | hypothetical commercial occupants | PAHs, metals |

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EXHIBIT 3 (continued)

| Media | Current or Future | Potential Exposure Pathway | Potential Receptor | PCOC |
|---|---|---|---|---|
| GROUNDWATER | | | | |
| | Future | ingestion | hypothetical residential occupants | light aromatic, PAH, metals |
| | | ingestion | hypothetical commercial occupants | light aromatic, PAH metals |

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EXHIBIT 4

RETAINED POTENTIAL ENVIRONMENTAL EXPOSURE PATHWAYS

Sediment

Potential exposures to terrestrial, amphibious and aquatic wildlife from ingesting or dermally contacting sediments in drainage ditches containing PCOC.

Potential exposures to terrestrial, amphibious and aquatic wildlife from ingesting organisms containing PCOC.

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# SECTION 1.0 - INTRODUCTION

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# 1.0 INTRODUCTION

## 1.1 Purpose of Study

A remedial investigations (RI) is the data gathering activities undertaken to determine the degree and extent of potential contamination associated with the site. The data obtained are used in the identification, screening, and evaluation of remedial alternatives. The objective of the remedial investigation is to collect "necessary and sufficient" data to determine the distribution and migration of contaminants; identify cleanup criteria; and identify the support the remedial alternative technical feasibility evaluation, the public health evaluation, the environmental assessment, and the cost analysis.

Remedial investigations are conducted concurrently with the feasibility study (FS) in an iterative process wherein data are evaluated with respect to their applicability to remedial alternatives. Data collection and evaluation during the remedial investigation is performed only to the extent required to justify the identification and evaluation of remedial alternatives. The remedial investigation must provide data to demonstrate the need for remedial action, determine the extent of remedial action required, and evaluate the feasibility of the potential remedial alternatives.

This Remedial Investigation Report was developed in accordance with Task 5 of the April 4, 1985 Work Plan (Document No. 141-WP1-WP-ATEW-3) prepared by Camp Dresser & McKee Inc. (CDM) for the South Cavalcade Street CERCLA Site. The purpose of this report is to assemble the results of the

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data collection activities, analysis, and evaluations, and to characterize the South Cavalcade Street site in terms of:

- The presence, nature, and toxicity of the possible contamination associated with the site.
- The extent to which potential contaminants have migrated from the site and the concentrations of those contaminants.
- The preliminary environmental and health impacts of the potential contamination.

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## 1.2 Site Location and Description

The South Cavalcade Site is located in north Houston, Texas near the 2000 block of Cavalcade Street. The site is approximately 66 acres and is bounded by Cavalcade Street on the north, Collingsworth Street on the south, and Houston Belt & Terminal (HB&T) Railroad on the east and west. Figure 1-1 presents a site location map.

General land use of the South Cavalcade Site vicinity consists of industrial areas located to the east and south of the site. Areas located to the west of the site are characterized by interspersed residences and small businesses. Adjacent to the site is the 26-acre North Cavalcade Site investigated by the U.S. Environmental Protection Agency under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA).

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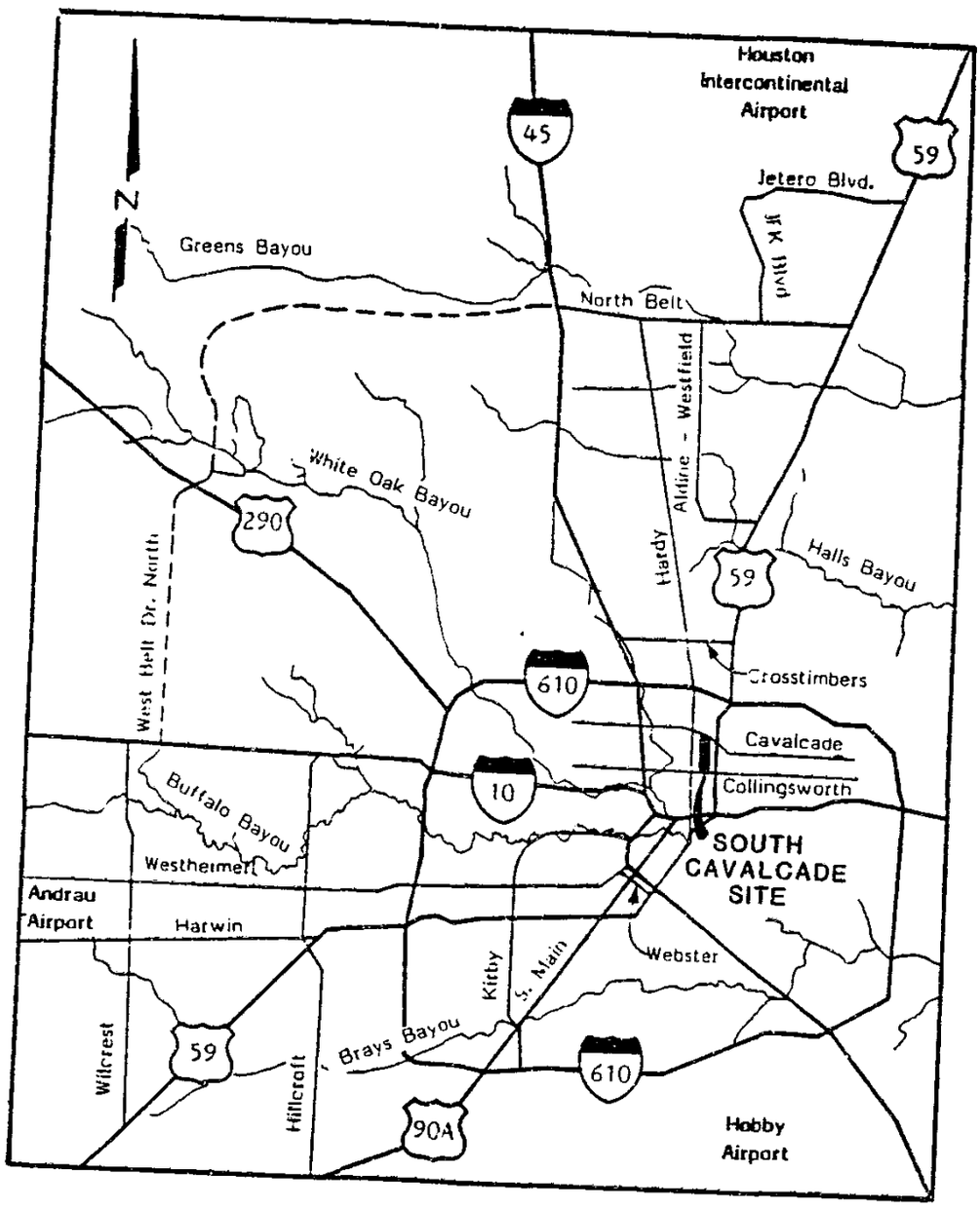


SCALE - MILES

0 4 8

# SITE VICINITY MAP

FILE NO. 85-317
FIGURE 1-1

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## 1.3 Site History

A historical review of the South Cavalcade Site was conducted to evaluate: (1) previous site ownership; (2) former wood preserving treatment and tar distillation areas; and (3) potential locations of waste disposal areas. The historical review included evaluation of data from three primary sources: deed research, previous Koppers Company, Inc., records, and historical aerial photographs. A discussion of each of the primary data sources is presented as follows.

1.3.1 Deed Research. Previous deed research from the Cavalcade Contaminant Survey Report, dated July 11, 1983, and the Planning Research Corporation (PRC) South Cavalcade Title Search Report, dated August 30, 1985, indicated the National Lumber and Creosoting Company acquired ownership of about 55 acres in 1910. National Lumber and Creosoting Company apparently operated at the site until 1938 when they were acquired by the Wood Preserving Corporation, a subsidiary of Koppers Company. In 1940, the Wood Preserving Corporation became part of Koppers Company. In 1944, Koppers Company incorporated and became Koppers Company, Inc. Records indicate that the site was operated as a wood treating facility until 1962 when it was sold to Merchants Fast Motor Lines, Inc.

In 1962, Merchants Fast Motor Lines sold the 55-acre tract to Mr. Gene Whitehead who also purchased an additional 12 acres in 1963. Mr. Whitehead then subdivided the property and in 1965, 1969, and 1977 sold portions to the following current property owners:

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TABLE 1-1
SUMMARY OF CURRENT PROPERTY OWNERSHIP

| Property Owner | Purchase Date | Acreage |
|---|---|---|
| Meridian Transport Co. (Merchants Fast Motor Lines) | 1965<br>1969 | 24.5<br>8.5 |
| Baptist Foundation of Texas (leased to Transcon Lines) | 1969 | 22.5 |
| Mr. Rex King | 1977 | 10.3 |
| | Total | 65.8 acres |

A schematic of the historical site ownership summary from the 1985 PRC Title Search Report is reproduced on Figure 1-2.

Additional deed research was conducted by McClelland Engineers, Inc., to prepare site base maps delineating previous and current ownership property boundaries. Results of the McClelland Engineers Report indicate the following findings:

1. The additional 12 acres of the current 66-acre site not previously owned by the Koppers Company, Inc., was located at the northwest portion of the tract. The PRC Title Search Report states that there was no evidence that the 12-acre tract was used for previous creosoting operations.

2. The 55-acre tract previously owned by Koppers Company, Inc., is generally located south of present-day Cavalcade Street and appears to be separate from the wood preserving operations formerly located at the North Cavalcade Site.

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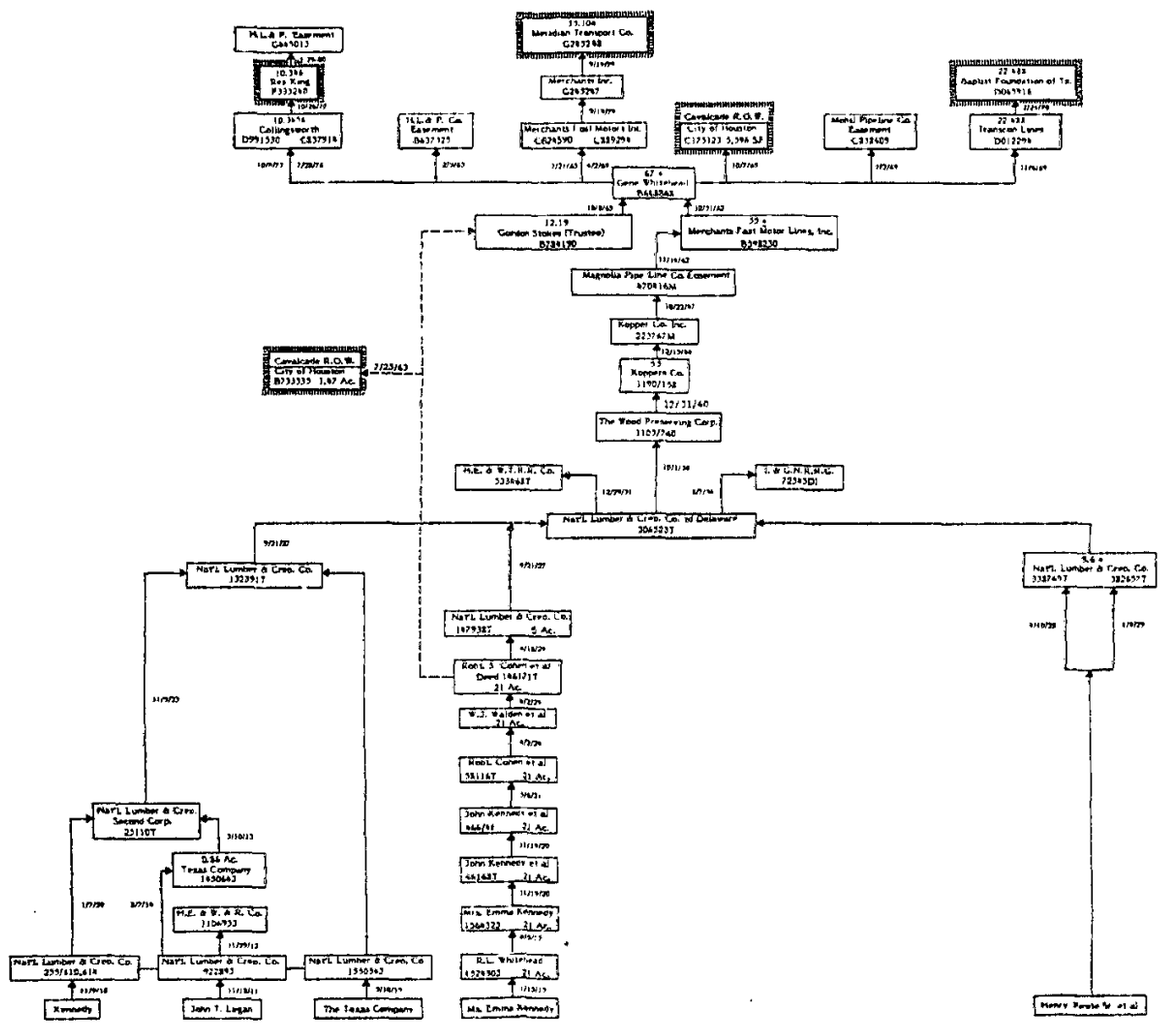


LEGEND :

= CURRENT OWNER

1. INFORMATION BASED ON PLANNING RESEARCH CORPORATION FINAL TITLE SEARCH LETTER REPORT TO EPA DATED AUGUST 30, 1985.

SOUTH CAVALCADE SITE
HOUSTON, TEXAS

KOPPERS COMPANY, INC.
PITTSBURGH, PENNSYLVANIA

Page 1-6

| SCALE | MADE | DATE | FILE NO |
|---|---|---|---|
| NTS | LLD | 12-9-86 | 86-317 |
| | CHECK WRT | DATE 12-9-86 | |

PREVIOUS SITE OWNERSHIP

FIGURE 1-2

3. Property lines of the 55-acre tract previously owned by Koppers Company, Inc., are located approximately 110 ft west of the current eastern property line.

1.3.2 Historical Site Layout. A review of the previous layout of the wood preserving operations was based on historical maps of the site area. Historical site maps were obtained from the Sanborn Insurance Maps for 1929 and 1950. The 1929 site map indicates the wood preserving operations were located at the southern portion of the tract adjacent to Collingsworth Street. The 1950 map shows expanded wood preserving operations and the Koppers Company, Inc., coal tar distillation plant located near the southeast portion of the tract.

As part of the RI/FS, additional site maps were collected from Koppers Company, Inc., and submitted in accordance with Subtask 1A. A 1945 fire insurance map was obtained and is presented on Figure 1-3 showing the wood preserving operations and the coal tar distillation plant.

A list of key plant facilities shown on the historical site maps is presented as follows:

TABLE 1-2

PREVIOUS PLANT FACILITIES

| Wood Preserving Plant | Coal Tar Distillation Plant |
|---|---|
| Retort House | Pitch Pans |
| Spray Pond | Spray Ponds |
| Creosote Oil Tanks | Still |
| Zinc Shed | Tar Tanks |
| Pond | Oil Tank |
| Incinerator | |
| Fuel Oil Tanks | |
| Wolman Salt Tanks | |
| Zinc Chloride Tanks | |
| Gasoline Tank | |
| Protexol Solution | |
| Lime Vat | |

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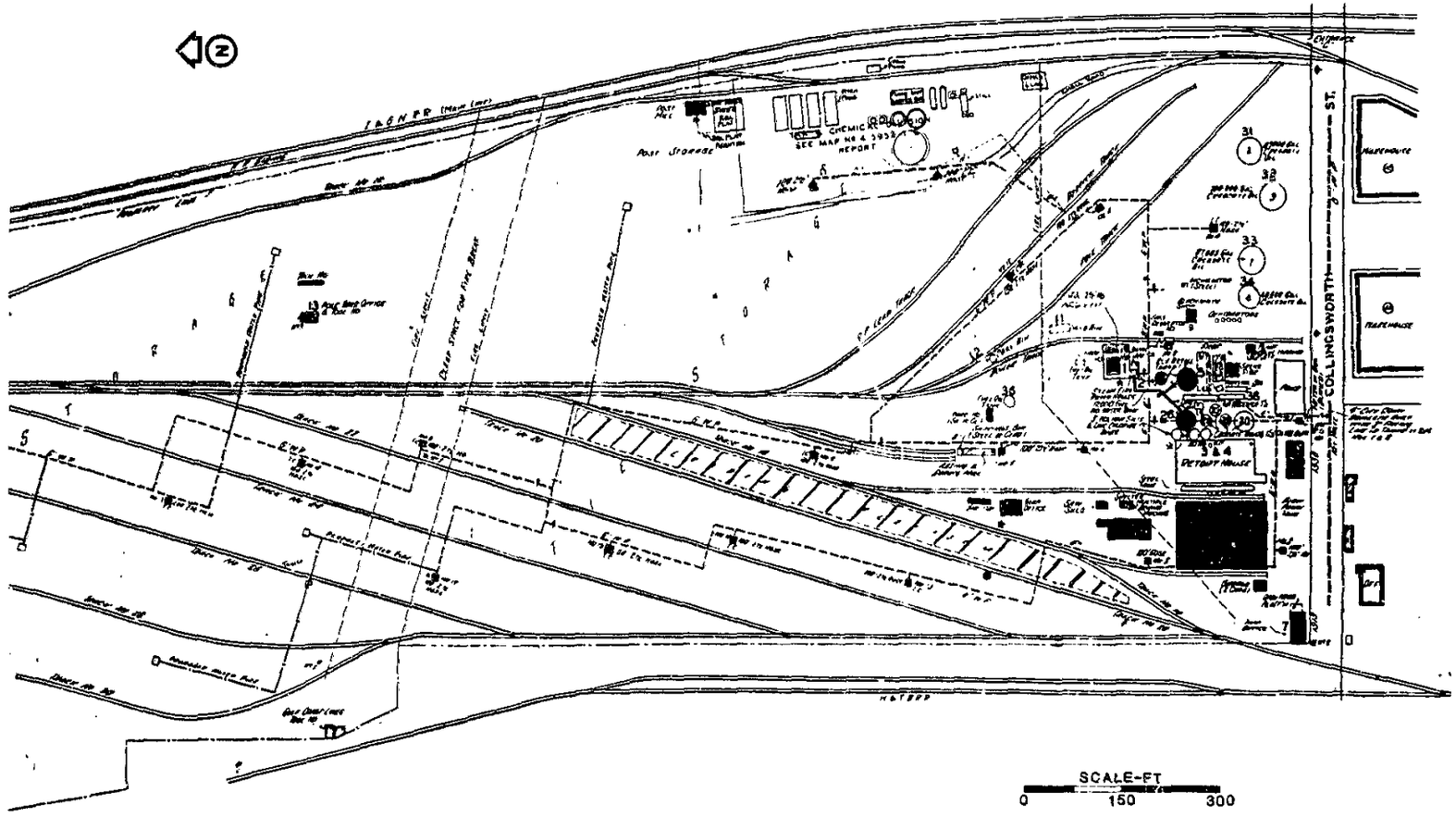


NOTE : 1. MAP BASED ON MARSH & McLENNAN INC., INSURANCE, NEW YORK .
2. NORTHERN PORTION OF SITE NOT SHOWN .

| | |
|---|---|
| SOUTH CAVALCADE SITE<br>HOUSTON, TEXAS | Page 1-8 |
| KOPPERS COMPANY , INC.<br>PITTSBURGH, PENNSYLVANIA | SCALE NOTED · MADE · CHECK · DATE · DATE · FILE NO 65-317 |
| | PREVIOUS SITE LAYOUT -1945 · FIGURE 1-3 |

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1.3.3 Previous Site Operations. The wood preserving process operations, located at the southwestern portion of the site, included treating cylinders, working tanks, drip tracks, and the spray pond. The working tanks were fed with wood preservatives from the main storage tanks and were used as intermediate storage during the treating process. These tanks charged the treating cylinders with wood preservatives. After a treating process was complete, the withdrawn wood preservatives from the treating cylinders were fed back into the working tanks to be used again. The principal chemicals reportedly used were creosote and Wolman treating salts. Creosote oils are produced by coking of coal or wood at high, oxygen-deficient environments followed by fractional distillation of the resultant tars to obtain the creosote fractional.

1.3.4 Potential Contaminants Of Concern. The chemical compounds found in the site soils and groundwater are associated with the wood treating and preservation industry. This industry typically utilizes three major preservatives in its process: creosote, pentachlorophenol (PCP), and various water soluble inorganic compounds (salts of copper, chromium, and arsenic). However, no records of PCP wood preservation techniques are indicated for the South Cavalcade Site.

Based on the site history and the types of compounds found at the South Cavalcade Street Site, creosote was the major preservative type used at the facility. Creosote is a primary product in the fractional distillation of coal tar. Coal tars are produced as a by-product from the coking of bituminous coal. Creosote is a mixture of chemicals that

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include aromatic hydrocarbons, tar acids, and tar bases. The major potential constituents of concern are in a group of chemicals called polynuclear aromatic hydrocarbons (PAH), also referred to as PNA (polynuclear aromatics). These compounds are present in various percentages that are dependent on the fractionation and coking processes. Table 3-3 lists the hazardous substance list (HSL) compounds which are constituents of creosote.

In order to reduce the high viscosity of creosote, many operations add carriers such as diesel, fuel oil, kerosene, etc. These carriers permit easier and deeper penetration into the preserved wood. Associated with these carriers are additional HSL compounds. These HSL compounds typically include benzene, toluene, xylene (BTX), and ethylbenzene.

The mobility of these constituents is a function of numerous factors such as solubility, vapor pressure, partition coefficients, etc. Table 1-3 summarizes these parameters. A brief explanation of each parameter follows.

Molecular Weight is the sum of the atomic weights of the atoms in a molecule.

Specific Gravity is a dimensionless number that expresses the ratio between the weight of a substance and the weight of an equal volume of water. Substances with a specific gravity greater than 1.0 tend to sink in water whereas those less than 1.0 would tend to float on a water surface.

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TABLE 1-3
POTENTIAL ORGANIC CONTAMINANT OF CONCERN PARAMETER SUMMARY[1]

| LIGHT AROMATICS | Molecular Weight | Specific Gravity[3] | Water Solubility[4] | Vapor Pressure[5] | Log $K_{OW}$[6] | Log $K_{OC}$[7] | Henry's Constant(H) | Mobility Index[8] |
|---|---|---|---|---|---|---|---|---|
| BENZENE | 78 | 0.79 | 1780 | 76 | 2.13 | 1.92 | | 3.2 |
| TOLUENE | 92 | 0.9 | 520 | 22 | 2.28 | 2.07 | 0.27 | 2.0 |
| ETHYLBENZENE | 106 | 0.87 | 152 | 7 | 3.15 | 2.98 | 0.27 | 0.05 |
| XYLENE | 106 | 0.88 | 175 | 5 | 3.68 | 2.43 | 0.21 | 0.5 |
| PAH | | | | | | | | |
| FLUORENE | 116 | 1.16 | 1.98 | $10^{-3}$ | 4.18 | | | |
| NAPHTHALENE | 128 | 1.15 | 34.4 | 0.49 | 3.37 | 3.47 | 0.19 | -2.2 |
| 2-METHYLNAPHTHALENE | 142 | 0.99 | 27 | 1 | 4.03 | 2.2 | | -0.8 |
| ACENAPHTHENE | 154 | 1.07 | 3.42 | 0.01 | 4.33 | | | |
| ANTHRACENE | 178 | 1.25 | 0.073 | $1.9\times10^{-4}$ | 4.45 | | | |
| PHENANTHRENE | 178 | 1.03 | 1.15 | $6.8\times10^{-4}$ | 3.61 | 4.46 | | -7.6 |
| FLUORANTHENE | 202 | 1.25 | 0.26 | $10^{-5}$ | 5.33 | 3.96 | $4.2\times10^{-4}$ | -9.6 |
| PYRENE | 202 | 1.27 | 0.14 | $6.9\times10^{-17}$ | 5.32 | 3.56 | $5.4\times10^{-4}$ | -20.6 |
| CHRYSENE | 228 | 1.27 | 0.006 | $10^{-6}$ | 4.86 | 5.61 | | -13.8 |
| BENZO(A)ANTHRACENE | 228 | | 0.014 | $5\times10^{-9}$ | 4.66 | 5.61 | | -15.8 |
| BENZO(A)PYRENE | 252 | | 0.0038 | $5\times10^{-9}$ | 4.97 | 6.04 | | -16.8 |
| BENZO(B)FLUORANTHENE | 252 | | 0.0012[2] | $10^{-11}$ | 6.57 | | | |
| BENZO(K)FLUORANTHENE | 252 | | 0.00055[2] | $9.6\times10^{-11}$ | 6.84 | | | |
| OTHER | | | | | | | | |
| PENTACHLOROPHENOL | 266 | 1.98 | 14.0 | $1.1\times10^{-4}$ | 5.10 | | | |

NOTES:
1. From "Remedial Investigation Report for North Cavalcade Street Site", by Camp Dresser & McKee Inc. October, 1987.
2. From "The Land Treatability of Creosote/Pentachlorophenol Wastes", by Environmental Research and Technology, Inc., August, 1985.
3. Specific gravity at 20 degrees Celsius relative to water at 4 degrees Celsius.
4. Water solubility in mg/L at 20 degrees Celsius.
5. Vapor pressure in mm mercury at 20 degrees Celsius.
6. Log Octanol/Water Partition Coefficient.
7. Log Adsorption Coefficient.
8. Index = Log (water solubility vapor x pressure/$K_{OC}$).





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Water Solubility is a critical parameter governing the fate of organic and inorganic contaminants. Chemicals with high solubilities tend to migrate quickly in the environment. These chemicals also have low soil absorption coefficients and therefore tend to move easily in groundwater rather than attenuate in the aquifer-soil matrix. Chemicals with low water solubility will not dissolve readily in water and their extent of transport in the groundwater and surface pathways will be minimal.

Vapor Pressure governs the rate at which a liquid will evaporate into the atmosphere. Chemicals with low vapor pressures do not easily volatilize into the air; therefore, these chemicals are persistent in near-surface soils. In contrast, chemicals with higher vapor pressures volatilize easily and are not persistent in near surface soils. These chemicals also tend to be easily biodegraded.

Octanol/Water Partition Coefficient ($K_{ow}$) is the theoretical ratio of a chemical's concentration in the organic phase (octanol) and in the aqueous phase (water). $K_{ow}$ is used to estimate the tendency of the chemical to partition itself between an organic phase and an aqueous phase. Large $K_{ow}$ values indicate the chemical will tend to be absorbed in an organic phase.

Adsorption Coefficient ($K_{oc}$) estimates the extent to which an organic chemical partitions itself between the solid and solution phases of water saturated or unsaturated soil, or runoff water and sediment. $K_{oc}$ is a useful index of leachability and is roughly independent of the particular soil. Large $K_{oc}$ indicates the chemical will tend to be absorbed on soil organic materials, i.e., less mobile.

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Henry's Constant (H) estimates the extent to which an organic chemical will volatilize from a chemical/water solution. The concentration of the chemical in air is that which is observed directly above the water in the gas-liquid-equilibrium phase. The higher the value of H, the greater the tendency the chemical has to volatilize from the solution.

Mobility Index is an indicator of relative contaminant mobilities and migration potentials:

| Relative Mobility Index | Mobility Descriptor |
|---|---|
| >5.0 | Extremely Mobile |
| 0.0 to 5.0 | Very Mobile |
| -5.0 to 0.0 | Slightly Mobile |
| -10.0 to -5.0 | Immobile |
| <-10.0 | Very Immobile |

The mobility index is calculated as: Index = Log (water solubility times vapor pressure/absorption coefficient). The mobility properties of inorganic compounds (salts of chromium, copper, and arsenic) are different than PAH compounds. The concentration of these metals in groundwater is dependent on the water pH and the metals' ability to form aqueous salt compounds. The metals are more soluble in acidic groundwater (low pH). Generally, the rate of migration of metal ions is dependent on the rate of groundwater flow and the amount of clay present in the subsurface. Metal ions will tend to be absorbed onto the negatively charged clay particles and prevented from further migration.

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1.3.5 Historical Aerial Photographs. As part of Subtask 1B - Aerial Photo Evaluation, of the RI/FS, a review of historical aerial photographs of the site area was conducted to supplement information obtained from the deed research and previous site maps. The following table includes a summary of the aerial photograph enlargements reviewed for the Remedial Investigation.

TABLE 1-4
SUMMARY OF HISTORICAL AERIAL PHOTOGRAPHS

| Year | Photograph No. | Source | Scale |
|---|---|---|---|
| 1930 | 722-2-43 | Tobin Research | 1 in. = 200 ft. |
| 1938 | BQY-5-3 | National Archives | 1 in. = 630 ft. |
| 1944 | BQY-4C-144B | ASCS | 1 in. = 200 ft. |
| 1953 | BQY-13M-123D | ASCS | 1 in. = 200 ft. |
| 1958 | BQY-4T-13JC | ASCS | 1 in. = 200 ft. |
| 1960 | B-5-8 | Harper Leipier | Oblique |
| 1961 | NH-556-C | Harper Leipier | Oblique |
| 1964 | BQY-3FF-144B | ASCS | 1 in. = 200 ft. |
| 1969 | 6214 | EPA | 1 in. = 100 ft. |
| 1975 | 5-34-1437 | EPA | 1 in. = 210 ft. |
| 1980 | 2-16-363 | EPA | 1 in. = 265 ft. |
| 1984 | 455 | Landis Aerial Photo | 1 in. = 200 ft. |

The 1930 aerial photograph corresponds to the period of ownership by National Lumber and Creosoting Company and is the earliest known public aerial photograph of the area. The 1930 photograph revealed that the primary wood preserving operations (retorts) and storage tank areas were located at the southern portion of the site adjacent to Collingsworth Street. Most of the northwestern portion of the site, extending to present-day Cavalcade Street, was vacant and undisturbed. The middle portion of the site appears to have been used primarily for wood storage, including treated and untreated products, as indicated by

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photographic tonal changes. No evidence of the tar distillation plant was observed from the 1930 aerial photograph. Evidence of activity (not associated with the wood-preserving operations) was also observed in the 1930 aerial photograph at the present-day locations of Mobil Bulk Oil Terminal, Airco Industries, and Crozier-Nelson Chemical Company.

The 1938 aerial photograph corresponds to the year the Wood Preserving Corporation acquired ownership of the site. The 1938 aerial photograph is very similar to the 1930 photograph, indicating few plant changes. The plant operations are located at the southern portion of the tract and wood storage was mostly throughout the middle and northeastern sections. The northwest portion of the tract is undeveloped. The eastern area of the site, location of the future tar plant, appears to be mostly cleared of product storage areas evident in the 1930 aerial photograph.

The 1944 aerial photograph revealed that the Koppers operations were limited to the southern end of the tract, similar to the 1930 and 1938 aerial photographs. The main treatment and processing areas appear to be located adjacent to Collingsworth Street, bordered on the east and west by the railroad lines. Most of the material storage areas were located towards the back of the property, north of the operations areas. The total area of activity occupied approximately 46 acres. The northern extent of activity was about 500 ft south of present-day Cavalcade Street. An undeveloped triangular-shaped area of approximately 19 acres was located at the northwest corner of the tract, south of Cavalcade Street. No wood treating activity was observed in the tract north of Cavalcade Street. Large

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trees and dense vegetation are evidence that these undisturbed areas had been vacant for several years. Details of the tar plant were observed in the southeastern portion of the site from the 1944 aerial photograph including storage tanks, spray ponds and pitch pans.

The 1953 aerial photograph indicated some plant changes compared to the previous aerial photographs. The tar plant area located along the east site border appears to have expanded and includes additional support structures, two spray ponds, and additional storage tanks. The Mobil Bulk Oil Terminal, located adjacent to the site along the west site border, was expanded to an area of about 10 acres and includes four storage tanks and additional support buildings. In addition, evidence of the wood preserving operations at the North Cavalcade Site was observed in the 1953 aerial photograph. The northwestern portion of the South Cavalcade Tract remained undeveloped, extending north to present-day Cavalcade Street. A copy of the 1953 aerial photograph is presented on Figure 1-4.

The 1958 aerial photograph revealed site features similar to those observed from the 1953 aerial photograph. Some additional storage tanks were observed at the tar plant area. A small ponded area, as noted by a dark contrasting tone, was observed about 600 ft south of present-day Cavalcade Street. This feature was located adjacent to interior site drain ditches and probably represents a low-lying area that ponded during a period of wet weather. This ponded area was also observed from the 1960 and 1961 oblique aerial photographs.

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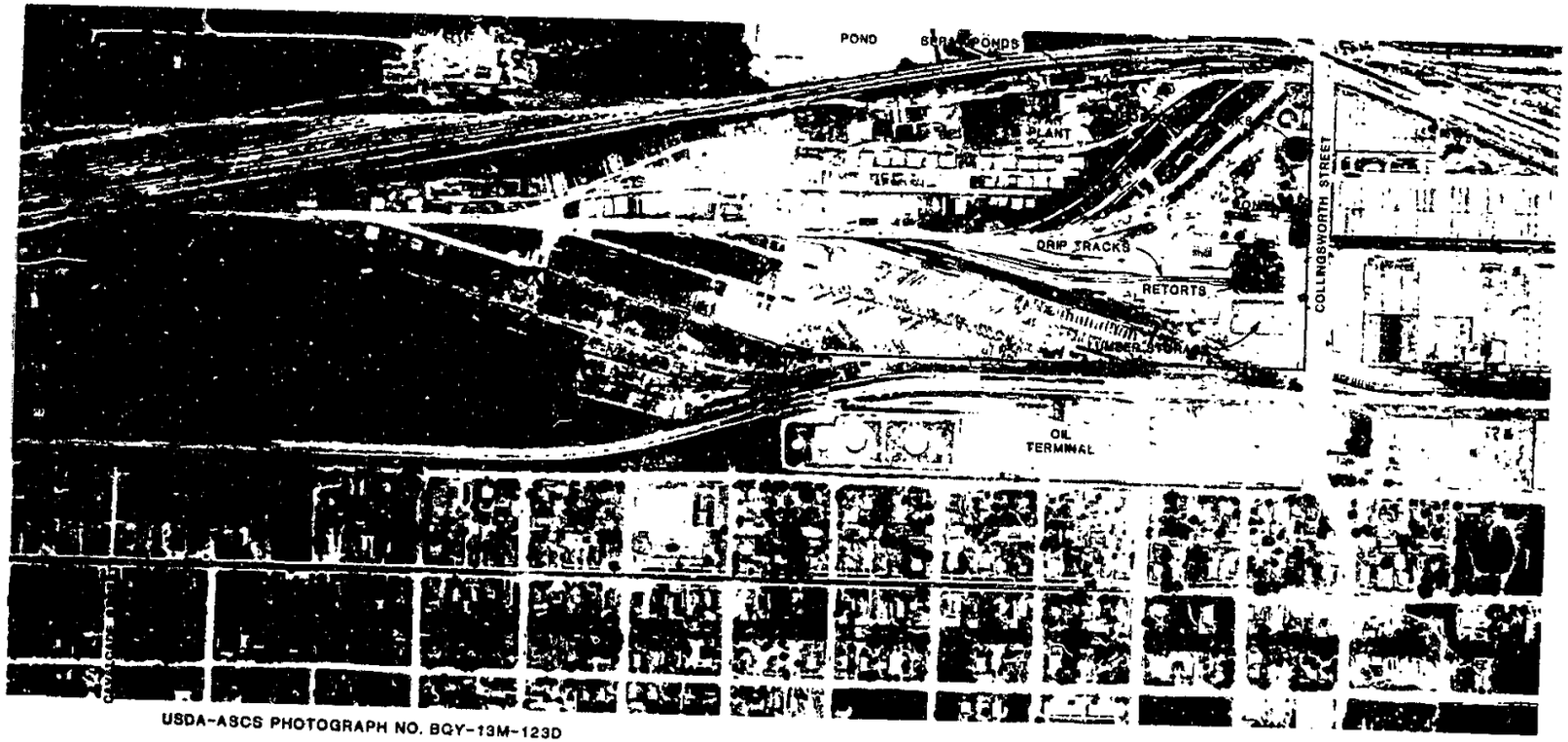


USDA-ASCS PHOTOGRAPH NO. BQY-13M-123D

APPROXIMATE SCALE-FT
0 100 200 300 600

| | |
|---|---|
| SOUTH CAVALCADE SITE<br>HOUSTON, TEXAS | Page 1-17 |
| KOPPERS COMPANY, INC.<br>PITTSBURGH, PENNSYLVANIA | SCALE NOTED · MADE · DATE · CHECK · DATE · FILE NO. 85-317 |
| | AERIAL PHOTOGRAPH - 1953 · FIGURE 1-4 |

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Additional activity at the North Cavalcade Site was observed from the 1958 aerial photograph. Evidence of the North Cavalcade Site was also observed from the 1960 and 1961 oblique aerial photographs. The northwest portion of the South Cavalcade Tract appeared vacant, extending north to present-day Cavalcade Street.

The 1964 aerial photograph corresponds to ownership by Merchants Fast Motor Lines, Inc. Most of the wood preserving operations appear to have been removed and replaced by the Merchants Fast Motor Lines building and truck yard. The plant rail lines and wood stockpile areas also appear to have been removed. A portion of the tar plant facilities appears to have been dismantled. The northwestern portion of the site remains vacant, extending north to present-day Cavalcade Street. Operations at the North Cavalcade Street Site also appear to have been partially dismantled. The ponded area, first observed from the 1958 aerial photograph, also appears on the 1964 aerial photograph. In addition, a light-colored, circular-shaped feature was also observed from the 1964 aerial photograph, located about 50 ft southeast of the ponded area. This feature is indicative of potential fill or disturbed ground and is shown on a copy of the aerial photograph presented on Figure 1-5.

The 1969 aerial photograph shows an enlargement of the northern portion of the site. Cavalcade Street is shown to extend through the north property boundary. The ponded area is less pronounced on the 1969 aerial photograph. Also, the light-colored, circular-shaped feature located adjacent to the pond area is not evident from the 1969 aerial photograph.

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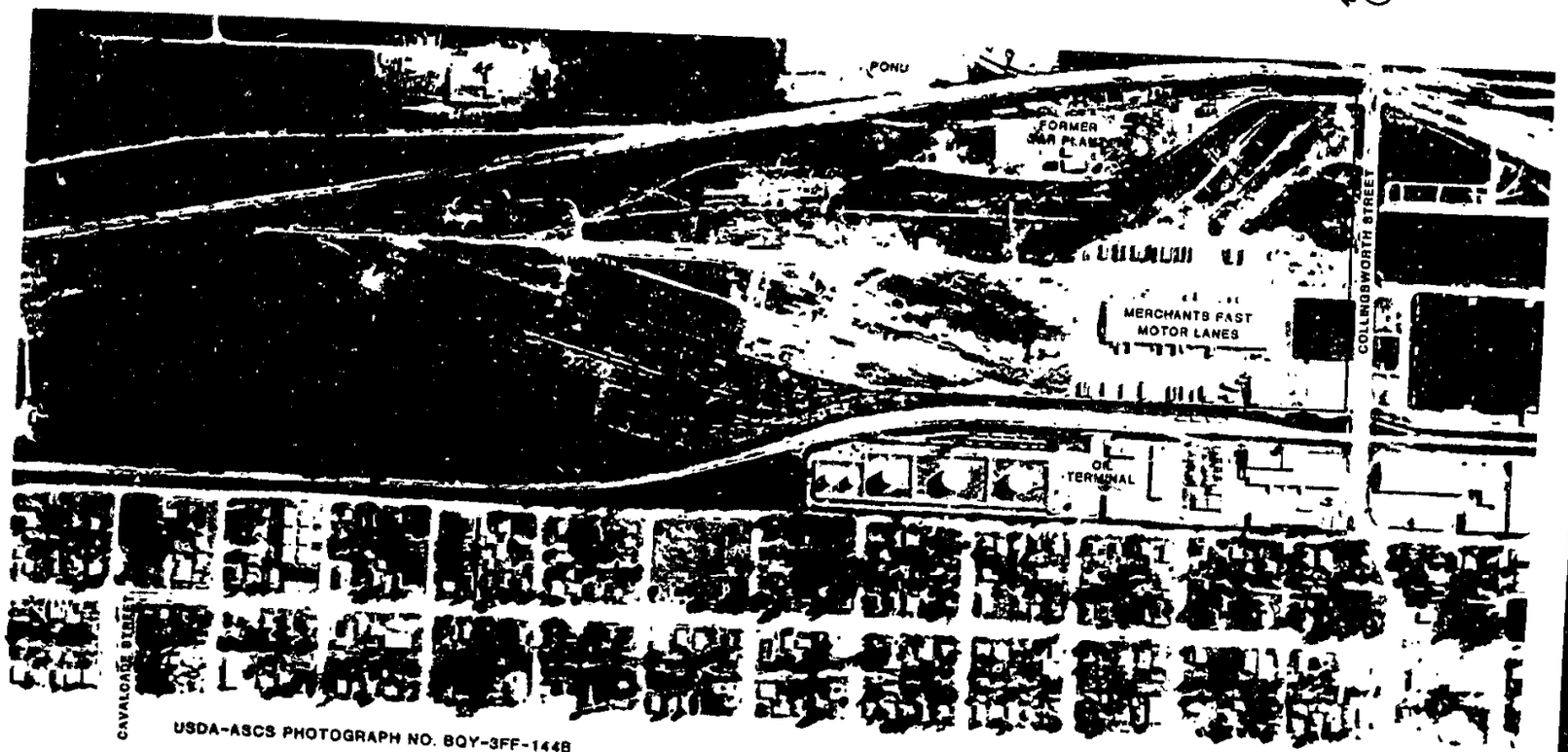


USDA-ASCS PHOTOGRAPH NO. BQY-3FF-144B

APPROXIMATE SCALE-FT
0 100 200 300 600

| | |
|---|---|
| SOUTH CAVALCADE SITE<br>HOUSTON, TEXAS | Page 1-19 |
| KOPPERS COMPANY, INC.<br>PITTSBURGH, PENNSYLVANIA | SCALE NOTED · MADE · CHECK · DATE · DATE · FILE NO 86-317 |
| | AERIAL PHOTOGRAPH - 1964 · FIGURE 1-5 |

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The 1975 aerial photograph shows further site development. Transcon Truck Lines occupies the northern portion of the site, adjacent to Cavalcade Street. Merchants Fast Motor Lines appears to have expanded their building. Remnant features of the tar plant are observed from the 1975 aerial photograph, including the spray ponds. The 1980 aerial photograph shows Palletized Truck Lines located at the former tar plant area. The 1984 aerial photograph shows expanded facilities at Palletized Truck Lines, with the interior portion of the tract largely undeveloped.

## 1.4 Previous Studies

A contaminant survey was conducted in 1983 by Camp Dresser & McKee, Inc., (CDM) to evaluate the suitability of the South Cavalcade Site for use as a maintenance yard and transit station for the proposed METRO-Stage One, Regional Rail System (RRS). The contaminant survey included a preliminary evaluation of shallow soil and groundwater conditions primarily throughout the northern portion of the site, with limited analytical testing. Results from the study indicated the potential for localized areas of contamination.

Physical and chemical data obtained from the contaminant survey were evaluated for quality and for potential utility based upon EPA PRP data criteria for assessing existing data supplied by parties other than EPA or its contractors. Preliminary evaluation of the data from the Cavalcade Contaminant Survey Report with respect to the PRP data criteria indicates the following conclusions:

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1. Chemical Data: Level A data meets the first level screening criteria but not the second level criteria. This class of data could be used to help develop or refine study plans, evaluate different sampling or analysis techniques, or identify gaps in the data base.

2. Physical Data: Level A data meets the first level screening criteria but not the second level criteria. This class of data could be used to help develop or refine study plans, evaluate different sampling or analysis techniques, or identify gaps in the data base.

EPA Level A criteria indicates the following information must be fully documented through sampling and field records or laboratory records:

- Sampling date;
- Sampling team and/or member in charge;
- Sampling location within the required tolerances for the study;
- Sampling depth increment for soils;
- Sample collection technique;
- Field preparation techniques;
- Sample preservation technique(s);
- Sample shipping data and laboratory analysis date;

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- Laboratory preparation techniques;
- Laboratory analysis methods including reference method;
- Companion sampling efforts such as crops or livestock; and
- Visual classification of sample using an accepted classification system.

## 1.5 Regulatory Summary

As a result of the Cavalcade Contaminant Survey Report, the site was referred to the Texas Department of Water Resources (TDWR). On April 16, 1984, the TDWR recommended to the U.S. Environmental Protection Agency (EPA) Region VI that the South Cavalcade Site be placed on the updated National Priorities List (NPL).

1.5.1 NPL Hazard Ranking. On October 15, 1984, the South Cavalcade Site was included on the proposed NPL Update No. 2. On June 10, 1986, the South Cavalcade Site was included on the final NPL. The South Cavalcade Site ranks 415 out of 802 final sites included on the July 1987 NPL. The NPL included the North Cavalcade Site separate from the South Cavalcade Site.

1.5.2 Administrative Order on Consent. On March 28, 1985, Koppers Company, Inc., entered into an Administrative Order on Consent (AOC) with the U.S. Environmental Protection Agency, Region VI. The AOC (CERCLA VI-8-85) required that Koppers Company, Inc.,: (1) determine the nature and extent

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of contamination, and (2) evaluate remedial action alternatives for the South Cavalcade Site. The AOC also specified that all RI/FS activities are subject to EPA approval and shall be consistent with the National Oil and Hazardous Substance Contingency Plan (NCP). A copy of the AOC is included in Appendix A, Volume 2.

## 1.6 Remedial Investigation Overview

The Remedial Investigation for the South Cavalcade Site was conducted in general accordance with Task 2 of the RI/FS Work Plan. Task 2 includes the following subtasks:

| Subtask | Description |
|---|---|
| 2A | Surface Water Characterization |
| 2B | Surface Sediment Characterization |
| 2C | Geophysical Surveying |
| 2D | Subsurface Soil Sampling |
| 2E | Shallow and Deep Groundwater Investigation |
| 2G | Air Quality Investigation |

Most of the field subtasks were conducted by McBride-Ratcliff and Associates, Inc., (MRA). Various subcontractors were used throughout the remedial investigation and are summarized as follows:

| Subcontractor | Subtask |
|---|---|
| Van and Sons Drilling Service | Soil Borings |
| Randy L. Stroud | Topographic Survey |
| Layne-Western Company | Shallow Monitoring Wells |
| Southwestern Laboratories | Deep Monitoring Well |
| Gullet & Associates | Well Casing Elevations |
| Spectrix Division, Keystone Environmental Resources | Analytical Testing |

Subtasks completed by Keystone Environmental Resources Inc., include groundwater sampling, deep well design and

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installation supervision, air quality investigation, data validation, and preliminary public health environmental assessment.

A summary of each subtask is described as follows:

1.6.1 Surface Water and Sediment Characterization. Both surface water and sediment characterization subtasks were combined. A total of seven samples were collected during Round 1 and nine samples during Round 2. Two rounds of samples were obtained subsequent to rainfall events to evaluate potential surface contaminant transport. Analytical testing included HSL volatile and semivolatile organics, HSL metals, cyanide, and iron. Also included was surface film analysis for total petroleum hydrocarbons. Evaluation of surface water and sediment quality is presented in Section 5.0.

1.6.2 Geophysical Surveying. A geophysical feasibility survey was conducted at three test site locations to evaluate surface resistivity, electromagnetic profiling, and ground-penetrating radar techniques. The eletromagnetic profiling method was selected and a site survey was conducted throughout approximately one-quarter of the site area. Results of the geophysical site survey were used to develop a shallow subsurface geophysical anomalies map to assist in locating soil borings. Evaluation of the geophysical test data is presented in Section 3.4.

1.6.3 Subsurface Soil Sampling. The initial phase of soil sampling consisted of drilling a total of 139 auger borings to a depth of about 8 ft within the unsaturated zone (vadose zone). Recovered auger boring soil samples were analyzed using photoionization headspace measurements for

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total organic vapors and X-ray fluorescence for metals. The auger borings were used to evaluate geophysical anomaly areas, explore for potential surficial contaminant source areas, and to further assist in locating soil borings. A surficial soil quality evaluation of the vadose zone to a depth of 6 ft is presented in Section 6.0.

Following the initial auger boring phase, a total of 82 soil borings were continuously sampled to an average depth of 64 ft within the saturated zone. Selected soil samples from the soil borings were screened using photoionization headspace measurements for total organic vapors, X-ray fluorescence for metals, and fluorescence spectrophotometry for total aromatic hydrocarbons (surrogate testing). Selected soil samples from the soil boring surrogate testing program were assigned for semivolatile organic and metals testing. Results of the saturated zone subsurface soil sampling were used to supplement the groundwater quality data and to evaluate subsurface matrix quality. Descriptions of the drilling and soil sampling program are presented in Sections 3.5 and 3.6.

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1.6.4 Groundwater Investigation. During the Remedial Investigation, 21 groundwater monitoring wells were installed, including 20 installed in the shallow water-bearing zone and one installed in a deep water-bearing zone. Nine shallow groundwater monitoring wells were previously installed during the Cavalcade Contaminant Survey. Therefore, a total of 29 monitoring wells are screened into the shallow water-bearing zone to evaluate vertical and lateral extent of potentially impacted groundwater quality. The deep monitoring well was installed to evaluate groundwater quality in a water-bearing zone at a depth of approximately 200 ft. A deep monitoring well was also previously

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installed during the Cavalcade Contaminant Survey. Two rounds of groundwater samples were analyzed for volatile and semivolatile organics, pesticides and PCB, iron, cyanide, and HSL metals. Results of the groundwater tests were used in conjunction with the saturated zone soil quality data to evaluate subsurface matrix quality. Descriptions of the monitoring well installation and sampling procedures are included in Sections 3.7 and 3.8. Evaluation of the subsurface matrix quality is presented in Section 7.0.

1.6.5 Air Quality Investigation. Air quality samples were collected at 1 upwind and 2 downwind locations on three consecutive days. Both particulate phase and vapor phase organic compounds were evaluated for EPA Method 604 priority pollutant phenolic and EPA Method 610 polynuclear aromatic hydrocarbon (PAH) compounds. Details of the air sampling and evaluation of air quality are included in Section 8.0.

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## 1.7 Remedial Investigation Report Format

The South Cavalcade Remedial Investigation Report is presented in three volumes:

Volume 1 - Remedial Investigation Report
Volume 2 - Appendices
Volume 3 - Appendices

The Remedial Investigation (RI) Report includes nine sections organized in accordance with the EPA Guidance Manual on Remedial Investigations under CERCLA. In general, the RI report is designed to provide descriptions of the field sampling activities and the results of these activities. Detailed descriptions of field procedures and analytical

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data are presented separately in the appendices for purposes of clarity. Previous subtask report submittals are included by reference.

## 1.8 References


1. Camp Dresser & McKee, Inc., Cavalcade Contaminant Survey, Volume 1 - Engineering Report (Draft), July 11, 1983.

2. Planning Research Corporation, South Cavalcade Final Title Search Letter Report, August 30, 1985.

3. McClelland Engineers, Inc., Base Map Preparation - Collingsworth Site, MEI Report No. 0184-8033, May 8, 1984.

4. City of Houston Library Archives, Sanborn Insurance Maps.

5. Camp Dresser & McKee, Inc., Work Plan for South Cavalcade Street Remedial Investigation/Feasibility Study, Document No. 143-WP1-WP-ATEW-3, April 4, 1985.

6. Koppers Company, Inc., Addenda to the Site Plans for South Cavalcade, Houston, Texas, July, 1985.

7. U.S. Environmental Protection Agency, Administrative Order on Consent, CERCLA VI-8-85, March 28, 1985.

8. U.S. Environmental Protection Agency, Guidance on Remedial Investigations Under CERCLA, May 1985.

9. Federal Register, Vol. 52, No. 140, July 22, 1987.


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# SECTION 2.0 - SITE FEATURES

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# 2.0 SITE FEATURES

## 2.1 General

The site features discussed within this section characterize site geography. These geographical features include topography, surficial soil type, land use, wildlife habitats, demography, and climatology.

## 2.2 Topography

2.2.1 Area Topography. The topography of the site area was evaluated from the 1922 and 1982 Settegast, Texas U.S.G.S. topographic quadrangle maps. Topographic trends of the area were more clearly shown on the 1922 map (Figure 2-1) where topographic detail is enhanced by a contour interval of 1 ft. Shown by the 1922 map, the area land surface generally slopes from northwest to southeast, with a gradient ranging from about 10 ft/mile to the northwest, to less than 3 ft/mile to the southeast.

A general decrease in land surface elevation at the site vicinity between 1922 and 1982 was observed from comparison of the topographic quadrangle maps, although the maps are based on different datums. In 1922, the center of the South Cavalcade Site was mapped at an elevation of approximately 55 ft MSL. In 1982, following benchmark releveling in 1973 and 1979, the center of the site was mapped at an elevation of approximately 50 ft MSL. This decline is believed to be the result of subsidence in the Houston area which is estimated to be approximately 4 to 5 ft.

2.2.2 Site Topography. Topography for the South Cavalcade Site is shown on Figure 2-2. The topographic survey was completed in May 1985 by R. L. Stroud, Registered Public Surveyor in accordance with Subtask 1C of the RI/FS Work

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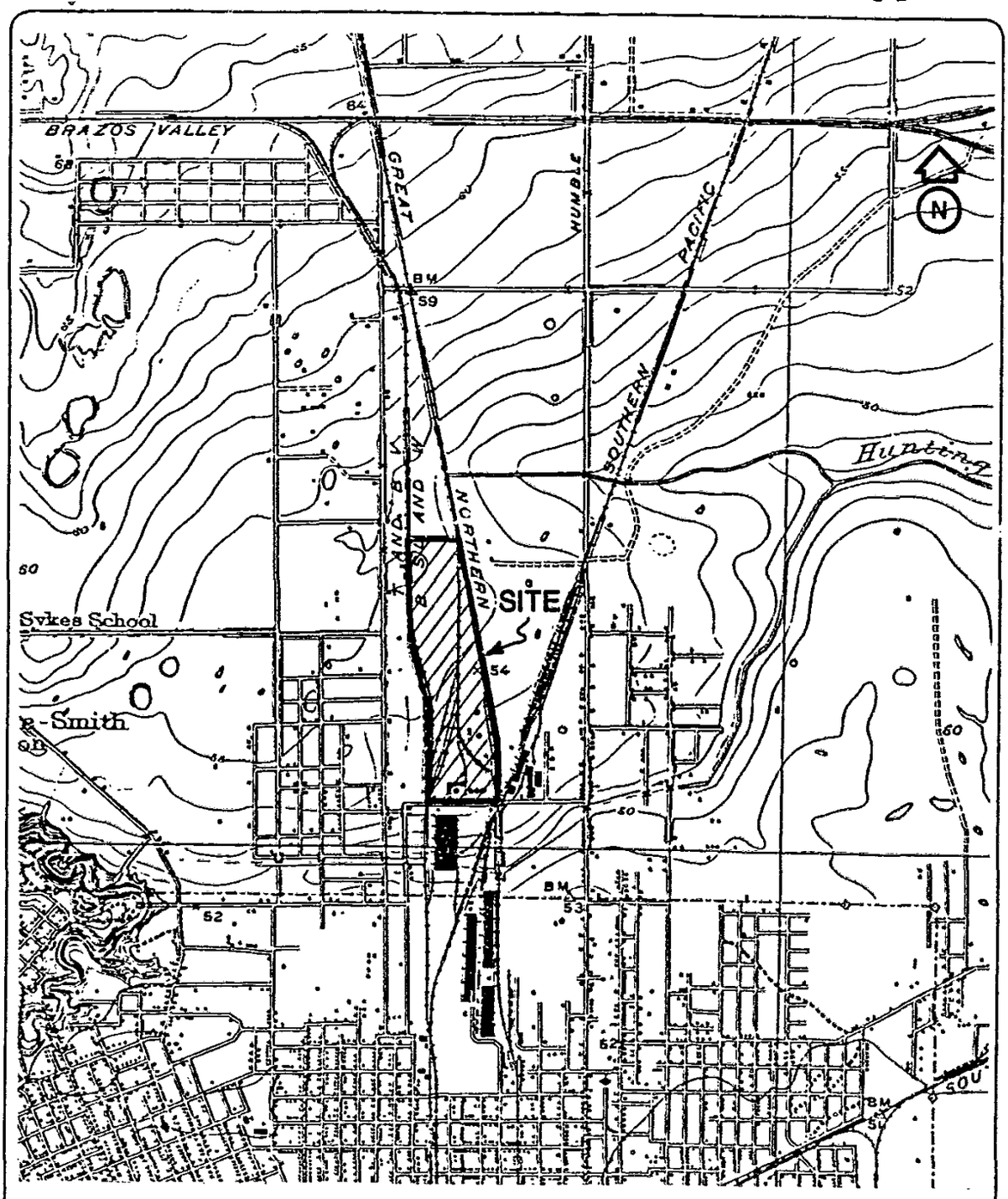


NOTE : TOPOGRAPHIC MAP IS FROM U.S.G.S. SETTEGAST, TEXAS (1922) SHEET.

SCALE-FT

0 2000 4000

## AREA TOPOGRAPHIC MAP - 1922

FILE NO. 85-317
FIGURE 2-1

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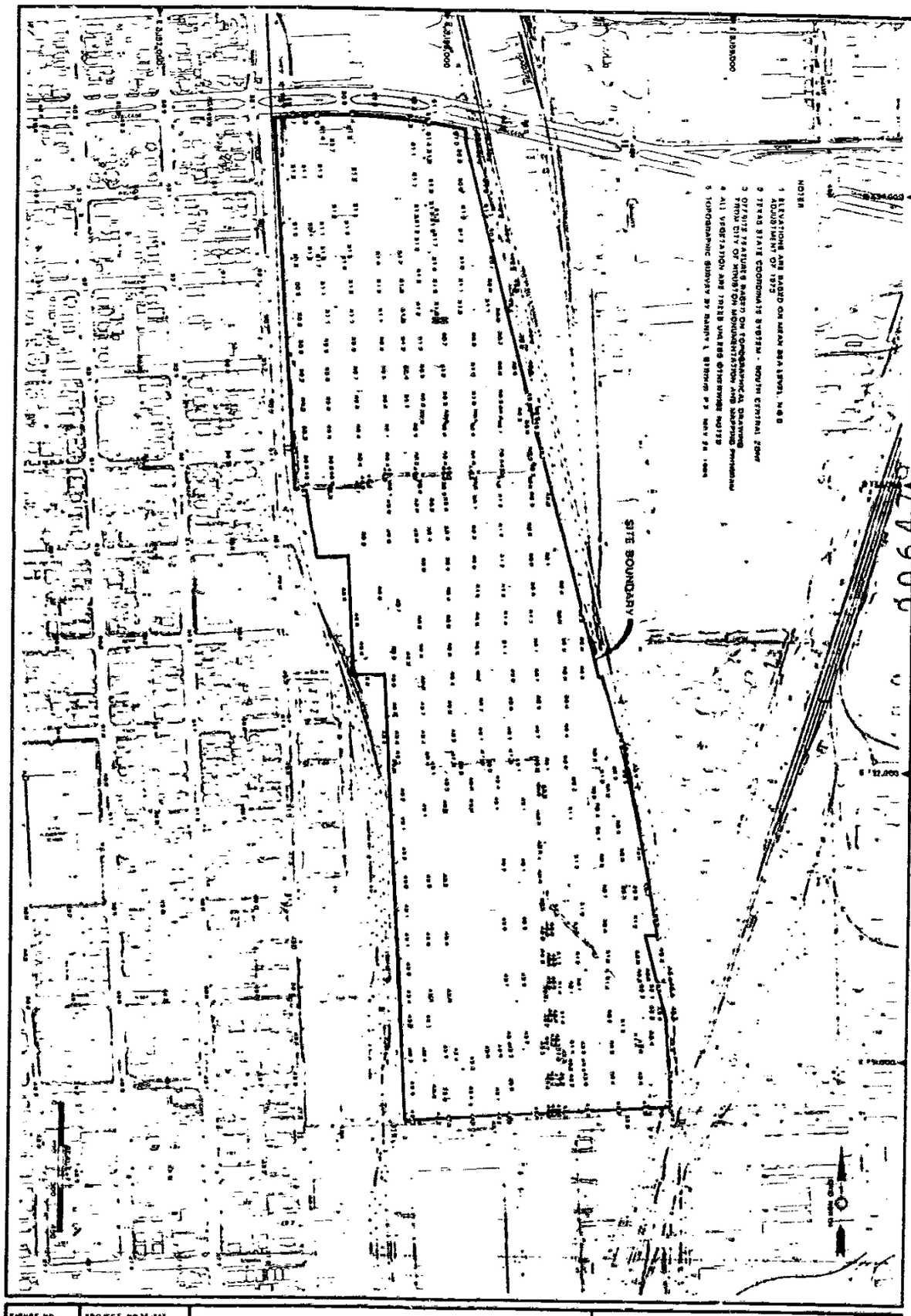


| FIGURE NO | PROJECT NO 85-317 | SITE TOPOGRAPHIC MAP - 1985<br>SOUTH CAVALCADE SITE<br>HOUSTON, TEXAS<br>KOPPERS COMPANY, INC. | Page 2-1 |
|---|---|---|---|
| 2-2 | DATE 7-15-87 | | |
| | ENGINEER | | |
| | DRAWN BY | | |

Plan. As indicated by the figure, the site is relatively flat, generally sloping north to south.

At the northern end of the site near Cavalcade Street, land-surface elevation is generally between 51 ft and 52 ft MSL. Towards the southern end of the site, land-surface elevation decreases irregularly to approximately Elevation 49 ft MSL.

The highest measured point on the site indicated by the May 1985 survey is 52.7 ft MSL. This point is located in the extreme northwest corner of the site near the intersection of Cavalcade Street and the Houston Belt and Terminal (HB&T) Railroad. The lowest measured point on the site indicated by the survey is at Elevation 47.8 ft MSL, located at the southwest corner of the site near Collingsworth Street. The measured relief for the site is about 4.9 ft.

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2.2.3 Regional Subsidence. Withdrawal of large quantities of groundwater in the Houston area has resulted in water level declines of up to 250 ft in wells completed in the Chicot Aquifer, and up to 300 ft in wells completed in the Evangeline Aquifer, from 1943 to 1977 (Gabrysch, 1984). These water-level declines have caused pronounced regional subsidence of the land surface.

The center of regional subsidence is located in the Pasadena area, just southeast of Houston, where more than 9 ft of subsidence has occurred from 1906 to 1978 (Holzchuh, 1980). In the north Houston vicinity, which encompasses the South Cavalcade Site, subsidence from 1906 to 1978 is reported as approximately 5 ft. These magnitudes of subsidence are based on bench mark releveling data and are consistent with the historical topographic data.

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## 2.3 Soil Type

The objective of evaluating surficial soil types for the site was to review published background data relative to site geology. This phase of the study was accomplished by review of the 1976 USDA Soil Survey of Harris County, Texas.

Soil types mapped on the South Cavalcade Site include the Urban land (Ur), which covers most of the site, and the Gessner-Urban land complex (Gu), mapped only along the northwest corner. The published distribution of these soils is shown on Figure 2-3.

Urban land soils are characteristic of most of the Houston metropolitan area. These areas are extensively developed where as much as 75 percent to 100 percent of the ground surface is either covered by structures or disturbed by cutting, filling or grading. Urban land soils are so altered and obscured that classification is not possible.

Gessner-Urban land complex soils are made up of a mix of soil types including 20 percent to 80 percent Gessner soils, 10 percent to 75 percent Urban land soils and 10 percent to 20 percent of other soils. As discussed, Urban land soils have been altered or covered by buildings and are thus unclassified. Gessner soils generally consist of a friable, slightly acidic, grayish-brown loam grading downward to a firm, moderately alkaline, light gray sandy clay to a depth of 84 inches.

Characteristic terrain for which the Gessner-Urban soil type consists of broad, nearly level areas, or depressions. These areas are poorly drained and have severe limitations for both farming and urban development.

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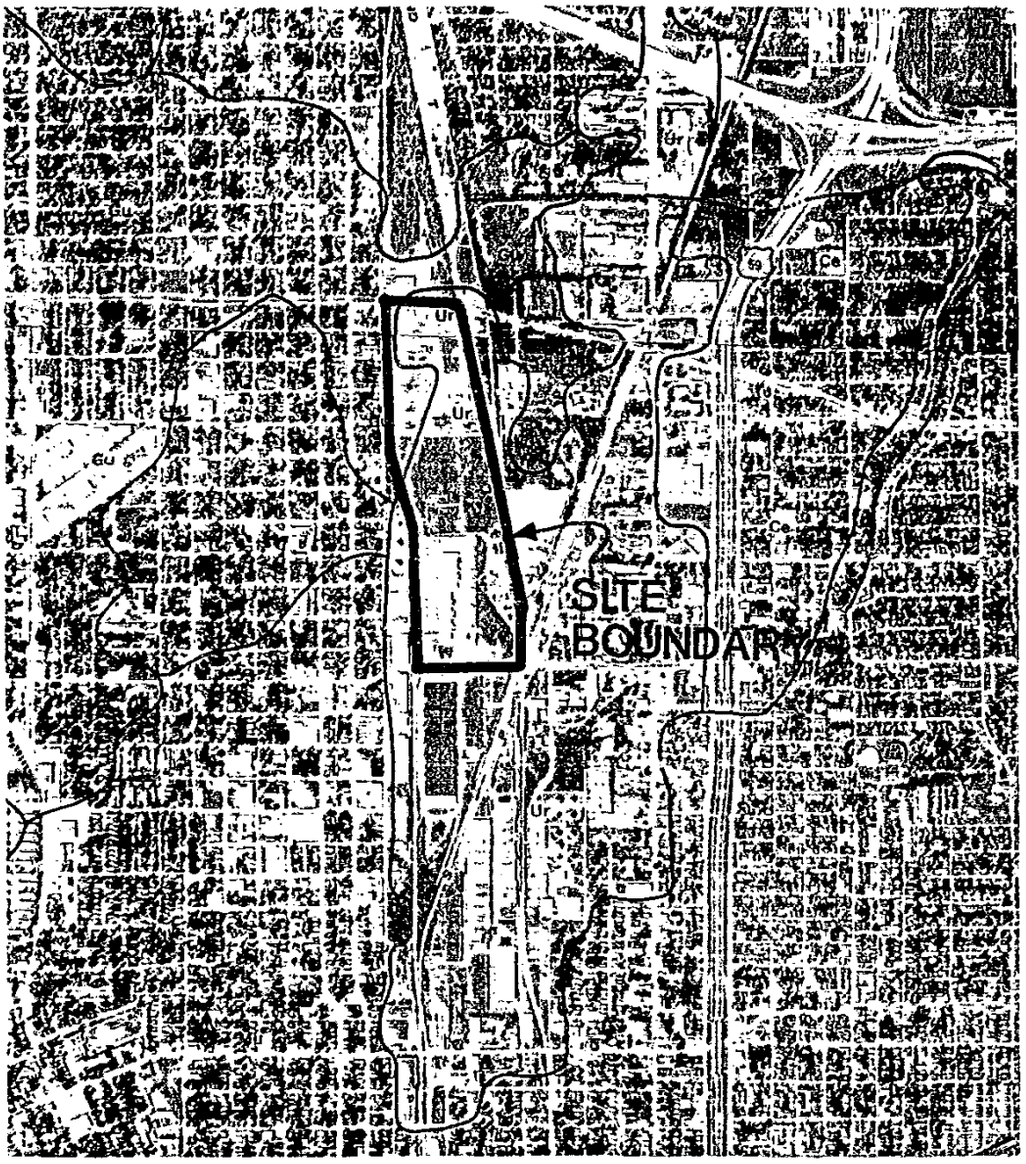
# SOIL SURVEY MAP
## SOUTH CAVALCADE SITE




NOTE: MAP FROM UNITED STATES DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE - SOIL SURVEY OF HARRIS COUNTY, TEXAS - DATED AUGUST, 1976.

SCALE - MILES
0 0.25 0.5

LEGEND

Ak - ADDICKS-URBAN LAND COMPLEX
Ce - CLODINE - URBAN LAND COMPLEX
Gu - GESSNER - URBAN LAND COMPLEX
Mu - MIDLAND - URBAN LAND COMPLEX
Ur - URBAN LAND

FILE NO. 85-317
FIGURE 2-3

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## 2.4 Land Use

2.4.1 On-Site Land Use. Land use data for the site was obtained from the CDM Cavalcade Contaminant Survey Report, dated July 1983. The report reveals that part of the South Cavalcade Site is utilized by several trucking firms (see Table 1-1). The trucking operations occupy tracts under ownership designated on Figure 2-4. Shown on the figure is a 22.5-acre tract at the northern end of the site owned by the Baptist Foundation of Texas. This tract is occupied by Transcon Lines. South of this tract, in the central portion of the South Cavalcade Site, lies 18.2 acres owned by Meridian Transport Company, which is presently unused.

At the southern end of the site, adjacent to Maury Street and Collingsworth Street, lies a 14.5-acre tract owned by Meridian Transport Company and occupied by Merchants Fast Motor Lines. East of this tract is a 10.3-acre parcel owned by Rex King and occupied by Palletized Trucking, Inc.

2.4.2 Area Land Use. A general land-use map of the South Cavalcade Site vicinity is shown on Figure 2-5. The map was developed from site reconnaissance and an analysis of low-level, 1984 black and white aerial photography. The major land-use groups within the site vicinity are industrial and mixed commercial-residential. Open areas within the land-use map boundaries designate unoccupied property.

Mixed commercial-residential areas within the land-use study boundaries were mapped generally west of Maury Street. These areas are characterized by interspersed residences and small businesses. Industrial areas were mapped generally east of Maury Street and occupy the majority of the property within the study boundaries. Based upon Cole's City of Houston Directory, 1986-1987, a

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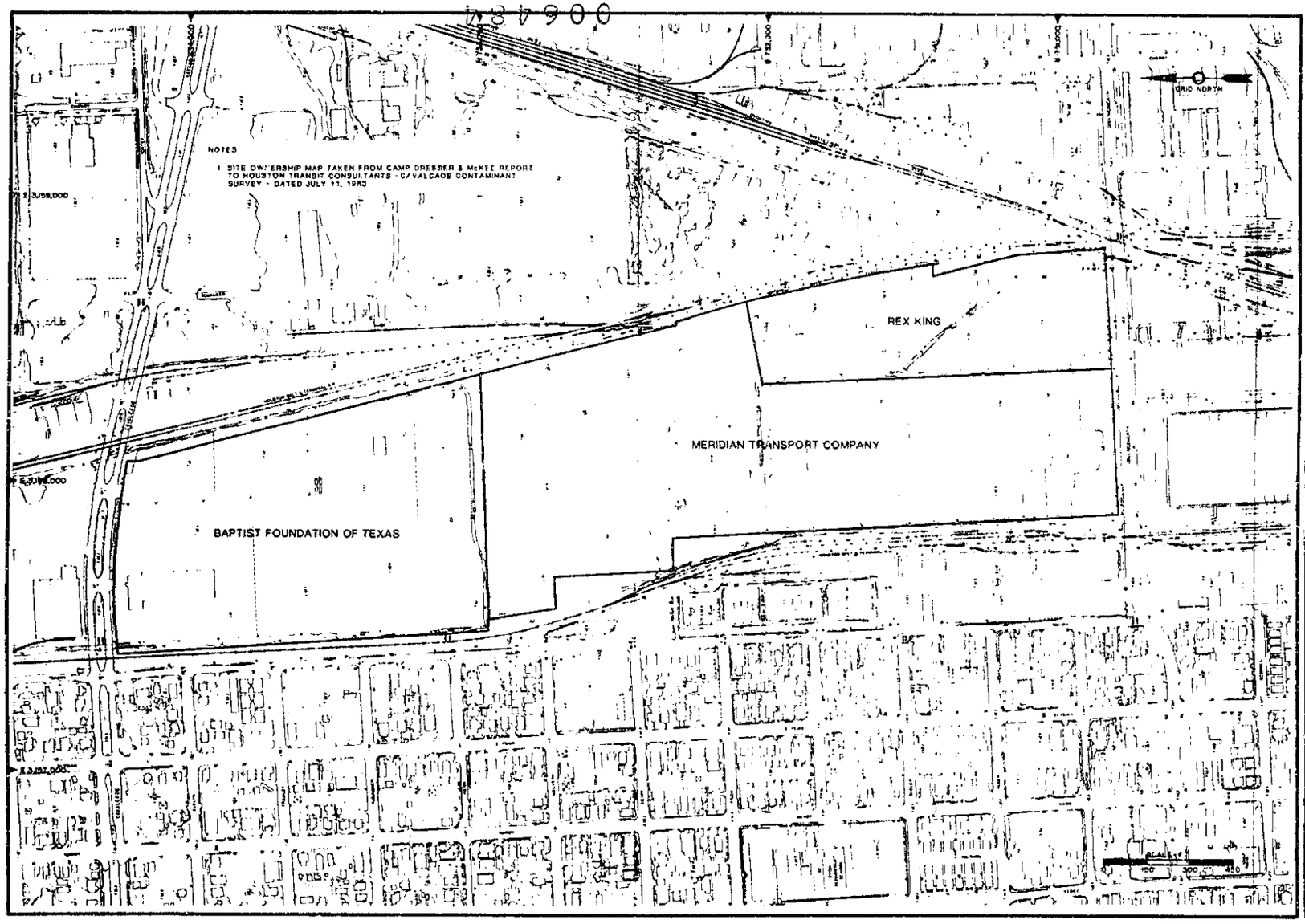


Page 2-8

SITE OWNERSHIP MAP
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

KOPPERS COMPANY, INC.

| | |
|---|---|
| PROJECT NO | 85-317 |
| DATE | 8-23-87 |
| ENGINEER | |
| DRAWN BY | |
| FIGURE NO | 2-4 |

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AREA LAND-USE MAP
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

KOPPERS COMPANY, INC.

FIGURE NO. 2-5

PROJECT NO. 89-317
DATE 8-18-87
ENGINEER
DRAWN BY

list of industries in the South Cavalcade site vicinity is presented in Table 2-1. These industries consist predominantly of transportation companies and metal fabricating and distributing operations.

2.4.3 Documented Regulated Sites. A summary of 35 documented area regulated sites located in the vicinity of the South Cavalcade Site is presented in Table 2-2. These facilities are registered with the Texas Department of Health (TDH), Texas Water Commission (TWC), and the Environmental Protection Agency (EPA) for association with storage, generation, or transportation of potentially hazardous materials.

Industries in the vicinity of the South Cavalcade Site have also been cited by the Texas Water Commission for RCRA violations. Lead and acid contamination was documented at 3799 Jensen, in 1981. In 1983, a facility located at 3511 Jensen was cited for the unauthorized release of metal fabrication cutting oils. An adjacent facility, located at 3603 Jensen was cited for PCB contamination in 1986. The Houston Fire Department has documented 17 spills of gasoline, diesel, naphtha, acetylene, sulfuric acid, etc., in the site vicinity, as indicated on Table 2-3.

2.4.4 MTA Regional Mobility Plan. In 1983, the Metropolitan Transit Authority (METRO) proposed that the South Cavalcade Site be used for a yard, shop, and terminal facility as part of its METRO-Stage One, Regional Rail System (RRS). Since this proposal, however, an alternative plan has been developed which includes a transportation corridor approximately three miles southeast of the site, in the vicinity of White Oak Bayou.

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TABLE 2-1
SUMMARY OF LOCAL INDUSTRIES

| Industry | Location |
|---|---|
| A and B Metal Mfg. | 3314 Carr |
| Airco, Inc. | 3603 Cherry |
| American Distributing | 3801 Jensen |
| American Warehouse, Inc. | 1918 Collingsworth |
| Arsham Metals, Inc. | 3616 Cherry |
| Bodner Metal and Iron | 3660 Schalker |
| Bowman Transportation | 3801 Cherry |
| Cargill, Inc. | 2501 Cavalcade |
| Crozier-Nelson Chemicals | 2505 Collingsworth |
| Daniel Industries, Inc. | 3905 Jensen |
| Freedman Packing, Inc. | 3821 Jensen |
| Global Fuel, Inc. | 2505 Collingsworth |
| Hopper Freight Systems | 1919 Collingsworth |
| Houston Belt and Terminal RR | 501 Crawford (offices) |
| Houston Scrap Co. | 3799 Jensen |
| Jam Distributing | 1801 Collingsworth |
| KO Forge, Inc. | 3315 Carr |
| L.R. McCallister Oil | 2505 Collingsworth |
| Marsh Distributing | 1714 Collingsworth |
| Max Metals Co. | 3119 Jensen |
| McAffee Standard Transmissions | 5723 Jensen |
| Merchants Fast Motor Lines | 1919 Collingsworth |
| Mobile Houston Terminal | 1801 Collingsworth |
| National Starch and Chemical | 1918 Collingsworth |
| Northwest Wrecker Service | 3603 Jensen |
| Olds Press and Forge, Inc. | 3303 Carr |
| Overnight Transportation Co. | 2525 Cavalcade |
| Palletized Trucking, Inc. | 2001 Collingsworth |
| Pitkins Trucking | 5122 Cherry |
| Rayner Packing Co. | 3713 Jensen |
| Standard Rendering | 3701 Schalker |
| T Aycock Transport | 3801 Jensen |
| Texas Cotton Production | 3311 Cherry |
| Texas Liquid Fertilizer | 3508 Cherry |
| Transcon Lines | 2000 Cavalcade |

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TABLE 2-2
SUMMARY OF DOCUMENTED REGULATED SITES

| Facility Name | Location | Type |
|---|---|---|
| A and E Messenger Service | 3102 Maury | Generator |
| Capital Electoplating Co. | 3011 Champan | Generator |
| Country Pride Foods | 2701 Porter St. | Generator |
| Daniel Industries, Inc. | 3905 Jensen | Generator |
| Global Fuel, Inc. | 2505 Collingsworth | Generator, Transporter, Storage |
| Gold Street Plant | 5711 Gold | Generator |
| Greater Houston Transport Co. | 1406 Hays | Transporter |
| Greater Houston Transmission | 1500 Hays | Generator |
| Gulf Coast Oil and Gas | 1204 Hays | Generator |
| Gull Industries, Inc. | 3233 Gano | Generator |
| Hall Chevrolet | 3515 Kelly | Generator |
| Houston Scrap Co. | 3799 Jensen | Generator, Storage |
| Hudson Machine Works | 1419 Hays | Generator |
| Jensen Drive Scrap | 3603 Jensen | Generator, Storage |
| McAffee Standard Transmission | 5723 Jensen | Generator |
| L. R. McCallister Oil | 2505 Collingsworth | Other |
| Mid-Century Transport | 3801 Jensen | Generator |
| Mobil Houston Terminal | 1801 Collingsworth | Generator |
| North Cavalcade St. Site | Cavalcade & Hardy | Generator, Storage |
| Olds Press and Forge, Inc. | 3303 Carr | Generator |
| Overnight Transportation Co. | 2525 Cavalcade | Transporter |
| Palletized Trucking, Inc. | 2001 Collingsworth | Transporter |
| Polly-Pig By Knapp, Inc. | 1209 Hardy | Other |
| Rustproof Sign and Metal Co. | 4021 Gano | Generator |
| Southwestern Plating Co. | 1312 Halpern | Generator |
| Texaco Inc. | 2661 Stevens St. | Other |
| Torque Petroleum Products | 2505 Collingsworth | Generator |
| Gulf Iron and Supply | 3603 Jensen | Generator |
| Universal Urethanes | 3919 Eastex Freeway | Generator |

Note:
Summary includes documented regulated sites located within 0.5 mile of the South Cavalcade Site.

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TABLE 2-3
HFD LOCAL CHEMICAL SPILL SITES

| Year | Location | Chemical |
|---|---|---|
| 1980 | 2505 Collingsworth | Naptha |
| | Cavalcade & Jensen | Diesel |
| | 1919 Collingsworth | Diesel |
| | 3400 Maury | MAPP Gas |
| 1981 | 1919 Collingsworth | Diesel |
| | 3603 Jensen | Diesel |
| | Collingsworth & Maury | Nako 5613 |
| 1982 | 3401 Hardy | Acetylene |
| | 3660 Schalker | Sulfuric Acid |
| 1983 | Jensen & Collingsworth | Gasoline |
| 1984 | 5131 Elysian | Natural Gas |
| | 1918 Collingsworth | Potassium Lignite |
| 1985 | Maury & Bunton | Gasoline, Diesel |
| | Collingsworth & Carr | Petroleum Sludge |
| 1986 | Cavalcade & Maury | Gasoline |
| | 3300 Jensen | Unknown (pH=4) |
| | Jensen & Quanah | Diesel |

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## 2.5 Wildlife Habitats

2.5.1 Endangered Species. On November 16, 1987, the United States Fish and Wildlife Service assessed the South Cavalcade Site vicinity to determine the possible existence of any listed or proposed endangered species in the general area. Based upon evaluation of documented sitings of flora and fauna by the U.S. Fish and Wildlife Service on November 16, 1987, no listed or proposed endangered species are present in the site area (Appendix G, Volume 2).

## 2.6 Demography

Demographic data for Harris County is published by the Houston-Galveston Area Council. The South Cavalcade Site and vicinity lies in 1980 Census Tract 207.04 which is bounded by Maury Street to the west, I-610 to the north, U.S. 59 to the east, and Collingsworth Street to the south.

The 1980 Census of Population and Housing reported a total population of 988 for Census Tract 207.04. The total housing units for the tract was 396; the number of vacant housing units was 76. The vacancy rate for the tract was 19.19 percent, which was greater than the vacancy rate for the City of Houston of 11.1 percent.

Population and employment projections for Harris County to the year 2000 were reported by the Houston-Galveston Area Council's Interagency Data Base Task Force in 1983. A summary of their findings for Census Tract 207.04 is presented in Table 2-4.

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TABLE 2-4
1983 DATA
FOR CENSUS TRACT 207.04

| Year | Employment | | | | | Total Population | Total Households |
|---|---|---|---|---|---|---|---|
| | Retail | Office | Industry | Institution | Total | | |
| 1970 | - | - | - | - | - | 1775 | 504 |
| 1980 | 656 | 82 | 1434 | 225 | 2397 | 988 | 320 |
| 1990 | 656 | 150 | 1434 | 225 | 2465 | 764 | 273 |
| 2000 | 656 | 361 | 1434 | 225 | 2676 | 658 | 247 |

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As reflected by the data in Table 2-4, a decline in total population and households for Census Tract 207.04 since 1970 is projected to continue to the year 2000. Employment projections show stability for numbers of persons employed in retail, industry, and by institutions, yet an increase by over 300 percent from 1980 to 2000 is projected for persons employed in offices.

EPA data from the Remedial Investigation Report for North Cavalcade Street Site, Houston, Texas indicates that the average population ages for Census Tract 207.04 in 1980 were 39 percent under 20, 47 percent aged 20 to 54, and 14 percent over 55. The median family income for Census Tract 207.04 was $14,603 and the mean family income was $15,033.

## 2.7 Climatology

Houston is located about 50 miles from the Gulf of Mexico and about 25 miles from Galveston Bay, resulting in a climate which is predominantly marine. In general, influence of winds from the Gulf of Mexico result in warm, humid summers and mild winters. Statistical meteorological data for Houston was obtained from the National Weather Service (1983).

Normal annual temperatures from 1951 to 1980 ranged from 57.4°F to 79.1°F. The average normal monthly temperature was 68.3°F. The mean number of days per year with temperatures 32°F and below is 24 (means established for 1969 to 1983). The mean number of days per year with temperatures 90°F and above is 92.

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Annual precipitation from 1951 to 1980 ranged from a minimum of 21.68 inches to a maximum of 46.9 inches. The average monthly precipitation for this period was 3.73 inches. The average annual precipitation from 1951 to 1980 was 44.77 inches. Since thunderstorms are the main source of rainfall, precipitation may vary substantially in different parts of the city on a daily basis.

Prevailing winds are from the southeast and south. In January, however, frequent passages of high pressure areas bring prevailing northerly winds. Mean wind speed from 1969 to 1983 was 7.8 mph. Though destructive wind storms are fairly infrequent, winds may reach velocities over 40 mph during tropical storms.

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## 2.8 Summary

As indicated by U.S.G.S. quadrangle maps, area topography generally slopes northwest to southeast at gradients ranging from 3 ft/mile to 10 ft/mile. Land surface elevations decreased between 1922 and 1982 from Elevation 55 ft MSL to Elevation 50 ft MSL, which appears to be due to regional subsidence in the Houston area. Regional subsidence is due primarily to large quantities of withdrawn groundwater from the Chicot and Evangeline Aquifers, with groundwater level declines of up to 250 ft and 300 ft, respectively, from 1943 to 1977.

Site topography is generally flat and slopes north to south. The northern end of the site is generally between Elevation 51 ft and 52 ft MSL and slopes to approximately Elevation 49 ft MSL at the southern end. The highest measured point on the site is Elevation 52.7 ft MSL and the lowest measured point is Elevation 47.8 ft MSL.

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USDA data indicates that site soils include Urban land (Ur) and Gessner-Urban land complex soils. Urban land soils are characteristically in areas developed from 75 percent to 100 percent of total developable soils and are generally altered so that classification is not possible. Gessner-Urban land complex soils include 20 percent to 80 percent Gessner soils, 10 percent to 75 percent Urban soils, and 10 percent is 20 percent of other soils. Gessner soils are typically friable, slightly acidic, grayish-brown loams grading downward to firm, moderately alkaline, light gray sandy clays to a depth of 84 inches. Gessner Urban land complex soils are typically poorly drained and are generally located in flat, broad areas.

Trucking operations occupy approximately 72 percent of the site (47.3 acres out of 66 acres). Approximately 28 percent (18.2 acres) is currently undeveloped. The major land-use groups within the site vicinity are industrial and mixed commercial-residential. The industrial land group consists primarily of transportation companies and metal fabricating and distributing operations.

Thirty-five documented TDH, TWC, and EPA sites are located in the vicinity of the site, and consist of hazardous material storage, generation, or transportation facilities. Three sites have been cited by TWC for RCRA violations involving unauthorized releases of PCB, lead, or cutting oils. The Houston Fire Department has documented 17 spills of fuel oils, acids, etc., in the site vicinity.

As indicated by assessment of area geographic features, the South Cavalcade Site area is predominently industrial. Industry has been attracted to this area by the close proximity of transportation corridors including Houston Belt and Terminal Railroad, I-610, I-45, and Highway 59.

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The site was proposed in 1983 as a yard, shop, and terminal facility by the Metropolitan Transit Authority (METRO), as part of a METRO Regional Rail System. An alternative site has been chosen three miles southeast of the site near White Oak Bayou.

In November, 1987, the United States Fish and Wildlife Service assessed the site for endangered species of flora and fauna. No listed or proposed endangered species were identified in the site area.

Population trends indicate a vacancy rate for the site vicinity which is significantly greater than that for the City of Houston. A continued decline in total population and households is predicted to continue to the year 2000.

The climate of the site and region is predominately marine. Winds from the Gulf of Mexico cause warm, humid summers and mild winters. Normal annual temperatures range from 57.4°F to 79.1°F, based on National Weather Service data from 1951 to 1980. Average monthly temperatures for those years was 68.3°F. Annual precipitation ranged from 21.68 inches to 46.9 inches, with an average from 1951 to 1980 of 44.77 inches. Prevailing winds are from the southeast and south, except for January, which brings prevailing northerly winds. Mean wind speed from 1969 to 1980 was 7.8 mph with infrequent windstorms over 40 mph.

## 2.9 References

1. Gabrysch, R.K., Ground-Water Withdrawals and Land Surface Subsidence in the Houston-Galveston Region, Texas, 1906-1980; Texas Dept. of Water Resources Rept. 287, 1984.

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2. Wheeler, Frankie F.; Soil Survey of Harris County, Texas; National Cooperative Soil Survey, U.S.D.A, 1976.

3. Camp Dresser & McKee, Inc., Cavalcade Contaminant Survey, Volume I, Engineering Report, July, 1983.

4. Cole Publications, Cole's City of Houston Directory; 1986-1987.

5. EPA Region VI CERCLIS Listing, EPA Region VI Superfund Compliance Section, May 21, 1987.

6. EPA Notifiers List for Region VI - Texas, EPA Region VI RCRA File, March 3, 1987.

7. TDH Permit Application File, TDH Bureau of Solid Waste Management, May 4, 1987.

8. United States Department of the Interior, Fish and Wildlife Service, Division of Ecological Services, Consultation No. 2-13-88-I-15, November 16, 1987.

9. Houston-Galveston Area Council, 1980 Person and Housing Unit Counts, October, 1981.

10. National Weather Service, Meteorological Data for the Current Year, 1983.

11. Holzchuh, J.C., Subsidence in the Houston Area, Harris-Galveston Coastal Subsidence District, 1980.

12. Camp Dresser and McKee, Inc., Remedial Investigation Report for North Cavalcade Street Site, Houston, Texas, October 28, 1987.

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# SECTION 3.0 - SOIL AND GROUNDWATER SAMPLING AND ANALYSIS

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# 3.0 SOIL AND GROUNDWATER SAMPLING AND ANALYSIS

## 3.1 Introduction

Presented within this section are descriptions of the soil boring and sampling techniques and groundwater monitoring well installation procedures which were utilized during the South Cavalcade Site Remedial Investigation. These activities include Subtask 2C-Geophysical Surveying, Subtask 2D-Subsurface Soil Sampling, and Subtask 2E-Shallow and Deep Groundwater Investigation of the RI/FS Work Plan.

## 3.2 Field Sampling and Analytical Plan

The field sampling and analytical testing was conducted in general accordance with the Field Sampling and Analytical Plan. The Field Sampling and Analytical Plan outlines field sample locations, sampling protocol, and analytical test assignments. Site-specific Standard Operating Procedures (SOP) and surrogate testing methods were developed for some of the field sampling procedures and analytical procedures to supplement the Field Sampling and Analytical Plan. McBride-Ratcliff and Associates, Inc., (MRA) Standard Operating Procedures are included in Appendix D, Volume 3.

## 3.3 Health and Safety Plan

The field operations were carried out in general accordance with the Health and Safety Plan. The Health and Safety Plan includes procedures for medical surveillance, personnel decontamination, personnel protection, air monitoring, and emergency procedures. As required by the Health and Safety Plan, 15-minute interval breathing and ground-level air monitoring was performed during the field drilling operations. The HNU photoionization analyzer was utilized for daily monitoring during the drilling operations. Background air monitoring was also performed daily.

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## 3.4 Surface Geophysical Study

The surface geophysical study was conducted in general accordance with Subtask 2C of the RI/FS Work Plan. The primary objectives of the geophysical study were to delineate areas of shallow subsurface anomalies associated with potential fill areas and to assist in locating soil borings. The geophysical study was organized into two components. An initial geophysical feasibility survey was conducted over limited areas to evaluate three potentially feasible geophysical exploration techniques. A detailed geophysical survey was then conducted with the selected geophysical technique to assess the site for shallow subsurface anomalies associated with fill soils. Subsequent soil borings were used to evaluate the fill soils for potential contaminant source areas.

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### 3.4.1 Geophysical Feasibility Survey.

The objective of the geophysical feasibility survey was to evaluate three potential geophysical methods for gathering site background data. The geophysical test methods evaluated during this feasibility study included resistivity soundings, electromagnetic profiling, and ground-penetrating radar.

The resistivity soundings were conducted in general accordance with guidelines set forth by the Texas Department of Health, Division of Solid Waste Management: Technical Guide No. 1. All readings for this test were obtained using a Bison Instruments Model 2350B Earth Resistivity Meter. The resistivity sounding stations were located at a 50-ft grid spacing in accordance with Section 9.1 of the Field Sampling and Analytical Plan. The Lee Modification of the Wenner Electrode Configuration was chosen for the resistivity sounding survey since it introduces a fifth electrode into the center of the array to dinstinguish between horizontal and vertical variations in the subsurface.

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The electromagnetic profiling was conducted under the guidelines set forth in Section 4.0 of the Geonics Limited: EM 31 Operating Manual. All readings for this method were obtained using a Geonics Limited Model EM31-D Non-Contacting Terrain Conductivity Meter. Readings were obtained at station intervals of 30-ft, with a 20-ft spacing between station traverses in accordance with Section 9.1 of the Field Sampling and Analytical Plan.

The ground-penetrating radar (GPR) profiling method was performed by Detection Sciences, Inc. All readings for this method were obtained using a custom-modified 120 MHz radar antenna in conjunction with a GSSI SIR System-8 radar system.

Three test areas were used to evaluate which geophysical method or combination of geophysical methods were potentially applicable for a detailed site survey. In an open field area, Test Site 1, conductivity, surface resistivity, and ground-penetrating radar techniques were tested to evaluate relative responses between background conditions and previously documented subsurface anomalies. Conductivity and ground-penetrating radar were tested in an asphalt paved area at Test Site 2 to evaluate potential interferences caused by asphalt paving. Conductivity and ground-penetrating radar were also tested in a concrete paved area at Test Site 3 to evaluate potential sampling interferences caused by reinforced concrete paving.

Evaluation of apparent resistivity sounding data indicates a generally lower sensitivity to subsurface anomalies because of the 50-ft grid spacing. In addition, because most of the site is paved or heavily wooded, logistical concerns limit the applicability of intrusive geophysical methods, such as earth resistivity measurements.

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The electromagnetic profiling data indicated a wide range of conductivity values for all three test sites. Those areas that exhibited conductivity values greater than 60 mmho/m or less than 40 mmho/m were interpreted as potential subsurface anomalies. The conductivity method appeared to respond to subsurface anomalies in areas paved with asphalt. Areas paved with steel reinforced concrete disclosed sufficient damping resulting in generally low sensitivities.

The ground-penetrating radar profiling method detected electromagnetic responses in the subsurface limited to a depth of approximately 7 ft. The ground-penetrating radar method appears to have a limited penetration depth at the site due to the high electrical conductivity of the upper clayey stratum which is highly attenuative of the radar pulse. The ground-penetrating radar appeared to have a generally low sensitivity to electromagnetic responses in the shallow subsurface in areas paved with asphalt. Areas paved with steel reinforced concrete exhibited sufficient damping resulting in generally low sensitivities.

Results of the geophysical feasibility survey are summarized as follows:

1. Electromagnetic profiling methods achieved a greater depth penetration than ground-penetrating radar (GPR), which is limited because of the upper clayey soils.

2. Electromagnetic profiling methods are more responsive to potential subsurface anomalies in asphalt-paved areas than GPR.

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3. Electromagnetic profiling methods are non-intrusive and can be used in asphalt-paved areas that are not generally feasible for surface resistivity methods.

4. Electromagnetic profiling methods permit real time measurements for field interpretation and flexibility in changing grid spacing to more accurately delineate anomalous areas.

Based on the results of the geophysical feasibility survey (MRA Report No. 85-317 dated December 18, 1985), the electromagnetic survey method was selected.

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3.4.2 Electromagnetic Geophysical Survey. The objective of the geophysical site survey was to explore areas of subsurface anomalies associated with potential fill areas. The geophysical survey included 696 electromagnetic data stations and substations, as indicated on Figure 3-1. All readings were obtained using a Geonics Limited Model EM31-D Non-Contacting Terrain Conductivity Meter with an intercoil spacing of approximately 12 ft. This spacing yields a penetration depth of about 19.7 ft.

Electromagnetic profiling was performed over approximately one-quarter of the site. The remaining three-quarters of the site was not profiled because of access restrictions due to buildings, trailers, trees, etc., and because of interferences from reinforced concrete paved areas.

Traverse lines were typically located with a 50-ft spacing and were field located by using a transit. Readings were obtained generally at 50-ft station intervals. At several locations, substations were located in the traverse line between consecutive stations to further delineate the boundaries of anomalous areas. Several other substations were located perpendicular to the traverse line.

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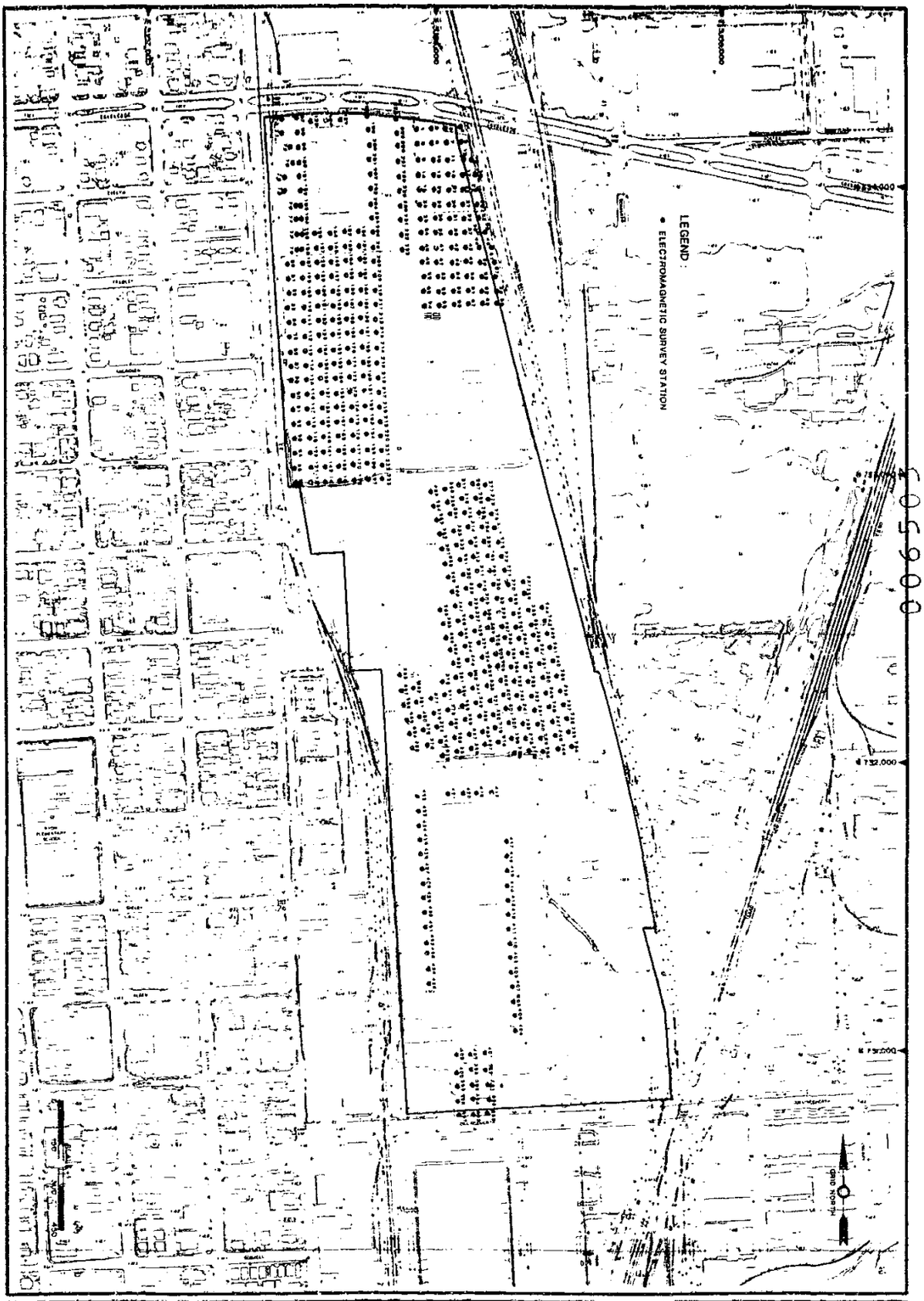


| FIGURE NO | PROJECT NO 85-317 | ELECTROMAGNETIC SURVEY STATIONS<br>SOUTH CAVALCADE SITE<br>HOUSTON, TEXAS<br><br>KOPPERS COMPANY, INC. | Page 3-6 |
|---|---|---|---|
| 3-1 | DATE 3/25/88 | | |
| | ENGINEER | | |
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Two sets of readings were obtained at each station, one with the coils oriented north-south, the other with the coils oriented east-west. This procedure yields an average apparent conductivity value to compensate for lateral variations of conductivity in the underlying soil layers at each station. A copy of the apparent conductivity measurements is included in Appendix B, Volume 2.

3.4.3 Geophysical Anomalies. Results of the electromagnetic geophysical survey (MRA Report No. 85-317 dated December 27, 1985) are summarized as follows:

1. The survey detected electromagnetic responses in the subsurface which were interpreted as apparent conductivity anomalies at several locations at the site.

2. Apparent conductivity anomalies were evaluated for surface features, underground utilities, and potential fill areas.

3. Anomalies interpreted as potential fill areas were delineated on a site map to assist in locating the soil borings.

The electromagnetic data reflected a wide range of apparent conductivity values throughout the surveyed areas of the South Cavalcade site. The electromagnetic data were used to construct an apparent conductivity contour map, as shown on Figure 3-2. The average measured background range of apparent conductivity values vary from about 40 mmhos/m to 60 mmhos/m, based upon values from stations in areas known to be undisturbed by previous site activities. Apparent conductivity values less than 40 mmho/m or greater than 60 mmho/m in vegetated areas, and values less than 40 mmho/m

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| FIGURE NO. | PROJECT NO. 85-517 |
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| | ENGINEER |
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APPARENT CONDUCTIVITY CONTOUR MAP
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

KOPPERS COMPANY, INC.

or greater than 80 mmho/m in asphalt-paved areas, were interpreted as potential subsurface geophysical anomalies. The geophysical anomalies map is shown on Figure 3-3. The negative off-scale readings are interpreted as responses from underground utilities or abandoned railroad tracks, and therefore are not included on Figure 3-3. Apparently conductivity data used to construct the geophysical anomalies presented on Figure 3-3 are located in Appendix B, Volume 2.

## 3.5 Shallow Auger Boring Study

A total of 139 shallow auger borings were completed during the Remedial Investigation. Approximate locations of the auger borings are shown on Figure 3-4. Also referenced on Figure 3-4 are the Work Plan aerial photograph areas and the geophysical anomaly areas identified from Subtasks 1B and 2C, respectively. The shallow auger boring study report was previously submitted (see MRA Report No. 85-317, dated May 30, 1986). This task was conducted in general accordance with Section 4.2 of the Field Sampling and Analytical Plan.

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3.5.1 General. The shallow auger boring study was conducted to evaluate geophysical anomalies, explore potential on-site contaminant source locations, and to assist in the location of subsequent deep soil borings. Auger borings were also located in areas associated with previous wood treating and coal tar distillation facilities and operation areas, located from review of historical aerial photographs (Section 1.2.3). A list of areas explored and the number of auger borings drilled within each area is presented in Table 3-1.

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NOTES
1 ON-SITE SHADED AREAS DENOTE GENERAL SUBSURFACE ANOMALIES BASED ON QUALITATIVE INTERPRETATION OF APPARENT CONDUCTIVITY MEASUREMENTS
2 AREAS OF SUBSURFACE ANOMALIES MAY BE PRESENT AT LOCATIONS NOT SURVEYED OR BETWEEN SURVEY LINES
3 CONDUCTIVITY MEASUREMENTS WERE OBTAINED ON NOVEMBER 22 & 25 1985 USING A GEONICS LIMITED MODEL EM-31D NON-CONTACTING TERRAIN CONDUCTIVITY METER
4 AREAS A02, A04 AND A13 CORRESPOND TO BOTH AERIAL PHOTOGRAPHIC ANOMALY AND GEOPHYSICAL ANOMALY AREAS AREAS A16 THROUGH A19 AND A24 THROUGH A26 DENOTE GEOPHYSICAL ANOMALY AREAS
GRID NORTH
A02
A04
A13
A16
A17
A18
A19
A24
A25
A26
E 3,057,000
E 3,057,500
E 3,058,000
E 3,058,500
E 3,059,000
E 3,059,500
E 3,060,000
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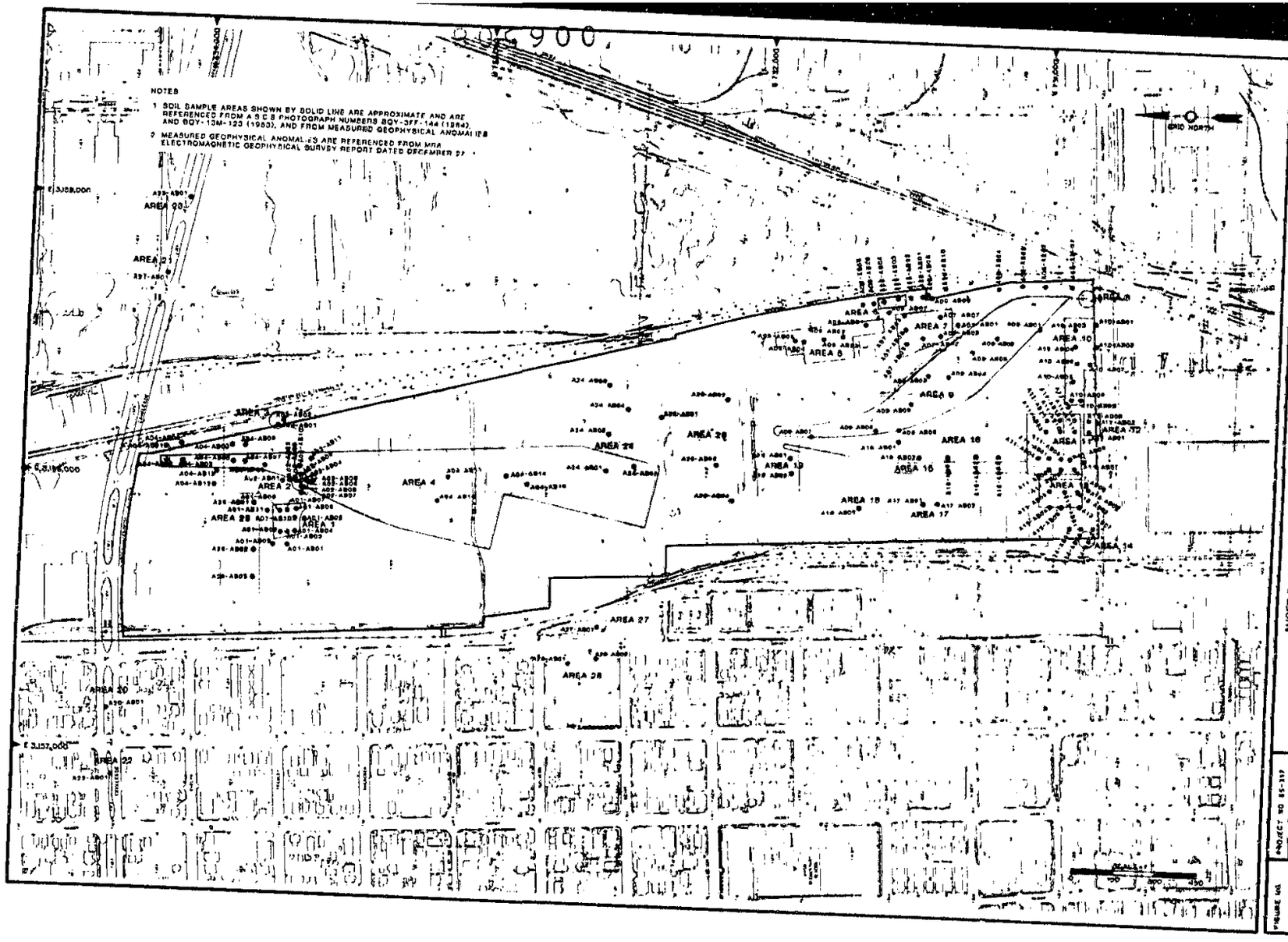


AUGER BORING LOCATION MAP
SOUTH CAVALCADE SITE
KOPPERS COMPANY, INC.
HOUSTON, TEXAS

| | |
|---|---|
| FIGURE NO. | 3-4 |
| PROJECT NO. 85-319 | |
| DATE 7-12-87 | |
| ENGINEER | |
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TABLE 3-1
AUGER BORING LOCATION DISTRIBUTION

AERIAL PHOTOGRAPHIC ANOMALIES:

| Area No. | Completed Auger Borings |
|---|---|
| A01 | 11 |
| A02 | 11 |
| A03 | 2 |
| A04 | 15 |
| A05 | 5 |
| A06 | 10 |
| A07 | 7 |
| A08 | 4 |
| A09 | 9 |
| A10 | 9 |
| A11 | 14 |
| A12 | 3 |
| A13 | 7 |
| A14 | 3 |
| A15 | 3 |

GEOPHYSICAL ANOMALIES:

| | |
|---|---|
| A02 | * |
| A04 | * |
| A13 | * |
| A16 | 2 |
| A17 | 2 |
| A18 | 1 |
| A19 | 2 |
| A24 | 5 |
| A25 | 3 |
| A26 | 4 |

OFFSITE BACKGROUND:

| | |
|---|---|
| A20 | 1 |
| A21 | 1 |
| A22 | 1 |
| A23 | 1 |
| A27 | 1 |
| A28 | 2 |
| | 139 Total Auger Borings |

NOTE:

* Denotes that Areas A02, A04, and A13 geophysical anomaly areas were located in aerial photographic anomaly areas. Auger borings listed under aerial photographic anomalies also apply to geophysical anomaly areas.

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Shallow auger boring drilling was performed using an all-terrain Geospace B-250 auger rig to an average depth of 8 ft. Auger advancement was conducted using solid-stem, dry augering techniques, and was typically in increments of 2 ft. Visual soil classification of the auger samples was performed by the field geologist, with notation of odors and visual soil staining. Auger boring logs are presented in Appendix C, Volume 2. Soil classifications are based upon visual classification using the Unified Soil Classification System (USCS) and are not verified by laboratory testing. Boring coordinates and ground-surface elevations included on the auger boring logs are approximate and are based upon the site topographic map shown on Figure 2-2.

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3.5.2 Shallow Auger Boring Location Areas. The plan of auger borings (Figure 3-4) references auger boring numbers which are grouped with respect to aerial photograph and geophysical anomaly areas. The anomaly areas are numbered as follows:

1. Areas A01 through A15 designate Work Plan aerial photograph areas. Photographs referenced include ASCS Aerial Photographs BQY-3FF-144B (1964) and BQY-13M-123D (1953). The areas are defined in Section 4.1 of the Field Sampling and Analytical Plan.

2. Areas A16 through A19 and Areas 24 to 26 designate geophysical anomalies which were mapped from the MRA report, Electromagnetic Geophysical Survey, dated December 27, 1985.

3. Areas A20 through A23 and Areas A27 and A28 designate off-site background locations.

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3.5.3 Soil Sampling Procedures. The soil sampling procedures utilized during the shallow auger boring study were conducted in general accordance with MRA Standard Operating Procedure SOP-HWF-01, included in Appendix D, Volume 3.

An average of one soil sample was obtained from each shallow auger boring. Additional samples were collected at changes within soil strata and where visual soil staining was encountered. Samples were collected directly from the auger flights with a disposable wooden tongue depressor. Samples were placed into detergent-washed, 16-oz glass jars, and capped with Teflon-lined lids. Each jar was labeled with a sample identification number, sample depth, date, and time. Field headspace measurements of total organic vapors were obtained by using a calibrated HNU photoionization analyzer equipped with a 10.2 eV probe. The field headspace measurements were converted into naphthalene equivalents and recorded on the auger boring logs presented in Appendix C, Volume 2. The samples were placed on ice and transported to the MRA laboratory on a daily basis with chain-of-custody documentation.

Auger flights were cleaned between each borehole by a high-pressure, hot water spray. At the end of each work day, the auger drilling rig was also cleaned with a high-pressure, hot water spray. Soil cuttings not utilized as samples were collected into 55-gallon metal drums and stored onsite. Auger boreholes were backfilled with dry, nonpolymer bentonite.

3.5.4 Sample Identification. Auger boring soil sample identification for the project is based upon the coding system: SCK-Axx-AByy-zz where:

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SCK - identifies the South Cavalcade Site
Axx - identifies area number
AByy - identifies auger boring number
zz - identifies sample number

3.5.5 Soil Surrogate Testing. Soil surrogate testing of the auger boring samples was conducted to evaluate potential soil contaminants. The surrogate testing program consisted of laboratory headspace analysis for total organic vapors using a photoionization detector. Qualitative metals screening for arsenic, chromium, copper, lead, and zinc was conducted using an X-ray fluorescence analyzer. Details of the auger boring sample surrogate testing are given in Section 3.9.1.

3.5.6 Surficial Soil Anomalies. Evaluation of the shallow auger boring data did not indicate the presence of potential shallow soil contaminant source areas. However, during the auger boring program, areas were disclosed containing visual soil staining. The results of the shallow auger boring program were used to construct a surficial soil anomalies map. This map is presented on Figure 3-5. Anomaly area boundaries are based upon visual observations and are therefore approximate. Anomaly areas A, B, and C correspond to auger boring areas A02/A04, A05/A06, and A11/A13, respectively. This map does not reflect or depict an interpretation that the soil anomaly areas are considered for possible remedial action, either expressed or implied. The map was used to assist in locating areas for further investigation during the soil boring program. Data used to construct the surficial soil anomalies map are located on the auger boring logs presented in Appendix C, Volume 2.

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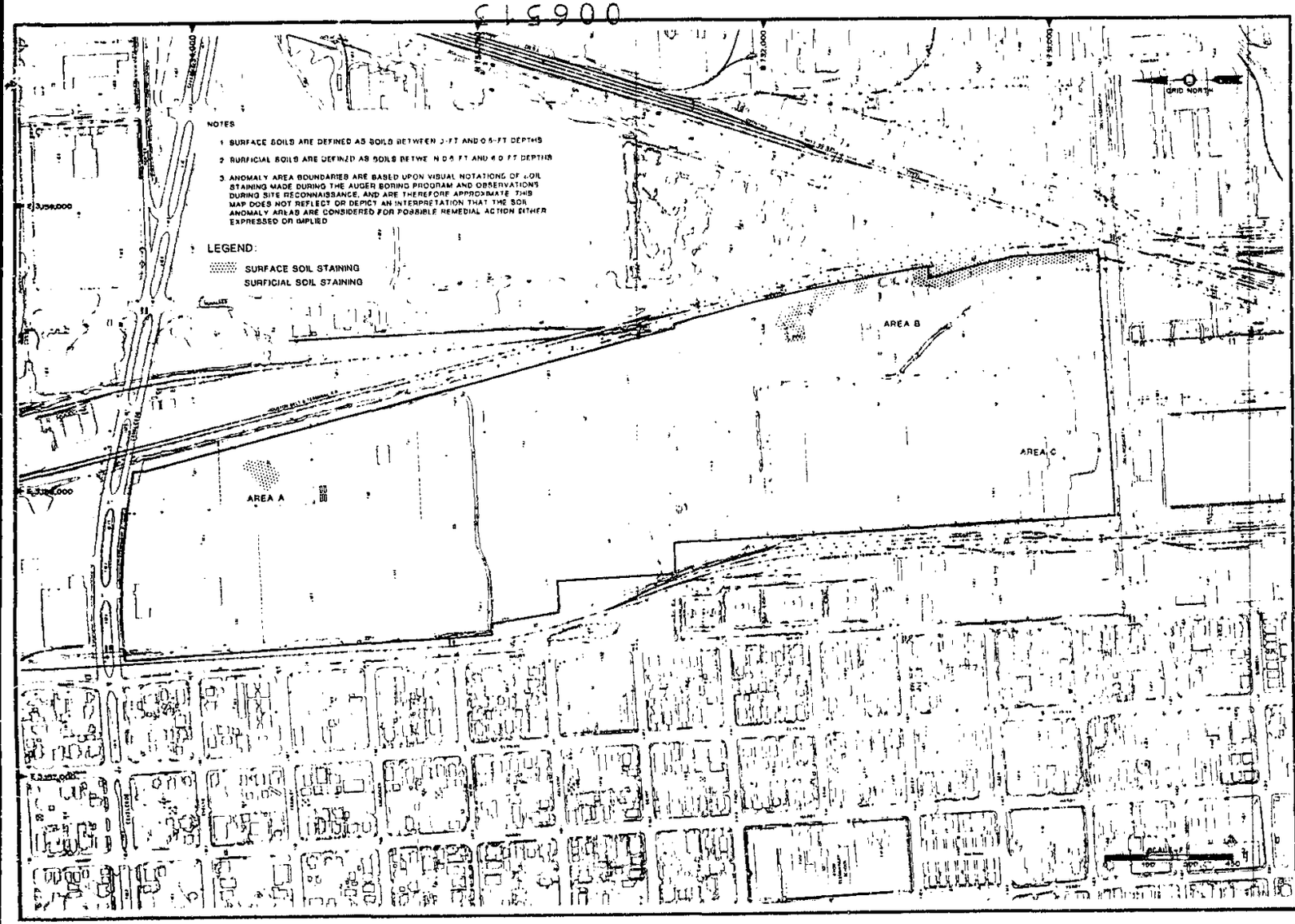


Page 3-16

SURFICIAL SOILS ANOMALIES MAP
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

KOPPERS COMPANY, INC.

| | |
|---|---|
| PROJECT NO. 85-317 | |
| DATE 6-10-87 | |
| ENGINEER | |
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| FIGURE NO. 3-5 | |

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## 3.6 Soil Boring Program

A total of 82 soil borings (including two deep monitoring well borings) were completed for the Remedial Investigation. Approximate soil boring locations are shown on Figure 3-6. Also shown on Figure 3-6 are four cone penetrometer test (CPT) locations. The cone penetrometer data included a continuous soil profile and was used to supplement the soil boring data. The soil borings were drilled using hollow-stem augering with continuous soil sampling.

3.6.1 General. The objective of the soil boring program was to explore surficial soil anomaly areas and to evaluate subsurface (saturated zone) soil quality. The soil borings were located in areas associated with previous wood treating, coal tar distillation facilities, and operation areas, as outlined in the RI/FS Work Plan. Soil borings were also located in areas of surficial soil anomalies.

The number of soil borings and boring locations were assessed throughout the field exploration program based upon preliminary interpretations of on-going field boring data. In the event visual soil staining was noted, additional soil borings were assigned to more accurately delineate the lateral extent of potential subsurface contaminants. Selected borings were also drilled offsite to assess offsite subsurface soil quality. Also, a soil boring was drilled offsite (JCK-A27-SB01) to evaluate background conditions.

3.6.2 Soil Sampling Procedures. Soil sampling was conducted in general accordance with MRA Standard Operating Procedure SOP-HWF-02, Appendix D, Volume 3. Soil samples were generally collected at continuous 2-ft intervals and

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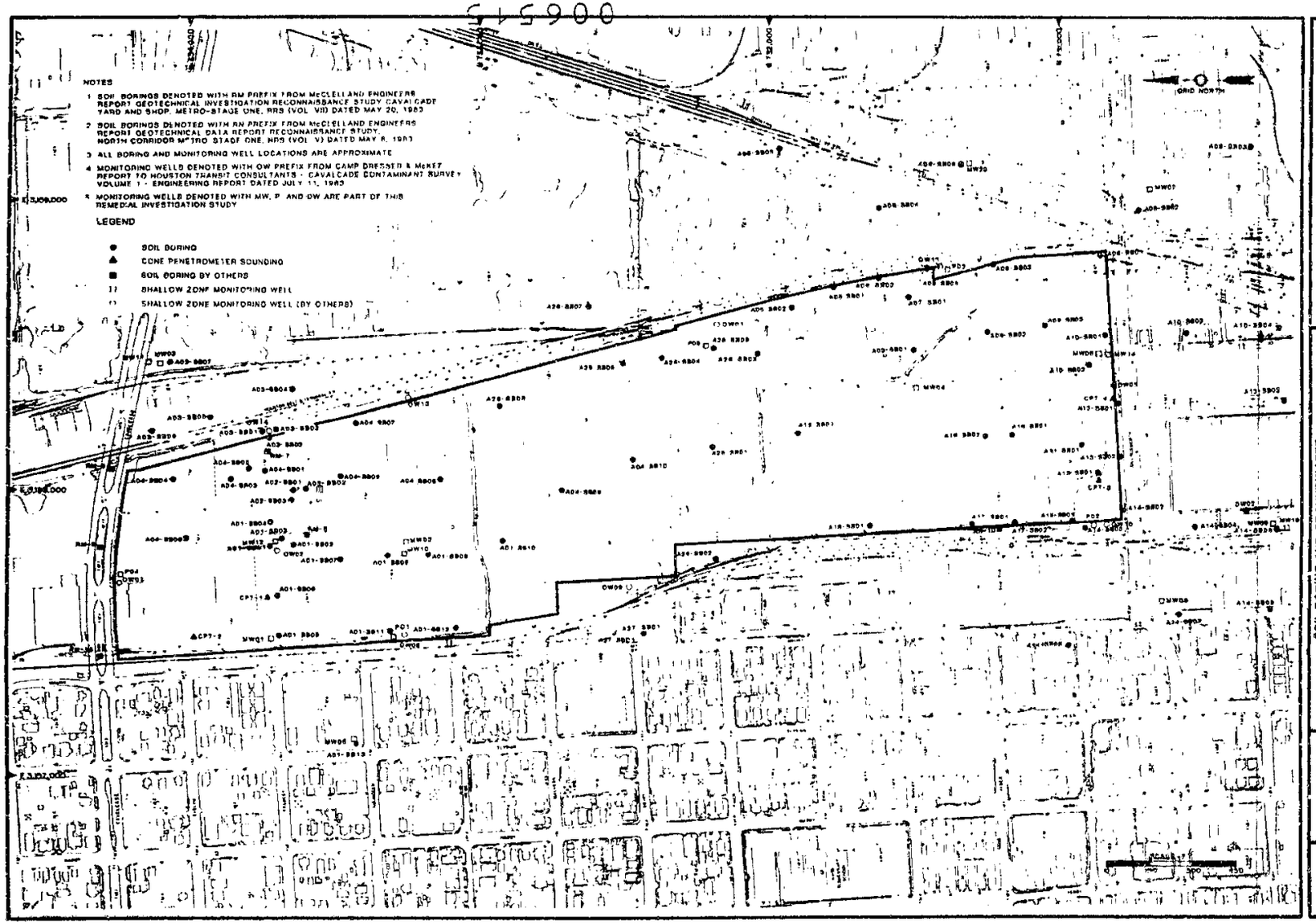


SOIL BORING AND GROUNDWATER MONITORING WELL LOCATION MAP

SOUTH CAVALCADE SITE

HOUSTON, TEXAS

KOPPERS COMPANY, INC.

FIGURE NO 3-8

PROJECT NO 85-317

DATE 6-28-87

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visually classified by the field geologist using the Unified Soil Classification System (USCS), noting visual soil staining. Soil boring logs are presented in Appendix F, Volume 2. Visual soil classifications presented on the boring logs are not verified by laboratory testing.

Field procedures for continuously sampling a shallow sand zone were modified because of flowing sand conditions caused by unbalanced hydrostatic pressures within the sand zone. The flowing sand condition prevented continuous sampling of sands by hollow-stem drilling methods, thus sampling of lower sections of the sand unit was omitted.

Soil boring depths were outlined in the RI/FS Work Plan and included advancement to a depth of 5 ft below a shallow sand zone for 50 percent of the soil borings, and to a depth of 50 ft below the ground surface for the remaining soil borings within any designated area. Due to the disclosure of deeper visual soil staining, the majority of the soil borings were generally extended to the depth of unobservable visual staining and olfactory responses and to the clay layer immediately below a silt layer which was generally continuous throughout the site. The average soil boring completion depth was 64 ft.

Soil samples were collected by utilizing thin-walled Shelby tubes or split-spoon samplers. Samplers were cleaned between sampling intervals. Cleaning of the sampling device included a detergent solution wash, methanol rinse, and clean water rinse.

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After samples were removed from the sampler and classified, a representative section of the soil sample was removed with a clean knife and placed into a detergent-washed, 16-oz. glass jar with a Teflon-lined lid. Each sample was labeled with a sample identification number, sample depth, date, and time. Field headspace measurements of total organic vapors were obtained by a calibrated HNU photoionization analyzer equipped with a 10.2 eV probe. The field headspace measurements were converted into naphthalene equivalents and recorded on the soil boring logs presented in Appendix F, Volume 2. The samples were placed on ice and transported daily to the MRA laboratory with chain-of-custody documentation.

Auger flights, drill rig, and tools were cleaned with a high-pressure, hot water spray between each boring location. Soil cuttings, unused soil samples, drilling fluids, and disposable items were collected in 55-gallon metal drums and containers, and stored onsite.

The soil borings were pressure-grouted with a cement-nonpolymer bentonite grout upon the completion of each boring. The grout mixture was injected into the soil boring from the completion depth to the surface. The grouting was commenced before removal of the flight augers. A positive head of the grout was maintained within the flight auger during the removal procedure.

<u>3.6.3 Sample Identification</u>. Soil boring sample identification for the project is based upon the coding system: SCK-Axx-SByy-zz where:

SCK - identifies the South Cavalcade Site
Axx - identifies area number
SByy - soil boring number
zz - identifies sample number

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During the soil boring program, duplicate samples were taken from some soil samples. All duplicate samples are identified with a random sample code number (zz) between 60 and 69. This separation in sample code numbers was used to prevent the pairing of samples with corresponding duplicate samples, thus eliminating potential biased laboratory test results. Duplicate sample locations are referenced on the soil boring logs presented in Appendix F, Volume 2.

3.6.4 Soil Surrogate Testing. Soil surrogate testing of the soil boring samples was conducted to screen samples for subsequent EPA Hazardous Substance List (HSL) analysis and also to aid in evaluating soil quality. The surrogate testing program consisted of (a) laboratory headspace analysis for total organic vapors using a photoionization detector, (b) fluorescence analysis for total aromatic hydrocarbons using a spectrofluorometer, and (c) qualitative metals screening for arsenic, chromium, copper, lead, and zinc using an X-ray fluorescence analyzer. Details of the soil boring sample surrogate testing are given in Section 3.9.2.

3.6.5 Cone Penetrometer Soundings. Cone penetrometer soundings with a conductivity meter were performed to evaluate a relationship of in-situ conductivity between former operation areas and background areas and to obtain a continuous soil profile to supplement the soil boring data. The purpose of the cone conductivity soundings was to evaluate the potential of using a relatively rapid and continuous investigative technique to accurately delineate subsurface quality. The cone soundings were performed by Fugro. All soundings were pressure grouted with a cement-bentonite grout upon completion. All downhole equipment was cleaned with a high- pressure, hot water wash between soundings.

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Four soundings were conducted and are located as shown in Figure 3-6. Soundings SCK-CPT-01 and SCK-CPT-02 were located outside previous plant operations areas to provide a background conductivity log. Soundings SCK-CPT-03 and SCK-CPT- 04 were located in suspected operations areas to compare with background measurements. The logs of the cone conductivity soundings are presented in Appendix E, Volume 2.

From the four cone conductivity soundings performed, a conclusive correlation of conductivity readings between former operation areas and background areas could not be drawn. Further attempts at correlation with this method were therefore abandoned.

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3.6.6 Previous Soil Borings. Geotechnical reports prepared for the Metro Regional Rail System (RRS) study were reviewed to obtain additional site background data. These reports present soil boring data which was utilized to supplement the project soil borings for evaluation of site geology. Previous soil borings from the Metro RRS study are referenced on Figure 3-6.

## 3.7 Shallow Groundwater Monitoring Wells

3.7.1 General. The purpose of the groundwater monitoring well program was to evaluate groundwater flow patterns in the shallow water-bearing zone and to supplement the soil quality data for evaluation of subsurface quality. Nine groundwater monitoring wells were installed during the Remedial Investigation in the shallow zone and 11 were installed in deeper discontinuous sands and silts to assess vertical hydraulic characteristics. In addition, nine existing groundwater monitoring wells were previously

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installed during the Cavalcade Contaminant Survey and are included in the comprehensive groundwater monitoring program. The locations of the groundwater monitoring wells are included on Figure 3-6.

The monitoring well locations were based upon one of the following criteria:

1. Zones of observed soil staining.
2. Monitoring of potential migration.
3. Background monitoring wells were placed up-gradient (based on previous work by CDM - Cavalcade Contaminant Survey) from areas of observed soil staining.

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3.7.2 Installation Procedures. The installation procedures for the shallow zone monitoring wells were in general accordance with the Field Sampling and Analytical Plan. All wells were installed using a hollow-stem auger drilling rig. The wells were generally located adjacent to completed soil borings to eliminate the need for continuous soil sampling during installation. Some soil samples were collected in the monitoring zone and checked for visual staining and field and laboratory headspace measurements. Grain-size analysis of selected soil samples from the monitoring zone were conducted to provide an approximation of field permeability ranges and is discussed in the Field Permeability Test Data in Appendix I, Volume 3. Results of the grain-size analyses are included in Appendix A, Volume 3.

Auger flights, well screen, blank casing, and end caps were cleaned using a high-pressure, hot water spray before installation. Filter sand was backfilled around the screen

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to reduce formation soils from entering the well. A bentonite pellet seal was placed above the filter sand, with the remainder of the borehole grouted with a cement-nonpolymer bentonite grout. At six monitoring well locations (SCK-P01 to SCK-P05 and SCK-MW23) the grout backfill was placed directly above the filter sand in lieu of a bentonite seal due to internal size restrictions of the hollow-stem auger.

Elevations at the top of each well casing were surveyed by Gullett and Associates, Inc. Location coordinates used for the monitoring wells are approximate.

3.7.3 Well Construction. Construction details of the monitoring wells are presented on logs in Appendix F, Volume 3. The logs present well construction data and soil boring data for each well installation. The boring data are based on visual classification of soil cuttings.

Well casing was constructed of 2-in.-diameter Schedule 40 PVC with threaded flush joints. Well screen (0.010-in. slots) lengths were installed to monitor the entire thickness of the water-bearing zone.

The monitoring wells were completed with concrete pads, concrete-filled barrier posts, and locking protective steel casings. Seven monitoring wells were completed flush with the ground because of locations in high traffic areas (Monitoring Wells SCK-MW04, SCK-MW06, SCK-MW08, SCK-MW09, SCK-MW14, SCK-MW16, and SCK-MW23), and are covered with locked utility man-hole castings.

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3.7.4 Well Development. All groundwater monitoring wells were developed utilizing an air-lift development technique. Dual inline air filters arranged in series were utilized to reduce potential contamination from the air compressor during the development procedure. The wells were developed until the discharge was visually clear of sediments. Table 3-2 lists the well development data for the monitoring wells. Water-level measurements were taken prior to development to calculate well volumes.

Development water from the wells was collected directly into storage drums. Tygon tubing was used to develop the monitoring wells and was replaced between each well location to reduce the potential for cross contamination.

3.7.5 Previous Shallow Monitoring Wells. Nine shallow groundwater monitoring wells were installed into the shallow water-bearing zone during the previous site investigation by Camp Dresser & McKee (CDM). Construction reports of the wells are included in Appendix F, Volume 3. The previous monitoring well locations are referenced on Figure 3-6. The previous wells were installed using wet-rotary drilling techniques and were constructed with 2-in.-diameter PVC materials, similar to the wells installed for the Remedial Investigation. Casing elevations of the previous monitoring wells were re-surveyed to provide a consistent datum for all subsequent water-level measurements.

3.7.6 Water-Level Measurements. Water-level measurements were obtained on approximately a monthly basis for the 20 shallow wells installed during the Remedial Investigation and for the 9 wells installed during the previous CDM study. The monthly readings were taken to measure seasonal

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TABLE 3-2
GROUNDWATER MONITORING WELL DATA

| Well No.(2) | Coordinates(1) North | Coordinates(1) East | Well Development Date | Well Development Purged (gal) | Well Development Well Volume(gal)(4) |
|---|---|---|---|---|---|
| OW01 | 732,152 | 3,158,563 | NA | NA | NA |
| OW02 | 733,695 | 3,157,796 | NA | NA | NA |
| OW06 | 733,670 | 3,158,050 | NA | NA | NA |
| OW07 | 734,241 | 3,157,700 | NA | NA | NA |
| OW08 | 733,241 | 3,157,488 | NA | NA | NA |
| OW09 | 732,465 | 3,157,665 | NA | NA | NA |
| OW10 | 730,827 | 3,157,878 | NA | NA | NA |
| OW11 | 731,400 | 3,158,750 | NA | NA | NA |
| OW13 | 733,216 | 3,158,329 | NA | NA | NA |
| OW14 | 733,720 | 3,158,200 | NA | NA | NA |
| MW01 | 733,700 | 3,157,490 | 8-11-86 | 18 | 7.0 |
| MW02 | 733,230 | 3,157,830 | 8-11-86 | 35 | 12.8 |
| MW03 | 734,110 | 3,158,440 | 11-07-86 | 55 | 16.7 |
| MW04 | 731,480 | 3,158,350 | 8-08-86 | 30 | 8.9 |
| MW05 | 733,430 | 3,157,120 | 8-13-87 | 60 | 25.4 |
| MW06 | 730,820 | 3,158,440 | 8-08-86 | 20 | 6.2 |
| MW07 | 730,690 | 3,159,020 | 8-08-86 | 5 | 1.3 |
| MW08 | 730,650 | 3,157,590 | 8-13-87 | 55 | 24.5 |
| MW09 | 730,250 | 3,157,870 | 8-08-86 | 30 | 9.7 |
| MW10 | 733,240 | 3,157,800 | 8-11-86 | 25 | 3.8 |
| MW11 | 734,120 | 3,158,440 | 11-07-86 | 27 | 6.0 |
| MW12 | 733,690 | 3,157,800 | 8-11-86 | 20 | 3.9 |
| MW14 | 730,820 | 3,158,450 | 8-08-86 | 10 | 2.0 |
| MW16 | 730,240 | 3,157,870 | 8-08-86 | 3 | 0.5 |
| MW23 | 731,340 | 3,159,130 | 11-23-87 | 60 | 11.7 |
| P01 | 733,270 | 3,157,500 | 6-03-86 | 24 | 5.7 |
| P02 | 730,870 | 3,157,870 | 6-04-86 | 32 | 6.1 |
| P03 | 731,370 | 3,158,750 | 6-05-86 | 45 | 11.9 |
| P04 | 734,240 | 3,157,720 | 6-03-86 | 28 | 5.2 |
| P05 | 732,180 | 3,158,500 | 6-04-86 | 40 | 6.7 |
| DW02 | 730,350 | 3,157,930 | 5-12-87 | 7150 | 72.2 |
| P06(3) | 729,290 | 3,158,200 | 3-30-87 | NA | NA |
| P07(3) | 734,180 | 3,155,650 | 3-30-87 | NA | NA |
| CT-OW01(3) | 740,300 | 3,156,240 | NA | NA | NA |

Notes
1. Monitoring well location coordinates are approximate.
2. Monitoring wells denoted with OW prefix from Camp Dresser & McKee report to Houston Transit Consultants - Cavalcade Contaminant Survey, July 11, 1983.
3. Denotes monitoring wells used for water-level measurements only. Not included in sampling and analytical program.
4. Well volume calculated as the amount of water within well casing based on water level at time of well development.

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groundwater level fluctuations. A summary of the water-level measurements is presented in Appendix T, Volume 3. Selected groundwater hydrographs showing monthly water-level changes are presented in Appendix H, Volume 3.

Water-level measurements were obtained using a weighted tape from the top of all well casings. The measuring tape used during the procedure was cleaned between each well. Cleaning included the use of both methanol and potable water.

3.7.7 Groundwater Sampling Summary. Two rounds of shallow groundwater sampling were conducted in general accordance with the Field Sampling and Analytical Plan, except that no filtering was performed. Most of the Round 1 groundwater samples were collected on December 9 to 12, 1986. Most of the Round 2 groundwater samples were collected on February 3 to 5, 1987. A list of sample containers are shown on Table 3-3.

Prior to sampling, water levels were measured to calculate well volumes. Based upon the calculated well volume, each well was purged by bailing methods to remove at least five well volumes, except Monitoring Well CAV-OW02, which was purged and sampled utilizing a peristaltic pump. One measurement of pH, conductivity, and temperature was generally obtained at each well location prior to sampling. Purged well volumes, pH, temperature, and conductivity measurements are presented in Appendix U, Volume 3. All groundwater produced during sampling was placed in drums and placed in on-site storage.

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TABLE 3-3

SUMMARY OF GROUNDWATER SAMPLE CONTAINERS

| Container Size | Container | Laboratory Testing |
|---|---|---|
| 1 liter | amber glass | base/neutral extractables |
| 1 liter | amber glass | acid extractables |
| 1 liter | plastic | cyanide |
| 1 liter | plastic | metals |
| 1 liter | plastic | nitrate |
| 40 ml. | VOA vials | volatiles |
| 1 liter | amber glass | pesticides/PCBs |

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3.7.8 Field Permeability Testing. The field permeability testing program was designed to evaluate the horizontal hydraulic conductivity of the shallow water-bearing zone. The hydraulic conductivity test program was performed in general accordance with EPA Method 9100. The field permeability testing was conducted after the Round 2 groundwater sampling to prevent alterations in the groundwater quality due to the potable water added to the well.

Falling-head hydraulic conductivity tests were run in four fully-cased monitoring wells screened over the test strata. Prior to testing, each well was developed using filtered compressed air to remove any accumulated sediments that would tend to clog the filter materials, and thereby affect the test results. Excess heads were induced by rapidly injecting a known volume of potable water into each well. Water-level recovery data was then obtained with an electric water-level indicator and a surveyors tape graduated to 0.01 ft until at least 85 percent of the original excess head had dissipated. The results of the field permeability testing program are presented in Appendix I, Volume 3 and are summarized in Section 4.0.

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## 3.8 Deep Groundwater Monitoring Well

3.8.1 General. One deep groundwater monitoring well was installed during the Remedial Investigation instead of two required by the RI/FS Work Plan as agreed by the EPA on September 11, 1986. Documentation of this agreement is provided on Koppers Company, Inc., correspondence dated September 16, 1986 (Appendix G, Volume 2). Monitoring Well SCK-DW01 was initially to be installed in the Merchants Fast Motor Lines southeast parking lot. A soil boring was

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drilled to 145 ft, with soil samples taken at 5-ft intervals. The soil boring log is presented in Appendix F, Volume 2. The borehole was geophysically logged (Appendix G, Volume 3), and the surface casing set. Due to problems with setting the surface casing, it was agreed that Monitoring Well SCK-DW01 was to be abandoned, the surface casing pulled, and the annulus grouted for the full depth.

Before selecting a new location for the deep well, two off-site piezometers, Piezometers SCK-P06 and SCK-P07, were installed to measure the deep groundwater gradient. This was accomplished by correlating groundwater levels between the two piezometers and two existing deep monitoring wells, Monitoring Wells CAV-OW06 and CT-OW01. Monitoring Well CAV-OW06 was previously installed onsite during the CDM Cavalcade Contaminant Survey and Monitoring Well CT-OW01 was previously installed offsite during the CDM Crosstimbers Contaminant Survey. The locations of the deep piezometers and wells are shown on Figure 3-7. The installation procedures for Piezometers SCK-P06 and SCK-P07 utilized mud rotary drilling procedures. The deep piezometers are used only for obtaining groundwater level measurements.

Based upon the potentiometric surface of the deep zone, Monitoring Well SCK-DW02 was located downgradient and offsite the southwest property boundary, on the west side of American Warehouse property. This location was approved by the EPA in letter form, dated April 9, 1987 (see Appendix G, Volume 2). Soil samples for the deep well installation were generally taken at 5-ft intervals to a depth of 215 ft. The boring log is presented in Appendix F, Volume 2. The geophysical log is presented in Appendix G, Volume 3. The deep monitoring well was double cased to prevent possible cross contamination from overlying strata.

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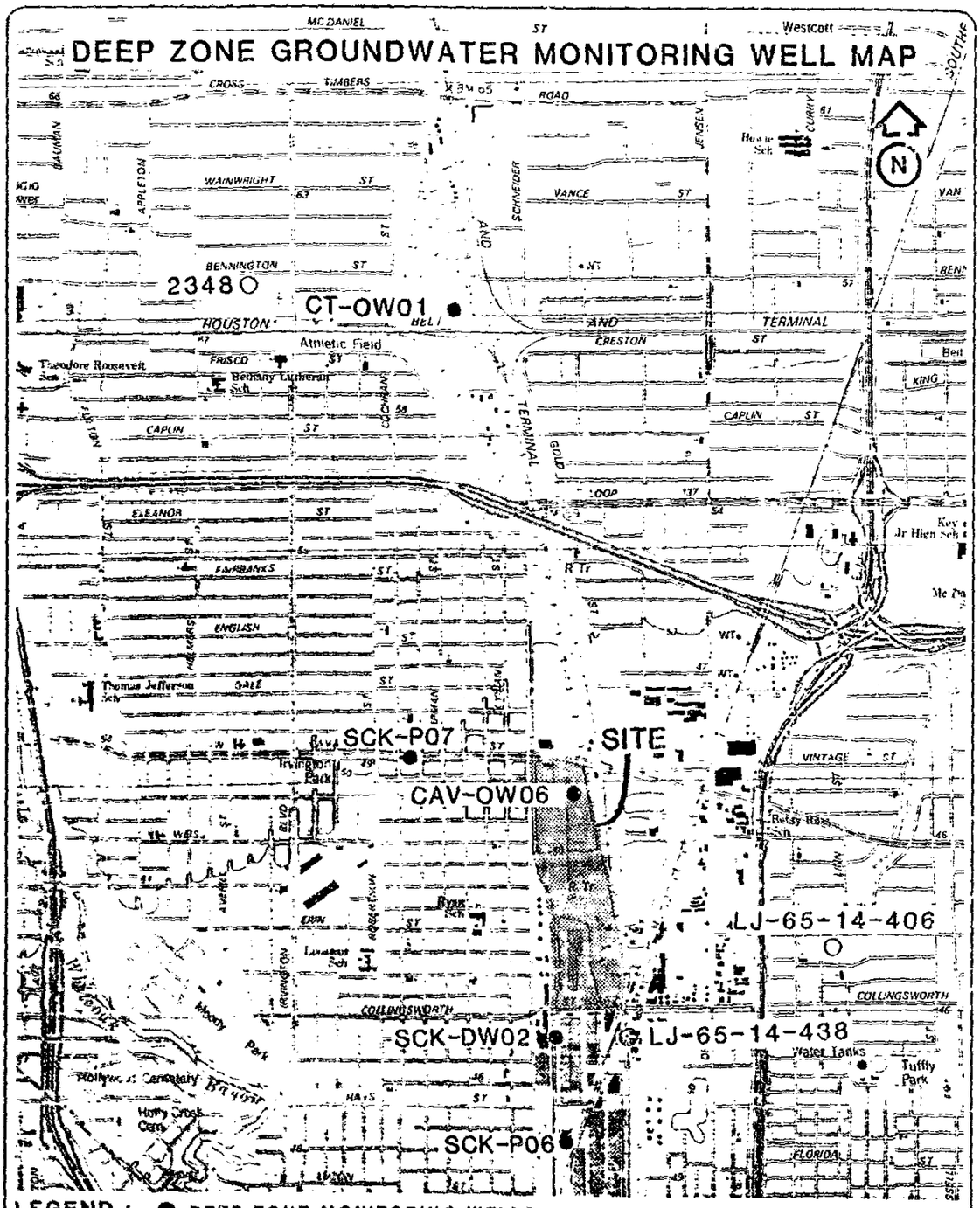
# DEEP ZONE GROUNDWATER MONITORING WELL MAP




LEGEND : ● DEEP ZONE MONITORING WELLS

○ PREVIOUSLY SAMPLED PRODUCTION WELL LOCATIONS

NOTES : 1. MAP FROM U.S.G.S. SETTEGAST, TEXAS ( 1982) SHEET.

2. CT-OW01, SCK-P06, AND SCK-P07 ARE FOR WATER LEVELS ONLY.

SCALE-FT

0 2000 4000

FIGURE 3-7

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3.8.2 Installation Procedures. The installation procedures for the deep Monitoring Well SCK-DW02 were in general accordance with the General Specifications for Construction of Deep Groundwater Monitoring Well (Appendix J, Volume 3), with the exception that steel casing was substituted for PVC. All downhole equipment, drilling rig, and tools were cleaned between each phase of installation with a high-pressure, hot water spray. All surface casing, screen, caps, and blank casing were also cleaned before installation.

The sample boring and casing installation were performed using a Gardner-Denver 1000 drill rig. An initial 4-in.-diameter soil boring was drilled and sampled to a depth of 72 ft. The borehole was geophysically logged, to provide a more accurate profile between soil samples, and then reamed with an 18-in.-diameter bit. A 13 3/8-in. O.D. steel surface casing was installed to a depth of approximately 72 ft and pressure-grouted in place with a cement-bentonite grout. The grout was allowed at least 48 hours curing time before work was continued.

After the grout curing time was reached, a 4-in.-diameter soil boring was advanced from a depth of 72 ft to 142 ft. The borehole was geophysically logged and then reamed with a 12 1/4-in.-diameter bit. A 8 5/8-in. O.D. steel surface casing was set to a depth of approximately 141.5 ft and pressure-grouted in placed with a cement-bentonite grout. The grout was allowed at least 48 hours curing time before work was continued.

After completion of the grout curing time, a 4-in.-diameter soil boring was advanced from a depth of 142 ft to a total depth of 221 ft. The borehole was geophysically logged and then reamed with a 7 7/8-in.-diameter bit to a depth of 215 ft.

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A nonpolymer bentonite mud was tremied into the borehole through the drill stem. The drill stem was raised to a depth of 120 ft, inside the surface casing, and fresh water pumped into the borehole to remove the bentonite mud from a depth of 120 ft to the surface.

3.8.3 Well Construction. Approximately 30 ft of stainless steel wire-wrap screen was installed from a depth of 180 ft to 210 ft. Schedule 40, Type 304 stainless steel casing was set to above ground level. A sand filter pack was tremied in place throughout the entire monitoring zone. A nonpolymer bentonite mud was tremied in place above the sand filter pack, and a cement-bentonite grout placed above the bentonite seal to the surface. The deep monitoring well log showing the constructed dimensions is presented in Appendix F, Volume 3.

3.8.4 Well Development. Well development was conducted by using a combination of air surge techniques and pumping until a sediment-free condition was attained (less than 0.1 ml by Imhoff Cone) and constant conductivity measurements were observed. After development, a cleaned stainless steel pump and stainless steel riser pipe were installed in the monitoring well. The monitoring well was then purged of approximately 5,550 gallons by using a dedicated stainless steel submersible pump. A total of 7,150 gallons were removed during well development and purging. All groundwater produced was placed in drums and stored onsite.

3.8.5 Previous Deep Monitoring Well. Monitoring Well CAV-OW06 was previously installed at the north portion of the site to a depth of 210 ft. A monitoring well log is included in Appendix F, Volume 3. The well was installed

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using wet-rotary drilling methods and includes a 6-in.-diameter steel surface casing to a depth of about 120 ft. Details of the installation procedures are included in the CDM Cavalcade Contaminant Survey Report. A dedicated stainless steel submersible pump was also installed in Monitoring Well CAV-OW06 to facilitate sampling.

3.8.6 Deep Groundwater Sampling. Monitoring Well CAV-OW06 was sampled three times and Monitoring Well SCK-DW02 was sampled twice in general accordance with the Field Sampling and Analytical Plan, except that no filtering was performed. Monitoring Well CAV-OW06 was sampled on December 10, 1986, February 5, 1987, and June 10, 1987. Monitoring Well SCK-DW02 was sampled on June 10, 1987 and August 4, 1987.

Prior to sampling the deep monitoring wells, approximately five well volumes were purged from the wells utilizing the dedicated stainless steel submersible pumps previously installed. Samples were obtained with the stainless steel submersible pumps. One measurement of pH, conductivity, and temperature was measured at each well location. Purged well volumes, pH, temperature, and conductivity measurements are presented in Appendix U, Volume 3. All groundwater produced was placed in drums and stored onsite.

## 3.9 Soil and Groundwater Analytical Testing

Analytical testing of auger boring samples, soil boring samples, and groundwater samples was performed in general accordance with the RI/FS Work Plan and the QA/QC Plan. Auger boring samples were analyzed using soil surrogate test methods. Soil boring samples were analyzed using both surrogate test methods and EPA Contract Laboratory Program (CLP) procedures. Groundwater samples were analyzed using EPA CLP procedures, high performance liquid chromatography (HPLC), and standard water quality analysis test methods.

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The soil surrogate testing program generally consisted of X-ray fluorescence analysis for metals, headspace analysis for total organic vapors, and fluorescence analysis for total aromatic hydrocarbons. The soil CLP testing program generally consisted of analysis for Hazardous Substance List (HSL) semivolatile (SV) organics and selected HSL inorganics. The groundwater testing program generally consisted of CLP analyses for HSL SV organics, volatile (VOA) organics, pesticides/PCB, and inorganics. General water quality parameters were also analyzed. Table 3-4 lists the organic and inorganic constituents included in the HSL soil and groundwater analytical testing programs.

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3.9.1 Auger Boring Surrogate Testing. Soil surrogate testing of recovered auger boring soil samples included metals screening with an X-ray fluorescence analyzer and headspace measurements for total organic vapors with an HNU photoionization analyzer. Soil surrogate testing was conducted for each shallow auger boring soil sample. Field and laboratory headspace measurements were obtained for the auger boring soil samples. Field headspace measurements were not obtained on some auger boring soil samples due to problems with high humidity and mechanical problems with the analyzer.

Calibration of the photoionization analyzer was performed on a daily basis in general accordance with the MRA Standard Operating Procedure SOP-HWCL-02 (Appendix D, Volume 3). The span gas used for the HNU calibration was isobutylene, at both low and high concentrations. All field and laboratory headspace measurements were corrected by subtracting background organic vapor readings. Laboratory headspace readings were made after samples were allowed 4 hours to 10 hours to attain room temperature. These results were converted to naphthalene equivalents

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TABLE 3-4

HSL SEMIVOLATILE ORGANICS[1]

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(g)fluoranthene
Benzo(ghi)perylene
Benzoic Acid
Benzo(k)fluoranthene
Benzyl Alcohol
Bis(2-Ethylhexyl)phthalate
Bis(2-Chloroethoxy)methane
Bis(2-Chlorethyl)ether
Bis(2-Chloroisopropyl)ether
4-Bromophenyl Phenyl Ether
Butyl Benzyl Phthalate
4-Chloroaniline
2-Chloronaphthalene
2-Chlorophenol
4-Chlorophenyl Phenyl Ether
Chrysene
Dibenzo(ah)anthracene
Dibenzofuran
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3'-Dichlorobenzidine
2,4-Dichlorophenol
Diethyl Phthalate
2,4-Dimethylphenol
Dimethyl Phthalate
Di-N-Butyl Phthalate
4,6-Dinitro-2-Methylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-N-Octyl Phthalate
Fluorene
Fluorathene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-cd)pyrene
Isophorone
2-Methylnaphthalene
2-Methylphenol
4-Methylphenol
Naphthalene
2-Nitroaniline
3-Nitroaniline
4-Nitroaniline
Nitrobenzene
2-Nitrophenol
4-Nitrophenol
N-Nitrosodiphenylamine
N-Nitrosopropylamine
P-Chloro-M-Cresol
Pentachlorophenol
Phenanthrene
Phenol
Pyrene
1,2,4-Trichlorobenzene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

Note:
1. Included in both soil and groundwater analytical testing programs.

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TABLE 3-4 (cont'd)

| HSL VOLATILE ORGANICS[1] | HSL Pesticides/PCB[1] |
|---|---|
| Acetone | Aldrin |
| Benzene | Alpha-BHC |
| Bromodichloromethane | Aroclor-1016 |
| Bromoform | Aroclor-1221 |
| Bromomethane | Aroclor-1232 |
| 2-Butanone | Aroclor-1242 |
| Carbon Disulfide | Aroclor-1248 |
| Carbon Tetrachloride | Aroclor-1254 |
| Chlorobenzene | Aroclor-1260 |
| Chloroethane | Beta-BHC |
| 2-Chloroethylvinyl Ether | Chlordane |
| Chloroform | 4,4'-DDD |
| Chloromethane | 4,4'-DDE |
| Cis-1,3-Dichloropropene | 4,4'-DDT |
| Dibromochloromethane | Delta-BHC |
| 1,1-Dichloroethane | Dieldrin |
| 1,2-Dichloroethane | Endosulfan I |
| 1,1-Dichloroethene | Endosulfan II |
| 1,2-Dichloropropane | Endosulfan Sulfate |
| Ethylbenzene | Endrin |
| 2-Hexanone | Endrin Aldehyde |
| Methylene Chloride | Endrin Ketone |
| 4-Methyl-2-Pentanone | Gamma-BHC (Lindane) |
| Styrene | Heptachlor |
| 1,1,2,2-Tetrachloroethane | Heptachlor epoxide |
| Toluene | Methoxychlor |
| Total Xylenes | Toxaphene |
| Trans-1,2-Dichloroethene | |
| Trans-1,3-Dichloropropene | |
| Trichloroethene | |
| Vinyl Acetate | |
| Vinyl Chloride | |

HSL AND NON-HSL INORGANICS[2,3]

| | |
|---|---|
| Antimony | Lead |
| Arsenic | Mercury |
| Beryllium | Nickel |
| Cadmium | Nitrate |
| Chromium | Selenium |
| Copper | Silver |
| Cyanide | Thallium |
| Iron | Zinc |

Notes:
1. Included in groundwater analytical testing program only.
2. Iron and nitrate are non-HSL inorganics.
3. Arsenic, chromium, copper, cyanide, iron, lead, and zinc included in soil analytical testing program. Complete list included in groundwater analytical testing program.

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using a correction factor of 0.92, and recorded on the auger boring logs in Appendix C, Volume 2. The naphthalene conversion factor was established by HNU Systems, Inc., by measuring the instrument response at various span potentiometer settings for known concentrations of naphthalene vapors.

In general accordance with the RI/FS Work Plan, the following metals were included in the soil sample surrogate testing: arsenic, chromium, copper, lead, and zinc. Sample screening was performed with a CSI X-Met 840 portable X-ray analyzer. The X-ray analyzer was calibrated by CSI based upon comparisons with metal concentrations measured by atomic absorption techniques. Laboratory quality assurance/quality control (QA/QC) methods and instrument detection limits were evaluated by MRA. Documentation of the X-ray fluorescence calibration data was included in MRA Report No. 85-317, dated May 14, 1986. Standard Operating Procedure SOP-HWCL-03 (Appendix D, Volume 3) outlines the testing procedures used for the X-ray analyzer.

A total of 156 metal screenings were performed for the auger boring soil samples. The results of the soil surrogate metals analyses are referenced on the auger boring logs presented in Appendix C, Volume 2 and are summarized in Appendix D, Volume 2.

<u>3.9.2 Soil Boring Analytical Testing</u>. Soil boring analytical testing generally consisted of the soil surrogate testing program and the CLP procedures for HSL SV and selected HSL inorganics. Soil surrogate testing included metals screening with an X-ray fluorescence analyzer, headspace measurements for total organic vapors with an HNU

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photoionization analyzer, and fluorescence analysis for total aromatic hydrocarbons. Soil surrogate testing was conducted on at least four samples per soil boring, except headspace measurements, which were performed on every sample. Soil samples selected for surrogate testing were generally taken from the shallow water-bearing zone, and from the first clay unit under the sand zone. Additional surrogate testing was assigned in lower water-bearing zones at key locations to aid in evaluation of vertical subsurface quality.

A total of 2052 samples were analyzed for total organic vapors during the soil boring surrogate testing program. A total of 282 samples were analyzed for surrogate soil metals, and a total of 389 samples were analyzed for total aromatic hydrocarbons. A total of 68 samples analyzed for total aromatic hydrocarbons from the surrogate testing program were analyzed for HSL SV, five HSL metals (zinc, copper, chromium, lead, arsenic) and iron, and cyanide, as required in the RI/FS Work Plan.

Total organic vapors surrogate testing procedures were the same as procedures used for the auger boring samples (Section 3.9.1). Quality assurance protocol for the total organic vapors surrogate testing consisted of analysis of field duplicates and a comparison of laboratory and field results and is presented in the Surrogate Testing Quality Assurance Report in Appendix C, Volume 3. Ninety-three percent of the samples which had detected soil organic vapors in the laboratory also had detected soil organic vapors in the field. Additionally, 75 percent of the detected HSL total aromatic hydrocarbon results were supported by positive headspace responses, and 64 percent of the non-detected HSL total aromatic hydrocarbon results were supported by non-detected headspace responses.

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Metals screening procedures were the same as procedures used for the auger boring samples (Section 3.9.1). Of the total of 282 soil metals surrogate analyses performed, 23 were field duplicates. Quality assurance protocol for the metals surrogate analytical program consisted of analysis of field duplicates, laboratory replicates, and an end-of-day standard analysis. A comparison of metal surrogate data to the HSL analytical data indicates poor correlations. Arsenic, chromium, copper, and lead demonstrated 0 percent comparability between positive analytical results and surrogate test results, indicating that the X-ray fluorescence method did not detect these metals when the analytical results indicated that these metals were present in the soil samples. Zinc demonstrated 67 percent comparability between positive analytical results and surrogate test results.

The metals surrogate analytical program was discontinued because results of the metals surrogate testing and CLP testing on the same soils indicated poor correlation. Discontinuation was approved by the EPA on June 26, 1986. A copy of the EPA correspondence is included in Appendix G, Volume 2.

Fluorescence analysis techniques were used to qualitatively assess the total aromatic hydrocarbon concentrations within selected soil samples. A total of 389 fluorescence surrogate soil tests were performed, not including 34 samples analyzed as field duplicates. An evaluation of fluorescence surrogate data indicates that 85 percent of the soil samples which tested positive for HSL semivolatile fraction aromatic compounds also tested positive using the fluorescence surrogate method. Eighty-five percent which tested negative for HSL semivolatile fraction aromatic compounds also tested negative using the fluorescence surrogate method.

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The results of the soil boring surrogate analytical program are presented on the soil boring logs in Appendix F, Volume 2 and summarized in Appendix B, Volume 3. An evaluation of the surrogate analytical quality assurance program is presented in Appendix C, Volume 3. Standard operating procedures for the surrogate analytical techniques are presented in Appendix D, Volume 3.

A total of 88 selected soil samples (excluding two samples analyzed for inorganics only), 68 of which were part of the soil surrogate testing program, were assigned for analytical testing using CLP procedures, as listed in Table 3-5. Seventy-six samples were taken from the soil borings and six samples were field duplicates of soil boring samples. Six additional samples were taken from the deep monitoring well borings. A 20-peak library search for HSL SV was also conducted to identify non-HSL compounds.

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TABLE 3-5

SUMMARY OF SOIL ANALYTICAL TEST METHODS

| Analysis | Method |
|---|---|
| 1. Semivolatile Organics | EPA 7/85 Revision CLP Statement of Work for Organics |
| 2. HSL Metals | EPA 7/84 Revision CLP Statement of Work for Inorganics |
| 3. Iron | EPA 7/84 Revision CLP Statement of Work for Inorganics |
| 4. Cyanide | EPA 7/84 Revision CLP Statement of Work for Inorganics |

Four samples of the total of 82 (duplicates not included) selected soil samples were analyzed as matrix spike/matrix spike duplicates (MS/MSD) for SV organics and duplicate/spikes (DUP/SPIKE) for inorganics. A discussion of soil analytical test data is presented in Section 6.0. Soil boring sample analytical data reports are presented in Appendix R, Volume 3.

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3.9.3 Groundwater Analytical Testing. As specified in the RI/FS Work Plan, two rounds of groundwater sampling and analysis were conducted at the South Cavalcade Site, with an additional Round 3 sampling and analysis of CAV-OW06 for select PAH compounds. Round 1 analyses included HSL VOA, HSL SV, HSL inorganics, iron, HSL pesticides and PCB on all samples. In addition, selected Round 1 samples were analyzed for general water chemistry parameters. Round 2 samples were analyzed for HSL SV and select metals, and one-third were analyzed for VOA. Groundwater samples were not analyzed for pesticides, PCB, and general water quality parameters during Round 2 analyses, with approval of the EPA. A copy of the EPA correspondence dated, February 3, 1987, is included in Appendix G, Volume 2. A 10-peak library search for VOA and a 20-peak library search for SV was conducted for Round 1. Selected Round 2 samples were subjected to library searches. Additionally, Samples CAV-OW06-003 and SCK-DW02-002 were analyzed for seven select PAH compounds using high performance liquid chromatography (HPLC) techniques. Table 3-6 lists the groundwater analytical test methods.

TABLE 3-6
SUMMARY OF GROUNDWATER ANALYTICAL TEST METHODS

| Analysis | Method No. |
|---|---|
| 1. Volatile Compounds | EPA 7/85 Revision CLP Statement of Work for Organics |
| 2. Semivolatile Compounds | EPA 7/85 Revision CLP Statement of Work for Organics |
| 3. Pesticides and PCB | EPA 7/85 Revision CLP Statement of Work for Organics |
| 4. HSL Metals | EPA 7/84 Revision CLP Statement of Work for Inorganics |
| 5. Iron | EPA 7/84 Revision CLP Statement of Work for Inorganics |
| 6. Cyanide | EPA 7/84 Revision CLP Statement of Work for Inorganics |

| Analysis | Method No. |
|---|---|
| 7. General Water Quality Parameters<br>- conductivity, total organic carbon, total phenols, pH, chloride, nitrate, sulfate, ammonia, total dissolved solids, alkalinity, calcium, magnesium, potassium, sodium | EPA Methods of Chemical Analysis of Water and Wastes, EPA-600/4-79-020 |
| 8. Select PAH Compounds<br>- benzo(a)anthracene, benzo(a)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenzo(ah)anthracene, indeno(1,2,3-cd)pyrene | EPA Method 610 |

A total of 31 Round 1 monitoring well samples were analyzed. Five Round 1 field duplicates, seven field rinseate blanks, and seven trip blanks were also analyzed . A total of 29 Round 2 monitoring well samples were analyzed. Five Round 2 field duplicates, five field rinseate blanks, and three trip blanks were also analyzed. Four samples from Round 1 and four samples from Round 2 were analyzed as matrix spike/matrix spike duplicates (MS/MSD) for HSL organics and duplicate/spike (DUP/SPIKE) for HSL inorganics. One Round 3 sample was analyzed for seven select HPLC detectable PAH only and had one corresponding field blank but no trip blanks or duplicates. A discussion of the groundwater analytical test data is presented in Section 7.0. Groundwater analytical test reports are presented in Appendix Q, Volume 3.

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## 3.10 Analytical Data Validation

Data validation of the analytical data was performed for the surface water and sediment samples, soil samples, groundwater samples, and field QA/QC samples. Data validations were designated as follows:

Valid (V) - all criteria passed with acceptable results. Data is used to quantify types and concentrations of potential contaminants of concern.

Qualified (Q) - all criteria followed but matrix effects may affect results. Data is used qualitatively to assess the presence or absence of selected compounds for evaluation of location boundaries.

Invalid (I) - QA/QC criteria not followed or performed incorrectly.

Not Validated (NV) - Validation of analytical test results not performed.

The data validation is based upon criteria set forth in the QA/QC Plan and includes a review of the analytical data package and observations of laboratory procedures during audits. Details of criteria used to establish the data validation status of the analytical data are included in Appendix E, Volume 3.

## 3.11 References

1. Koppers Company, Inc.; Field Sampling and Analytical Plan, Remedial Investigation and Feasibility Study, Koppers South Cavalcade Site, October 1985.

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2. Koppers Company, Inc.; Health and Safety Plan for Remedial Investigation, Koppers/South Cavalcade Site May 1985.

3. Camp Dresser and McKee; Work Plan for South Cavalcade Street Houston, Texas Remedial Investigation/Feasibility Study, Document No. 143-WP1-WP-ATEW-3, April 4, 1985.

4. Texas Department of Health; Technical Guide No. 1, March 24, 1980.

5. Geonics Limited; EM 31 Operating Manual, June 1984.

6. McBride-Ratcliff and Associates, Inc.; Geophysical Feasibility Survey, Engineering Report, December 18, 1985.

7. McBride-Ratcliff and Associates, Inc.; Electromagnetic Geophysical Survey, Engineering Report, December 1985.

8. McBride-Ratcliff and Associates, Inc.; Shallow Auger Boring Study, Engineering Report, May 30, 1985.

9. Camp Dresser and McKee; Cavalcade Contaminant Survey, Volume I - Engineering Report, July 11, 1983.

10. Camp Dresser and McKee; Crosstimbers Contaminant Survey, Volume I - Engineering Report, July 11, 1983.

11. McClelland Engineers, Inc.; Geotechnical Investigation Reconnaissance Study Cavalcade Yard and Shop, Metro-Stage One, RRS, May 20, 1983.

12. U.S. Environmental Protection Agency; EPA SW-846, Test Methods for Evaluating Solid Waste, Third Edition, Method 9100, November, 1986.

13. McBride-Ratcliff and Associates; Method of X-Ray Fluorescence Analysis of Metals in Soil, January, 1986.

14. Camp Dresser and McKee; "Use of X-Met Data at North Cavalcade; Arsenic, Copper, Lead, Chromium," August 18, 1986.

15. McBride-Ratcliff and Associates, Inc.; Summary of X-ray Fluorescence Calibration Data, May 14, 1986.

16. Koppers Company, Inc.; Quality Assurance/Quality Control Plan for Remedial Investigation and Feasibility Studies at the Koppers South Cavalcade Site, Houston, Texas, September, 1985.

# SECTION 4.0 - SITE GEOLOGY AND HYDROGEOLOGY

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006544

# 4.0 SITE GEOLOGY AND HYDROGEOLOGY

## 4.1 Geology

4.1.1 General. A review of regional and site geology was conducted to evaluate the geologic setting and depositional environments in the vicinity of the South Cavalcade Site. The analysis of geologic data was used in the evaluation of regional geology for the study area, the preparation of geologic cross-sections of depositional units, and contour maps of depositional unit contacts.

The evaluation of regional geology included a review of the following data sources:

1. Published geologic literature and file data pertaining to geologic conditions in the project site;

2. Black and white aerial photographs from the years 1938, 1944, 1953, 1972, and 1984, and 1981 NASA high altitude false-colored infrared aerial photographs;

3. Historic United States Geologic Survey topographic maps (1-ft contour interval) Houston Heights, Tx (1915) and Settegast, Tx (1915); and

4. Project soil borings and previous soil borings by others.

4.1.2 Regional Geology. The regional geologic setting for the South Cavalcade Site is presented on Figure 4-1. The South Cavalcade Site is situated on the Quaternary Gulf

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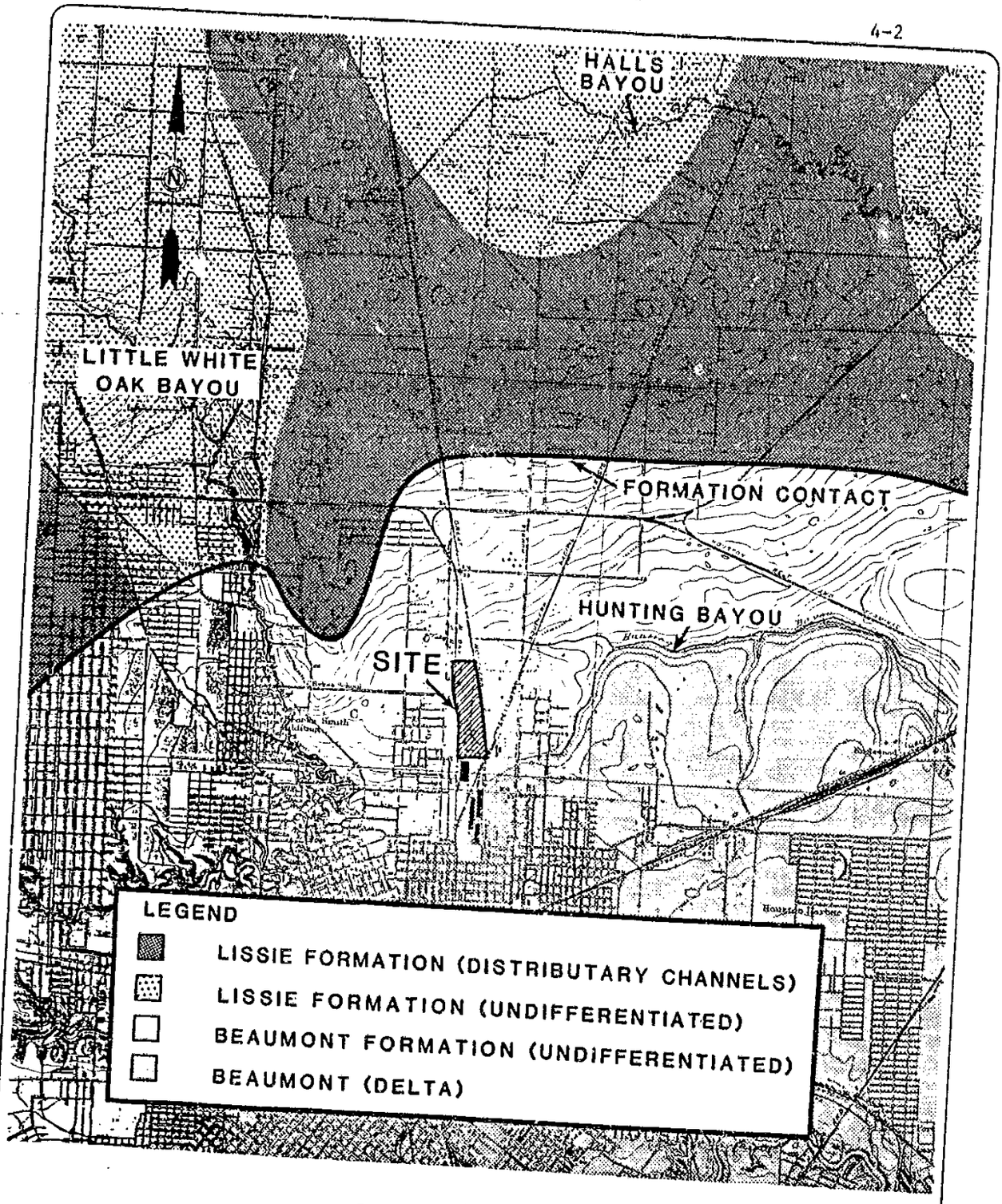


0 5,000 10,000

SCALE-FT

REGIONAL GEOLOGY

FILE NO. 85-317
FIGURE 4-1

006546

Coastal Plain of Texas. This region is comprised of a series of sedimentary depositional plains. The youngest of these plains is of recent, post-glacial deposition (Holocene deposits). Sediments of Holocene deposition are deposited along the coast and in alluvial flood plains of present river systems. Progressively older plains (Pleistocene deposits) are associated with the fluvial/deltaic depositional systems of the Beaumont Formation and the Lissie Formation. The depositional environments of the fluvial/deltaic systems consist of distributary channel fill, flood basin/bay fill, and delta fringe environments. Deposits of the Beaumont Formation onlap the older Lissie Formation, which gives a smooth contact between the formations as shown on Figure 4-1. The sediments of both the Holocene and Pleistocene are non-cemented and non-indurated, and, thus are classified as soils by engineering terms.

The Texas Coastal Plain is characterized by several stratigraphic units spanning Tertiary and Quaternary time periods. Correlation between these units and geologic formations of the Texas Coastal Plain (Baker, 1979) is shown on Figure 4-2. Boundaries and composition of hydrogeologic units are defined from exploration of formation outcrops, geophysical log interpretation, and analysis of well data, including static water levels, water-level fluctuations, and transmissibility.

Distributary channel fill deposits are comprised of a upward fining sequence of sediment with non-cohesive soils (sands and silts) filling abandoned channels. This is overlain by a top stratum of cohesive soils (sandy clays, silty clays, and clays) deposited in natural levee environments.

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POST - OLIGOCENE STRATIGRAPHIC AND HYDROLOGIC FRAMEWORK OF THE TEXAS COASTAL PLAIN

| ERA | SYSTEM | SERIES | STRATIGRAPHIC UNITS | HYDROGEOLOGIC UNITS |
|---|---|---|---|---|
| CENOZOIC | QUATERNARY | HOLOCENE | ALLUVIUM | CHICOT AQUIFER |
| | | PLEISTOCENE | BEAUMONT CLAY | |
| | | | LISSIE FORMATION | |
| | | | WILLIS SAND | |
| | TERTIARY | PLIOCENE | GOLIAD SAND | EVANGELINE AQUIFER |
| | | MIOCENE | FLEMING FORMATION | BURKEVILLE CONFINING SYSTEM |
| | | | OAKVILLE SANDSTONE | JASPER AQUIFER |
| | | | CATAHOULA TUFF OR SANDSTONE | CATAHOULA CONFINING SYSTEM |

NOTE :

MODIFIED FROM BAKER, 1979.

STRATIGRAPHIC FRAMEWORK

FILE NO. 85-317
FIGURE 4-2

006548

Interdistributary flood basin deposits were formed in basins located between distributary channel systems. Flood basins are characterized as low, flat, relatively featureless and poorly drained to inundated areas. Overbank deposits of noncohesive soils (sands and silts) are encountered within flood basin areas, but are not of great areal continuity.

Delta fringe sediments were deposited in the shallow waters of a prodelta. Soils are deposited in environments including fringing beaches, distributary mouth bars, interdistributary bays, undifferentiated fringe (including small coalescing river bars and sand swept by waves and longshore currents), delta margin coastal barriers and spits, and tidal flats (including mudflats, tidal deltas, and tidal channels).

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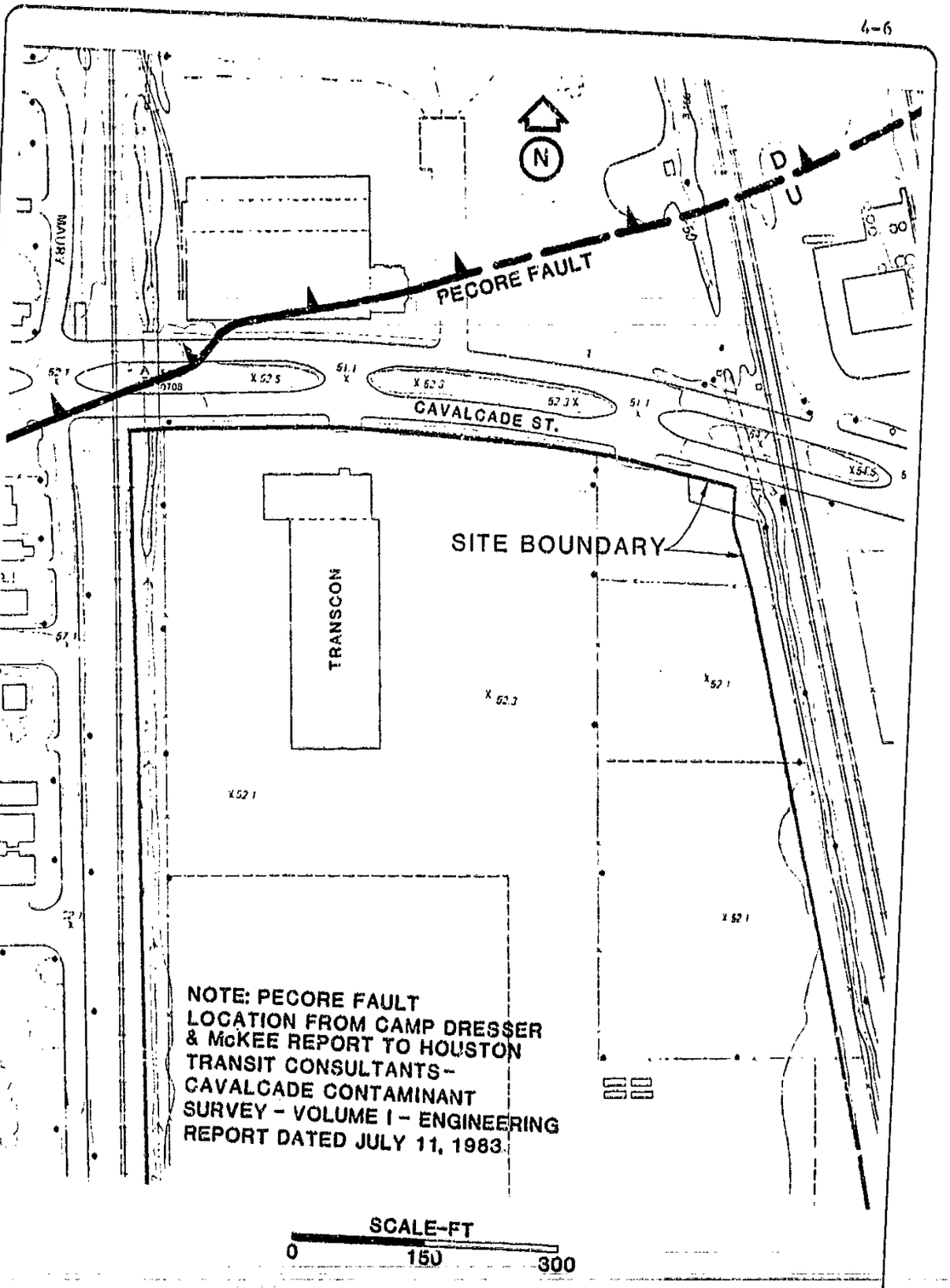
4.1.3 Geologic Faulting. Active geologic faults have been documented within the regional geologic setting of the Texas Gulf Coastal Plain. Faults develop around salt domes (radial faults) and as growth faults along ancient continental slopes formed contemporaneously with deposition (regional faults). The Pecore Fault is the closest known documented fault in the site vicinity and is located adjacent to the north site border. The Pecore Fault is a complimentary fault within a regional fault system. The approximate surface trace of the fault, as mapped by others, is shown on Figure 4-3.

4.1.4 Site Geology. Formation outcrop at the South Cavalcade Site is shown on Figure 4-1. The site is situated within surface sediments of the Beaumont Formation. The majority of the soil borings were drilled to depth of 65 ft and were used to constructed the generalized shallow geologic profiles presented on Figures 4-4A to 4-4F.

006549




PECORE FAULT MAP

FILE NO. 85-317
FIGURE 4-3

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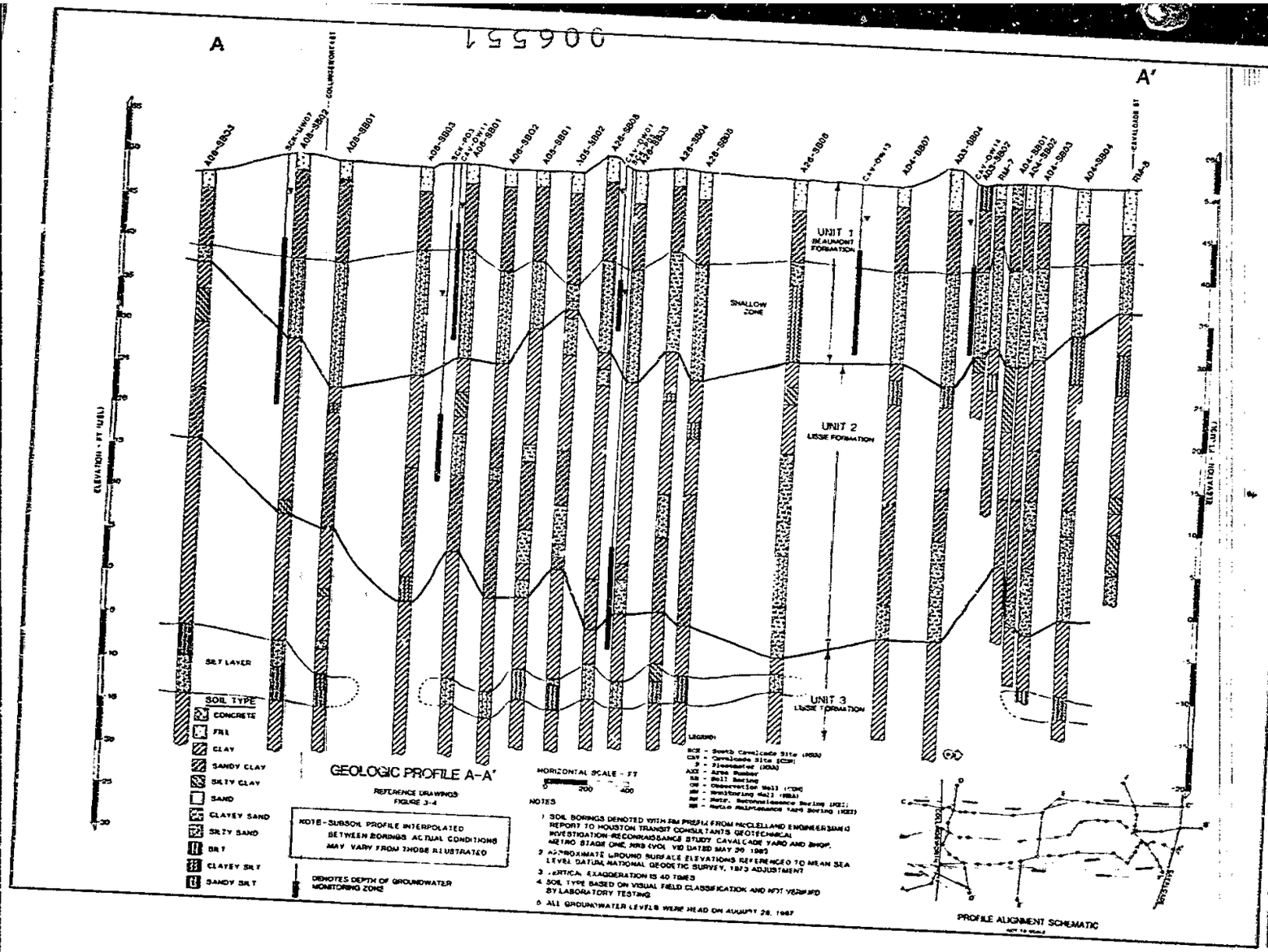
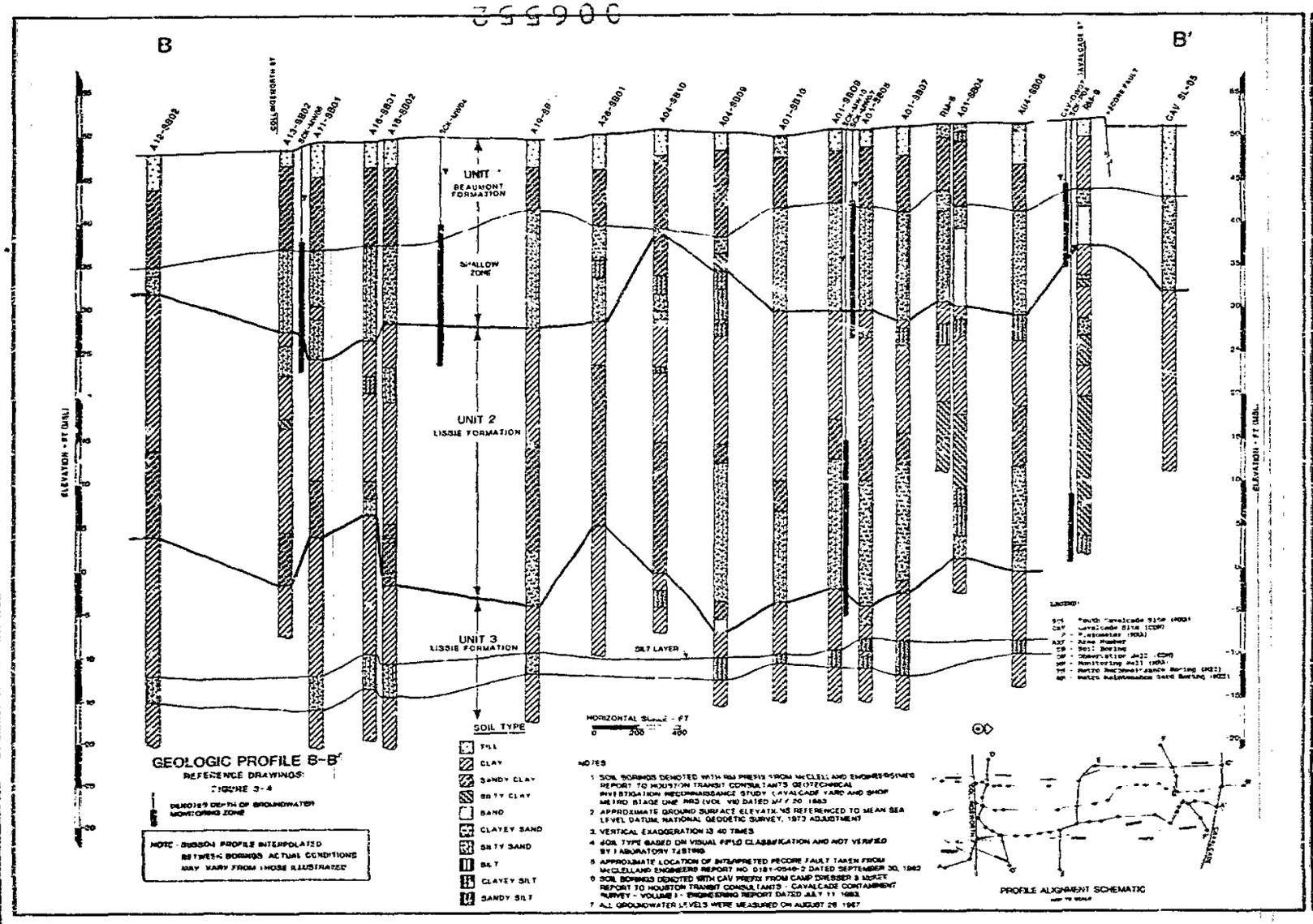



GENERALIZED GEOLOGIC PROFILE
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.

| | |
|---|---|
| PROJECT NO. | 61-317 |
| DATE | 6-30-88 |
| ENGINEER | |
| DRAWN BY | |
| FIGURE NO. | 4-4A |

Page 4-7


B
B'
UNIT 1
BEAUMONT FORMATION
SHALLOW ZONE
UNIT 2
LISSIE FORMATION
UNIT 3
LISSIE FORMATION
SILT LAYER
ELEVATION - FT (MSL)
SOIL TYPE
FILL
CLAY
SANDY CLAY
SILTY CLAY
SAND
CLAYEY SAND
SILTY SAND
SILT
CLAYEY SILT
SANDY SILT
HORIZONTAL SCALE - FT
0
200
400
GEOLOGIC PROFILE B-B'
REFERENCE DRAWINGS:
FIGURE 3-4
DENOTES DEPTH OF GROUNDWATER MONITORING ZONE
NOTE - BISSON PROFILE INTERPOLATED BETWEEN BORINGS ACTUAL CONDITIONS MAY VARY FROM THOSE ILLUSTRATED
NOTES
1 SOIL BORINGS DENOTED WITH A A PREFIX FROM MCCLELLAND ENGINEERS REPORT TO HOUSTON TRANSIT CONSULTANTS GEOTECHNICAL INVESTIGATION RECONNAISSANCE STUDY CAVALCADE YARD AND SHOP METRO STAGE ONE REP (VOL VIII DATED MAY 20 1983
2 APPROXIMATE GROUND SURFACE ELEVATIONS REFERENCED TO MEAN SEA LEVEL DATUM NATIONAL GEODETIC SURVEY, 1973 ADJUSTMENT
3 VERTICAL EXAGGERATION IS 40 TIMES
4 SOIL TYPE BASED ON VISUAL FIELD CLASSIFICATION AND NOT VERIFIED BY LABORATORY TESTING
5 APPROXIMATE LOCATION OF INTERPRETED PECORE FAULT TAKEN FROM MCCLELLAND ENGINEERS REPORT NO 0181-0540-2 DATED SEPTEMBER 30, 1982
6 SOIL BORINGS DENOTED WITH CAV PREFIX FROM CAMP DRESSER & MCKEE REPORT TO HOUSTON TRANSIT CONSULTANTS - CAVALCADE CONTAINMENT SURVEY - VOLUME I - ENGINEERING REPORT DATED JULY 11 1983
7 ALL GROUNDWATER LEVELS WERE MEASURED ON AUGUST 28 1987
PROFILE ALIGNMENT SCHEMATIC
LEGEND
SOUTH CAVALCADE SITE (MOD)
CAVALCADE SITE (CDM)
PIEZOMETER (MOD)
AIR MONITOR
SOIL BORING
OBSERVATION WELL (CDM)
MONITORING WELL (MOD)
METRO MAINTENANCE BORING (MOD)
METRO MAINTENANCE SAND BORING (MOD)
PECORE FAULT
PROJECT NO 85-311
DATE 8-30-88
ENGINEER
DRAWN BY
FIGURE NO
4-4B
GENERALIZED GEOLOGIC PROFILE
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.
Page 4-8

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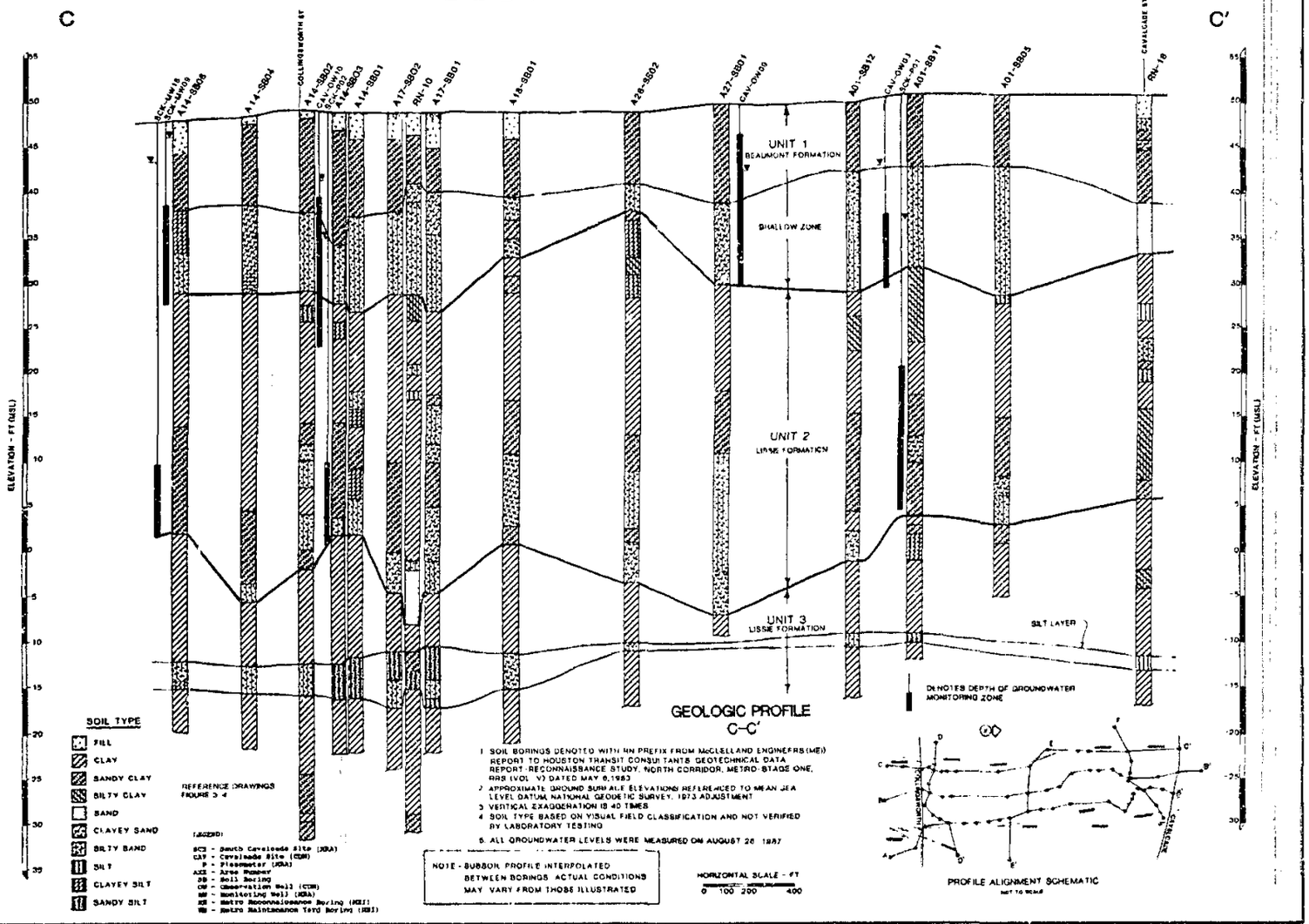


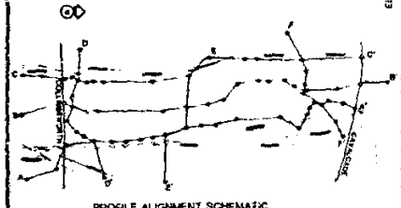

GENERALIZED GEOLOGIC PROFILE
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.

| | |
|---|---|
| PROJECT NO. | 85-317 |
| DATE | 8-30-88 |
| ENGINEER | |
| DRAWN BY | |
| FIGURE NO. | 4-4C |

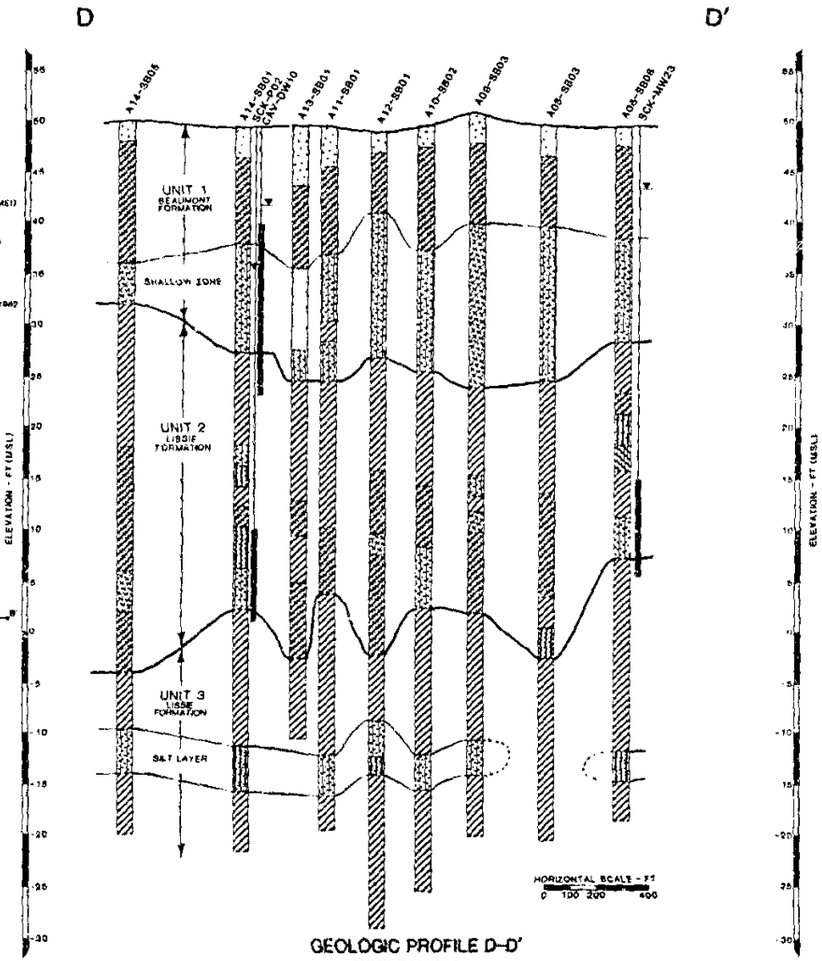
006554

NOTES

1. SOIL BORINGS DENOTED WITH AN PREFIX FROM McCLELLAND ENGINEERS (MEI) REPORT TO HOUSTON TRANSIT CONSULTANTS-GEOTECHNICAL INVESTIGATION-RECONNAISSANCE STUDY, CAVALCADE YARD AND SHOP, METRO- STAGE ONE, IRB (VOL VII) DATED MAY 20 1983
2. APPROXIMATE GROUND SURFACE ELEVATIONS REFERENCED TO MEAN SEA LEVEL DATUM NATIONAL GEODETIC SURVEY, 1973 ADJUSTMENT
3. VERTICAL EXAGGERATION IS 20 TIMES
4. SOIL TYPE BASED ON VISUAL FIELD CLASSIFICATION AND NOT VERIFIED BY LABORATORY TESTING
5. APPROXIMATE LOCATION OF INTERPRETED PECORS FAULT TAKEN FROM McCLELLAND ENGINEERS REPORT NO D181-0646-2 DATED SEPTEMBER 30, 1982
6. SOIL BORINGS DENOTED WITH CAV PREFIX FROM CAMP DRESSER & McKEE REPORT TO HOUSTON TRANSIT CONSULTANTS - CAVALCADE CONTAINMENT SURVEY - VOLUME I - ENGINEERING REPORT DATED JULY 11, 1980
7. ALL GROUNDWATER LEVELS WERE MEASURED ON AUGUST 26, 1987




PROFILE ALIGNMENT SCHEMATIC
NOT TO SCALE




GEOLOGIC PROFILE D–D'
REFERENCE DRAWINGS
FIGURE 3-4

NOTE - SUBSOIL PROFILE INTERPOLATED BETWEEN BORINGS. ACTUAL CONDITIONS MAY VARY FROM THOSE ILLUSTRATED

DENOTES DEPTH OF GROUNDWATER MONITORING ZONE

SOIL TYPE

- FILL
- CLAY
- SANDY CLAY
- SILTY CLAY
- SAND
- CLAYEY SAND
- SILTY SAND
- SILT
- CLAYEY SILT
- SANDY SILT

LEGEND

- SCK - South Cavalcade Site (MRS)
- CAV - Cavalcade Site (CDM)
- P - Piezometer (MRS)
- A2X - Area Number
- SB - Soil Boring
- OW - Observation Well (CDM)
- MW - Monitoring Well (MRS)
- BM - Metro Reconnaissance Boring (MEI)
- MM - Metro Maintenance Yard Boring (MEI)

Page 4-10

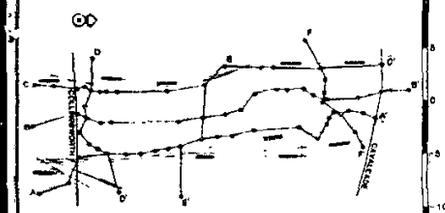
GENERALIZED GEOLOGIC PROFILE
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.

| | |
|---|---|
| PROJECT NO. | 18-317 |
| DATE | 12-22-87 |
| ENGINEER | |
| DRAWN BY | |
| FIGURE NO | 4-10 |

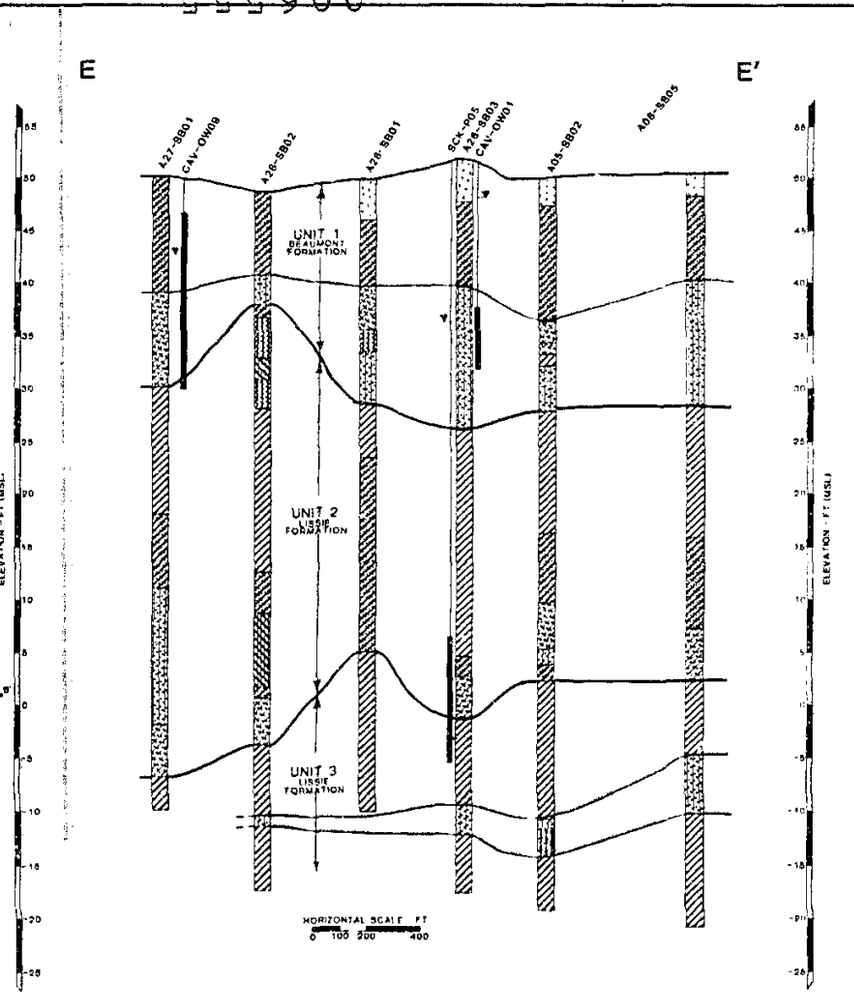
006554

NOTES

1. SOIL BORINGS DENOTED WITH RM PREFIX FROM McCLELLAND ENGINEERS (1983) REPORT TO HOUSTON TRANSIT CONSULTANTS-GEOTECHNICAL INVESTIGATION-RECONNAISSANCE STUDY CAVALCADE YARD AND SHOP, METRO-STAGE ONE, RRS (VOL VIII DATED MAY 20 1983
2. APPROXIMATE GROUND SURFACE ELEVATIONS REFERENCED TO MEAN SEA LEVEL DATUM NATIONAL GEODETIC SURVEY, 1973 ADJUSTMENT
3. VERTICAL EXAGGERATION IS 40 TIMES
4. SOIL TYPE BASED ON VISUAL FIELD CLASSIFICATION AND NOT VERIFIED BY LABORATORY TESTING
5. APPROXIMATE LOCATION OF INTERPRETED RECORE FAULT TAKEN FROM McCLELLAND ENGINEERS REPORT NO 01E1-05AR-2 DATED SEPTEMBER 10, 1982
6. SOIL BORINGS DENOTED WITH CAV PREFIX FROM CAMP DRESSER & McKEE REPORT TO HOUSTON TRANSIT CONSULTANTS - CAVALCADE CONTAINMENT SURVEY - VOLUME II - ENGINEERING REPORT DATED JULY 11, 1983
7. ALL GROUNDWATER LEVELS WERE MEASURED ON AUGUST 28, 1987




PROFILE ALIGNMENT SCHEMATIC
NOT TO SCALE




NOTE - SUBSOIL PROFILE INTERPOLATED BETWEEN BORINGS ACTUAL CONDITIONS MAY VARY FROM THOSE ILLUSTRATED

DENOTES DEPTH OF GROUNDWATER MONITORING ZONE

SOIL TYPE

- FILL
- CLAY
- SANDY CLAY
- SILTY CLAY
- SAND
- CLAYEY SAND
- SILTY SAND
- SILT
- CLAYEY SILT
- SANDY SILT

LEGEND:

SCK - South Cavalcade Site (HOUA)
CAV - Cavalcade Site (CDM)
P - Piezometer (HOUA)
A32 - Area Number
SB - Soil Boring
OW - Observation Well (CDM)
MW - Monitoring Well (HOUA)
MW - Metro Reconnaissance Boring (MRI)
MW - Metro Maintenance Yard Boring (MRI)

GEOLOGIC PROFILE E-E'

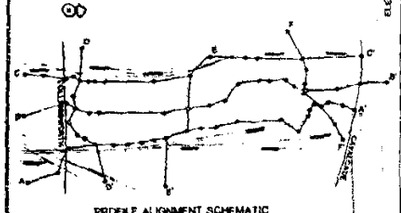
REFERENCE DRAWINGS:
FIGURE 3-4

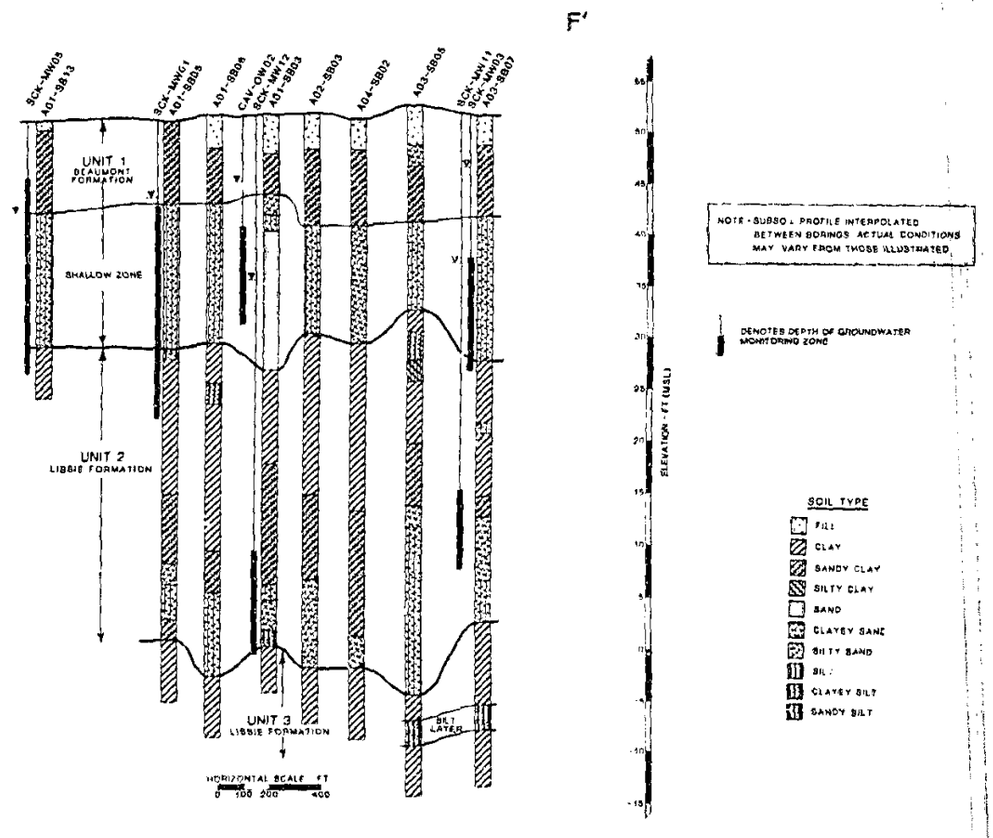
GENERALIZED GEOLOGIC PROFILE
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.

| | |
|---|---|
| PROJECT NO. | 65-317 |
| DATE | 12-28-87 |
| ENGINEER | |
| DRAWN BY | |
| FIGURE NO | 4-4E |

NOTES

1. SOIL BORINGS DENOTED WITH RM PREFIX FROM McCLELLAND ENGINEERS (MEI) REPORT TO HOUSTON TRANSIT CONSULTANTS-GEOTECHNICAL INVESTIGATION-RECONNAISSANCE STUDY CAVALCADE YARD AND SHOP, METRO-STAGE CWE, RMR (VOL VIII) DATED MAY 20 1982
2. APPROXIMATE GROUND SURFACE ELEVATIONS REFERENCED TO MEAN SEA LEVEL DATUM, NATIONAL GEODETIC SURVEY, 1973 ADJUSTMENT
3. VERTICAL EXAGGERATION IS 40 TIMES
4. SOIL TYPE BASED ON VISUAL FIELD CLASSIFICATION AND NOT VERIFIED BY LABORATORY TESTING
5. APPROXIMATE LOCATION OF INTERPRETED RECENT FAULT TAKEN FROM McCLELLAND ENGINEERS REPORT NO 0181-0546-2 DATED SEPTEMBER 30, 1982
6. SOIL BORINGS DENOTED WITH CAV PREFIX FROM CAMP DRESSER & McKEE REPORT TO HOUSTON TRANSIT CONSULTANTS - CAVALCADE CONTAINMENT SURVEY - VOLUME I - ENGINEERING REPORT DATED JULY 11, 1983
7. ALL GROUNDWATER LEVELS WERE MEASURED ON AUGUST 26, 1987




GEOLOGIC PROFILE F-F'

REFERENCE DRAWINGS:
FIGURE 3-4

GENERALIZED GEOLOGIC PROFILE
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.

| | |
|---|---|
| FIGURE NO. | 4-4F |
| PROJECT NO. | 85-517 |
| DATE | 11-25-89 |
| ENGINEER | |
| DRAWN BY | |

Deep soil borings were drilled to depths of about 200 ft to explore hydrogeologic zones and were used to construct the generalized regional hydrogeologic fence diagram presented on Figure 4-5. Deeper geologic and hydrogeologic units are discussed in Section 4.2. The units represented on the geologic profiles and fence diagram designate the geologic formation and the depositional environments as follows:

TABLE 4-1
PRIMARY GEOLOGIC UNITS

| Unit | Formation | Geology | Average Depth(ft) |
|---|---|---|---|
| 1 | Beaumont | Deltaic Deposits | 0 - 21 |
| 2 | Lissie | Fluvial/Deltaic Deposits | 21 - 50 |
| 3 | Lissie | Deltaic Deposits | 50 - 125 |
| 4 | Lissie | Fluvial/Deltaic Deposits | 125 - 200 |
| 5 | Lissie | Pro-Delta Deposits | below 200 |

The sediments comprising Unit 1 represent undifferentiated delta fringe soils of the Beaumont Formation. The soil profile consists of a top stratum of cohesive soils (sandy clays and silty clays) and a substratum of cohesionless soils (silty sands, clayey sands, and poorly graded sands). Unit 1 strata were encountered between elevations of approximately +50 and +29 ft MSL and extend to an average depth of about 21 ft. Based on the generalized geologic profiles (Figures 4-4A to 4-4F), the deltaic sands are generally continuous throughout the site. Results of the previous CDM Cavalcade Contaminant Survey indicate that the Unit 1 sands extend regionally offsite for a distance of at least 1 mile, east and west, characteristic of deltaic deposits. Borings A01-SB12, A01-SB11, and A01-SB05 (Figure 4-4C) exhibit a typical soil profile of Unit 1 delta fringe deposits.

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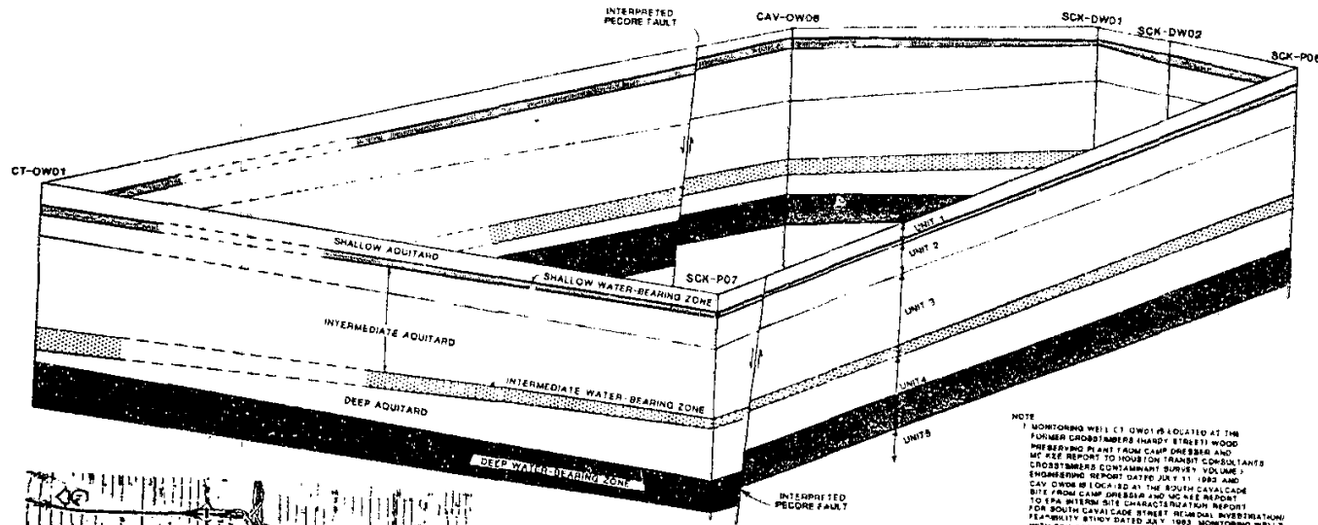
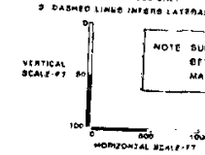
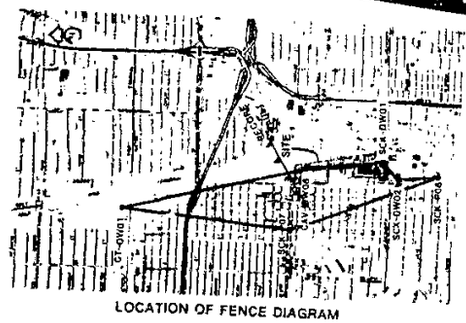



NOTE
1 MONITORING WELL CT OW01 IS LOCATED AT THE FORMER CROSSTIMBERS (HARDY STREET) WOOD PRESERVING PLANT FROM CAMP DRESSER AND MCKEE REPORT TO HOUSTON TRANSIT CONSULTANTS CROSSTIMBERS CONTAMINANT SURVEY VOLUME I ENGINEERING REPORT DATED JULY 11 1983 AND CAV OW06 IS LOCATED AT THE SOUTH CAVALCADE SITE FROM CAMP DRESSER AND MCKEE REPORT TO EPA INTERIM SITE CHARACTERIZATION REPORT FOR SOUTH CAVALCADE STREET REMEDIAL INVESTIGATION/ FEASIBILITY STUDY DATED JULY 1983 MONITORING WELLS WITH SCK DESIGNATIONS ARE FROM THIS STUDY
2 THROW AND DIP OF THE PECORE FAULT IS SHOWN FOR ILLUSTRATIVE PURPOSE ONLY
3 DASHED LINES INFERS LATERAL CONTINUITY




NOTE SUBSOIL PROFILE INTERPOLATED BETWEEN BORINGS ACTUAL CONDITIONS MAY VARY FROM THOSE ILLUSTRATED.

VERTICAL EXAGGERATION 10 TIMES




LOCATION OF FENCE DIAGRAM

GENERALIZED REGIONAL HYDROGEOLOGIC FENCE DIAGRAM
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.

| | |
|---|---|
| PROJECT NO. | 85-317 |
| DATE | 4-20-87 |
| ENGINEER | |
| DRAWN BY | |
| FIGURE NO. | 4-6 |

Figure 4-6 illustrates the base contour map of the Unit 1/ Unit 2 contact. The surface of Unit 2 reveals a paleo-landscape with relief of about 14 ft. The slope direction of the Unit 2 surface is approximately west to east. A curved incised drainage feature dominates the surface in the southern two thirds of the tract.

Unit 2 is comprised of fluvial/deltaic deposits of delta fringe and undifferentiated flood basin/bay fill environments. The delta fringe environment is comprised of a top-stratum of cohesive deposits underlain by tidal bar cohesionless deposits. Unit 2 strata were generally encountered between elevations of about +29 to -5 ft MSL, and extend to an average depth of about 50 ft. Borings A26-SB06, A04-SB07, and A03-SB04 (Figure 4-4A) illustrate a typical cross-section of granular tidal bar deposits. The thickness of these strata varies considerably depending upon the location of the boring within the remnant inlet. At several boring locations no granular strata were encountered, indicating flood basin clay soils. Thicker, granular deposits were generally located throughout the northern portions of the site, grading to thinner and non-continuous deposits towards the south and east.

The flood basin/bay fill depositional environment is comprised of cohesive sediments with occasional cohesionless overbank flood deposits. Boring A08-SB02 (Figure 4-4A) exhibits this depositional environment.

Unit 3 is located in a lower (older) sequence of delta fringe deposits. Delta fringe depositional environments typically consist of alternating layers of cohesive and cohesionless soils. The top of Unit 3 was encountered at an average depth of 50 ft. The upper portion of Unit 3 includes cohesive backswamp deposits. These upper clays

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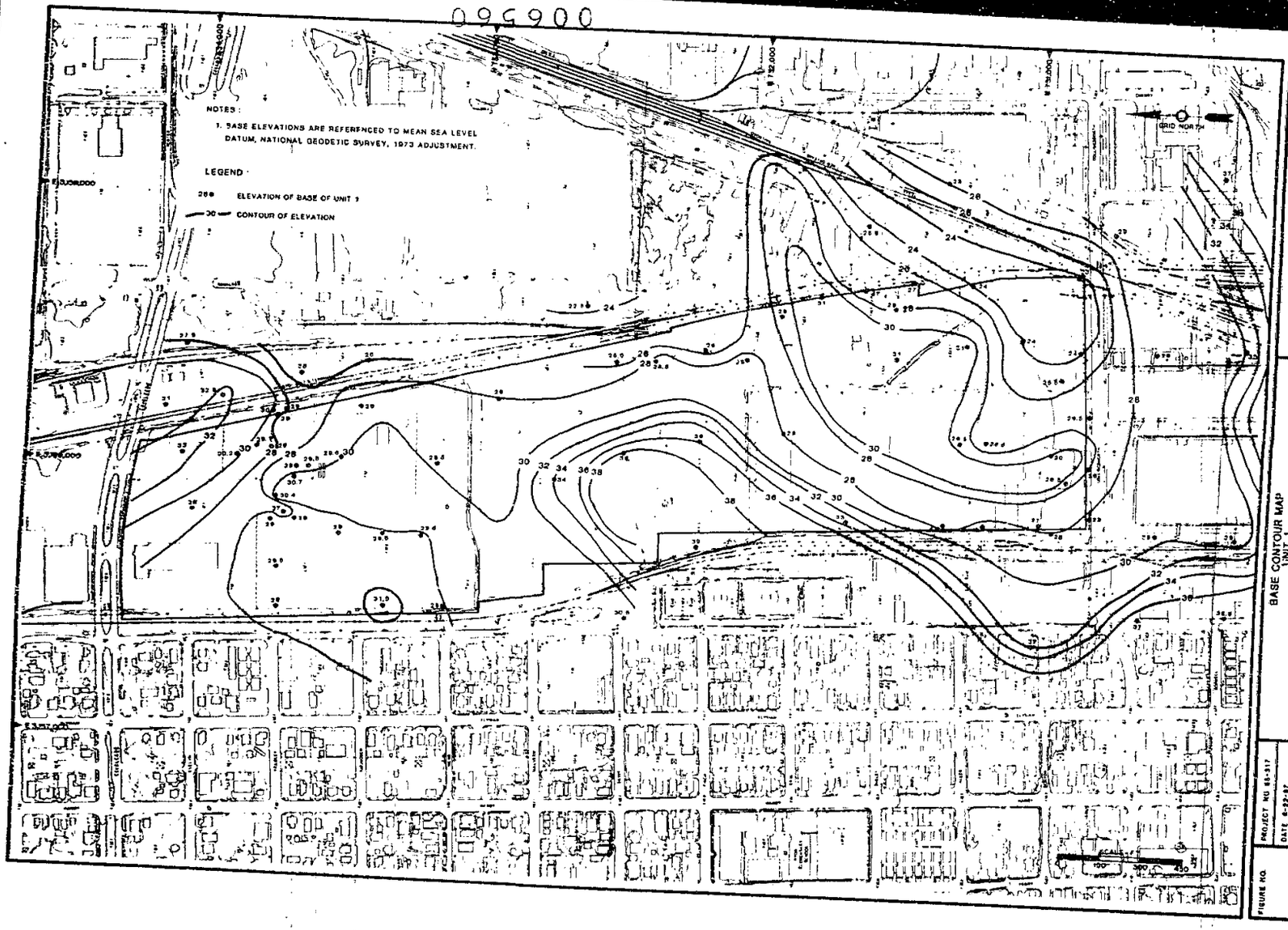


BASE CONTOUR MAP
UNIT 1
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.

FIGURE NO. 4-6

PROJECT NO. 85-317
DATE 6-22-87
ENGINEER
DRAWN BY

Page 4-16

typically include numerous silt and sand filled borrows and fissures. Located in Unit 3 is a characteristic silt layer, which was encountered generally continuous throughout the site between elevations of approximately -10 to -15 ft MSL. The lower silt layer is typically 3 to 5-ft thick, increasing in thickness toward the southern end of the site. The silt layer was typically encountered at an average depth of 60 ft, as shown on Figures 4-4A to 4-4F. The lower portion of Unit 3 is comprised of pro-delta cohesive clays. These clays are typically homogeneous and contain slickensided planes with highly developed substructures.

Unit 4 is comprised of cohesive sediments deposited in bay fill/flood basin environments. The top of Unit 4 was encountered at an average depth of 130 ft and extends to depths of about 214 ft. The cohesive sediments are composed of clays and sandy clays. The lower section of Unit 4 is comprised of cohesionless sediments deposited in a distributary channel environment. These sediments include silty sands, clayey sands, and sands. The sand deposits rade from a medium sandy to a coarse sand with gravel with increased depth.

Unit 5 sediments were encountered at a depth of about 214 ft. The upper portion of Unit 5 includes pro-delta cohesive deposits. These clays are typically homogenous and contain slickensided planes with highly developed substructures.

<u>4.1.5 Physical Soil Testing</u>. Physical soil testing was conducted for selected soil boring samples. The purpose of the physical soil testing was to evaluate soil index properties of the shallow soil deposits. Geotechnical

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analysis for natural moisture content, unit dry weight, percent passing No. 200 sieve, and unconfined compressive strength is specified in the RI/FS Work Plan. Previous soil index test results are included in the geotechnical study for the Metro Cavalcade Yard and Shop by McClelland Engineers (1983). Additional soils tests were conducted by GAI Consultants, Inc., for three undisturbed soil samples and include pH, cation exchange capacity (CEC), fractional organic carbon (FOC), unit weight, water content, Atterberg limits, mechanical sieve analysis, specific gravity, permeability, and unconfined compression. A summary of the soil index test data is presented in Table 4-2.

In addition to the soil index testing, a total of 12 constant-head laboratory permeability tests were conducted on selected undisturbed cohesive soil samples. The samples were selected from geological units that generally include the deeper clay soils. Details of the permeability testing procedures, and results of the tests are included in Appendix A, Volume 3. A summary of the laboratory permeability test results is presented in Table 4-3.

## 4.2 Regional Hydrogeology

4.2.1 General. Discussion of hydrogeologic units is focused on post-Oligocene strata which are predominant in supplying groundwater to the Texas Coastal Plain. Outlined by Baker (1979), post-Oligocene strata include the Catahoula Confining System, Jasper Aquifer, Burkeville Confining System, Evangeline Aquifer, and the Chicot Aquifer. A generalized profile of the hydrogeologic units is shown on Figure 4-7.

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TABLE 4-2
SOIL INDEX TEST DATA(1)

| Sample No. Depth (Ft) | SCK-DW01-20 97.8 - 100.0 | SCK-DW01-23 113.5 - 115.0 | SCK-DW01-27 138.2 - 140.0 |
|---|---|---|---|
| Geologic Unit | 3 | 3 | 4 |
| Unified Soil Classification | CH | CH | CL |
| pH | 8.6 | 8.2 | 8.0 |
| CEC (meq/100 g) | 37.5 | 37.4 | 32.8 |
| TOC (mg/kg) | 2300 | 580 | 1700 |
| Void Ratio | 0.871 | 0.727 | 0.615 |
| Porosity (%) | 46.6 | 42.1 | 38.1 |
| Water Content (%) | 33.7 | 28.6 | 26.4 |
| Unit Weight (PCF) | 120.7 | 127.1 | 130.8 |
| Passing No. 200 Sieve (%) | 94.72 | 76.42 | 84.72 |
| Liquid Limit | 73.5 | 53.4 | 38.5 |
| Plasticity Index | 48.1 | 31.8 | 23.9 |
| Specific Gravity | 2.73 | 2.73 | 2.70 |
| Coefficient of Permeability (cm/sec) | $1.9 \times 10^{-7}$ | $1.2 \times 10^{-7}$ | $8.2 \times 10^{-8}$ |
| Unconfined Compressive Strength (TSF) | 0.93 | 2.39 | 2.63 |

(1) Analyses performed by GAI Consultants, Inc., November 1986.

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TABLE 4-3
SUMMARY OF LABORATORY PERMEABILITY TEST RESULTS

| Sample No. | Unified Soil Classification | Depth (ft) | Geologic Unit | Plasticity Index | Average Vertical Permeability @ 20°C (cm/sec) |
|---|---|---|---|---|---|
| A16-SB02-24 | CH | 56-58 | 3 | 43 | $7.3 \times 10^{-9}$ |
| A16-SB01-28 | CH | 65-67 | 3 | 37 | $2.9 \times 10^{-9}$ |
| A16-SB01-18 | CH | 45-47 | 2 | 36 | $4.3 \times 10^{-9}$ |
| A14-SB03-19 | CL | 41.5-42.5 | 2 | 14 | $1.5 \times 10^{-7}$ |
| A14-SB03-27 | CH | 57-58 | 3 | 56 | $3.2 \times 10^{-9}$ |
| A14-SB03-31 | CL | 57.5-58.5 | 3 | 27 | $3.3 \times 10^{-9}$ |
| A04-SB07-09 | CH | 28-29 | 2 | 47 | $2.1 \times 10^{-9}$ |
| A04-SB07-26 | CH | 63-63.5 | 3 | 47 | $2.0 \times 10^{-9}$ |
| A04-SB02-11 | CH | 28-30 | 2 | 45 | $1.7 \times 10^{-9}$ |
| A04-SB02-26 | CH | 56-58 | 3 | 48 | $2.3 \times 10^{-9}$ |
| A04-SB01-23 | CH | 53-55 | 3 | NA | $3.2 \times 10^{-9}$ |
| A04-SB01-09 | CL | 25-27 | 2 | NA | $4.8 \times 10^{-9}$ |



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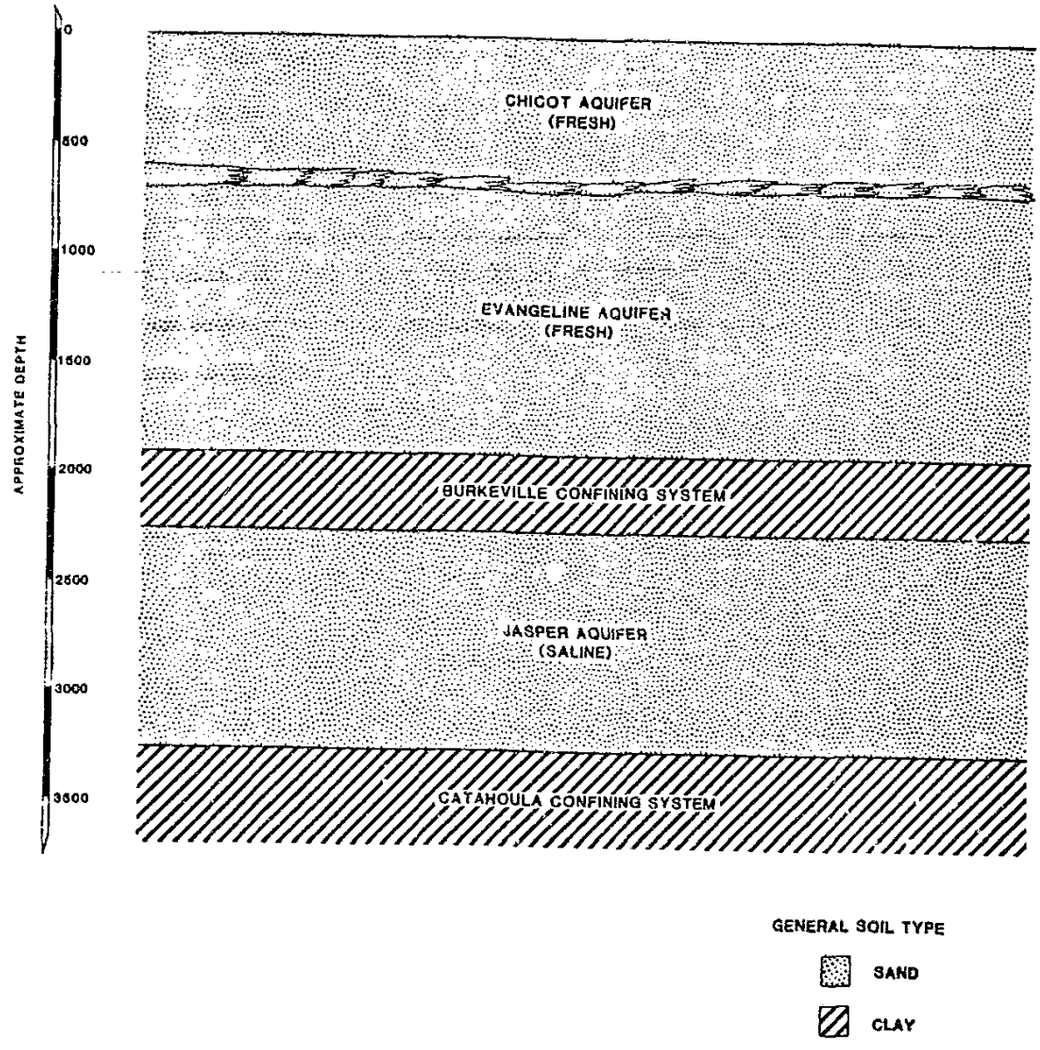
CONCEPTUAL PROFILE OF POST - OLIGOCENE
HYDROGEOLOGIC UNITS OF THE LOWER TEXAS COASTAL PLAIN




CONCEPTUAL HYDROGEOLOGIC PROFILE

FILE NO. 85-317
FIGURE 4-7

006565

4.2.2 Catahoula Confining System. The Catahoula Confining System is composed predominantly of clay and tuff, and some interbedded sands containing saline water. In most areas the sands are of limited extent, thus the system acts as a hydrologic barrier between the overlying Jasper Aquifer and underlying pre-Oligocene aquifers. In central Harris County, Texas the top of the Catahoula Confining System is encountered at a depth of approximately 3250 ft.

4.2.3 Jasper Aquifer. The Jasper Aquifer exhibits several distinct sand layers containing zones of fresh to highly saline water, varying with aquifer thickness and proximity to the coastline. The sands are interbedded with clay layers which comprise up to 70 percent of the aquifer. Individual sand layers range in thickness from 10 to 50 ft, and decrease in prominence with depth. The top of the Jasper Aquifer is encountered at a depth of approximately 2250 ft below ground surface in central Harris County, Texas and is saline.

4.2.4 Burkeville Confining System. The Burkeville Confining System is composed predominantly of clay and silt, and acts as a hydrologic barrier retarding groundwater flow between the underlying Jasper Aquifer and overlying Evangeline Aquifer. Individual sand layers, typically 5 to 10-ft thick, comprise about 10 percent of the confining system. In central Harris County, the top of the Burkeville is encountered at a depth of approximately 1900 ft below ground surface. The corresponding thickness of the Burkeville Confining System is about 350 ft.

4.2.5 Evangeline Aquifer. The Evangeline Aquifer contains interbedded sand and clay layers of nearly equal proportion. Individual sand layers typically range in thickness

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from 10 to 50 ft, yielding abundant supplies of good quality groundwater throughout Harris County. Clay layers within the Evangeline reach thicknesses of up to 50 ft. These layers, however, are limited in horizontal extent and are thus not expected to prohibit communication between interbedded sand layers. The upper contact of the Evangeline Aquifer is encountered at about 650 ft below ground surface in central Harris County. The thickness of the aquifer in this region is approximately 1200 ft.

4.2.6 Chicot Aquifer. In the Houston area, the Chicot Aquifer has been subdivided into upper and lower units (Jorgensen, 1975). This differentiation is based upon a predominance of clay in the upper portions of the Chicot which exhibits potentiometric levels different than the mostly sandy strata below. The lower sandy unit of the Chicot has been frequently tapped for groundwater of good quality and supply in Harris County, although discontinuous, clay layers are often interbedded with the sands. In central Harris County, the upper Chicot unit is approximately 150-ft thick and includes extensive clays of the Beaumont Formation. Interbedded sands and clays of the lower Chicot are approximately 500-ft thick.

4.2.7 Aquifer Recharge. Recharge to aquifers along the Texas Coastal Plain has occurred primarily at strata outcrops. These outcrops generally occur as bands trending northeast to southwest along the strike of the coastward dipping formation beds.

Gabrysch (1977) mapped approximate areas of recharge to the Chicot and Evangeline Aquifers in the Houston-Galveston area, as shown on Figure 4-8. Illustrated on the figure, the South Cavalcade Site lies within an outcrop of the

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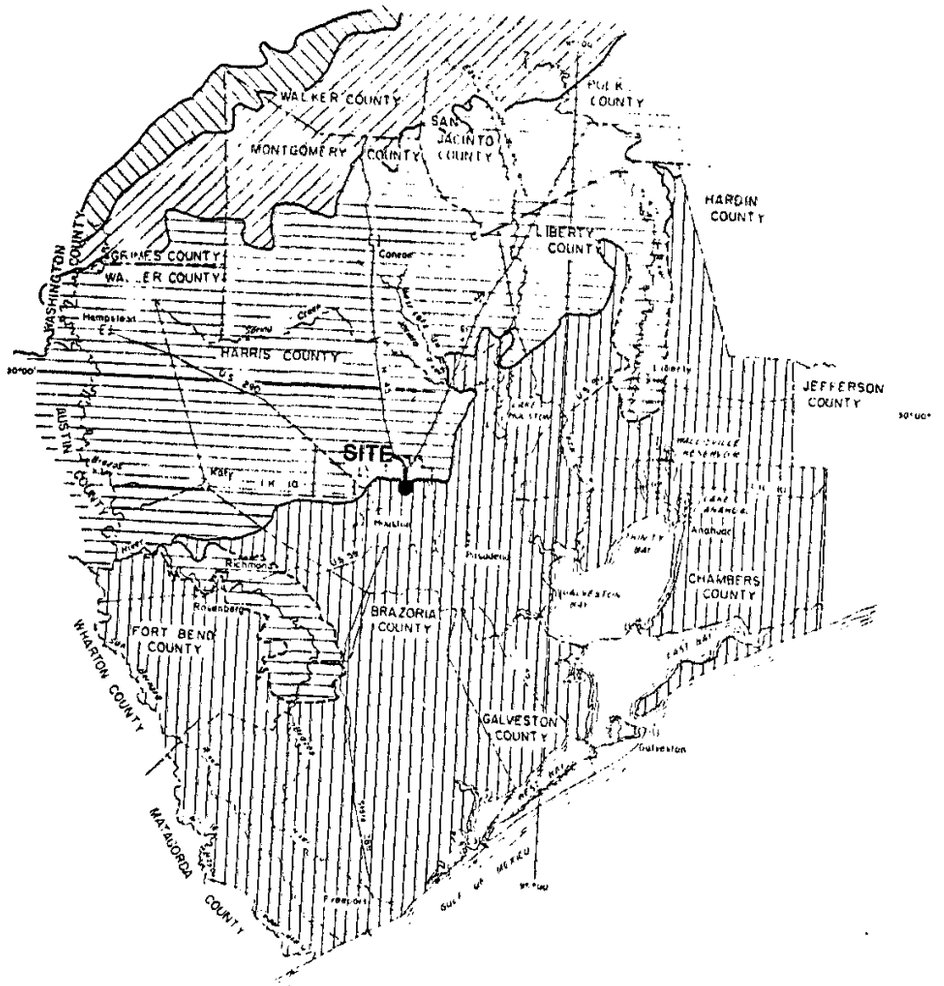


AFTER GABRYSCH, 1977

## LOCATION MAP

### EXPLANATION

- Burkeville confining system (basal part of Fleming Formation, area of little or no recharge)
- Recharge area of the Evangeline aquifer system (includes the landward Willis Formation and coastward part of Fleming Formation)
- Recharge area of the Chicot aquifer system (includes Montgomery and Bentley Formations and coastward Willis Formation)
- Beaumont Clay (area of little or no recharge)
- Coastward extent of incision in the Beaumont Clay

SCALE-MILES
0 15 30

SOUTH CAVALCADE SITE
HOUSTON, TEXAS

KOPPERS COMPANY, INC.
PITTSBURGH, PENNSYLVANIA

Page 4-24

| SCALE | MADE | DATE | FILE NO |
|---|---|---|---|
| NOTED | LLD | 12-9-86 | 85-317 |
| | CHECK WRT | DATE 12-9-86 | |

REGIONAL AQUIFER RECHARGE MAP — FIGURE 4-8

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Beaumont Formation. The Beaumont consists predominantly of surficial clays, and thus recharge is inhibited to underlying sands of the Chicot Aquifer.

In the northwest portion of Figure 4-8, recharge areas of the Chicot and Evangeline Aquifers are mapped where strata comprising these units outcrop. In the extreme northwest corner of the map, the recharge zones are traversed by a narrow exposure of lower Fleming clays. These clays constitute the Burkeville confining system and allow little or no recharge to the underlying Jasper Aquifer. Recharge areas of the Jasper occur further northwest, outside the mapped area. Recharge of the aquifers in the outcrop areas occurs at a slow rate over geologic time due to a preponderance of clay rich surficial soils.

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4.2.8 Aquifer Discharge. Discharge of groundwater from hydrologic units in the Texas Coastal Plain occurs primarily through pumping of wells. For the Houston-Galveston region, the United States Geological Survey has monitored water levels in wells in the Chicot and Evangeline Aquifers. The water-levels in the Chicot and Evangeline aquifers are reported to have been at or above ground surface at the turn of the century. Heavy pumpage began in the Houston area around 1940.

Historic water-level trends are illustrated on Figure 4-9 which shows approximate changes in water levels in wells penetrating the Chicot and Evangeline Aquifers from 1943 to 1977. As shown, a regional cone of groundwater-level depression encompassed the Houston area with water-level declines of up to 250 ft and 300 ft observed for the Chicot

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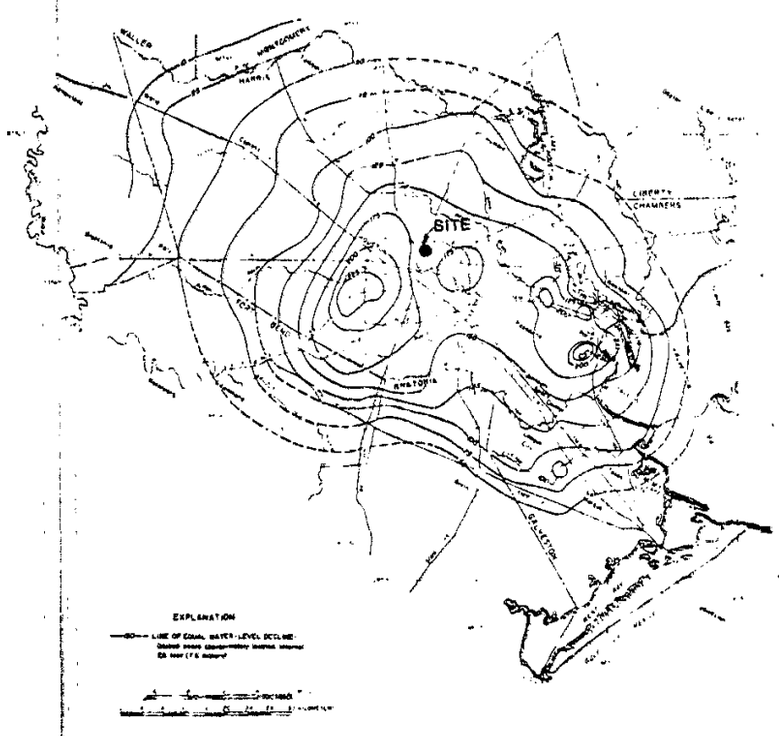
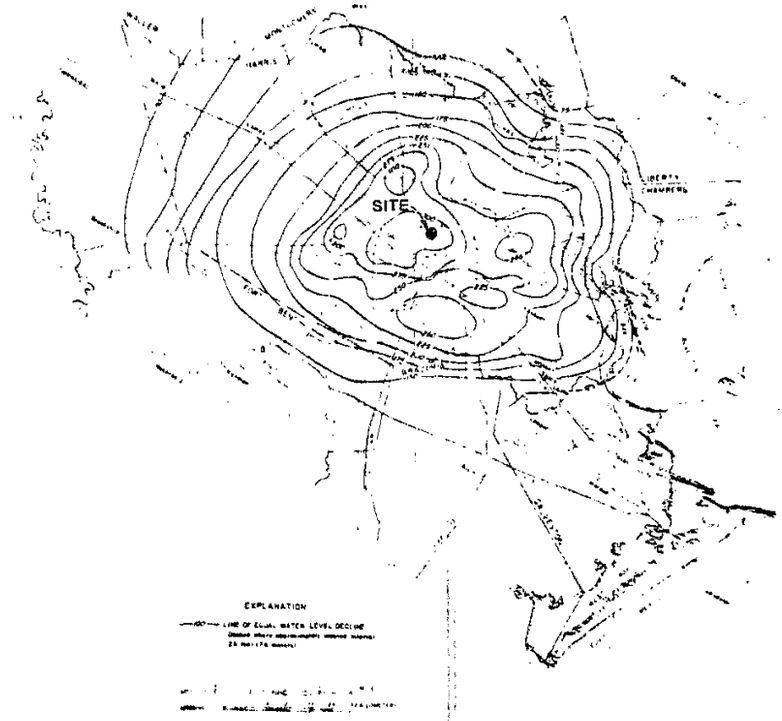
CHICOT AQUIFER




EVANGELINE AQUIFER




NOTE:
INFORMATION BASED ON TEXAS DEPARTMENT OF WATER RESOURCES REPORT 257 BY GABRYSCH.

| | | |
|---|---|---|
| SOUTH CAVALCADE SITE<br>HOUSTON, TEXAS | Page 4-26 | |
| KOPPERS COMPANY, INC.<br>PITTSBURGH, PENNSYLVANIA | SCALE NOTED<br>DATE 7-29-87<br>DATE 7-29-87 | FILE NO. 85-317 |
| | AQUIFER WATER LEVEL CHANGES-<br>1943 TO 1977 | FIGURE 4-9 |

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and Evangeline Aquifers, respectively. Water levels in the South Cavalcade Site vicinity for this period have declined between 150 and 175 ft for the Chicot Aquifer, and approximately 300 ft for the Evangeline Aquifer.

More recent water-level trends are illustrated on Figure 4-10 which shows approximate changes in water levels in wells penetrating the Chicot and Evangeline Aquifers from 1977 to 1986. As shown, a broad zone of water-level decline in wells persists in both the Chicot and Evangeline Aquifers in the west Houston vicinity. Water levels in wells penetrating the Chicot and Evangeline Aquifers in areas east of Houston, however, have risen up to 140 ft. This recovery is due to decreased reliance on groundwater supplies in the east Houston area. The South Cavalcade Site is shown to be located in an area of slight water-level rise, approximately 10 to 20 ft for both the Chicot and Evangeline Aquifers from 1977 to 1986.

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4.2.9 Well Inventory. A report of an inventory of water and oil and gas wells in the vicinity of the South Cavalcade Site was submitted in accordance with Subtask 2C of the RI/FS Work Plan (MRA Report No. 85-195, dated July 5, 1985). The well inventory included documented wells located within a 3-mile radius of the South Cavalcade Site, and undocumented wells located within 3 blocks of the site. The approximate locations of these wells are plotted on Figure 4-11. In addition, 7 documented existing shallow water wells (less than about 500-ft deep) were located within about a 1-mile radius of the site. Locations of the existing shallow water wells are plotted on Figure 4-12. Details of the shallow water wells are presented on Table 4-4. Existing shallow water well logs are included in Appendix K - Volume 3.

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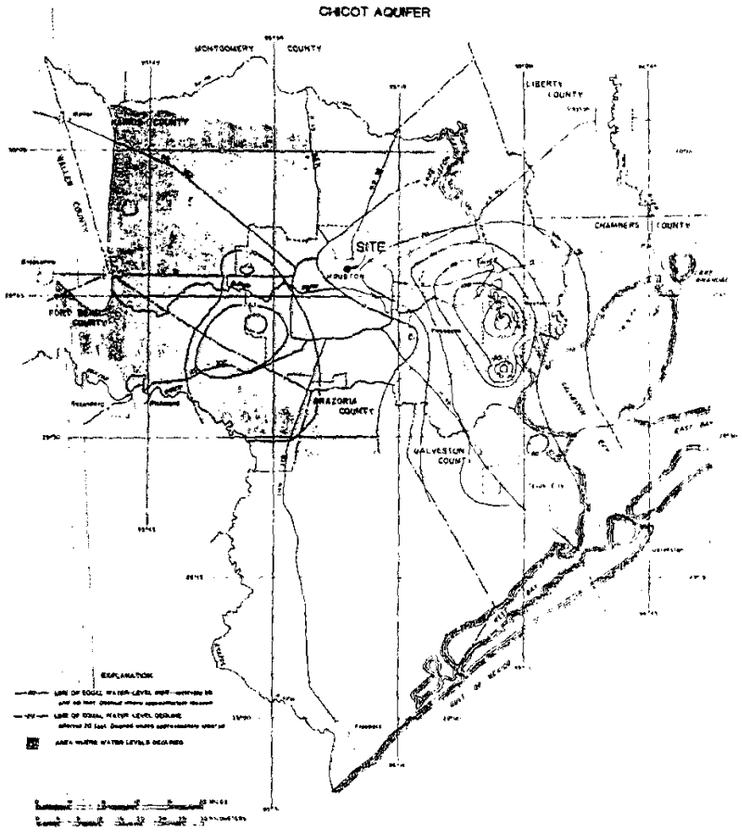


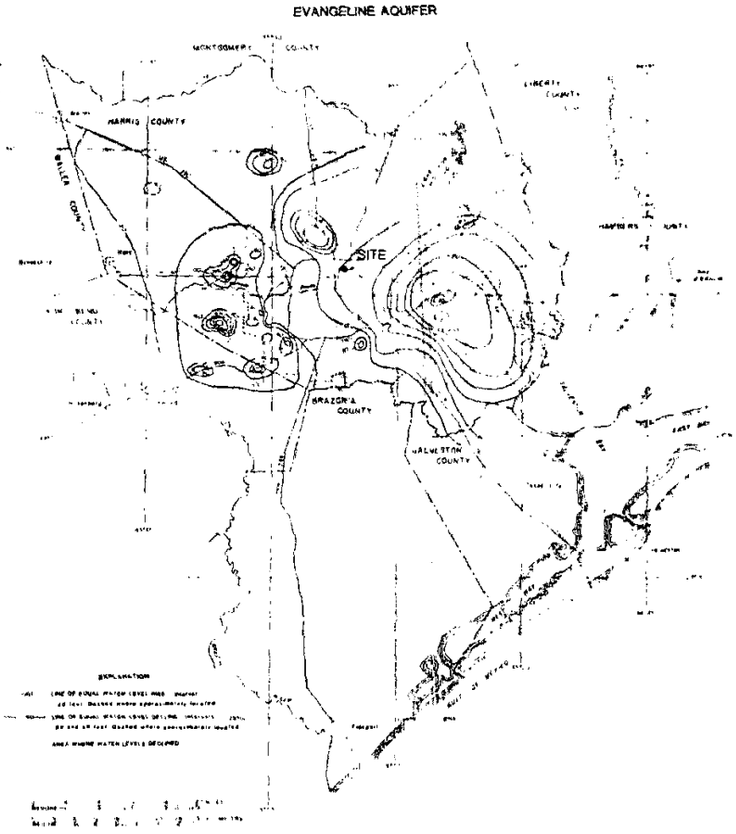


NOTE:
1. INFORMATION BASED ON U.S. GEOLOGICAL SURVEY OPEN-FILE REPORT 88-135 BY WILLIAMS AND RANZAU

| | | |
|---|---|---|
| SOUTH CAVALCADE SITE<br>HOUSTON TEXAS | Page 4-28 | |
| KOPPERS COMPANY, INC.<br>PITTSBURGH, PENNSYLVANIA | SCALE NOTED; MADE; CHECK; DATE 12-9-88; DATE 12-9-88; REF NO 85-317 | |
| | AQUIFER WATER LEVEL CHANGES-<br>1977 TO 1988 | FIGURE 4-10 |

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| FIGURE NO | PROJECT NO 65-317 | WELL INVENTORY | |
|---|---|---|---|
| 4-11 | DATE 5/20/85 | SOUTH CAVALCADE SITE<br>HOUSTON, TEXAS<br>KOPPERS COMPANY, INC | Page 4-29 |
| | ENGINEER: | | |
| | DRAWN BY | | |

EXISTING SHALLOW WATER WELL INVENTORY MAP

SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.

| FIGURE NO | PROJECT NO. 85-317 |
|---|---|
| 4-12 | DATE: 11/1/88 |
| | ENGINEER: |
| | DRAWN BY: |

TABLE 4-4
EXISTING SHALLOW WATER WELL DATA WITHIN 1-MILE RADIUS

| Well No. | Owner | Distance From Site (Miles) | Use | Screen Depth (ft) | Aquifer |
|---|---|---|---|---|---|
| LJ-65-14-438 | Olds Press and Forge | 0.1 SSE | Industrial | 282-302 | Chicot |
| 3993 | Goodwill Industries | 0.8 NE | Industrial | 500-540 | Chicot |
| LJ-65-14-1J | S.W. Plating | 0.9 SW | Industrial | 447-462 | Chicot |
| LJ-65-14-431 | Goodwill Industries | 0.9 NE | Industrial | 496-576 | Chicot |
| LJ-65-14-420 | Ready Mix | 0.9 N | Industrial | 456-476 | Chicot |
| 2334 | Freedman Packing | 0.3 NE | Industrial | 360-511 | Chicot |
| LJ-65-14-7J | Subsidence District | 0.9 SE | Test Well | 284-294 | Chicot |



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## 4.3 Site Hydrogeology

4.3.1 General. Evaluation of hydrogeology for the South Cavalcade Site was developed primarily from installation of monitoring wells at varied depths across the site and from stratigraphic information obtained during the soil boring program. Observations of water levels in monitoring wells provided data relative to the position of the piezometric surface, water-level fluctuations, and groundwater gradients across the site. Soil boring data were utilized to evaluate site hydrogeologic water-bearing zones and aquitards and to characterize the lithology and geometry of the water-bearing zones and aquitards.

The primary hydrogeologic aquitards encountered at the site are organized as follows: shallow aquitard; intermediate aquitard; and deep aquitard. Hydrogeologic water-bearing zones encountered in the vicinity of the South Cavalcade Site are organized as follows: shallow zone; intermediate zone; and deep zone. These water-bearing zones and aquitard units have been explored within depths of about 200 ft below ground surface. A generalized regional hydrogeologic fence diagram is presented on Figure 4-5 and conceptually illustrates the relationship between the water-bearing zones and aquitards. Table 4-5 further presents the primary hydrogeologic units and the average depth for each unit.

Table 4-5
PRIMARY HYDROGEOLOGIC UNITS

| Unit | Geologic Unit Number | Classification | Average Depth (ft) |
|---|---|---|---|
| Shallow Aquitard | 1 | Aquitard | 0-10 |
| Shallow Zone | 1 | Water-bearing zone | 10-21 |
| Intermediate Aquitard | 2,3 | Aquitard | 21-115 |
| Intermediate Zone | 3 | Water-bearing zone | 115-127 |
| Deep Aquitard | 4 | Aquitard | 127-174 |
| Deep Zone | 4 | Water-bearing zone | 174-200 |

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4.3.2 Shallow Aquitard. The shallow aquitard consists primarily of a surficial sandy clay layer. This layer is approximately 8 to 12-ft thick and overlies the shallow zone. Shallow aquitard sediments are apparently continuous across the South Cavalcade Site. In addition, approximately 75 percent of the site area is paved thereby permitting relatively little recharge from surface infiltration. Previous soil test results for the shallow aquitard soils reported by McClelland Engineers for the Metro Cavalcade Yard and Shop Geotechnical Study (1983) are summarized in Table 4-6 as follows:

Table 4-6
PREVIOUS SHALLOW AQUITARD SOIL TEST RESULTS

| Test Parameter | Range | Average |
|---|---|---|
| Plasticity Index | 5 to 23 | 14 |
| Undrained Compressive Strength (ksf) | 0.73 to 3.34 | 1.6 |

4.3.3 Shallow Zone. The shallow zone is a hydrogeologic water-bearing zone consisting predominantly of silty and clayey sands, with occasional gradations to sand and clayey silts. The silts and sands are overlain by a predominantly sandy clay layer. The shallow zone and overlying sandy clay layer comprise the Unit 1 Beaumont strata, deposited in a deltaic fringe environment.

Shallow zone sediments vary in thickness from approximately 2 to 15 ft, and are apparently continuous across the South Cavalcade Site, as shown by the generalized geologic profiles (Figures 4-4A to 4-4F). The shallow zone is encountered between Elevations +44 to +22 ft MSL as shown on Figure 4-4. The base of this zone is irregular and slopes generally to the east (Figure 4-6).

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The off-site extent of the shallow sand zone was documented in the CDM Cavalcade Contaminant Survey Report. The CDM report indicated that the shallow sand deposits extend continuously west to I-45, north to I-610, east to Highway 59, and just beyond Collingsworth Street to the south.

Groundwater monitoring wells installed into the shallow zone indicate a range in water levels from elevations of approximately +38 to +49 ft MSL. The average depth to shallow groundwater can be taken as 6.6 ft, which is about 3.4 ft above the top of the water-bearing zone based upon the November 30, 1987 water-level measurements. Seasonal groundwater fluctuations of up to 4.5 ft were observed in wells penetrating the shallow zone as indicated by the water-level hydrographs presented in Appendix H, Volume 3. Average shallow zone groundwater - level fluctuations were approximately 2.5 ft. A typical hydrograph of the shallow zone is shown on Figure 4-13.

Shallow zone groundwater trends at the South Cavalcade Site generally slope to the west at a gradient averaging about 20 ft/mi. The CDM Cavalcade Contaminant Survey indicated that the shallow zone extends continuously offsite to the west and intersects Little White Oak Bayou. This drainage feature may act as a groundwater discharge area thereby influencing westward-trending gradients. A surface impoundment located offsite along the east property line (see Figure 1-4) may cause localized groundwater mounding, which also would produce westward gradients in the shallow zone. Similar groundwater patterns were observed during the Remedial Investigation for the southern portion of the North Cavalcade Street Site (1987).

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# SUMMARY OF WATER LEVEL MEASUREMENTS

FIGURE NO.: 4-13
WELL NO.: OW-01

**PROJECT:** South Cavalcade Site

**LOCATION:** Houston, Texas

**CLIENT:** Koppers Company, Inc.

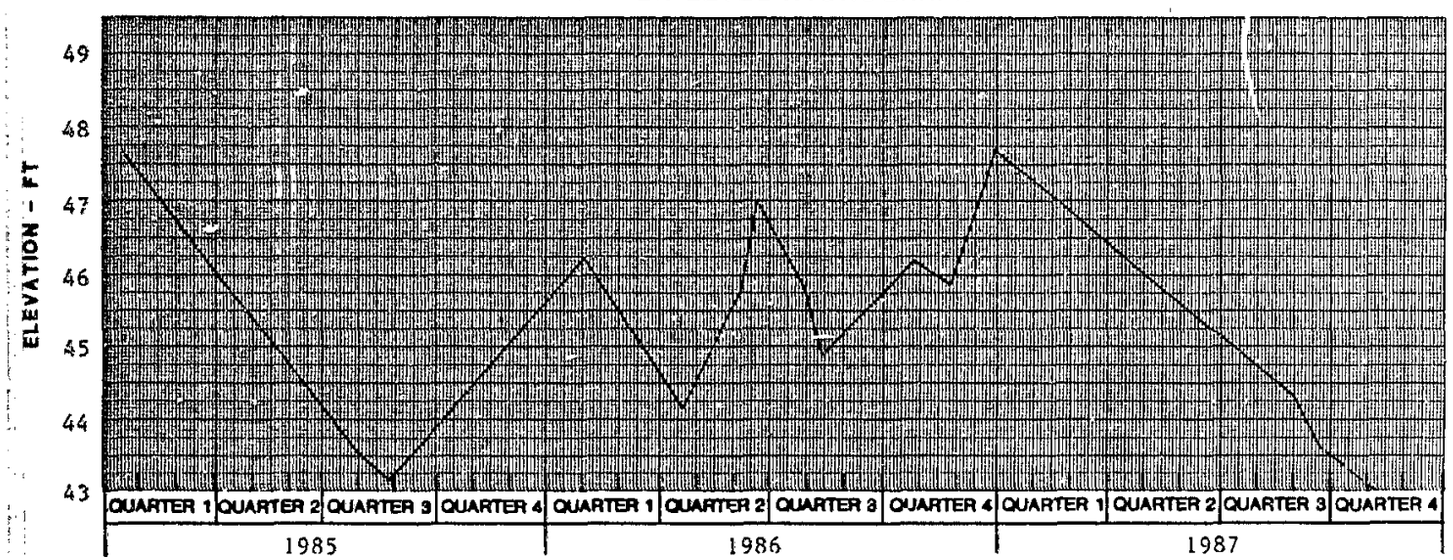
**PROJECT NO.:** 85-317

**TOP OF CASING ELEVATION:** 52.95 ft.
**INSTALLATION DATE:** February 5, 1983
**MEASUREMENT METHOD:** Weighted Tape

**WATER LEVEL DATA**

| DATE | TIME | WATER DEPTH - FT. | WATER ELEVATION - FT. |
|---|---|---|---|
| | | | |

**WATER LEVEL HYDROGRAPH**




McBride-Ratcliff and Associates, Inc.





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A groundwater contour map for the November 30, 1987 groundwater levels of the shallow zone is shown on Figure 4-14. Measurements for November 30, 1987 were chosen for the contour map to include monitoring wells installed later during the Remedial Investigation. Localized high groundwater levels were observed offsite in the vicinity of the southwest corner of the South Cavalcade Site (Figure 4-14) at Monitoring Well SCK-MW09. These elevated groundwater levels have been linked to a broken water pipe on the premises of American Warehouses, Inc. The discharge rate and duration of the leaking pipe are unknown. It is expected that long-term groundwater flow patterns will change when the pipe is repaired.

The hydraulic conductivity of the shallow zone was evaluated by conducting falling-head field permeability tests at selected well locations. Results of the field tests are presented in Appendix I, Volume 3. As shown on Table 4-7, measured field horizontal hydraulic conductivities for the shallow zone ranged from $2.4 \times 10^{-4}$ to $2.2 \times 10^{-3}$ cm/sec, and averaged $8.3 \times 10^{-4}$ cm/sec.

Table 4-7
FIELD HYDRAULIC CONDUCTIVITY TEST RESULTS
SHALLOW GROUNDWATER ZONE

| Monitoring Well | Soil Type | Screen Interval (ft) | Field Horizontal Hydraulic Conductivity (cm/sec) |
|---|---|---|---|
| SCK-MW01 | Sand | 9.0 - 24.0 | $2.4 \times 10^{-4}$ |
| SCK-MW02 | Silty Sand | 9.0 - 24.0 | $4.5 \times 10^{-4}$ |
| CAV-OW07 | Sand | 11.0 - 16.0 | $4.5 \times 10^{-4}$ |
| CAV-OW08 | Sand | 14.0 - 19.0 | $2.2 \times 10^{-3}$ |

4.3.4 Intermediate Aquitard. The intermediate aquitard consists of interbedded clays, silty clays, sandy clays underlain somewhat by discontinuous deposits of clayey and silty sands. The intermediate aquitard soils include

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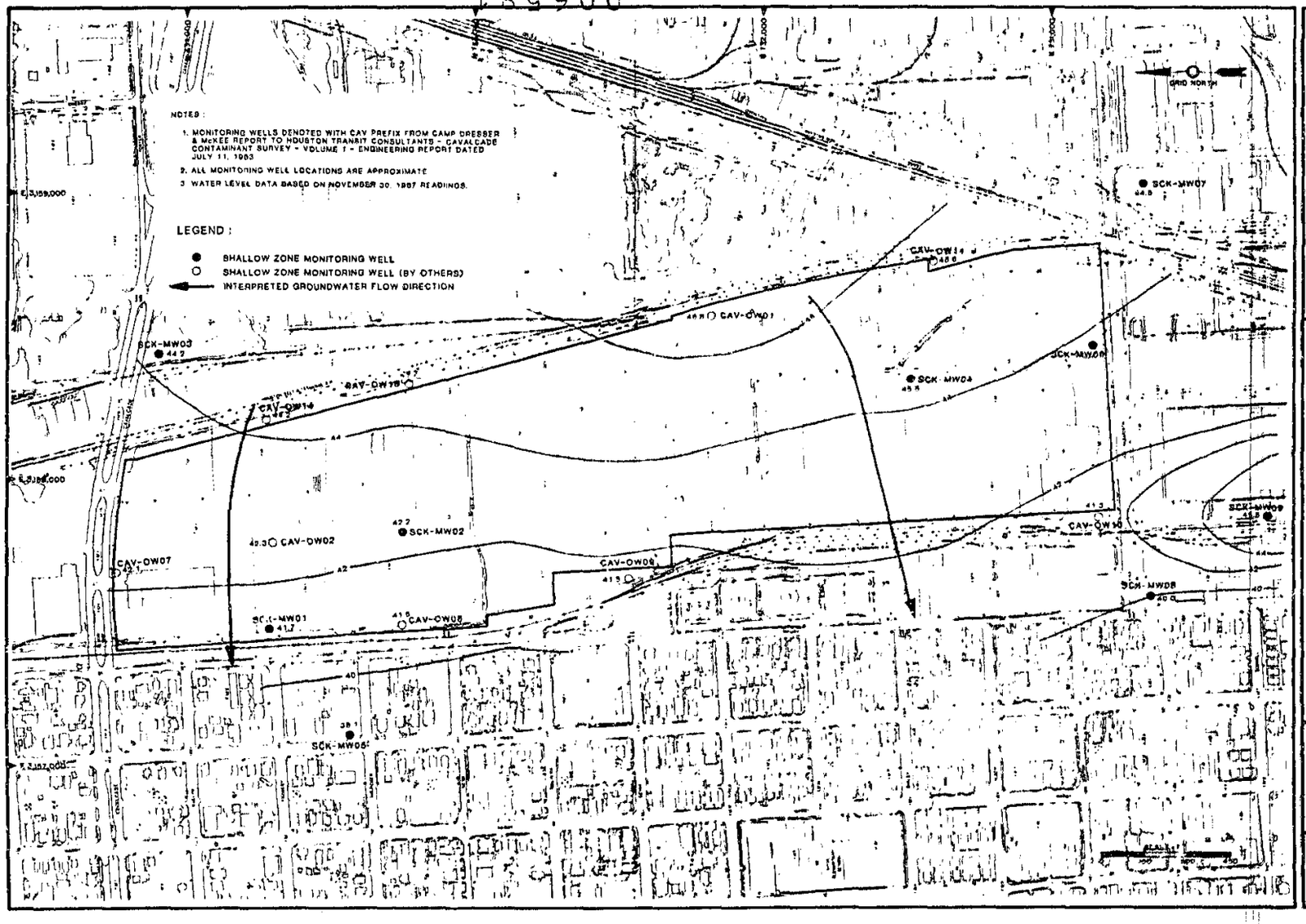


Page 4-37

GROUNDWATER PLOT
SHALLOW GROUNDWATER LEVELS
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.

| | |
|---|---|
| FIGURE NO | 4-14 |
| PROJECT NO | |
| DATE | |
| ENGINEER | |
| DRAWN BY | |

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deposits from Unit 2 and Unit 3. Unit 2 consists of 17 to 42-ft of interbedded clays, silty clays, sandy clays, and clayey and silty sands. Unit 2 intermediate aquitard sediments are apparently continuous across the South Cavalcade Site as shown by the generalized geologic profiles presented on Figures 4-4A to 4-4F.

Laboratory permeability tests presented in Appendix A, Volume 3, indicate that measured laboratory vertical hydraulic conductivities for the Unit 2 intermediate aquitard clay soils ranged from $1.7 \times 10^{-9}$ to $1.5 \times 10^{-7}$ cm/sec, and averaged $3.3 \times 10^{-8}$ cm/sec (Table 4-3). Based on the laboratory permeability tests and the magnitude of water-level fluctuations of lower monitoring wells placed into the discontinuous sand zones, the Unit 2 intermediate aquitard is interpreted to be a semi-confining layer.

Granular soil strata in the Unit 2 intermediate aquitard are typically 5 to 15-ft thick, and are generally encountered between Elevations +10 to -5 ft MSL. Indicated by the stratigraphic profiles on Figures 4-4A to 4-4F, these granular strata are somewhat discontinuous and highly variable throughout the site, typical of tidal bar deposits. The discontinuity of Unit 2 granular sediments results from deposition of sands in minor tidal channels. These tidal channels are marked by elongate areas of low elevation.

The Unit 3 intermediate aquitard consists of a 30 to 90-ft thick clay layer. Sediments of this aquitard are apparently continuous across the site as shown by the generalized geologic profiles presented on Figures 4-4A to 4-4F.

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4.3.5 Intermediate Zone. Shown on the generalized fence diagram (Figure 4-5), the intermediate water-bearing zone consists of approximately 5 to 15 ft of mostly silty sand from an average depth of 115 to 127 ft below ground surface. The intermediate zone is overlain by a clay layer. A summary of the intermediate zone locations was prepared from the soil boring logs (Appendix F, Volume 2) and the geophysical logs (Appendix G, Volume 3) and is presented in Table 4-8.

Table 4-8
SUMMARY OF INTERMEDIATE ZONE LOCATIONS

| Well | Strata Depth (ft) Top | Bottom | Zone Thickness (ft) | Overlying Confining Layer Thickness (ft) |
|---|---|---|---|---|
| SCK-DW01 | 117 | 132 | 15 | 72 |
| SCK-DW02 | 108 | 112 | 4 | 88 |
| CAV-OW06 | 122 | 137 | 15 | 54 |
| SCK-P06 | 120 | 130 | 10 | 32 |
| SCK-P07 | 107 | 126 | 19 | 61 |

4.3.6 Deep Aquitard. The deep aquitard underlies the intermediate zone water-bearing deposits and consists of a 20 to 60-ft thick clay and sandy clay layer. Soil index test data for one soil sample (SCK-DW01-27) from the deep aquitard (Unit 4) are pesented on Table 4-1.

4.3.7 Deep Zone. Based upon soil boring data and logs of geophysical borings, the deep zone is a hydrogeologic water-bearing zone consisting of approximately 10 to 35 ft of mostly fine to medium sand encountered at an average of 174 to 200 ft below ground surface. The deep zone is confined above by a predominantly clay and sandy clay layer (Deep Aquitard). A summary of the deep zone locations was prepared from the soil boring logs (Appendix F, Volume 2) and the geophysical logs (Appendix G, Volume 3) and is presented in Table 4-9. Deep well locations are referenced on Figure 3-6.

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Table 4-9
SUMMARY OF DEEP ZONE LOCATIONS

| Well | Strata Depth (ft) Top | Bottom | Zone Thickness (ft) | Overlying Confining Layer Thickness (ft) |
|---|---|---|---|---|
| SCK-DW02 | 175 | 210 | 35 | 40 |
| CAV-OW06 | 155 | 184 | 29 | 20 |
| SCK-P06 | 190 | 200 | 10 | 60 |
| SCK-P07 | 175 | 205 | 30 | 50 |

Water levels ranging from about Elevation -87 to -88 ft MSL are shown on the water-level hydrograph for Monitoring Well CAV-OW06 screened within the deep zone (Figure 4-15). This range in water-level fluctuation is considerably less than that exhibited by the shallow zone, and can be linked to confining units which reduce groundwater communication from overlying strata. The deep zone is considered a confined water-bearing zone.

Based upon observed water levels in monitoring wells screened within the deep zone, the apparent deep zone gradient across the South Cavalcade Site slopes to the south-southwest at a gradient of about 6 ft/mi. A groundwater contour map of the deep zone is shown on Figure 4-16 based on the November 30, 1987 water-level measurements.

The deep zone has been previously utilized as a groundwater source within a 3-mile radius by documented water wells disclosed during the water well inventory (Section 4.2.9). The closest documented water wells screened within the deep zone deposits from the well inventory report (1985) are located about 1200 ft west-northwest of the site (Well No. LJ-65-14-432) at Newsom Trucking and about 2000 ft east-northeast of the site (Well No. LJ-65-14-433) at City Custom Packing. However, a followup site reconnaissance conducted on January 13, 1987 did not locate the wells or

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# SUMMARY OF WATER LEVEL MEASUREMENTS

FIGURE NO.: 4-15

WELL NO.: OW-06

**PROJECT:** South Cavalcade Site

**LOCATION:** Houston, Texas

**CLIENT:** Koppers Company, Inc.

**PROJECT NO.:** 85-317

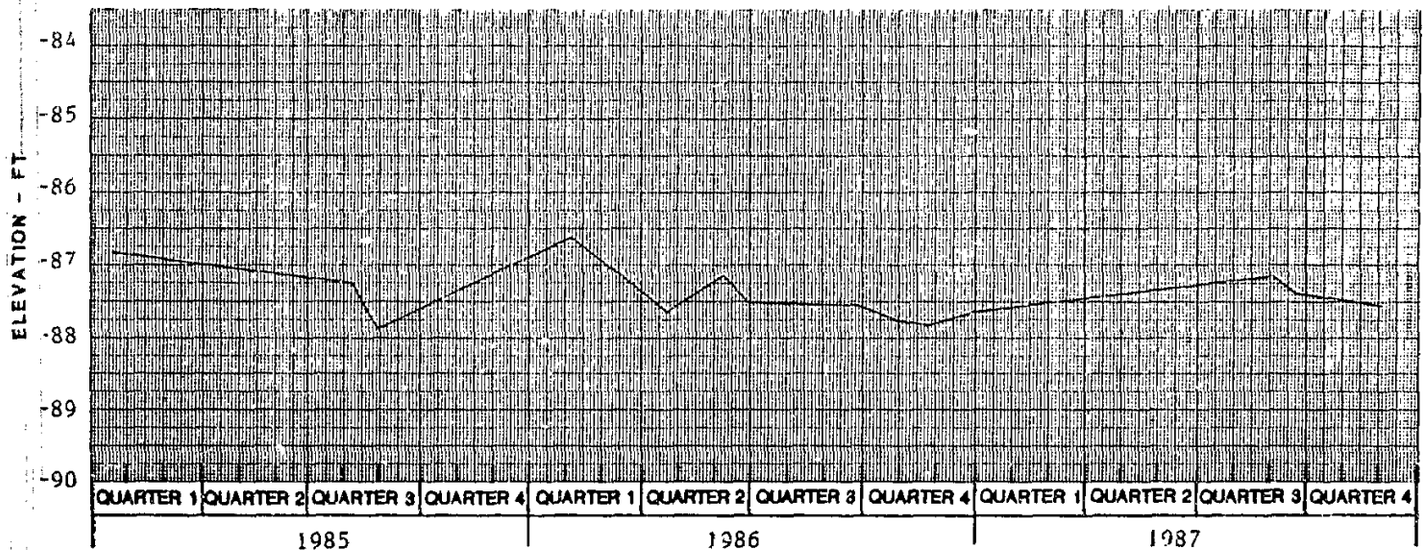
**TOP OF CASING ELEVATION:** 53.67 ft.

**INSTALLATION DATE:** May 11, 1983

**MEASUREMENT METHOD:** Weighted Tape and Electrical Tape

| WATER LEVEL DATA | | | |
|---|---|---|---|
| DATE | TIME | WATER DEPTH - FT. | WATER ELEVATION - FT. |
| | | | |

WATER LEVEL HYDROGRAPH




McBride-Ratcliff and Associates, Inc.

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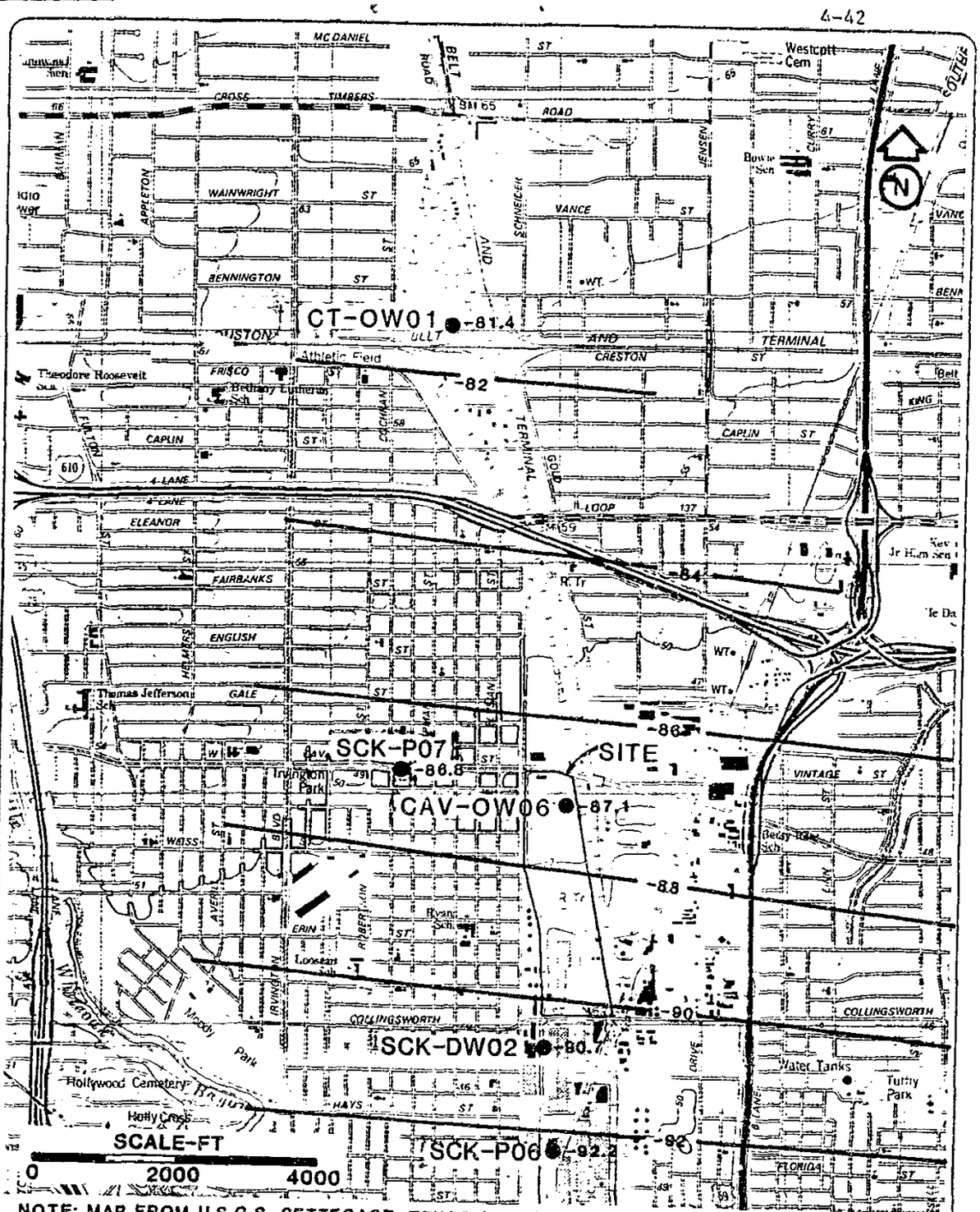


NOTE: MAP FROM U.S.G.S. SETTEGAST, TEXAS (1962) SHEET

-92.2 ● ELEVATION OF GROUNDWATER LEVEL (FT) ON NOVEMBER 30, 1987

—-92—CONTOUR OF ELEVATION (FT)

# GROUNDWATER CONTOUR MAP

## DEEP ZONE

FILE NO. 85-317
FIGURE 4-16

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the documented owners, indicating that the wells are currently inactive. The closest documented active City of Houston public water-supply well disclosed in the well inventory report (1985) is located about 3100 ft east of the site, but is screened at depths of 1030 ft to 2060 ft below ground surface.

4.3.8 Horizontal Groundwater Seepage. An initial estimate of horizontal groundwater seepage rate for the shallow zone was made assuming uniform, isotropic, steady-state conditions. Average hydraulic conductivities of $8.3 \times 10^{-4}$ cm/sec, based on field testing of the shallow zone, were selected for the analysis. The average interstitial flow velocity was evaluated based upon an assumed effective porosity (specific yield) of 0.20, typical of fine sand strata (Johnson, 1979). Based upon these parameters, and an average gradient for the shallow zone of about 20 ft/mi, the rate of horizontal groundwater seepage for the shallow zone is approximated at about 16 ft/year.

4.3.9 Vertical Groundwater Potentiometric Levels. A decline in potentiometric level with depth is evidenced by water levels in monitoring wells completed at various depths across the South Cavalcade Site. This trend is indicative of downward groundwater potential in response to a vertical hydraulic gradient. Declining potentiometric levels have historically been influenced by vertical gradients induced by groundwater pumpage in the Houston area. From 1943 to 1977, groundwater level declines in the Chicot Aquifer of 150 to 175 ft were observed southwest of the South Cavalcade Site (Figure 4-9), although a more recent trend of groundwater rise is exhibited by Figure 4-10.

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Surface infiltration recharge is limited throughout the site area due to the cohesive soil top stratum and because approximately 75 percent of the site area is paved. A review of historical water-level fluctuations indicates relatively constant groundwater flow patterns, in both paved and unpaved areas, as discussed in Section 4.3.3. These features indicate that groundwater-level fluctuations are probably more influenced by regional drainage features, such as Little White Oak Bayou located west of the site, and Hunting Bayou located east of the site.

Vertical gradients were calculated for nested monitoring well locations at the South Cavalcade Site (Table 4-10). An apparent downward, or negative, vertical gradient was found between the shallow zone and the Unit 2 granular soil strata. The presence of a gradient indicates reduced hydraulic communication between these two water-bearing strata. This reduction of hydraulic communication can be contributed to a clay confining layer below the shallow zone.

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Table 4-10
NESTED GROUNDWATER VERTICAL GRADIENTS

| Shallow Zone | | Unit 2 Granular Strata | | Water Level Elevation Difference (ft) | Vertical Gradient (ft/ft) |
|---|---|---|---|---|---|
| Monitoring Well No. | Water Level* | Monitoring Well No. | Water Level* | | |
| SCK-MW02 | 42.2 | SCK-MW10 | 32.7 | 9.5 | 0.30 |
| SCK-MW03 | 44.2 | SCK-MW11 | 32.3 | 11.9 | 0.66 |
| SCK-MW06 | -- | SCK-MW14 | 33.9 | -- | -- |
| SCK-MW09 | 45.8 | SCK-MW16 | 41.6 | 4.2 | 0.16 |
| CAV-OW01 | 46.8 | SCK-P05 | 37.3 | 9.5 | 0.25 |
| CAV-OW02 | 42.3 | SCK-MW12 | 33.2 | 9.1 | 0.28 |
| CAV-OW07 | 42.1 | SCK-P04 | 33.7 | 8.4 | 0.24 |
| CAV-OW08 | 41.5 | SCK-P01 | 33.3 | 8.2 | 0.32 |
| CAV-OW10 | 41.3 | SCK-P02 | 33.2 | 8.1 | 0.37 |
| CAV-OW11 | 45.6 | SCK-P03 | 31.8 | 13.8 | 0.73 |

* Reading taken on November 30, 1987

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Average potentiometric variations between the shallow zone and the deep zone were also estimated for the South Cavalcade Site. Parameters used for the evaluation of vertical gradients are presented in Table 4-11.

Table 4-11
PARAMETERS FOR VERTICAL FLOW RATE COMPUTATION

| | Average Water Level Elevation (ft)* | Average Depth To Top of Zone (ft) |
|---|---|---|
| Shallow Zone | 43 | 21 |
| Deep Zone | -89 | 174 |

* Water Levels Based on November 30, 1987 Readings

The potentiometric level between the shallow zone and the deep zone yields a downward vertical gradient of 0.86 ft/ft for a decline in average water-level elevation of 132 ft over an average vertical distance of 153 ft, assuming saturated conditions.

Vertical groundwater seepage rates are expected to be limited by the relatively low permeability confining strata; therefore an upper-bound vertical hydraulic conductivity of $1 \times 10^{-7}$ cm/sec was assumed. This value is based upon experience in evaluating vertical hydraulic conductivities in the field for soils geologically similar to those at the South Cavalcade Site. Although lower laboratory hydraulic conductivity values were reported in Table 4-3 for the clay aquitard soils, the upper-bound hydraulic conductivity was selected due to secondary soil structures which have been observed at the South Cavalcade Site (i.e., fissures, silt seams, sand layers, slickensides). The net interstitial seepage velocity was evaluated based upon an assumed effective porosity (specific yield) of 0.05 for clay soils (Johnson, 1979).

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Based upon the average vertical gradients and assumed hydraulic conductivity and effective porosity, an estimated vertical groundwater seepage rate of about 1.8 ft/year was calculated between the shallow zone, and the deep zone assuming saturated conditions. These results indicate that the horizontal groundwater seepage component may be about 9 times greater than the average vertical seepage component for the shallow zone.

## 4.4 References


1. McClelland Engineers, Inc., Study of Pecore Fault, Report to Houston Transit Consultants, MEI Report No. 0181-0546-2, September 30, 1982.

2. Camp Dresser & McKee, Inc., Cavalcade Contaminant Survey, Volume I, Engineering Report, July 11, 1983.

3. Baker, E.T. Jr., Stratigraphic and Hydrogeologic Framework of Part of the Coastal Plain of Texas, Texas Department of Water Resources, Report No. 236, 1979.

4. Jorgensen, D.G., Analog-Model Studies of Groundwater Hydrology in the Houston District, Texas, Texas Water Development Board Report 190, 1975.

5. Gabrysch, R.K., Approximate Areas of Recharge of the Chicot and Evangeline Aquifer Systems in the Houston-Galveston Area, Texas, U.S. Geological Survey Open-File Report 77-754, 1977.

6. Gabrysch, R.K, Ground-Water Withdrawals and Land Surface Subsidence in the Houston-Galveston Region, Texas, 1906-1980, Texas Department of Water Resources Report 287, 1984.


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7. McBride-Ratcliff & Associates, Inc., Well Inventory, Subtask 1D, MRA Report No. 85-195, July 5, 1985.

8. Koppers Company, Inc., Field Sampling and Analytical Plan, Remedial Investigation and Feasibility Study, Koppers South Cavalcade Site, October 14, 1985.

9. Design Professionals Management Systems, Surface Display System Program User's Manual, 1985.

10. McClelland Engineers, Inc.; Geotechnical Investigation, Reconnaissance Study, Cavalcade Yard and Shop, Metro-Stage One RRS, May 20, 1983.

11. Camp Dresser & McKee, Inc., Remedial Investigation Report for North Cavalcade Street Site, October 28, 1987.

12. Freeze, R.A. and Cherry, J.A., Groundwater, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1979.

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# SECTION 5.0 - SURFACE WATER AND SEDIMENT QUALITY EVALUATION

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# 5.0 SURFACE WATER AND SEDIMENT QUALITY EVALUATION

## 5.1 General

As specified under Subtasks 2A and 2B of the RI/FS Work Plan, two rounds of surface water and sediment sampling and analyses were conducted at the South Cavalcade Site to assess potential migration from surface water runoff. Drainage ditches and topographic lows adjacent to the site were sampled on June 11, 1986 and October 13, 1986 after rainfall events. Round 1 consisted of sampling four on-site paired surface water and sediment points and one background sediment point. Round 2 consisted of sampling the same Round 1 points and two additional off-site paired points.

Surface water and sediment sample identification is based upon the coding system SCK-AAyy-zz where:

SCK - identifies the South Cavalcade Site
AA - identifies type of sample
SW - Surface Water
SD - Sediment
yy - identifies the sample location
zz - identifies the sample number

## 5.2 Surface Drainage

5.2.1 Regional Drainage Features. Regional drainage in the vicinity of the South Cavalcade Site is provided by the east-southeast flowing Hunting Bayou. The site is situated in the Hunting Bayou District within the San Jacinto River Basin as defined by the Harris County Flood Control District and is shown on Figure 5-1.

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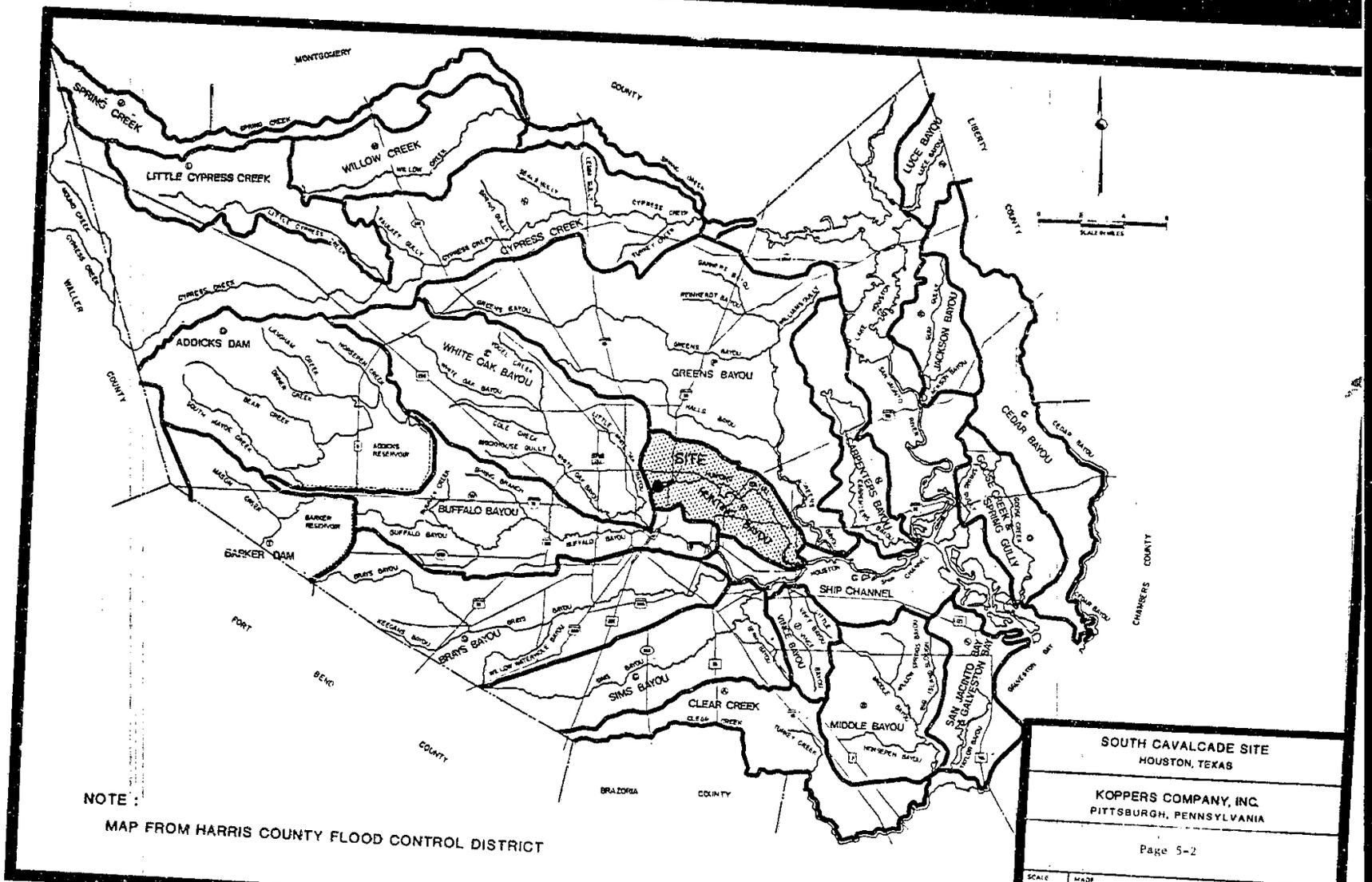


SOUTH CAVALCADE SITE
HOUSTON, TEXAS

KOPPERS COMPANY, INC.
PITTSBURGH, PENNSYLVANIA

Page 5-2

| SCALE | MADE | DATE | FILE NO |
|---|---|---|---|
| NOTED | CHECK | DATE | 65-317 |

REGIONAL DRAINAGE FEATURES — FIGURE 5-1

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Hunting Bayou is located approximately 1000 ft north of the site, and has a tributary about 3500 ft east of the site. Little White Oak Bayou is located approximately 4300 ft west of the site. The site is located above the 100-year and 500-year floodplain boundaries, as defined by the Federal Emergency Management Agency (FEMA), and is shown on Figure 5-2.

5.2.2 Site Drainage Features. Surface drainage at the South Cavalcade Site is managed by ditches and storm sewers. Primary drainage ditches are located between the east and west property lines and the railroad tracks. A historical ditch that crossed Palletized Trucking property from northwest to southeast was backfilled during pavement construction, and a short section at the south end was lined with concrete pipe. A drainage ditch also runs along the south end of the Baptist Foundation of Texas property, and a ditch runs between the Meridian Transport Company property and Palletized Trucking property. The location of the drainage ditches and the estimated flow directions are referenced on Figure 5-3. The on-site ditch depths are typically less than about 6 ft and do not intersect the shallow zone deposits. Estimated flow directions are based on observations of surface water runoff during Round 1 and Round 2 surface water and sediment sampling.

The Houston Belt & Terminal (HB&T) Railroad tracks on the east and west sides of the site act as levees. These levees prevent off-site surface waters from entering the site from the east or west.

Catch basins collect the surface water runoff and divert the water into the City of Houston storm sewer system. Catch basins are located in paved areas developed for the

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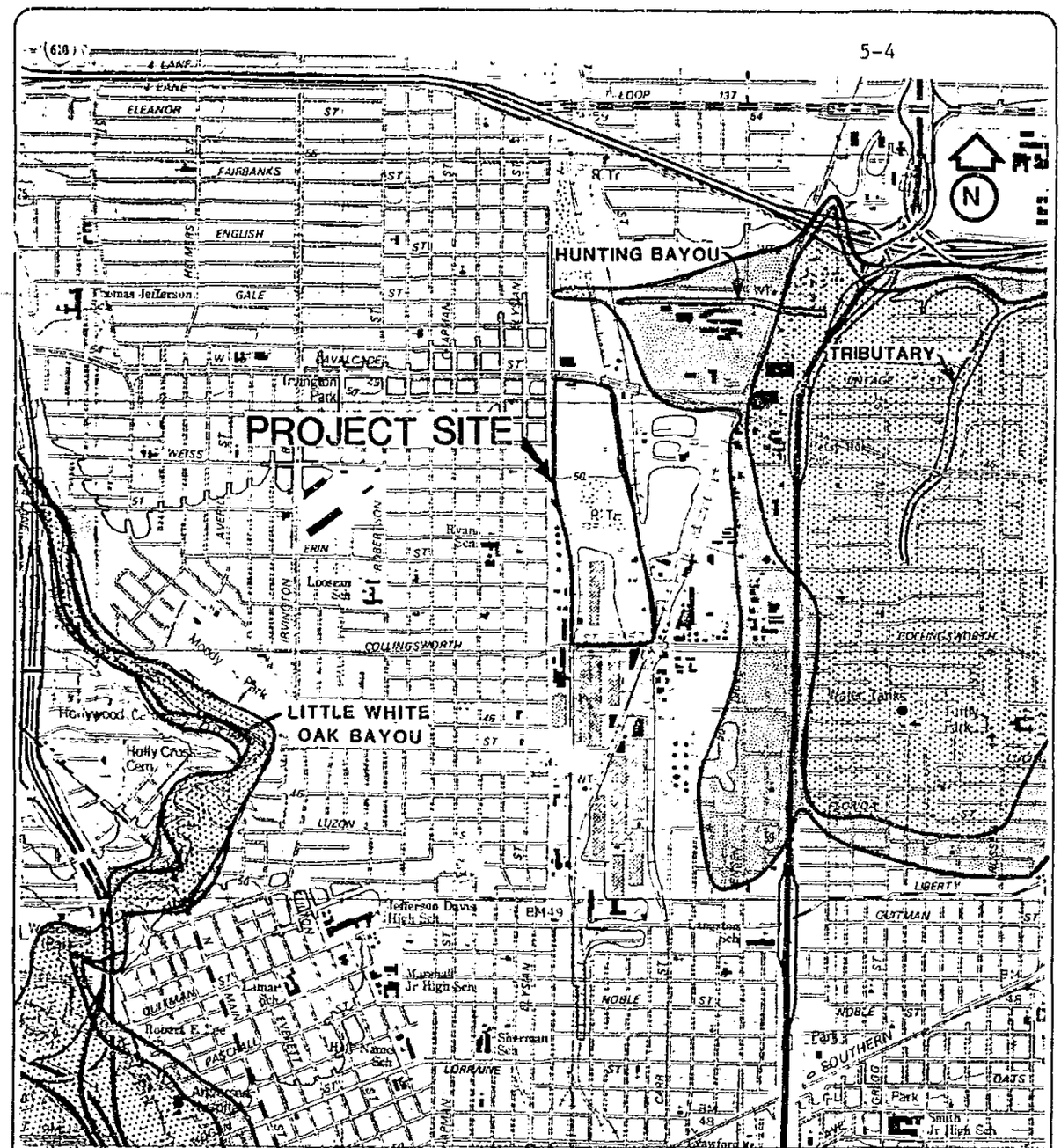


NOTES: 1. TOPOGRAPHIC MAP IS FROM U.S.G.S. SETTEGAST, TEXAS (1982) SHEET.
2. FLOODPLAIN BOUNDARIES FROM FEDERAL EMERGENCY MANAGEMENT AGENCY - FLOOD INSURANCE RATE MAP - 480296 0090C DATED SEPTEMBER 27, 1985

FILE NO. 85-317
FIGURE 5-2

# FLOODPLAIN MAP

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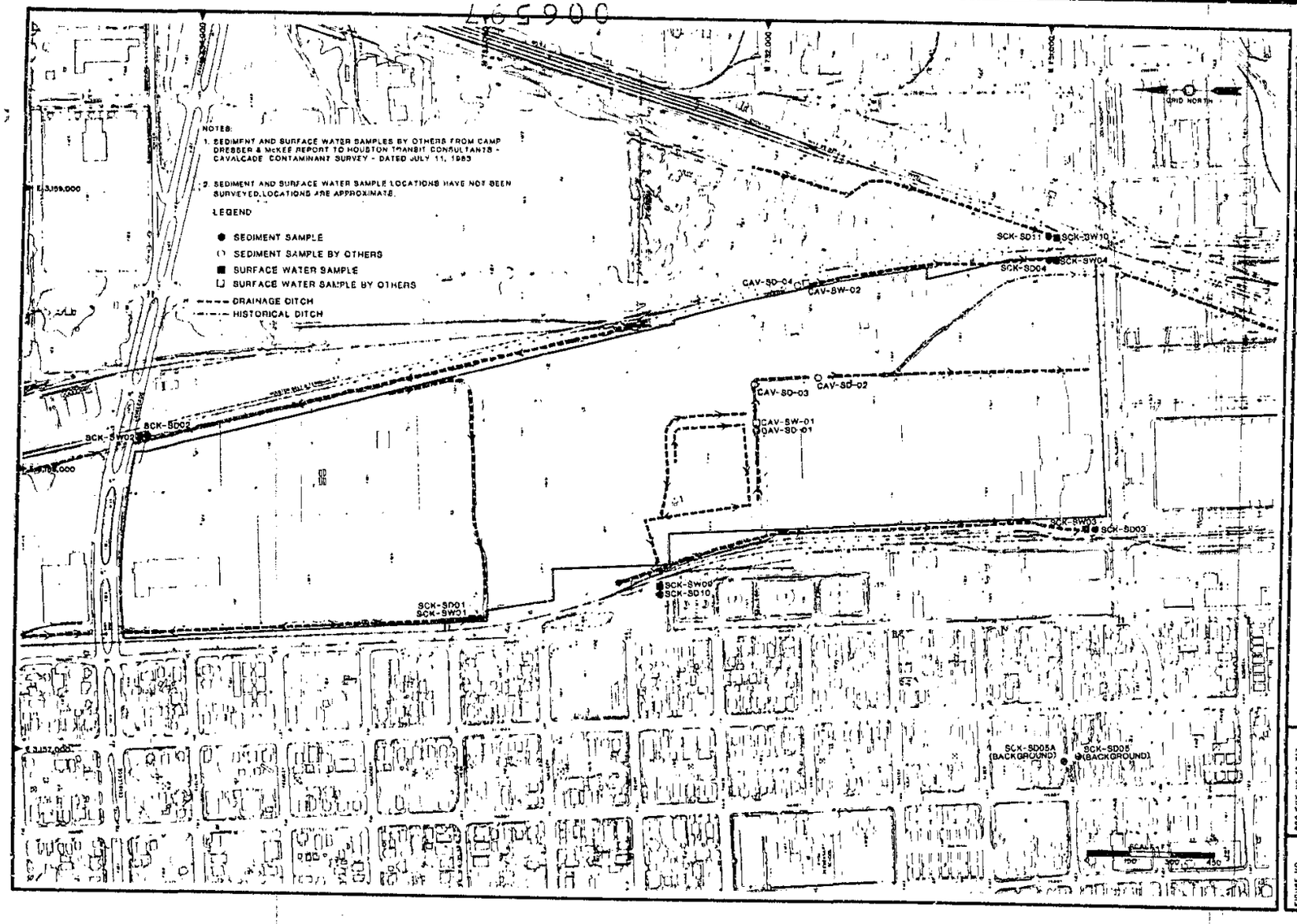


Page 5-5

COMPOSITE SURFACE WATER AND SEDIMENT SAMPLING MAP
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

KOPPERS COMPANY, INC.

| | |
|---|---|
| PROJECT NO | 65-317 |
| DATE | 6-10-87 |
| ENGINEER | |
| DRAWN BY | |
| FIGURE NO | 5-3 |

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on-site trucking firms. Paved areas cover approximately 75 percent of the site.

The ditches and catch basins at the north end of the site empty into a storm sewer line under Cavalcade Street. This storm sewer line eventually empties into Hunting Bayou near the U.S. 59 bridge over Hunting Bayou. The ditches and catch basins at the south end of the site empty into a storm sewer line under Collingsworth Street, which eventually empties into the Hunting Bayou Tributary near Legion Street.

## 5.3 Surface Water Quality

Two rounds of surface water sampling were performed. A total of seven Round 1 and nine Round 2 samples were taken, including duplicates and blanks. A summary of the surface water samples is listed in Table 5-1.

TABLE 5-1
SUMMARY OF SURFACE WATER SAMPLES

| Round 1 | Round 2 |
|---|---|
| SCK-SW01-01 | SCK-SW01-02 |
| SCK-SW02-01 | SCK-SW02-02 |
| SCK-SW03-01 | SCK-SW03-02 |
| SCK-SW04-01 | SCK-SW04-02 |
| SCK-SW05-01 (SW03-01 duplicate) | SCK-SW06-01 (SW01-02 duplicate) |
| SCK-SW07-01 | SCK-SW08-01 |
| (field blank at SW04-01) | (field blank at SW01-02) |
| Trip Blank 1 | SCK-SW09-01 (Round 2 addition) |
| | SCK-SW10-01 (Round 2 addition) |
| | Trip Blank 2 |

5.3.1 Data Validation. Data validations for both sampling rounds were designated as follows:

Valid (V) - all criteria passed with acceptable results.

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Qualified (Q) - all criteria followed but matrix effects may affect results.

Invalid (I) - QA/QC criteria not followed or performed incorrectly.

Not Validated (NV) - Validation of analytical test results not performed.

The data validation and completeness goals are based upon criteria set forth in Appendix E, Volume 3, as discussed in Section 3.10. Data validation is based upon a review of the analytical data package and observations of laboratory procedures during audits.

Summaries of the surface water and sediment sample validation results are presented as follows:

Surface Water Sample Validation Results

| Fraction | Valid (V) | Qualified (Q) | Invalid (I) | Not Validated (NV) | Total |
|---|---|---|---|---|---|
| Volatiles | 4 | 2 | 0 | 0 | 6 |
| Semivolatiles | 10 | 0 | 0 | 0 | 10 |
| Inorganics | 10 | 0 | 0 | 0 | 10 |

Sediment Sample Validation Results

| Fraction | Valid (V) | Qualified (Q) | Invalid (I) | Not Validated (NV) | Total |
|---|---|---|---|---|---|
| Volatiles | 7 | 0 | 0 | 0 | 7 |
| Semivolatiles | 8 | 4 | 0 | 0 | 12 |
| Inorganics | 12 | 0 | 0 | 0 | 12 |

The surface water and sediment quality evaluation (Section 5.0) will include all analytical data, including valid (V) and qualified (Q) data.

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5.3.2 Surface Water Sampling. Sample locations were selected at the following key areas:

1. Points receiving drainage from large unpaved portions of approximately equal areas of the site.

2. Points located at the site boundaries.

3. Site surface water exit points that are readily discernible.

4. Points that receive relatively large flow volumes.

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Surface water sampling was performed in accordance with Section 2.0 of the Field Sampling and Analytical Plan, except that some of the sampling locations were modified based on a more detailed review of site drainage patterns to permit more strategic sample points. Additional changes included provisions to obtain pH, conductivity, dissolved oxygen (DO), and temperature measurements in the laboratory after sampling. Additionally, 1-liter plastic sample bottles for cyanide and metals were used instead of cubitainers. Samples were preserved in accordance with the Field Sampling and Analytical Plan. Surface water samples were not filtered to be consistent with the groundwater sampling protocol. Stream flow rates could not be taken during sampling due to poor site drainage and low runoff velocities.

Quality assurance duplicate and rinseate blank samples were taken at two locations for both rounds. The blanks and

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duplicates were labeled similarly as the surface water samples and were given arbitrary sampling times. Preservation of the blanks and duplicates was performed as for regular samples. A trip blank, consisting of two laboratory-filled 40 ml VOA vials, was taken in addition to the field rinsate blank and the duplicate sample. Surface film was observed during surface water sampling; therefore, additional samples at each location were collected for both rounds for total petroleum hydrocarbon (TPH) analyses. Due to scheduling constraints caused by the variability of rainfall events, no surface water sample splits were obtained by CDM. Presentation of the field surface water quality assurance sample analytical data is included in Appendix R, Volume 3.

As noted previously, Round 2 sampling consisted of sampling the same points as for Round 1, and two additional points. Other differences between Round 1 and Round 2 sampling were: (1) one TPH sample was collected at each location instead of two split samples; and (2) volatile organic analysis was performed for only two of the six samples. The reduction in Round 2 volatile organic analyses was requested by Koppers Company on September 17, 1986 and approved on November 19, 1986 by the EPA. A copy of the correspondence is included in Appendix G, Volume 2.

All field activities were recorded in a field notebook, such as sampling time, sample depth, preservation techniques, etc. A surface water sample log was completed for each sample. Pertinent laboratory and field data were recorded on the log. Additional comments were recorded concerning sample appearance or other characteristics. The surface water sample logs are presented in Appendix L, Volume 3. Chain-of-custody procedures were conducted in accordance with Section 4.0 of the QA/QC Plan.

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5.3.3 Surface Water Analytical Testing. Analytical testing of surface water samples consisted of EPA Hazardous Substance List (HSL) volatile organic compounds (VOA), HSL semivolatile organic compounds (SV), HSL metals and iron, total petroleum hydrocarbons (TPH), and cyanide. A listing of the HSL constituents included in the analyses is presented on Table 3-3. In addition to organic compounds identified from the HSL, a computerized mass spectral library search was performed to identify up to 10 additional compounds for the VOA fraction and up to 20 additional compounds for the SV fraction. The laboratory procedures used for the surface water sample analyses are listed in Table 5-2.

TABLE 5-2

SUMMARY OF SURFACE WATER ANALYTICAL METHODS

| Analysis | Method No. |
|---|---|
| 1. Volatile Organics | EPA 7/85 Revision CLP Statement of Work for Organics |
| 2. Semivolatile Organics | EPA 7/85 Revision CLP Statement of Work for Organics |
| 3. HSL Metals | EPA 7/84 Revision CLP Statement of Work for Inorganics |
| 4. Iron | EPA 7/84 Revision CLP Statement of Work for Inorganics |
| 5. Cyanide | EPA 7/84 Revision CLP Statement of Work for Inorganics |
| 6. DO | EPA 360.1 |
| 7. pH | EPA 150.1 |
| 8. Conductivity | EPA 120.1 |
| 9. Temperature | EPA 120.1 |
| 10. TPH | EPA 418.1 |

Procedures for analysis of HSL organics and inorganics were performed according to the EPA Contract Laboratory Program (CLP) protocol.

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5.3.4 Surface Water Quality Summary. Surface water sample analytical data reports are included in Appendix O, Volume 3. A summary of the Round 1 and Round 2 organic test results presented on Tables 5-3 and 5-4 indicates detected levels less than 100 ug/l of both semivolatile and volatile HSL organic compounds in the surface water samples. Round 1 and Round 2 surface water samples disclosed no detected polynuclear aromatic hydrocarbon (PAH) compounds. Detected compounds are defined as compounds detected above the method detection limit of the analytical technique. Bis(2-ethylhexyl)phthalate was detected at three sample locations (SCK-SW01, SCK-SW03, SCK-SW04). Volatile organics (acetone and methylene chloride) were detected at two sample locations (SCK-SW03 and SCK-SW04). However, these compounds were also detected in both laboratory and field blanks. Therefore, these compounds are considered common laboratory and field sampling contaminants.

As shown on Table 5-5, arsenic, zinc, lead, and iron were the commonly detected metals. Arsenic was detected at all sampling points but one for both rounds (Sample SCK-SW10-01) and ranged from 16 ug/l to 56 ug/l. Zinc was detected at all sampling points for both rounds, ranging from 31 ug/l to 140 ug/l. Lead was detected at all sampling points but one (Sample SCK-SW10-01) and ranged from 6.4 ug/l to 31 ug/l. Iron was detected at all sampling points for both rounds, ranging from 170 ug/l to 3100 ug/l.

Copper was detected at one location (SCK-SW04) in each round at 17 ug/l and 14 ug/l, respectively. Nickel was detected at two locations (SCK-SW04 and SCK-SW10) at 36 ug/l. Silver was detected at one location (SCK-SW03) at 11 ug/l, and cyanide was not detected at any location for either round.

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TABLE 5-3
SUMMARY OF DETECTED SURFACE WATER SEMIVOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | SW01-01 | SW01-02(SOR) | SW06-01(DUP) | SW02-01 | SW02-02 | SW03-01(SOR) | SW05-01(DUP) |
|---|---|---|---|---|---|---|---|
| BIS(2-ETHYLHEXYL)PHTHALATE | 20 U | 23 | 10 J | 10 U | 10 J | 20 U | 10 U |
| PHENANTHRENE | 20 U | 10 U | 10 U | 10 U | 10 U | 20 J | 10 J |
| VALIDATION STATUS | V | V | V | V | V | V | V |
| TOTAL PAH COMPOUNDS | 20 U | 10 U | 10 U | 10 U | 10 U | 20 U | 10 U |
| TOTAL PETROLEUM HYDROCARBONS(mg/l) | 5.0 U | 5.00 U | 5.00 U | 5.0 U | 5.00 U | 5.0 U | 5.0 U |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. V = Valid
3. Q = Qualified
4. SW = Surface Water Sample
5. SOR = Sample of Record
6. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit or Field Blank





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TABLE 5-3 (continued)
SUMMARY OF DETECTED SURFACE WATER SEMIVOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | SW03-02 | SW04-01 | SW04-02 | SW09-01 | SW10-01 |
|---|---|---|---|---|---|
| BIS(2-ETHYLHEXYL)PHTHALATE | 15 | 39 | 97 | 10 J | 10 J |
| FLUORANTHENE | 10 U | 10 J | 10 U | 10 U | 10 U |
| PYRENE | 10 U | 10 J | 10 U | 10 U | 10 U |
| VALIDATION STATUS | V | V | V | V | V |
| TOTAL PAH COMPOUNDS | 10 U | 10 U | 10 U | 10 U | 10 U |
| TOTAL PETROLEUM HYDROCARBONS(mg/l) | 5.00 U | 5.0 U | 5.00 U | 7 | 5.00 U |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. V = Valid
3. Q = Qualified
4. SW = Surface Water Sample
5. SOR = Sample of Record
6. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit or Field Blank





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TABLE 5-4
SUMMARY OF DETECTED SURFACE WATER VOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | SW01-01 | SW01-02(SOR) | SW06-01(DUP) | SW02-01 | SW02-02 | SW03-01(SOR) | SW05-01(DUP) | SW03-02 | SW04-01 |
|---|---|---|---|---|---|---|---|---|---|
| ACETONE | 10 U | NA | NA | 10 U | 10 U | 10 | 10 U | 10 U | 10 U |
| BENZENE | 5 U | NA | NA | 5 U | 5 U | 5 J | 5 U | 5 U | 5 U |
| CARBON DISULFIDE | 5 U | NA | NA | 5 U | 5 U | 5 U | 5 J | 5 U | 5 U |
| METHYLENE CHLORIDE | 5 J | NA | NA | 5 U | 5 U | 5 U | 5 U | 5 U | 14 |
| TOLUENE | 5 U | NA | NA | 5 U | 5 U | 5 J | 5 U | 5 U | 5 U |
| VALIDATION STATUS | V | NA | NA | V | Q | V | V | Q | V |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. V = Valid
3. Q = Qualified
4. NA = Not Analyzed
5. SW = Surface Water Sample
6. SOR = Sample of Record
7. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





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TABLE 5-4 (continued)
SUMMARY OF DETECTED SURFACE WATER VOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | SW04-02 | SW09-01 | SW10-01 |
|---|---|---|---|
| ACETONE | NA | NA | NA |
| BENZENE | NA | NA | NA |
| CARBON DISULFIDE | NA | NA | NA |
| METHYLENE CHLORIDE | NA | NA | NA |
| TOLUENE | NA | NA | NA |
| VALIDATION STATUS | NA | NA | NA |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. V = Valid
3. Q = Qualified
4. NA = Not Analyzed
5. SW = Surface Water Sample
6. SOR = Sample of Record
7. DUP = Duplicate





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TABLE 5-5
SUMMARY OF DETECTED SURFACE WATER INORGANICS (ug/l)[1]

| METAL | SW01-01 | SW01-02(SOR) | SW06-01(DUP) | SW02-01 | SW02-02 | SW03-01(SOR) | SW05-01(DUP) | SW03-02 |
|---|---|---|---|---|---|---|---|---|
| ARSENIC | 33 | 16 | 16 | 24 | 56 | 50 | 55 | 50 |
| CADMIUM | 4 U | 5 U | 5 U | 4 U | 5 U | 4 U | 4 U | 5 U |
| CHROMIUM | 9 U | 9 U | 9 U | 9 U | 9 U | 9 U | 9 U | 9 U |
| COPPER | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| IRON | 3100 | 680 | 600 | 170 | 400 | 540 | 430 | 700 |
| LEAD | 30 | 6.4 | 11 | 5 U | 11 | 7.3 | 5 U | 31 |
| MERCURY | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| NICKEL | 20 U | 29 U | 29 U | 20 U | 29 U | 20 U | 20 U | 29 U |
| SILVER | 9 U | 10 U | 10 U | 9 U | 10 U | 11 | 9 U | 10 U |
| THALLIUM | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| ZINC | 84 | 31 | 45 | 38 | 47 | 51 | 47 | 140 |
| VALIDATION STATUS | V | V | V | V | V | V | V | V |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. V = Valid
3. SW = Surface Water Sample
4. SOR = Sample of Record
5. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit





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TABLE 5-5 (continued)
SUMMARY OF DETECTED SURFACE WATER INORGANICS (ug/l)[1]

| METAL | SW04-01 | SW04-02 | SW09-01 | SW10-01 |
|---|---|---|---|---|
| ARSENIC | 45 | 40 | 56 | 10 U |
| CADMIUM | 4 U | 5 U | 5 U | 5 U |
| CHROMIUM | 9 U | 9 U | 9 U | 9 U |
| COPPER | 17 | 14 | 10 U | 10 U |
| IRON | 1500 | 550 | 1400 | 300 |
| LEAD | 22 | 14 | 22 | 5 U |
| MERCURY | 0.2 U | 0.2 U | 0.2 U | 0.2 U |
| NICKEL | 20 U | 36 | 29 U | 36 |
| SILVER | 9 U | 10 U | 10 U | 10 U |
| THALLIUM | 10 U | 10 U | 10 U | 10 U |
| ZINC | 91 | 66 | 110 | 32 |
| VALIDATION STATUS | V | V | V | V |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. V = Valid
3. SW = Surface Water Sample
4. SOR = Sample of Record
5. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit





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A comparative review of TPH analytical data for the surface water film samples indicates little correlation with visual surface film observations. Detected TPH compounds were found in only one sample (SCK-SW09-01) at 7 mg/l. Table 5-6 indicates that no PAH compounds were detected, although surface film was observed at two locations. In addition, one TPH false positive and three TPH false negatives are noted relative to visual surface film.

TABLE 5-6
SURFACE WATER HYDROCARBON CORRELATION

| Sample Location | Visual Surface Film | | Detected PAH Compounds | | Detected TPH Compounds | |
|---|---|---|---|---|---|---|
| | Round 1 | Round 2 | Round 1 | Round 2 | Round 1 | Round 2 |
| SCK-SW01 | no | yes | no | no | no | no |
| SCK-SW02 | no | no | no | no | no | no |
| SCK-SW03 | yes | yes | no | no | no | no |
| SCK-SW04 | no | no | no | no | no | no |
| SCK-SW09 | | no | | no | | yes |
| SCK-SW10 | | no | | no | | no |

5.3.5 Previous Surface Water Sampling. Previous surface water sampling was conducted by Camp Dresser & McKee (CDM) on February 2, 1983 during the Cavalcade Contaminant Survey. Two samples (Samples CAV-SW-01-012 and CAV-SW-02-012), taken at the locations indicated on Figure 5-3, were analyzed for EPA priority pollutant VOA, SV, cyanide, metals and pesticides/PCB. No volatile organic compounds were detected in either sample. Seven PAH semivolatile organic compounds were detected in one sample (Sample CAV-SW-02-012) at concentrations less than 20 ug/l. The previously detected semivolatile organic

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compounds were not observed during the Remedial Investigation at a downstream sample location (SCK-SW04). Cadmium was detected at 50 ug/l and zinc was detected at concentrations ranging from 180 ug/l to 320 ug/l. Arsenic was not detected in either sample. However, the previous analytical data is considered as Level A EPA PRP chemical data and is therefore used on a generally qualitative basis. The previous surface water analytical data are summarized on Tables 5-7 and 5-8.

## 5.4 Sediment Quality

Two rounds of sediment sampling were performed simultaneously with the surface water sampling. A total of seven Round 1 and nine Round 2 sediment samples were taken, including sample duplicates and blanks. A summary of the sediment samples is listed in Table 5-9.

TABLE 5-9
SUMMARY OF SEDIMENT SAMPLES

| Round 1 | Round 2 |
|---|---|
| SCK-SD01-01 | SCK-SD01-02 |
| SCK-SD02-01 | SCK-SD02-02 |
| SCK-SD03-01 | SCK-SD03-02 |
| SCK-SD04-01 | SCK-SD04-02 |
| SCK-SD05-01 (offsite background) | SCK-SD05-02A (offsite background) |
| SCK-SD06-01 (duplicate for SD03-01) | SCK-SD07-01 (duplicate for SD01-02) |
| SCK-SD08-00 (field blank at SD04-01) | SCK-SD09-01 (field blank at SD01-02) |
| | SCK-SD10-01 (Round 2 addition) |
| | SCK-SD11-01 (Round 2 addition) |

5.4.1 Data Validation. Data validation results for sediment samples are included in Section 5.3.1. Data validation status for sediment samples is referenced on Tables 5-10, 5-11, and 5-12.

TABLE 5-7

SUMMARY OF PREVIOUS DETECTED SURFACE WATER SEMIVOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | SW-01-012 | SW-02-012 |
|---|---|---|
| BENZO(A)ANTHRACENE | 10 U | 10 |
| BENZO(A)PYRENE | 10 U | 10 |
| 3,4-BENZOFLUORANTHENE[3] | 10 U | 11 |
| BENZO(K)FLUORANTHENE[3] | 10 U | 10 |
| CHRYSENE | 10 U | 12 |
| DI-N-BUTYL PHTHALATE | 10 U | 18 |
| FLUORANTHENE | 10 U | 17 |
| PYRENE | 10 U | 14 |
| TOTAL PAH COMPOUNDS | 10 U | 84 |

NOTES:

1. Analytical test data from Mead CompuChem report to CDM, dated February 24, 1983.
2. Sample prefix for SD and SW is CAV.
3. Analytical method cannot distinguish between 3,4-Benzofluoranthene and Benzo(k)fluoranthene. Total detected concentration is split between the two compounds.
4. SW = Surface Water Sample

LEGEND:

U = Below Method Detection Limit



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TABLE 5-8
SUMMARY OF PREVIOUS DETECTED SURFACE WATER INORGANICS (ug/l)[1]

| COMPOUND | SW-01-012 | SW-02-012 |
|---|---|---|
| ARSENIC | 50 U | 50 U |
| BERYLLIUM | 20 U | 20 U |
| CADMIUM | 50 | 20 U |
| CHROMIUM | 100 U | 100 U |
| COPPER | 100 U | 100 U |
| CYANIDE | 10 U | 100 U |
| LEAD | 200 U | 200 U |
| MERCURY | 0.2 U | 0.2 U |
| NICKEL | 100 U | 100 U |
| SILVER | 60 U | 60 U |
| THALLIUM | 50 U | 50 U |
| ZINC | 320 | 180 |

NOTES:
1. Analytical test data from Mead CompuChem report to CDM, dated February 24, 1983.
2. Sample prefix for SD and SW is CAV.
3. SW = Surface Water Sample

LEGEND:
U = Below Method Detection Limit

TABLE 5-10
SUMMARY OF DETECTED SEDIMENT SEMIVOLATILE ORGANIC COMPOUNDS (ug/kg)[1]

| COMPOUND | SD01-01 | SD01-02(SOR) | SD07-01(DUP) | SD02-01 | SD02-02 | SD03-01(SOR) | SD06-01(DUP) |
|---|---|---|---|---|---|---|---|
| ACENAPHTHYLENE | 1020 U | 460 U | 440 U | 2400 J | 920 U | 17000 U | 19000 U |
| ANTHRACENE | 1020 J | 460 U | 440 U | 2400 J | 920 U | 17000 U | 19000 U |
| BENZO(A)ANTHRACENE | 1020 J | 460 U | 440 U | 2400 U | 920 J | 17000 U | 19000 U |
| BENZO(A)PYRENE | 1020 U | 460 U | 440 U | 2400 U | 920 J | 17000 U | 19000 U |
| BENZO(B)FLUORANTHENE | 1300 | 460 J | 440 J | 3000 | 920 J | 17000 J | 19000 U |
| BENZO(GHI)PERYLENE | 1020 U | 460 U | 440 U | 2400 J | 920 J | 17000 U | 19000 U |
| CHRYSENE | 1020 J | 460 U | 440 U | 2400 U | 920 J | 17000 J | 19000 U |
| DIETHYL PHTHALATE | 1020 J | 460 U | 440 U | 2400 U | 920 U | 17000 U | 19000 U |
| FLUORANTHENE | 1020 U | 460 J | 440 U | 2400 J | 920 J | 17000 J | 19000 J |
| INDENO(1,2,3-CD)PYRENE | 1020 U | 460 U | 440 U | 2400 J | 920 J | 17000 U | 19000 J |
| PHENANTHRENE | 1020 U | 460 U | 440 U | 2400 J | 920 U | 17000 U | 19000 U |
| PYRENE | 1000 | 460 J | 440 U | 2400 J | 920 J | 17000 J | 19000 J |
| VALIDATION STATUS | Q | V | V | Q | V | V[7] | V |
| TOTAL PAH COMPOUNDS | 2300 | 460 U | 440 U | 3000 | 920 U | 17000 U | 19000 U |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. V = Valid
3. Q = Qualified
4. SD = Sediment Sample
5. SOR = Sample of Record
6. DUP = Duplicate
7. Qualified for benzo(b)fluoranthene and benzo(k)fluoranthene; GC/MS technique cannot distinguish the two compounds.

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





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TABLE 5-10 (continued)
SUMMARY OF DETECTED SEDIMENT SEMIVOLATILE ORGANIC COMPOUNDS (ug/kg)[1]

| COMPOUND | SD03-02 | SD04-01 | SD04-02 | SD05-01 | SD10-01 | SD11-01 |
|---|---|---|---|---|---|---|
| ACENAPHTHENE | 3700 U | 15000 U | 24000 J | 25000 U | 940 U | 2500 U |
| ACENAPHTHYLENE | 3700 J | 15000 U | 24000 J | 25000 U | 940 U | 2500 J |
| ANTHRACENE | 3700 J | 15000 U | 24000 J | 25000 U | 940 U | 2500 J |
| BENZO(A)ANTHRACENE | 5600 | 15000 J | 24000 J | 25000 U | 940 U | 2500 J |
| BENZO(A)PYRENE | 9600 | 15000 U | 30000 | 25000 U | 940 J | 2500 J |
| BENZO(B)FLUORANTHENE | 28000 | 15000 J | 59000 | 25000 U | 940 J | 5000 |
| BENZO(GHI)PERYLENE | 11000 | 15000 J | 41000 | 25000 U | 940 J | 2500 J |
| BIS(2-ETHYLHEXYL)PHTHALATE | 3700 U | 15000 U | 24000 J | 25000 J | 940 U | 120000 |
| CHRYSENE | 10000 | 15000 J | 24000 J | 25000 U | 940 U | 2500 J |
| DIBENZO(AH)ANTHRACENE | 3700 U | 15000 U | 24000 J | 25000 U | 940 U | 2500 J |
| FLUORENE | 3700 U | 15000 U | 24000 J | 25000 U | 940 U | 2500 U |
| FLUORANTHENE | 5400 | 15000 J | 32000 | 25000 U | 940 J | 2500 J |
| INDENO(1,2,3-CD)PYRENE | 11000 | 15000 J | 30000 | 25000 U | 940 J | 2500 J |
| NAPHTHALENE | 3700 J | 15000 U | 24000 J | 25000 U | 940 U | 2500 U |
| PHENANTHRENE | 3700 J | 15000 U | 24000 J | 25000 U | 940 U | 2500 J |
| PYRENE | 9100 | 15000 J | 44000 | 25000 U | 940 J | 2700 |
| VALIDATION STATUS | Q | V[7] | Q | V | V | V |
| TOTAL PAH COMPOUNDS | 89700 | 15000 U | 236000 | 25000 U | 940 U | 7700 |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. V = Valid
3. Q = Qualified
4. SD = Sediment Sample
5. SOR = Sample of Record
6. DUP = Duplicate
7. Qualified for benzo(b)fluoranthene and benzo(k)fluoranthene; GC/MS technique cannot distinguish the two compounds.

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





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TABLE 5-11
SUMMARY OF DETECTED SEDIMENT VOLATILE ORGANIC COMPOUNDS (ug/kg)[1]

| COMPOUND | SD01-01 | SD01-02(SOR) | SD07-01(DUP) | SD02-01 | SD02-02 | SD03-01(SOR) | SD06-01(DUP) | SD03-02 | SD04-01 |
|---|---|---|---|---|---|---|---|---|---|
| ACETONE | 15 U | NA | NA | 25 | 64 | 17 U | 10 | 22 U | 10 |
| METHYLENE CHLORIDE | 30 | NA | NA | 140 | 16 | 46 | 53 | 11 U | 7 U |
| 1,1,2-TRICHLOROETHANE | 7 U | NA | NA | 7 U | 7 U | 8 J | 9 U | 11 U | 7 J |
| VALIDATION STATUS | V | NA | NA | V | V | V | V | V | V |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. V = Valid
3. Q = Qualified
4. NA = Not Analyzed
5. SD = Sediment Sample
6. SOR = Sample of Record
7. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





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TABLE 5-11 (continued)
SUMMARY OF DETECTED SEDIMENT VOLATILE ORGANIC COMPOUNDS (ug/kg)[1]

| COMPOUND | SD04-02 | SD05-01 | SD05-02A | SD10-01 | SD11-01 |
|---|---|---|---|---|---|
| ACETONE | NA | 120 | NA | NA | NA |
| METHYLENE CHLORIDE | NA | 25 U | NA | NA | NA |
| 1,1,2-TRICHLOROETHANE | NA | 12 J | NA | NA | NA |
| VALIDATION STATUS | NA | V | NA | NA | NA |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. V = Valid
3. Q = Qualified
4. NA = Not Analyzed
5. SD = Sediment Sample
6. SOR = Sample of Record
7. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit

TABLE 5-12
SUMMARY OF DETECTED SEDIMENT INORGANICS (mg/kg)[1]

| METAL | SD01-01 | SD02-02(SOR) | SD07-01(DUP) | SD02-01 | SD02-02 | SD03-01(SOR) | SD06-01(DUP) | SD03-02 |
|---|---|---|---|---|---|---|---|---|
| ARSENIC | 8.0 | 6.8 | 5 U | 19 | 22 | 34 | 30 | 30 |
| CADMIUM | 2 U | 2.5 U | 2.5 U | 3.0 | 2.5 U | 4 U | 5.0 U | 2.5 U |
| CHROMIUM | 4 U | 5 U | 6.0 U | 28 | 11 | 72 | 360 | 52 |
| COPPER | 5 U | 0.05 U | 5 U | 14 | 18 | 73 | 78 | 51 |
| IRON | 4400 | NA | NA | 5500 | NA | 8100 | 15000 | NA |
| LEAD | 18 | 10 | 4 | 64 | 71 | 340 | 440 | 230 |
| MERCURY | 0.1 U | 0.05 U | 0.05 U | 0.1 U | 0.05 U | 0.29 | 10 U | 0.05 U |
| NICKEL | 10 U | 14 U | 16 | 10 U | 14 U | 10 U | 10 U | 19 |
| SILVER | 4 U | 5 U | 8 U | 4 U | 5 U | 4 U | 4 U | 5 U |
| THALLIUM | 8 U | 5 U | 5 U | 7 U | 5 U | 9.0 | 9 U | 5 U |
| ZINC | 70 | 58 | 25 | 170 | 97 | 1200 | 3300 | 860 |
| VALIDATION STATUS | V | V | V | V | V | V | V | V |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. V = Valid
3. NA = Not Analyzed
4. SD = Sediment Sample
5. SOR = Sample of Record
6. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit





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TABLE 5-12 (continued)
SUMMARY OF DETECTED SEDIMENT INORGANICS (mg/kg)[1]

| METAL | SD04-01 | SD04-02 | SD05-01 | SD05-02A | SD10-01 | SD11-01 |
|---|---|---|---|---|---|---|
| ARSENIC | 25 | 6.2 | 5 U | 5 U | 13 | 26 |
| CADMIUM | 2 U | 2.5 U | 4.5 | 2.5 U | 2.5 U | 2.5 U |
| CHROMIUM | 10 | 14 | 18 | 12 | 19 | 14 |
| COPPER | 76 | 73 | 32 | 40 | 18 | 89 |
| IRON | 8500 | NA | 9300 | NA | NA | NA |
| LEAD | 160 | 85 | 540 | 250 | 83 | 76 |
| MERCURY | 1.23 | 0.05 U | 1.25 | 0.05 U | 0.05 U | 0.05 U |
| NICKEL | 10 U | 18 | 10 U | 15 | 14 U | 18 |
| SILVER | 4 U | 5 U | 4 U | 5 U | 5 U | 5 U |
| THALLIUM | 8 U | 5 U | 12 U | 5 U | 5 U | 5 U |
| ZINC | 150 | 170 | 630 | 480 | 150 | 280 |
| VALIDATION STATUS | V | V | V | V | V | V |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. V = Valid
3. NA = Not Analyzed
4. SD = Sediment Sample
5. SOR = Sample of Record
6. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit





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5.4.2 Sediment Sampling. Sediment sampling was performed in accordance with Section 3.0 of the Field Sampling and Analytical Plan. Sample locations were selected based upon the criteria used for surface water sampling, as stated in Section 5.3.2. Sediment samples were obtained with a stainless steel scoop, placed into 8 oz. wide-mouth glass jars with Teflon-lined lids, and cooled.

Quality assurance duplicate and rinseate samples were taken at two locations for both rounds. The blanks and duplicates were labeled similarly as the surface water and sediment samples and were given arbitrary sampling times. The bottles used for the rinseate blank were the same type as those for surface water samples, and were preserved in the same manner. The trip blank for the surface water samples also served as the trip blank for the sediment samples. Due to scheduling constraints caused by the variability of rainfall events, no sediment sample splits were obtained by CDM. Presentation of the field sediment quality assurance sample analytical data is included in Appendix R, Volume 3.

As noted previously, Round 2 sampling consisted of sampling the same points as for Round 1, and two additional points. Other differences between Round 1 and Round 2 were: (1) iron was not analyzed because it is a common constituent of soils and sediments; (2) VOA analysis was performed for two of seven samples; and (3) background Sample SCK-SD05-02A was sampled at a different location than background Sample SCK-SD05-01 because oily materials were present at that location subsequent to Round 1 sampling. The reduction in Round 2 iron and volatile organic analyses was requested by Koppers Company on September 17, 1986 and approved on November 19, 1986 by the EPA. A copy of the correspondence is included in Appendix G, Volume 2.

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All field activities were recorded in a field notebook. Data recorded consisted of the same information as the surface water samples. A sediment sample log was completed for each sample. Notations were made of soil type, other visual characteristics, and odors, if any. The sediment sample logs are presented in Appendix M, Volume 3. Chain-of-custody procedures were followed as for the surface water samples.

5.4.3 Sediment Analytical Testing. Analytical testing of sediment samples consisted of the same analyses as for surface water samples (Table 5-2), except DO, pH, temperature, and conductivity measurements were not obtained. Procedures for analysis were also performed as for surface water samples using the EPA CLP protocol. Particle-size analyses were also conducted and are presented in Appendix N, Volume 3.

5.4.4 Sediment Quality Summary. A summary of the sediment sample organic test results is presented on Tables 5-10 and 5-11. Sediment sample analytical data reports are included in Appendix O, Volume 3. A total of five sample locations had detected HSL semivolatile (SV) compounds, with total PAH concentrations ranging from approximately 2300 ug/kg to 236000 ug/kg and are summarized as follows.

Sediment PAH Concentrations

| Sediment Location | Total PAH Compounds (ug/kg) |
|---|---|
| SD01 | 2300 |
| SD02 | 3000 |
| SD03 | 89700 |
| SD04 | 236000 |
| SD11 | 7700 |

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No concentrations of PAH compounds were detected at corresponding paired surface water sample locations. Detected compounds are defined as compounds detected above the method detection limit of the analytical technique. The background samples (Samples SCK-SD05-01 and SCK-SD05-02A) showed no detected HSL semivolatile organic compounds.

HSL volatile organic compounds (VOA) were detected at all five of the locations tested, including the background sample (SCK-SD05-01). However, acetone and methylene chloride were the only volatile organic compounds detected and were also detected in both laboratory and field blanks. Therefore, these compounds are considered common laboratory and field sampling contaminants.

As shown on Table 5-12, arsenic, iron, lead, and zinc were detected at most locations for both rounds although iron, lead, and zinc were detected at the two background sediment sample locations (SD05-01 and SD05-02A). Arsenic was detected at all six on-site sample locations, ranging from 6.2 to 34 mg/kg. Iron was detected at all five locations, ranging from 4400 mg/kg to 15000 mg/kg at the background location (SCK-SD05). Lead was detected at all seven sample locations, ranging from 10 mg/kg to 540 mg/kg at the background location. Zinc was also detected at all seven sample locations, ranging from 58 to 3300 mg/kg, with a background concentration of 630 mg/kg.

Cadmium was detected at one Round 1 location (Sample SCK-SD02-01) at 3 mg/kg and the background sample (Sample SCK-SD05-01) at 4.5 mg/kg. Chromium was found at six locations, ranging from 10 to 360 mg/kg, including a background

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concentration of 18 mg/kg. Copper was found at six locations ranging from 14 to 89 mg/kg, including a background concentration of 40 mg/kg. Mercury was detected at three locations, ranging from 0.29 mg/kg to 1.25 mg/kg at the background location. Nickel was detected at four locations, ranging from 15 mg/kg at the background location to 19 mg/kg. Thallium was detected at one location at 9 mg/kg (Sample SCK-SD03-01). Antimony, beryllium, cyanide, selenium, and silver were not detected at any location for either round.

The highest detected PAH concentrations were at the south end of the site at Sample SCK-SD04-02 (236,000 ug/kg). Sample location SCK-SD04 is situated near a mapped surficial soil staining area (Figure 3-5). However, PAH concentrations were also detected at an upstream, off-site sample location (SCK-SD11) at 7700 ug/kg and indicates possible minor contributions of PAH concentrations in on-site sediment samples from off-site sources. PAH concentrations were also detected at the southwest corner of the site at Sample SCK-SD03-02 (89,700 ug/kg). Sample location SCK-SD07 is situated near an active trucking firm and therefore PAH concentrations may be more indicative of current on-site operations. PAH concentrations were detected at sample location SCK-SD02 which is situated near a mapped surficial soil staining area (Figure 3-5). A comparison of the Round 1 and Round 2 semivolatile organic test data in Table 5-10 shows consistent results only at the background sample location, indicating relatively high sample variability compared to the surface water results.

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The types of detected sediment metals at all of the on-site sample locations were typically similar to detected background sediment metals. One exception was arsenic, which was not detected at the background location, but ranged from 6.2 to 34 mg/kg at on-site locations. However, the concentrations of detected on-site sediment metals appear higher relative to detected sediment background metals.

5.4.5 Previous Sediment Sampling. Previous sediment sampling was conducted by Camp Dresser & McKee (CDM) on February 2, 1983 for the Cavalcade Contaminant Survey. Four on-site sediment samples were taken at the locations indicated on Figure 5-3 and analyzed for EPA priority pollutant VOA, SV, cyanide, metals and pesticides/PCB. Methylene chloride was detected at all four locations from 48 ug/kg to 110 ug/kg, which CDM identified as a possible laboratory contaminant. However, the previous analytical data is considered as Level A EPA PRP chemical data and is therefore used on a generally qualitative basis.

Generally, similar semivolatile organic compounds were found in CDM samples at concentrations comparable to those for the Round 2 sediment samples. One location (CAV-SD-04) disclosed total PAH concentrations exceeding 100 mg/kg and corresponds to detected PAH compounds for a paired surface water sample (CAV-SW-01-012). The metals results were more variable relative to Round 1 and Round 2 samples, but generally indicated comparable levels for all metals. Arsenic was detected at all four sediment sample locations. The previous CDM sediment analytical data are summarized on Tables 5-13 and 5-14.

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## 5.5 References


1. Camp Dresser & McKee, Inc., Work Plan for South Cavalcade Street Remedial Investigation/Feasibility Study, Document No. 143-WP1-WPATEW-3, April 4, 1985.

2. Federal Emergency Management Agency, Flood Insurance Rate Map No. 4802960090C, September 27, 1985.

3. Koppers Company, Inc., Field Sampling and Analytical Plan, Remedial Investigation and Feasibility Study, Koppers South Cavalcade Site, Houston, Texas, October, 1985.

4. Koppers Company, Inc., Quality Assurance/Quality Control Plan for Remedial Investigation and Feasibility Studies at the Koppers South Cavalcade Site, Houston, Texas, September, 1985.

5. Camp Dresser & McKee, Inc., Cavalcade Contaminant Survey, Volume 1 - Engineering Report (Draft), July 11, 1983.


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TABLE 5-13
SUMMARY OF PREVIOUS DETECTED SEDIMENT SEMIVOLATILE ORGANIC COMPOUNDS (ug/kg)[1]

| COMPOUND | SD-01-008 | SD-02-007 | SD-03-010 | SD-04-011 |
|---|---|---|---|---|
| ACENAPHTHENE | 200 U | 200 U | 200 U | 580 |
| ANTHRACENE | 240 | 4700 | 1600 | 2100 |
| BENZO(A)ANTHRACENE | 550 | 440 | 620 | 18000 |
| BENZO(A)PYRENE | 500 | 250 | 600 | 5400 |
| 3,4-BENZOFLUORANTHENE[3] | 550 | 450 | 650 | 4800 |
| BENZO(GHI)PERYLENE | 430 | 500 U | 520 | 500 U |
| BENZO(K)FLUORANTHENE[3] | 550 | 440 | 650 | 2900 |
| BIS(2-ETHYLHEXYL)PHTHALATE | 210 | 200 U | 200 U | 200 U |
| CHRYSENE | 550 | 530 | 680 | 14000 |
| FLUORANTHENE | 1100 | 750 | 1200 | 25000 |
| FLUORENE | 200 U | 360 | 200 U | 520 |
| INDENO(1,2,3-CD)PYRENE | 320 | 500 U | 600 | 500 U |
| PHENANTHRENE | 650 | 200 U | 860 | 14000 |
| PYRENE | 850 | 690 | 1100 | 22000 |
| TOTAL PAH COMPOUNDS | 6290 | 8610 | 9080 | 109300 |

NOTES:
1. Analytical test data from Mead CompuChem report to CDM, dated February 24, 1983.
2. Sample prefix for SD and SW is CAV.
3. Analytical method cannot distinguish between 3,4-Benzofluoranthene and Benzo(k)fluoranthene. Total detected concentration is split between the two compounds.
4. SD = Sediment Sample

LEGEND:
U = Below Method Detection Limit





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TABLE 5-14
SUMMARY OF PREVIOUS DETECTED SEDIMENT INORGANICS (mg/kg)[1]

| COMPOUND | SD-01-008 | SD-02-007 | SD-03-010 | SD-04-011 | SD-05-006 |
|---|---|---|---|---|---|
| ARSENIC | 2.0 | 2.4 | 1.5 | 2.2 | 1.5 |
| BERYLLIUM | 0.2 | 0.55 | 0.29 | 0.48 | 0.19 |
| CADMIUM | 0.8 | 0.64 | 0.97 | 1.4 | 0.2 U |
| CHROMIUM | 10 | 13 | 12 | 9.7 | 6.8 |
| COPPER | 13 | 60 | 21 | 82 | 21 |
| CYANIDE | 0.39 U | 0.46 U | 0.37 U | 0.42 U | 0.44 U |
| LEAD | 61 | 88 | 69 | 185 | 20 |
| MERCURY | 0.025 | 0.043 | 0.032 | 0.017 | 0.006 |
| NICKEL | 4.5 | 4.9 | 5.4 | 9.1 | 2.7 |
| SILVER | 0.4 | 0.64 | 0.6 U | 0.58 | 0.6 U |
| THALLIUM | 0.5 U | 0.06 | 0.97 | NR | 0.5 U |
| ZINC | 160 | 150 | 150 | 260 | 30 |

NOTES:
1. Analytical test data from Mead CompuChem report to CDM, dated February 24, 1983.
2. Sample prefix for SD and SW is CAV.
3. NR = Not Reported
4. SD = Sediment Sample

LEGEND:
U = Below Method Detection Limit





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# SECTION 6.0 – SURFICIAL SOIL QUALITY EVALUATION

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# 6.0 SURFICIAL SOIL QUALITY EVALUATION

## 6.1 General

An evaluation of soil and groundwater quality at the South Cavalcade Site included separate assessments of surficial media and subsurface media. The surficial media evaluation included shallow soil quality (vadose zone), and is discussed in this section. Surficial soils are collectively defined as soils from 0-ft to 6-ft deep, which approximately delineates the unsaturated soils of the vadose zone, as described in Section 4.3.2. The subsurface media (saturated zone) evaluation included both soil and groundwater quality, and is discussed in Chapter 7.0.

An assessment of surficial soil quality at the South Cavalcade Site was conducted to evaluate (1) the character of the geophysical anomalies; and (2) potential surficial soil staining areas. The surficial soil quality evaluation is based on data obtained from the geophysical survey, auger soil borings, and soil borings.

## 6.2 Data Validation

Data validation of the surficial soil analytical data included a total of four soil samples. Data for two surficial soil samples were valid (V) and two were qualified (Q) for HSL semivolatile organic compounds. Data for all four surficial soil samples were valid (V) for HSL inorganic constituents. A discussion of both surficial and subsurface soil analytical data validation results is presented in Chapter 7.0.

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## 6.3 Surficial Soil Anomaly Evaluation

6.3.1 Electromagnetic Survey. As part of Subtask 2C of the RI/FS Work Plan, an electromagnetic survey was conducted to evaluate potential surficial soil anomaly areas. The geophysical survey was performed over approximately one-quarter of the site area, including undeveloped cleared areas and areas with asphaltic paving. Results of the survey were used to construct the geophysical anomalies map presented on Figure 3-3. As shown on the map, a total of 11 geophysical anomaly areas were mapped based on qualitative interpretation of measured apparent ground conductivity measurements. The anomaly locations appear to be distributed throughout the site area.

6.3.2 Shallow Auger Boring Program. The shallow auger boring program was conducted to evaluate the geophysical anomaly areas and to explore locations of selected previous plant facilities based on interpretation of historical aerial photographs and plant maps. Data from the shallow auger boring program were used to develop components of the subsequent soil boring program and were not used for site assessment purposes. The auger boring location map is presented on Figure 3-4 and includes a total of 139 auger borings. The shallow auger borings were drilled to an average depth of about 8 ft to evaluate soils throughout the vadose zone (unsaturated soils). Generally, one soil sample was collected from each auger boring for soil surrogate testing. Soil surrogate testing included X-ray fluorescence analysis for metals and headspace measurements for total organic vapors.

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Evaluation of the shallow auger boring data did not indicate the presence of potential surficial soil contaminant source areas such as hydrocarbon-saturated soils and non-aqueous phase liquids (NAPL). However, during the auger boring program, areas were disclosed containing soil staining. The results of the shallow auger boring program were used to prepare a preliminary surficial soil anomalies map. This map is presented on Figure 3-5. Surficial soil anomaly area boundaries are based upon visual notations of soil staining from the shallow auger borings, and are therefore approximate. The map was used to assist in locating areas for further investigation during the soil boring program and does not include analytical data appropriate for site assessment purposes.

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6.3.3 Soil Boring Program. The soil boring program was conducted to evaluate the preliminary surficial soil anomaly areas (Figure 3-5) and to assess subsurface (saturated zone) soil quality. The soil boring location map is presented on Figure 3-6 and includes a total of 82 soil borings. Soil samples were obtained at generally 2-ft continuous intervals to an average depth of about 64 ft. All soil samples were tested for total organic vapors by conducting headspace measurements. Approximately 4.7 samples per soil boring were screened for total aromatic hydrocarbon concentrations using fluorescence analysis. Selected soil samples were analyzed for HSL semivolatile organics, select HSL metals, iron, and cyanide.

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Visual observations of soil boring samples to a depth of about 6 ft did not indicate the presence of potential shallow soil source contaminant areas such as hydrocarbon-saturated soils and non-aqueous phase liquids (NAPL). However, during the soil boring program, surficial soil areas were disclosed containing soil staining.

## 6.4 Surficial Soil Analysis

Laboratory analyses of surficial soil samples were conducted to assist in evaluation of surficial soil quality. Both qualified (Q) and valid (V) data were used for the surficial soil quality evaluation. A total of four surficial soil samples were analyzed for HSL semivolatile organic compounds and select inorganics. One soil boring (A10-SB01) from the surficial soil quality evaluation is located in a paved area and three soil borings (A07-SB01, A13-SB01, A27-SB01) are located in unpaved areas. Samples A07-SB01-22, A10-SB01-02, and A13-SB01-02 were selected for analysis based on visual observations of oily materials, olfactory sensation of hydrocarbon odors, and laboratory photoionization detector responses. Sample A27-SB01-02 was selected based on its off-site location to obtain data for background conditions.

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6.4.1 Surficial Soil Analytical Results. A summary of the detected semivolatile organic compounds is presented in Table 6-1. Two of four analyzed surficial soil samples did not disclose detected HSL semivolatile compounds. A total of 15 different HSL polynuclear aromatic hydrocarbon (PAH) compounds were detected, ranging in concentrations from below method detection limit to 2100 mg/kg. Detected compounds are defined as compounds detected above the

TABLE 6-1
SUMMARY OF DETECTED SURFICIAL SOIL SEMIVOLATILE
ORGANIC COMPOUNDS (mg/kg)

| COMPOUND | A07-SB01-02 4' | A13-SB01-02 3.5' | A27-SB01-02[3] 4' |
|---|---|---|---|
| ACENAPHTHENE | 75 | 440 | 0.38 U |
| ACENEPHTHYLENE | 24 J | 62 J | 0.38 U |
| ANTHRACENE | 47 | 560 | 0.38 U |
| BENZO(A)ANTHRACENE | 29 | 340 | 0.38 U |
| BENZO(A)PYRENE | 24 U | 210 | 0.38 J |
| BENZO(B)FLUORANTHENE | 24 U | 290 | 0.38 U |
| BENZO(GHI)PERYLENE | 24 U | 77 | 0.38 U |
| BENZO(K)FLUORANTHENE | 43 | 62 U | 0.38 J |
| BIS(ETHYLHEXYL)PHTHALATE | 24 U | 62 J | 0.38 U |
| CHRYSENE | 38 | 310 | 0.38 J |
| DIBENZOFURAN | 47 | 280 | 0.38 U |
| DI-N-BUTYL PHTHALATE | 24 U | 62 U | 0.38 J |
| FLUORANTHENE | 99 | 1600 | 0.38 U |
| FLUORENE | 72 | 490 | 0.38 U |
| INDENO(1,2,3-CD)PYRENE | 24 J | 62 J | 0.38 U |
| 2-METHYLNAPHTHALENE | 68 | 200 | 0.38 U |
| NAPHTHALENE | 470 | 950 | 0.38 U |
| PHENANTHRENE | 300 | 2100 | 0.38 U |
| PYRENE | 98 | 1200 | 0.38 J |
| VALIDATION STATUS | Q | Q | V |
| TOTAL PAH COMPOUNDS | 1271 | 8567 | 0.38 U |

NOTES:
1. Q = Qualified
2. V = Valid
3. Background Sample

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit

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method detection limit of the analytical technique. Total surficial soils PAH concentrations ranged from below method detection limit (BDL) to 8567 mg/kg. Comparison with the results of five surficial soil samples taken from four previous Cavalcade Contaminant Survey soil borings disclosed total PAH compound concentrations ranging from below method detection limit to about 1246 mg/kg, as shown on Table 6-2. However, the previous analytical data is considered as Level A EPA PRP chemical data and is therefore used in a generally qualitative basis. The previous soil boring locations are shown on Figure 6-1. PAH organic constituents are listed in Table 6-3.

A summary of the surficial soil inorganic test results is presented in Table 6-4. Arsenic, copper, chromium, and zinc were chosen as soil inorganic indicators based on information from the site map on Figure 1-3, which indicates that Wolman (arsenic, copper, chromium) salts and zinc chloride were previously present onsite. Lead was also chosen as a soil inorganic indicator; although it appears to be ubiquitous to the site relative to the off-site background sample. Soil inorganic indicator concentration ranges are presented as follows and are compared with the results of an off-site background sample from Soil Boring A27-SB01:

Soil Inorganic Indicators

| Constituent | Range (mg/kg) | Background (mg/kg) |
|---|---|---|
| Copper | BDL to 5 | BDL |
| Chromium | BDL to 9.5 | BDL |
| Arsenic | BDL to 8.8 | BDL |
| Zinc | BDL to 3480 | 12.5 |
| Lead | BDL to 30.4 | BDL |

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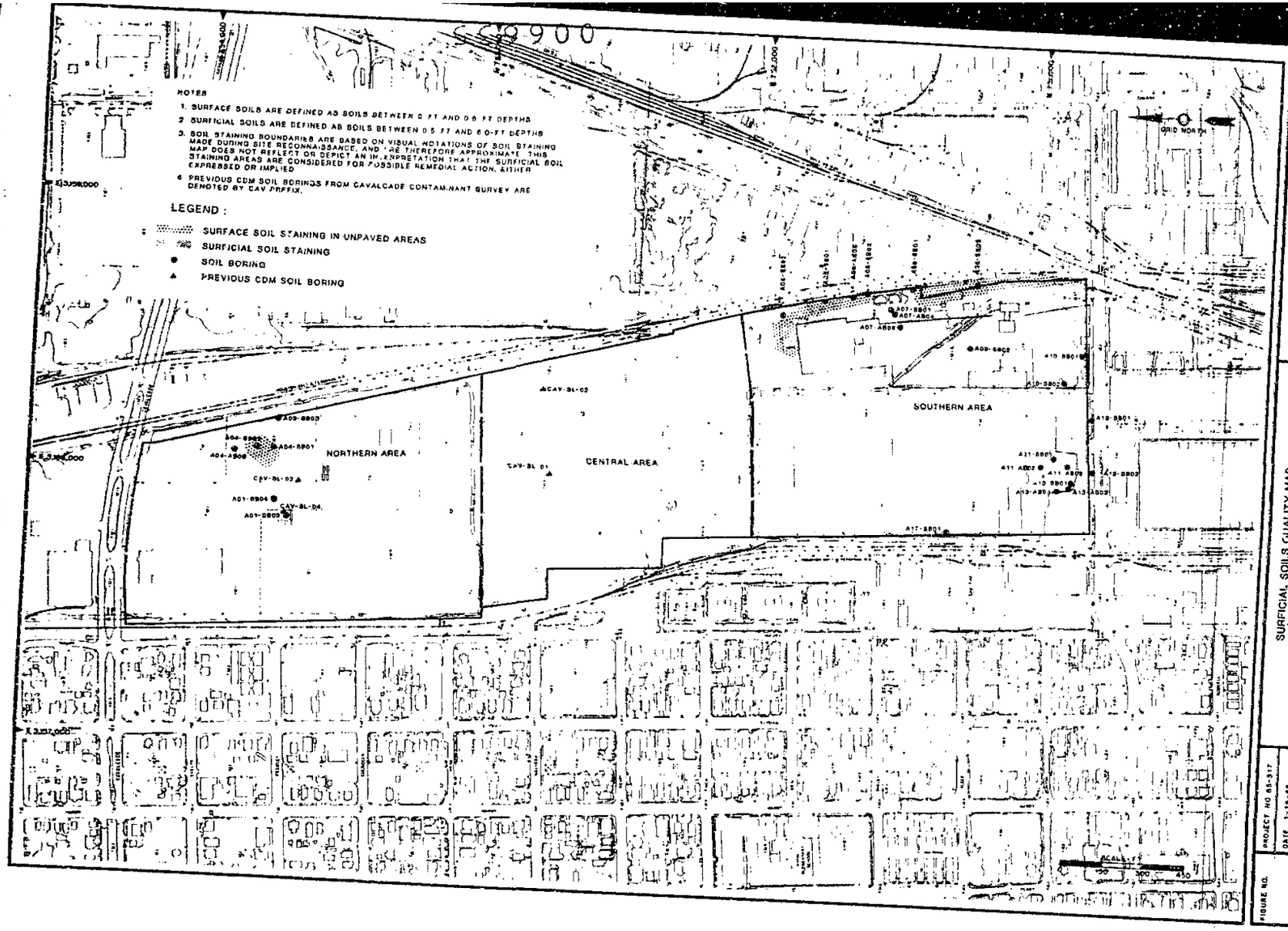


SURFICIAL SOILS QUALITY MAP
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

KOPPERS COMPANY, INC.

FIGURE NO. 6-1

PROJECT NO 65-317
DATE 1-15-88
ENGINEER
DRAWN BY

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TABLE 6-2
SUMMARY OF PREVIOUS DETECTED SURFICIAL SOIL SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)

| COMPOUND | SL-01-001 (Surficial) | SL-02-002 (Surficial) | SL-03-01 1' | SL-03-02 6' | SL-04-01 6' |
|---|---|---|---|---|---|
| ACENAPHTHENE | 0.2 U | 0.2 U | 0.78 | 0.2 U | 100 |
| ACENAPHTHYLENE | 0.2 U | 0.2 U | 2.4 | 0.28 | 3.0 |
| ANTHRACENE | 0.2 U | 0.2 U | 12 | 1.0 | 120[4] |
| BENZO(A)ANTHRACENE | 0.2 | 0.2 U | 32 | 5.6 | 17 |
| BENZO(A)PYRENE | 0.2 U | 0.2 U | 21 | 2.0 | 4.6 |
| 3,4-BENZOFLUORANTHENE[5] | 0.13 | 0.2 U | 23 | 3.4 | 10 |
| BENZO(GHI)PERYLENE | 0.5 U | 0.5 U | 7.2 | 1.6 | 5 U |
| BENZO(K)FLUORANTHENE[5] | 0.13 | 0.2 U | 23 | 3.4 | 10 |
| CHRYSENE | 0.2 | 0.2 U | 42 | 4.6 | 11 |
| DIBENZOFURAN | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 2 U |
| DI-N-OCTYL PHTHALATE | 0.2 U | 0.011 | 0.2 U | 0.2 U | 2 U |
| FLUORANTHENE | 0.2 U | 0.2 U | 120 | 24 | 260 |
| FLUORENE | 0.2 U | 0.2 U | 0.98 | 0.2 U | 80 |
| INDENO(1,2,3-CD)PYRENE | 0.5 U | 0.5 U | 7.2 | 1.8 | 5 U |
| 2-METHYLNAPHTHALENE | NR | NR | NR | NR | NR |
| NAPHTHALENE | 0.2 U | 0.2 U | 1.0 | 0.2 U | 340 |
| PHENANTHRENE | 0.2 U | 0.2 U | 20 | 5.8 | 120[4] |
| PYRENE | 0.01 | 0.2 U | 110 | 20 | 170 |
| TOTAL PAH COMPOUNDS | 0.67 | 0.2 U | 422.56 | 73.48 | 1245.60 |

NOTES:
1. Analytical test data from Mead CompuChem report to CDM, dated February 24, 1983.
2. Sample prefix for SL is CAV.
3. NR = Not reported.
4. Analytical method cannot distinguish between Anthracene and Phenanthrene. Total detected concentration is split between the two compounds.
5. Analytical method cannot distinguish between 3,4-Benzofluoranthene and Benzo(k)fluoranthene. Total detected concentration is split between the two compounds.

LEGEND:
U = Below Method Detection Limit

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TABLE 6-3
PAH ORGANIC CONSTITUENTS

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(ghi)perylene
Chrysene
Dibenzo(ah)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
Naphthalene
Phenanthrene
Pyrene

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TABLE 6-4
SUMMARY OF SURFICIAL SOIL INORGANICS (mg/kg)

| | A07-SB01-02 4' | A10-SB01-02 3.5' | A13-SB01-02 3.5' | A27-SB01-02[2] 4' |
|---|---|---|---|---|
| ARSENIC | 5 U | 8.8 | 5 U | 5.7 U |
| CHROMIUM | 5 | 9.5 | 7.5 | 4.5 U |
| COPPER | 4 U | 3.5 U | 5 | 4 U |
| CYANIDE | 1.5 U | 1.5 U | 1.5 U | 1.7 U |
| IRON | 3800 | 4970 | 5550 | 3640 |
| LEAD | 5 U | 6.3 | 30.4 | 2.8 U |
| ZINC | 4 U | 276 | 3480 | 12.5 |
| VALIDATION STATUS | V | V | V | V |

NOTES:
1. V = Valid
2. Background Sample

LEGEND:
U = Below Method Detection Limit

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Comparison with the results of the five surficial soil samples taken from the four previous Cavalcade Contaminant Survey soil borings disclosed concentrations of the inorganic indicators arsenic, chromium, copper, lead, and zinc, as shown on Table 6-5.

## 6.5 Surficial Soil Quality Evaluation

Results of both the auger boring and soil boring programs did not disclose evidence of potential surficial contaminant source areas, such as hydrocarbon-saturated soils and non-aqueous phase liquids (NAPL). Qualitative comparison of the soil boring data with the geophysical survey data indicates that the geophysical anomaly areas are generally a result of miscellaneous fill materials placed onsite. A review of the soil boring logs in Appendix F, Volume 2 indicates that fill materials were encountered in each soil boring located within a geophysical anomaly area, ranging from 2-ft to 4.5-ft depths. Soil borings are located in seven of a total of 11 geophysical anomaly areas. Listed as follows are soil borings located within geophysical anomaly areas shown on Figure 3-3 and their respective fill depths.

Soil Boring Fill Depths in Geophysical Anomaly Areas

| Geophysical Anomaly Area | Soil Boring | Fill Depth (ft) |
|---|---|---|
| A02 | A02-SB02 | 4 |
| A04 | A04-SB02 | 3 |
| | A04-SB03 | 3 |
| | A04-SB04 | 4.5 |
| | A04-SB09 | 2 |
| A13 | A13-SB01 | 4 |

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TABLE 6-5
SUMMARY OF PREVIOUS DETECTED SURFICIAL SOIL INORGANICS (mg/kg)

| METAL | SL-01-001 (Surficial) | SL-02-002 (Surficial) | SL-03-01 1' | SL-03-02 6' | SL-04-01 6' |
|---|---|---|---|---|---|
| ARSENIC | 0.35 | 2.5 | 82 | 1.5 | 1.8 |
| BERYLLIUM | 0.29 | 0.2 U | 0.2 | 0.2 | 0.26 |
| CADMIUM | 0.88 | 0.2 U | 0.1 | 0.2 U | 0.2 U |
| CHROMIUM | 12 | 7.6 | 79 | 14 | 14 |
| COPPER | 4.4 | 32 | 21 | 1.9 | 1.0 U |
| LEAD | 8.4 | 31 | 54 | 7.2 | 3.4 |
| MERCURY | 0.005 | 0.009 | 0.040 | 0.062 | 0.020 |
| NICKEL | 8.6 | 33 | 2.7 | 3.0 | 2.3 |
| SILVER | 0.7 | 0.6 U | 0.2 | 0.6 U | 0.6 U |
| THALLIUM | 0.05 U | 0.5 U | 0.1 | 0.5 U | 0.5 U |
| ZINC | 14 | 40 | 290 | 23 | 150 |

NOTES:
1. Prefix for SL is CAV.
2. Analytical data from Mead CompuChem report to CDM, dated February 24, 1983.

LEGEND:
U = Below Method Detection Limit

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Soil Boring Fill Depths in Geophysical Anomaly Areas

| Geophysical Anomaly Area | Soil Boring | Fill Depth (ft) |
|---|---|---|
| A16 | A16-SB02 | 3 |
| A19 | A19-SB01 | 3 |
| A24 | A04-SB10 | 3 |
| A26 | A26-SB01 | 4 |
| | A26-SB08 | 3 |

A surficial soils quality map is presented on Figure 6-1. The surficial soils quality map includes approximate areal distributions of both surface soil staining (0-ft to 0.5-ft) and surficial soil staining (0.5-ft to 6.0-ft). Criteria used to prepare the surficial soils quality map are summarized as follows:

1. Surface soils with observable soil staining and discoloration located within unpaved areas.

2. Surficial soils with detected PAH compounds (two samples).

3. Surficial soils with observable soil staining and positive surrogate test results (i.e., laboratory headspace measurements above 5 ppm or detected extractable fluorophores).

The soil quality distributions presented on Figure 6-1 are based on limited quantitative analytical test data and therefore qualitative surrogate test data and visual observations were used to supplement the data base. The surficial soil quality areas shown on Figure 6-1 do not reflect or depict an interpretation that the areas and their corresponding soil volumes are considered for possible remedial action, either expressed or implied.

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Preliminary interpretation of the surficial soils quality map shown on Figure 6-1 indicates potential areal visual soil staining in two distinct areas. Distributions throughout the northern portion of the site include two locations primarily in unpaved areas at Transcon Lines. This area also encompasses the general location of the aerial photograph anomaly observed in the 1964 aerial photograph shown on Figure 1-5. The estimated areal extent of visually stained surface soils throughout the northern area of the site is approximately 0.21 acres in unpaved areas. The estimated areal extent of visually stained surficial soils with positive surrogate test results is approximately 0.71 acres. The estimated areal extent of visually stained soils does not reflect or depict an interpretation that the areas and their corresponding soil volumes are considered for possible remedial action, either expressed or implied.

Soil staining areas throughout the southern portion of the site are primarily located at Palletized Trucking and the front of Merchants Fast Motor Lines. These areas also generally encompass the former locations of the site process areas shown on Figures 1-3 and 1-4. The estimated areal extent of visually stained surface soils throughout the southern area of the site is approximately 1.32 acres in unpaved areas. The estimated areal extent of visually stained surficial soils with positive surrogate test results is approximately 4.8 acres. The estimated areal extent of visually stained soils does not reflect or depict an interpretation that the areas and their corresponding soil volumes are considered for possible remedial action, either expressed or implied.

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## 6.6 Surficial Soil Quality Evaluation Summary

An assessment of surficial soil quality at the South Cavalcade Site indicates the following generalized conclusions:

1. No surficial soil contaminant source areas, such as hydrocarbon-saturated soils and NAPL, were disclosed from the electromagnetic geophysical survey, shallow auger boring program, or soil boring program.

2. Analytical testing of four selected surficial soil samples did not detect the presence of pentachlorophenol (PCP). Surficial soil organic compounds detected in two of the samples included primarily HSL PAH compounds, dibenzofuran, and 2-methylnaphthalene. Cyanide was not detected in the analyzed surficial soil samples.

3. Surficial soil quality areas with visual soil staining and positive surrogate test responses were typically distributed throughout two primary areas: (1) at the northern portion of the site (Transcon Lines), and (2) at the southern portion of the site (Palletized Trucking and Merchants Fast Motor Lines).

4. The estimated areal extent of visually stained <u>surface</u> soils is approximately 1.5 acres in unpaved areas. The estimated areal extent of visually stained <u>surficial</u> soils with positive

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surrogate test results is approximately 5.5 acres. The estimated areal extent of visually stained soils does not reflect or depict an interpretation that the areas and their corresponding soil volumes are considered for possible remedial action, either expressed or implied.

## 6.7 References

1. Camp Dresser and McKee; Work Plan for South Cavalcade Street, Houston, Texas, Remedial Investigation/ Feasibility Study, Document No. 143-WP1-WP-ATEW-3, April 4, 1985.

2. Camp Dresser and McKee, Inc., Cavalcade Contaminant Survey, Volume 1 - Engineering Report (Draft), July 11, 1983.

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# SECTION 7.0 – SUBSURFACE SOIL AND GROUNDWATER QUALITY EVALUATION

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# 7.0 SUBSURFACE SOIL AND GROUNDWATER QUALITY EVALUATION

## 7.1 General

An evaluation of subsurface quality at the South Cavalcade Site included assessment of soil and groundwater media. Both soil and groundwater quality data were composited to evaluate subsurface (saturated zone) quality. Separate evaluation of surficial soil quality (vadose zone) is presented in Chapter 6.0.

An evaluation of subsurface (below a 6-ft depth) soil quality was conducted to aid in the assessment of the lateral and vertical extent of potential subsurface migration. The primary objective of the subsurface soil quality evaluation was to qualitatively evaluate soil attenuation characteristics. The subsurface soil quality evaluation was based primarily on the analytical data from semivolatile organic test results from selected soil samples with additional data from selected soil surrogate test results. Valid (V) and Qualified (Q) soil analytical data were utilized to assist in developing a comprehensive groundwater monitoring program and to prepare a conceptual composite subsurface organic quality map. Assessment of subsurface soil quality was organized based on the three key geologic units discussed in Section 4.1.4. Generalized geologic profiles illustrating the delineation of the soil units are presented on Figures 4-4A to 4-4F. A soil boring location map is presented on Figure 3-6.

An assessment of groundwater quality at the South Cavalcade Site was conducted to evaluate (1) general groundwater chemistry; (2) lateral and vertical extent of potential subsurface migration; and (3) potential source areas. The groundwater quality evaluation was based upon analytical

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test results from two rounds of groundwater sampling. Evaluation of site hydrogeology, discussed in Section 4.3, identified three distinct water-bearing zones within the shallow sediments underlying the site:

Summary of Water-Bearing Zones

Shallow Zone

Intermediate Zone

Deep Zone

A generalized fence diagram illustrating the locations and depths of the water-bearing zones is shown on Figure 4-5. The groundwater monitoring program primarily included assessment of the upper-most water-bearing zone to evaluate shallow zone groundwater quality. Additional groundwater monitoring included assessment of a deep water-bearing zone believed to be the upper-most unit capable of yielding sufficient quantities of groundwater for domestic and commercial use. Groundwater monitoring well location maps are presented in Figures 3-6 and 3-7.

Data collected from the shallow zone and sand lenses within the intermediate aquitard are combined for presentation in this chapter. These data were combined because potential contaminants of concern were found in these two hydrogeological zones.

## 7.2 Data Validation

Data validation of the soil and groundwater analytical data were designated as follows:

Valid (V) - all criteria passed with acceptable results.

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Qualified (Q) - all criteria followed but matrix effects may affect results.

Invalid (I) - QA/QC criteria not followed or performed incorrectly.

Not Validated (NV) - no validation data available.

The data validation is based on criteria set forth in Appendix E, Volume 3, as discussed in Section 3.10. Sample validation is based on a review of the analytical data package and observations of laboratory procedures during audits. A summary of the soil sample validation results is presented as follows for both surficial and subsurface samples:

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Soil Sample Validation Results

| Fraction | Valid(V) | Qualified(Q) | Invalid(I) | Not Validated(NV) | Total |
|---|---|---|---|---|---|
| Semivolatiles[1] | 75 | 7 | 0 | 0 | 82 |
| Inorganics[2] | 82 | 0 | 0 | 2 | 84 |

Notes:

1. Acid fraction and base/neutral fraction obtained from one extraction and were validated as a whole.
2. Cyanide validation status not included in calculations. Cyanide validation status consists of 80 V, 2 Q, and 2 not analyzed.

A summary of the groundwater sample validation results is presented as follows:

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Groundwater Sample Validation Results

| Fraction | Valid(V) | Qualified(Q) | Invalid(I) | Not Validated(NV) | Total |
|---|---|---|---|---|---|
| Volatiles | 35 | 7 | 0 | 0 | 42 |
| Semivolatiles[1] | | | | | |
| Acid Fraction | 28 | 32 | 0 | 0 | 60 |
| Base/Neutral Fraction | 30 | 30 | 0 | 0 | 60 |
| Pesticides/PCBs | 41 | 3 | 0 | 0 | 44 |
| Inorganics | 52 | 8 | 0 | 0 | 60 |

Note:

1. Acid fraction and base/reutral fraction obtained from two separate extractions and were validated separately.

An evaluation of soil and groundwater completeness results is presented in Appendix E, Volume 3.

## 7.3 Soil and Groundwater Sampling Summary

A total of 88 selected soil samples (excluding two samples analyzed for inorganics only) were analyzed using EPA Contract Laboratory Program (CLP) protocol. A summary of the soil analytical test parameters is presented in Table 3-5. A total of 76 soil samples and 6 field duplicates were analyzed from the soil borings. Six additional soil samples were taken from the deep monitoring well borings (SCK-DW01 and SCK-DW02). A summary of the selected analytical soil samples is presented in Table 7-1. Soil boring sample analytical data reports are presented in Appendix P, Volume 3.

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TABLE 7-1
SUMMARY OF ANALYTICAL SOIL SAMPLES

| Sample No. | Geologic Unit No. | Depth(ft) | Date |
|---|---|---|---|
| SCK-A01-SB03-21 | 2 | 46 | 2-21-86 |
| SCK-A01-SB03-25 | 3 | 54 | 2-21-86 |
| SCK-A01-SB04-22 | 2 | 47 | 2-24-86 |
| SCK-A01-SB06-18 | 2 | 47.5 | 3-10-86 |
| SCK-A01-SB06-24 | 3 | 59.5 | 3-11-86 |
| SCK-A01-SB07-06 | 1 | 12 | 3-14-86 |
| SCK-A01-SB09-06 | 1 | 11.5 | 3-24-86 |
| SCK-A01-SB09-07 | 2 | 24 | 3-24-86 |
| SCK-A01-SB09-20 | 2 | 51.5 | 3-24-86 |
| SCK-A01-SB09-24 | 3 | 59.5 | 3-24-86 |
| SCK-A01-SB09-24MS/SPIKE | 3 | NA | 3-24-86 |
| SCK-A01-SB09-24MSD/DUP | 3 | NA | 3-24-86 |
| SCK-A01-SB10-07 | 2 | 23 | 3-25-86 |
| SCK-A01-SB11-16 | 2 | 40.5 | 3-26-86 |
| SCK-A01-SB12-06 | 1 | 11 | 7-28-86 |
| SCK-A01-SB12-21 | 3 | 52 | 7-28-86 |
| SCK-A01-SB13-08 | 2 | 27 | 7-30-87 |
| SCK-A01-SB13-08MS/SPIKE | 2 | NA | 7-30-87 |
| SCK-A01-SB13-08MSD/DUP | 2 | NA | 7-30-87 |
| SCK-A02-SB03-08 | 2 | 23.5 | 3-4-86 |
| SCK-A02-SB03-21 | 2 | 52.5 | 3-4-86 |
| SCK-A03-SB01-11 | 2 | 27.5 | 2-25-86 |
| SCK-A03-SB02-09 | 2 | 26 | 2-25-86 |
| SCK-A03-SB03-18 | 2 | 41 | 2-26-86 |
| SCK-A03-SB05-06 | 1 | 13 | 7-17-86 |
| SCK-A03-SB05-22 | 2 | 56.5 | 7-17-86 |
| SCK-A03-SB05-22MS/SPIKE | 2 | NA | 7-17-86 |
| SCK-A03-SB05-22MSD/DUP | 2 | NA | 7-17-86 |
| SCK-A03-SB05-24 | 3 | 60 | 7-17-86 |
| SCK-A03-SB07-18 | 2 | 48 | 7-30-86 |
| SCK-A03-SB07-23 | 3 | 58 | 7-30-86 |
| SCK-A04-SB01-06 | 1 | 10.5 | 3-5-86 |
| SCK-A04-SB03-27 | 3 | 61 | 3-7-86 |
| SCK-A04-SB05-21 | 3 | 54 | 3-13-86 |
| SCK-A05-SB01-19 | 2 | 50.5 | 4-30-86 |
| SCK-A06-SB01-19 | 2 | 45.5 | 4-22-86 |
| SCK-A06-SB01-19MS/SPIKE | 2 | NA | 4-22-86 |
| SCK-A06-SB01-19MSD/DUP | 2 | NA | 4-22-86 |
| SCK-A06-SB03-19 | 2 | 51.5 | 4-28-86 |
| SCK-A06-SB04-07 | 2 | 25 | 10-24-86 |
| SCK-A06-SB04-12 | 2 | 51 | 10-24-86 |
| SCK-A06-SB04-16 | 3 | 60.5 | 10-24-86 |

NOTES:
1. MS/SPIKE = Matrix Spike Organics/Spike Inorganics.
2. MSD/DUP = Matrix Spike Duplicate Organics/Duplicate Inorganics.

TABLE 7-1 (continued)
SUMMARY OF ANALYTICAL SOIL SAMPLES

| Sample No. | Geologic Unit No. | Depth(ft) | Date |
|---|---|---|---|
| SCK-A06-SB05-14 | 3 | 50 | 10-27-86 |
| SCK-A06-SB05-17 | 3 | 59 | 10-27-86 |
| SCK-A06-SB06-07 | 1 | 13.5 | 11-17-87 |
| SCK-A06-SB06-31 | 3 | 67.5 | 11-17-87 |
| SCK-A07-SB01-02 | 1 | 4 | 4-25-86 |
| SCK-A08-SB01-25 | 3 | 65.5 | 4-23-86 |
| SCK-A08-SB02-06 | 1 | 13 | 6-10-86 |
| SCK-A08-SB02-17 | 2 | 42.5 | 6-10-86 |
| SCK-A08-SB02-27 | 3 | 62 | 6-10-86 |
| SCK-A08-SB03-27 | 3 | 55 | 7-21-86 |
| SCK-A09-SB03-06 | 1 | 13.5 | 7-8-86 |
| SCK-A09-SB03-24 | 3 | 64 | 7-9-86 |
| SCK-A10-SB01-02 | 1 | 3.5 | 4-17-86 |
| SCK-A10-SB01-21 | 3 | 50.5 | 4-17-86 |
| SCK-A10-SB03-08 | 1 | 15 | 5-21-86 |
| SCK-A10-SB03-27 | 3 | 67.5 | 5-21-86 |
| SCK-A10-SB04-08 | 1 | 16 | 8-4-86 |
| SCK-A10-SB04-31 | 3 | 61.5 | 8-4-86 |
| SCK-A11-SB01-30 | 3 | 62.5 | 4-9-86 |
| SCK-A12-SB01-08 | 1 | 15.5 | 4-16-86 |
| SCK-A12-SB02-07 | 1 | 15.5 | 5-14-86 |
| SCK-A13-SB01-02 | 1 | 3.5 | 4-7-86 |
| SCK-A13-SB01-10 | 2 | 23 | 4-7-86 |
| SCK-A13-SB02-07 | 1 | 13.5 | 4-8-86 |
| SCK-A14-SB01-27 | 3 | 64 | 4-11-86 |
| SCK-A14-SB03-07 | 1 | 14 | 4-15-86 |
| SCK-A14-SB05-22 | 2 | 45.5 | 5-13-86 |
| SCK-A14-SB06-06 | 1 | 11.5 | 5-16-86 |
| SCK-A14-SB08-05 | 1 | 11.5 | 7-10-86 |
| SCK-A14-SB08-21 | 2 | 45.5 | 7-11-86 |
| SCK-A16-SB02-06 | 1 | 13 | 6-9-86 |
| SCK-A16-SB02-21 | 3 | 51.5 | 6-9-86 |
| SCK-A17-SB01-18 | 2 | 50 | 5-5-86 |
| SCK-A17-SB02-31 | 3 | 70 | 5-6-86 |
| SCK-A26-SB01-08 | 1 | 17.5 | 4-3-86 |
| SCK-A26-SB01-22 | 3 | 45.5 | 4-3-86 |
| SCK-A26-SB04-26 | 3 | 62.5 | 7-14-86 |
| SCK-A26-SB05-19 | 2 | 50 | 7-18-86 |
| SCK-A26-SB06-19 | 2 | 46 | 7-31-86 |
| SCK-A26-SB07-23 | 3 | 55.5 | 8-1-86 |

NOTES:
1. MS/SPIKE = Matrix Spike Organics/Spike Inorganics.
2. MSD/DUP = Matrix Spike Duplicate Organics/Duplicate Inorganics.

TABLE 7-1 (continued)
SUMMARY OF ANALYTICAL SOIL SAMPLES

| Sample No. | Geologic Unit No. | Depth(ft) | Date |
|---|---|---|---|
| SCK-A26-SB08-15 | 2 | 39.5 | 8-5-86 |
| SCK-A27-SB01-02 | 1 | 4 | 4-4-86 |
| SCK-A27-SB01-13 | 2 | 34 | 4-4-86(3) |
| SCK-A27-SB01-25 | 3 | 60 | 4-4-86(3) |
| SCK-A33-SB04-16 | 3 | 55.5 | 8-1-86 |
| (duplicate of SCK-A26-SB07-23) | | | |
| SCK-A35-SB09-15 | 3 | 70 | 5-6-86 |
| (duplicate of SCK-A17-SB02-31) | | | |
| SCK-A37-SB04-12 | 2 | 47.5 | 3-10-86 |
| (duplicate of SCK-A01-SB06-18) | | | |
| SCK-A37-SB05-21 | 2 | 23 | 4-7-86 |
| (duplicate of SCK-A13-SB01-10) | | | |
| SCK-A42-SB03-12 | 3 | 62 | 6-10-86 |
| (duplicate of SCK-A08-SB02-27) | | | |
| SCK-A43-SB01-15 | 3 | 67.5 | 11-17-86 |
| (duplicate of SCK-A06-SB06-31) | | | |
| SCK-DW01-28 | 4 | 143 | 10-8-86 |
| SCK-DW02-15 | 3 | 71 | 4-22-87 |
| SCK-DW02-28 | 4 | 140 | 4-28-87 |
| SCK-DW02-36 | 4 | 185 | 5-6-87 |
| SCK-DW02-38 | 4 | 191 | 5-7-87 |
| SCK-DW02-42 | 4 | 209 | 5-7-87 |

NOTES:
1. MS/SPIKE = Matrix Spike Organics/Spike Inorganics.
2. MSD/DUP = Matrix Spike Duplicate Organics/Duplicate Inorganics.
3. Inorganics analyzed only.

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Two rounds of groundwater sampling and analysis were conducted during the Remedial Investigation (RI). A summary of the groundwater analytical test parameters is presented in Table 3-6. Table 7-2 presents a summary of the shallow groundwater samples. A total of 29 Round 1 shallow groundwater samples were analyzed. Four Round 1 field duplicates, six field rinseate blanks, and six trip blanks were also analyzed. A total of 26 Round 2 samples were analyzed. Four Round 2 field duplicates, four field rinseate blanks, and three trip blanks were also analyzed.

A summary of the deep zone groundwater samples is presented in Table 7-3. A total of two Round 1 deep groundwater samples were analyzed. One field duplicate, one field rinseate blank, and one trip blank were also analyzed during Round 1. A total of two Round 2 samples were analyzed. One field duplicate and one field rinseate blank were also analyzed during Round 2. A Round 3 sample was obtained for HPLC analysis.

Groundwater sample analytical data reports are presented in Appendix Q, Volume 3. Separate presentations of soil and groundwater sample analytical summary tables are included in the Chapter 7.0 appendices, Appendix 7A and Appendix 7B, respectively.

## 7.4 General Groundwater Chemistry

General groundwater chemistry parameters were analyzed for samples obtained from the shallow and deep water-bearing zones to establish baseline groundwater chemistry characteristics. Groundwater chemistry data will also be utilized in conducting treatability studies and bench scale testing for evaluation of potential remedial alternatives during the Feasibility Study (FS).

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TABLE 7-2
SUMMARY OF SHALLOW ZONE GROUNDWATER SAMPLES

| Round 1 | Sample Date |
|---|---|
| SCK-MW01-001 | 12/10/86 |
| SCK-MW02-001 | 12/11/86 |
| SCK-MW03-001 | 12/10/86 |
| SCK-MW04-001 | 12/12/86 |
| SCK-MW05-001 | 9/11/87 |
| SCK-MW06-001 | 12/11/86 |
| SCK-MW07-001 | 12/11/86 |
| SCK-MW08-001 | 9/11/87 |
| SCK-MW08-001 MS/SPIKE | 9/11/87 |
| SCK-MW08-001 MSD/DUP | 9/11/87 |
| SCK-MW09-001 | 12/11/86 |
| SCK-MW09-001 MS/SPIKE | 12/11/86 |
| SCK-MW09-001 MSD/DUP | 12/11/86 |
| SCK-MW10-001 | 12/12/86 |
| SCK-MW11-001 | 12/10/86 |
| SCK-MW12-001 | 12/11/86 |
| SCK-MW13-001 (duplicate of CAV-OW02-001) | 12/12/86 |
| SCK-MW13-003 (duplicate of SCK-MW08-001) | 9/11/87 |
| SCK-MW14-001 | 12/11/86 |
| SCK-MW16-001 | 12/11/86 |
| SCK-MW17-001 (field blank) | 12/9/86 |
| SCK-MW18-001 (field blank) | 12/10/86 |
| SCK-MW18-003 (field blank) | 9/11/87 |
| SCK-MW19-001 (duplicate of SCK-MW01-001) | 12/10/86 |
| SCK-MW20-001 (duplicate of SCK-MW12-001) | 12/11/86 |
| SCK-MW21-001 (field blank) | 12/11/86 |
| SCK-MW22-001 (field blank) | 12/12/86 |
| SCK-MW23-001 | 12/9/87 |
| SCK-MW23-001 MS/SPIKE | 12/9/87 |
| SCK-MW23-001 MSD/DUP | 12/9/87 |
| SCK-MW23-002 (field blank) | 12/9/87 |

NOTES:
1. MS/SPIKE = Matrix Spike Organics/Spike Inorganics.
2. MSD/DUP = Matrix Spike Duplicate Organics/Duplicate Inorganics.

TABLE 7-2 (continued)
SUMMARY OF SHALLOW ZONE GROUNDWATER SAMPLES

| Round 1 | Sample Date |
|---|---|
| CAV-OW01-001 | 12/11/86 |
| CAV-OW02-001 | 12/12/86 |
| CAV-OW07-001 | 12/10/86 |
| CAV-OW08-001 | 12/12/86 |
| CAV-OW09-001 | 12/12/86 |
| CAV-OW10-001 | 12/9/86 |
| CAV-OW11-001 | 12/9/86 |
| CAV-OW13-001 | 12/11/86 |
| CAV-OW14-001 | 12/12/86 |
| SCK-P01-001 | 12/10/86 |
| SCK-P02-001 | 12/9/86 |
| SCK-P03-001 | 12/9/86 |
| SCK-P04-001 | 12/10/86 |
| SCK-P05-001 | 12/12/86 |
| Trip Blank 1 | 12/9/86 |
| Trip Blank 2 | 12/10/86 |
| Trip Blank 3 | 12/11/86 |
| Trip Blank 4 | 12/11/86 |
| Trip Blank 5 | 12/12/86 |
| Trip Blank 7 | 12/9/87 |

| Round 2 | Sample Date |
|---|---|
| SCK-MW01-002 | 2/5/87 |
| SCK-MW01-002 MS/SPIKE | 2/5/87 |
| SCK-MW01-002 MSD/DUP | 2/5/87 |
| SCK-MW02-002 | 2/5/87 |
| SCK-MW03-002 | 2/5/87 |
| SCK-MW04-002 | 2/5/87 |
| SCK-MW06-002 | 2/5/87 |
| SCK-MW07-002 | 2/5/87 |
| SCK-MW08-002 | 11/17/87 |
| SCK-MW08-002 MS/SPIKE | 11/17/87 |
| SCK-MW08-002 MSD/DUP | 11/17/87 |
| SCK-MW09-002 | 2/3/87 |
| SCK-MWA-Field Blank (field blank) | 11/17/87 |
| SCK-MW10-002 | 2/5/87 |
| SCK-MW11-002 | 2/5/87 |
| SCK-MW11-002 MS/SPIKE | 2/5/87 |
| SCK-MW11-002 MSD/DUP | 2/5/87 |
| SCK-MW12-002 | 2/4/87 |

NOTES:
1. MS/SPIKE = Matrix Spike Organics/Spike Inorganics.
2. MSD/DUP = Matrix Spike Duplicate Organics/Duplicate Inorganics.

TABLE 7-2 (continued)
SUMMARY OF SHALLOW ZONE GROUNDWATER SAMPLES

| Round 2 | Sample Date |
|---|---|
| SCK-MW13-002 (duplicate of SCK-MW16-002) | 2/4/87 |
| SCK-MW14-002 | 2/5/87 |
| SCK-MW16-002 | 2/4/87 |
| SCK-MW17-002 (field blank) | 2/3/87 |
| SCK-MW18-002 (field blank) | 2/4/87 |
| SCK-MW19-002 (duplicate of SCK-MW03-002) | 2/4/87 |
| SCK-MW20-002 (duplicate of SCK-MW07-002) | 2/5/87 |
| SCK-MW21-002 (field blank) | 2/5/87 |
| SCK-MW99 (duplicate of SCK-MW08-002) | 11/17/87 |
| CAV-OW01-002 | 2/4/87 |
| CAV-OW02-002 | 2/4/87 |
| CAV-OW07-002 | 2/4/87 |
| CAV-OW08-002 | 2/4/87 |
| CAV-OW09-002 | 2/4/87 |
| CAV-OW10-002 | 2/3/87 |
| CAV-OW11-002 | 2/3/87 |
| CAV-OW13-002 | 2/4/87 |
| CAV-OW14-002 | 2/4/87 |
| SCK-P01-002 | 2/5/87 |
| SCK-P02-002 | 2/3/87 |
| SCK-P03-002 | 2/3/87 |
| SCK-P04-002 | 2/4/87 |
| SCK-P05-002 | 2/4/87 |
| Trip Blank 8 | 2/3/87 |
| Trip Blank 9 | 2/4/87 |
| Trip Blank 10 | 2/5/87 |

NOTES:
1. MS/SPIKE = Matrix Spike Organics/Spike Inorganics.
2. MSD/DUP = Matrix Spike Duplicate Organics/Duplicate Inorganics.

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TABLE 7-3
SUMMARY OF DEEP ZONE GROUNDWATER SAMPLES

| Round 1 | Sample Date | Round 2 | Sample Date | Round 3 | Sample Date |
|---|---|---|---|---|---|
| SCK-DW02-001 | 6/10/87 | SCK-DW02-002 | 8/4/87 | CAV-OW06-003 (HPLC only)[3] | 6/10/87 |
| SCK-DW03-001 (duplicate of SCK-DW02-001) | 6/10/87 | SCK-DW02-003 (duplicate of SCK-DW02-002) | 8/4/87 | | |
| SCK-DW04-001 (field blank) | 6/10/87 | SCK-DW02-002 MS/SPIKE | 8/4/87 | | |
| Trip Blank 6 | 6/10/87 | SCK-DW02-002 MSD/DUP | 8/4/87 | | |
| CAV-OW06-001 | 12/10/86 | SCK-DW02-004 (field blank) | 8/4/87 | | |
| CAV-OW06-001 MS/SPIKE[1] | 12/10/86 | CAV-OW06-002 | 2/5/87 | | |
| CAV-OW06-001 MSD/DUP[2] | 12/10/86 | | | | |

NOTES:
1. MS/SPIKE = Matrix Spike Organics/Spike Inorganics.
2. MSD/DUP = Matrix Spike Duplicate Organics/Duplicate Inorganics.
3. HPLC = High Performance Liquid Chromatography.

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7.4.1 Shallow Zone Groundwater Chemistry. A total of eight monitoring wells were sampled from the shallow zone for groundwater chemistry testing. Results of the shallow zone groundwater chemistry testing are presented in Table 7-4. Trace concentrations of phenols (0.607 mg/l) were detected at Monitoring Well SCK-MW01. Elevated total organic carbon (TOC) concentrations were also observed at Monitoring Well SCK-MW01. Elevated nitrate concentrations were measured at Monitoring Well CAV-OW07 located near Cavalcade Street, indicating possible impacts from sanitary sewers.

Elevated concentrations of alkalinity, pH, potassium, conductivity, and nitrates were measured at Monitoring Well SCK-MW16, located offsite near American Warehouses, Inc. However, the relatively high concentrations of calcium, alkalinity and pH indicate possible grout intrusion into the monitoring well and therefore may not be representative of natural conditions.

7.4.2 Deep Zone Groundwater Chemistry. One sample from Monitoring Well CAV-OW06 was analyzed from the deep zone for groundwater chemistry parameters. Results of the deep zone groundwater chemistry analysis are presented in Table 7-5. Comparison of the test results were similar to the ranges in the shallow zone groundwater samples.

7.5 Subsurface Soil and Groundwater Quality Assessment

Assessment of subsurface soil and groundwater quality included organic and inorganic constituent assessments. Organic constituent assessments were based primarily upon

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TABLE 7-4
SUMMARY OF SHALLOW ZONE GROUNDWATER
CHEMISTRY PARAMETERS

| PARAMETER | MW01-001 | MW03-001 | MW07-001 | MW11-001 | MW16-001 | P01-001 | P04-001 | OW07-001 |
|---|---|---|---|---|---|---|---|---|
| ALKALINITY ($CaCO_3$) | | | | | | | | |
| mg/l at pH = 4.5 | 518.0 | 530.0 | 530.0 | 269.0 | 1146 | 163.0 | 228.0 | 318.0 |
| mg/l at pH = 8.3 | 0.0 | 0.0 | 0.0 | 0.0 | 1024 | 0.0 | 0.0 | 0.0 |
| AMMONIA (mg/l) | <1.00 | <1.00 | <1.00 | <1.00 | <1.00 | <1.00 | <1.00 | <1.00 |
| CALCIUM (mg/l) | 245 | 127 | 169 | 152 | 354 | 95.0 | 85.3 | 271 |
| CHLORIDE (mg/l) | 69.5 | 17.9 | 15.9 | 175 | 23.8 | 143 | 134 | 372 |
| CONDUCTIVITY (umhos/cm) | 790 | 670 | 870 | 780 | 4370 | 590 | 590 | 1610 |
| MAGNESIUM (mg/l) | 43.9 | 16.3 | 40.1 | 36.6 | <5.00 | 19.9 | 12.1 | 70.6 |
| NITRATE (mg/l) | <0.100 | <0.100 | <0.100 | <0.100 | 0.114 | <0.600 | <0.100 | 4.06 |
| pH | 6.3 | 6.2 | 6.9 | 7.3 | 12.2 | 7.3 | 7.5 | 6.3 |
| PHENOLS (mg/l) | 0.607 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| POTASSIUM (mg/l) | 6.61 | <5.00 | <5.00 | 21.9 | 129 | 5.58 | 11.2 | 6.84 |
| SODIUM (mg/l) | 92.7 | 79.2 | 65.0 | 97.5 | 81.2 | 83.3 | 109 | 195 |
| SULFATE (mg/l) | 20.0 | 40.5 | 68.9 | 49.3 | <10.0 | 25.3 | <10.0 | 64.7 |
| TOTAL DISSOLVED SOLIDS (mg/l) | 648 | 646 | 664 | 570 | 1148 | 452 | 496 | 1450 |
| TOTAL ORGANIC CARBON (mg/l) | 118 | 2.55 | 8.14 | 3.30 | 13.1 | 1.82 | 1.37 | 34.3 |





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16 select polynuclear aromatic hydrocarbon (PAH) compounds (Table 6-2) and aromatic volatile organics (benzene, toluene, ethylbenzene, styrene, xylene). Certain volatile and semivolatile organic compounds are commonly associated with laboratory contaminants encountered during analytical testing (i.e. methylene chloride, acetone, phthalates, etc.). These compounds are generally not associated with coal tars and coal tar distillates; therefore these constituents are not included in evaluation of subsurface soil and groundwater quality.

Inorganic constituent assessments were made based on qualitative comparisons of representative background conditions. Inorganic constituents were detected at selected off-site locations not considered to be potentially impacted by the former site operations and are therefore considered as natural or background conditions. Assessment of inorganic constituents was made by comparing detected inorganic indicators (copper, chromium, arsenic, zinc, lead) to representative background concentrations. Copper, chromium, arsenic, and zinc were selected as inorganic indicators because of their common useage as inorganic salts in wood preservatives. Lead was included as an inorganic indicator, although it appears to be ubiquitous to the site area (Section 2.4.3). Soil Borings SCK-A27-SB01 (Unit 1) and SCK-A01-SB13 (Unit 2) were chosen as the locations representative of background soil inorganic conditions. Monitoring Well SCK-MW07 was chosen as the location representative of background (upgradient) groundwater inorganic conditions for the shallow zone. The representative background soil boring and groundwater monitoring well locations are situated offsite at locations not previously utilized for wood preserving or coal tar distillation operations.

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TABLE 7-5
SUMMARY OF DEEP ZONE GROUNDWATER
CHEMISTRY PARAMETERS

| PARAMETER | OW06-001 |
|---|---|
| ALKALINITY ($CaCO_3$) | |
| mg/l at pH = 4.5 | 518.0 |
| mg/l at pH = 8.3 | 0.0 |
| AMMONIA(mg/l) | <1.00 |
| CALCIUM(mg/l) | 48.6 |
| CHLORIDE(mg/l) | 84.4 |
| CONDUCTIVITY(umhos/cm) | 505 |
| MAGNESIUM(mg/l) | 15.1 |
| NITRATE(mg/l) | <0.100 |
| pH | 7.0 |
| PHENOLS(mg/l) | 0.017 |
| POTASSIUM(mg/l) | <5.00 |
| SODIUM(mg/l) | 50.6 |
| SULFATE(mg/l) | <10.00 |
| TOTAL DISSOLVED SOLIDS(mg/l) | 350 |
| TOTAL ORGANIC CARBON(mg/l) | 15.6 |

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Summaries of the soil and groundwater analytical data are presented in Appendix 7A and 7B tables at the end of this chapter. The tables summarize only samples in which at least one organic or inorganic constituent was detected. Samples with no detected constituents for a particular analytical fraction (semivolatiles, volatiles, inorganics) are not presented in the tables.

## 7.6 Unit 1 Soil and Groundwater Quality Evaluation

A composite evaluation of Unit 1 soil and groundwater quality was conducted to aid in the assessment of potential subsurface migration. Unit 1 extends to an average depth of 21 ft and includes deposits from the shallow water-bearing zone. The Unit 1 subsurface quality evaluation is based upon (1) Unit 1 soil analytical test data; and (2) shallow zone groundwater analytical test data. The primary objective of the Unit 1 subsurface quality evaluation was to qualitatively assess potential PAH and metals distribution locations within the Unit 1 saturated deposits (below 6-ft depth). Additional subsurface quality data from selected soil surrogate analytical testing was used in conjunction with the soil and groundwater analytical data to complete data gaps. Valid (V) and qualified (Q) soil and groundwater analytical data were utilized for delineation of subsurface PAH compounds, aromatic volatile organic compounds (AVOC), and selected indicator metals.

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7.6.1 Unit 1 Soil Quality. A summary of the detected Unit 1 soil semivolatile organic compounds is presented in Table 7A-1, located in Chapter 7.0, Appendix 7A. A total of 13 different HSL semivolatile organic compounds were detected above the method detection limit, including 9 of the 16

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select PAH compounds listed in Table 6-2. Detected Unit 1 soil PAH concentrations were disclosed at the following soil boring locations:

Unit 1 Soil PAH Concentrations

| Soil Boring | Total PAH Compounds (mg/kg) |
|---|---|
| A04-SB01 | 2503 |
| A09-SB03 | 93 |
| A12-SB01 | 5020 |
| A13-SB02 | 2269 |
| A14-SB03 | 133 |

Total Unit 1 soil PAH concentrations ranged from below method detection limits to 5020 mg/kg at Soil Boring A12-SB01. Soil analytical test reports are included in Appendix P, Volume 3.

A summary of the Unit 1 subsurface soil (below 6-ft depth) inorganic concentrations is presented in Table 7A-2. Soil inorganic indicator ranges are presented as follows and are compared with the results of an off-site background sample (A27-SB01-02):

Unit 1 Soil Inorganic Indicators

| Constituent | Detected Range (mg/kg) | Detected Background Concentration (mg/kg) |
|---|---|---|
| Copper | BDL to 8 | BDL |
| Chromium | BDL to 10.4 | BDL |
| Arsenic | BDL | BDL |
| Zinc | BDL to 250 | 12.5 |
| Lead | BDL to 6.2 | BDL |
| | | Total = 12.5 mg/kg |

Detected Unit 1 soil total inorganic indicator (copper, chromium, arsenic, zinc, lead) concentrations ranged from below method detection limits to 256 mg/kg at Soil Boring

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A13-SB02. A review of the off-site background sample at Soil Boring A27-SB01 indicates a total inorganic indicator concentration of 12.5 mg/kg. A total of six of the 18 Unit 1 soil samples analyzed for HSL metals disclosed total inorganic indicator concentrations greater than 12.5 mg/kg and are presented as follows:

Unit 1 Soil Borings - Inorganic Indicators

A10-SB04
A12-SB02
A13-SB02
A14-SB03
A14-SB06
A26-SB01

7.6.2 Shallow Zone Groundwater Quality. A summary of the detected shallow zone groundwater semivolatile organic compounds is presented in Table 7B-1, located in Chapter 7.0, Appendix 7B. A total of 16 of 29 shallow zone groundwater wells showed detected polynuclear aromatic hydrocarbon (PAH) compounds. Detected shallow zone groundwater PAH concentrations were disclosed at the following monitoring well locations:

| Monitoring Well | Total PAH Compounds (ug/l)(1) |
|---|---|
| MW01 | 3684 |
| MW02 | 14960 |
| MW04 | 774 |
| MW06 | 2110000 |
| MW08 | 155 |
| MW10 | 4700 |
| MW12 | 15100 |
| MW14 | 867000 |
| P02 | 8730 |
| P03 | 288000 |
| P05 | 2800 |
| OW01 | 285 |
| OW02 | 26000 |

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| Monitoring Well | Total PAH Compounds (ug/l)(1) |
|---|---|
| OW10 | 93200 |
| OW11 | 21950000 |
| OW14 | 9200 |

(1) Total PAH compounds reported as the greater of the Round 1 and Round 2 samples and the greater of the sample of record and the field duplicate.

Total shallow zone PAH groundwater concentrations ranged from below method detection limits to 21950 mg/l at Monitoring Well CAV-OW11. No concentrations of pentachlorophenol (PCP) were detected in any of the shallow zone groundwater samples. Groundwater analytical test reports are included in Appendix Q, Volume 3.

A review of the listed shallow zone monitoring well locations shows that the shallow zone groundwater PAH concentrations are found throughout the site. A groundwater total PAH concentration map is presented on Figure 7-1. The highest measured shallow zone total PAH groundwater concentration was detected at Monitoring Well CAV-OW11 (21950 mg/l) and is located at the southeastern portion of the site, near the former plant process area. Round 2 PAH concentrations at Monitoring Well CAV-OW11 were greatly reduced (21.8 mg/l). Non-aqueous phase liquids (NAPL) were noted in the Monitoring Well CAV-OW11 during Rounds 1 and 2 sampling and could account for PAH concentration variability between sampling rounds. Notations of NAPL were also recorded at Monitoring Wells SCK-P03 and SCK-MW14. Additionally, accumulations of NAPL denser than water were noted in Monitoring Wells SCK-P03 and CAV-OW11 on June 16, 1988.

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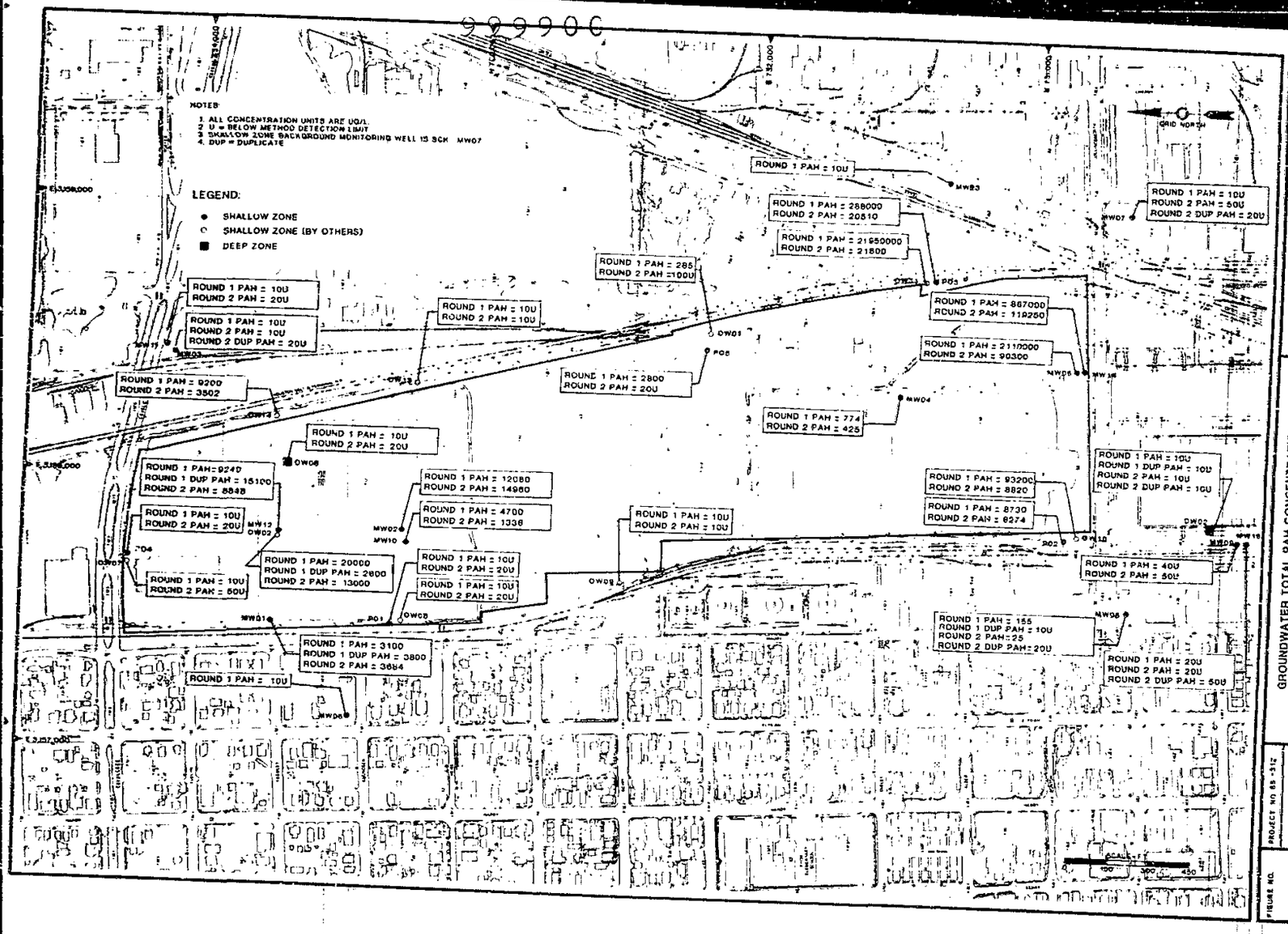


GROUNDWATER TOTAL PAH CONCENTRATIONS
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.

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PROJECT NO 88-312
DATE 4-14-89
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FIGURE NO. 7-1

A comparison of the shallow zone groundwater PAH distributions at paired monitoring well locations is presented as follows:

Shallow Zone Groundwater PAH Comparisons

| Shallow Monitoring Well | Total Detected PAH Compounds (ug/l) | | Paired Monitoring Well | Total Detected PAH Compounds (ug/l) | |
|---|---|---|---|---|---|
| | Round 1 | Round 2 | | Round 1 | Round 2 |
| MW02 | 12080 | 14960 | MW10 | 4700 | 1336 |
| MW03 | 10 U | 10 U | MW11 | 10 U | 20 U |
| MW06 | 2110000 | 90300 | MW14 | 867000 | 119250 |
| MW09 | 40 U | 50 U | MW16 | 20 U | 20 U |
| OW01 | 285 | 100 U | P05 | 2800 | 20 U |
| OW02 | 20000 | 13000 | MW12 | 15100 | 8848 |
| OW07 | 10 U | 50 U | P04 | 10 U | 20 U |
| OW08 | 10 U | 20 U | P01 | 10 U | 20 U |
| OW10 | 93200 | 8820 | P02 | 8730 | 6274 |
| OW11 | 23250000 | 21800 | P03 | 288000 | 20510 |

A review of the shallow zone groundwater PAH comparisons at paired monitoring well locations indicates that all shallow wells with detected PAH concentrations correspond to deeper monitoring wells with detected PAH concentrations. The paired wells consist of a monitoring well screened in the shallow zone and a nearby monitoring well screened in the sand lens within the intermediate aquitard. A review of the Round 1 and Round 2 groundwater results generally indicates reduced total PAH concentrations in the wells located in the deeper discontinuous sand and silt layers. Although all shallow zone monitoring wells with detected total PAH concentrations disclosed corresponding deeper monitoring wells with total PAH concentrations, it appears that total PAH concentrations are partially attenuated below the shallow zone.

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Comparison with the results of two shallow zone groundwater samples from the previous Cavalcade Contaminant Survey disclosed detected PAH compounds at Monitoring Wells CAV-OW01 and CAV-OW02, as shown on Table 7B-2. The total PAH groundwater concentrations were reported to be 1.009 mg/l at Monitoring Well CAV-OW01 and 18.040 mg/l at Monitoring Well CAV-OW02 which are generally comparable to the results report for the South Cavalcade Remedial Investigation (Table 7B-1). Pentachlorophenol was detected in a groundwater sample from Monitoring Well CAV-OW02 at a concentration of 0.066 mg/l, but was not detected in two sampling rounds during the Remedial Investigation.

Shallow zone groundwater aromatic volatile organic compounds (benzene, toluene, ethylbenzene, styrene, xylene) were detected at 10 of 29 shallow zone monitoring well locations, as listed on Table 7B-3. Detected shallow zone groundwater aromatic volatile organic compounds (AVOC) were disclosed at the following monitoring well locations:

| Monitoring Well | Total Aromatic Volatile Organic Compounds (ug/l) |
|---|---|
| MW01 | 108 |
| MW02 | 770 |
| MW06 | 2696 |
| MW10 | 8 |
| MW14 | 1470 |
| P03 | 1540 |
| OW02 | 42 |
| OW10 | 3150 |
| OW11 | 2696 |
| OW14 | 56 |

A groundwater total aromatic volatile compound concentration map is presented on Figure 7-2. The highest measured groundwater total aromatic volatile organic concentration was detected at Monitoring Well CAV-OW10 (3150 ug/l).

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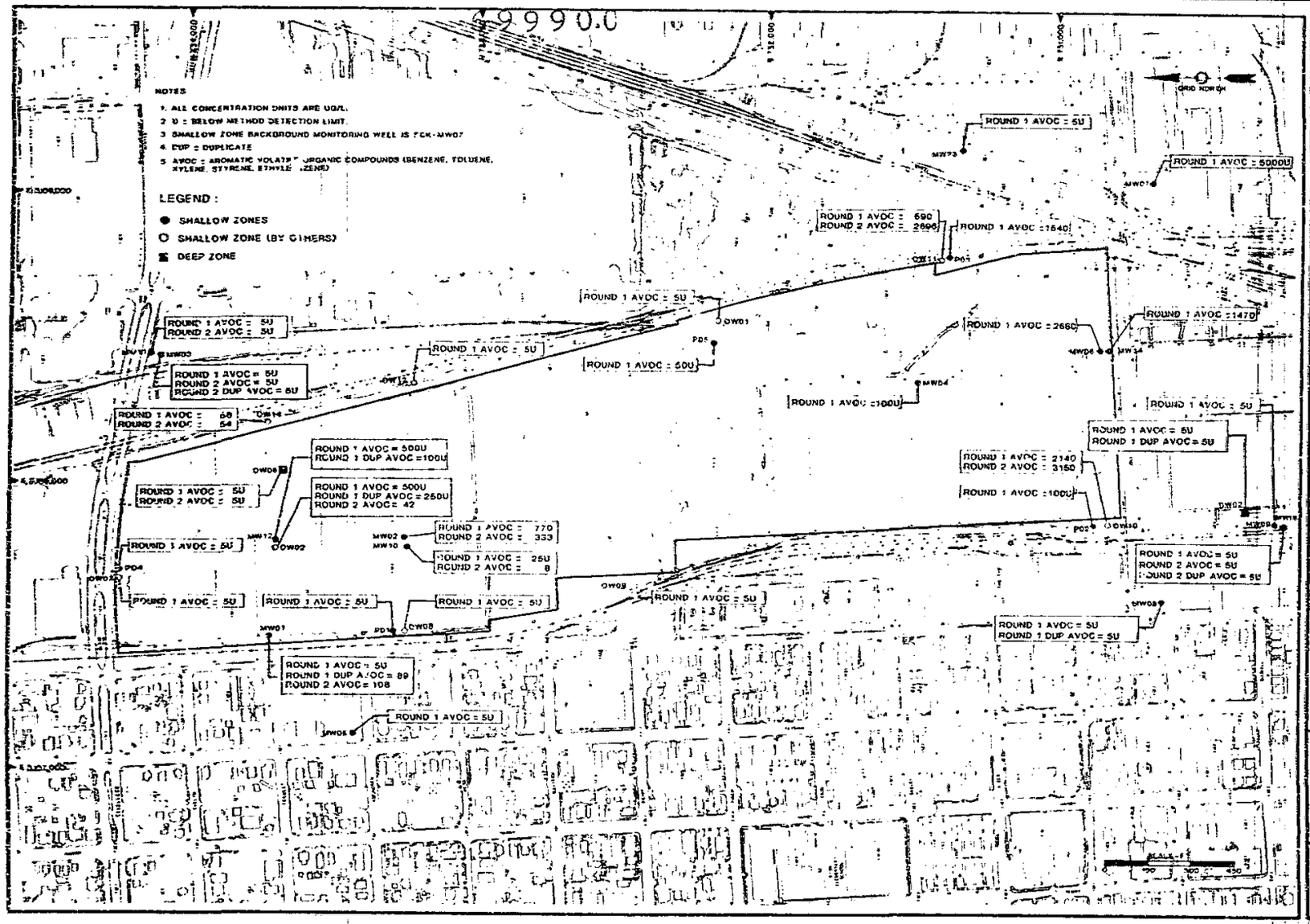


GROUNDWATER TOTAL AROMATIC VOC CONCENTRATIONS

SOUTH CAVALCADE SITE

HOUSTON, TEXAS

KOPPERS COMPANY, INC.

FIGURE NO 7-2

PROJECT NO

DATE 4-14-88

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Comparison with the results of two groundwater samples from the previous Cavalcade Contaminant Survey disclosed shallow zone groundwater concentrations of benzene, ethylbenzene, and toluene at Monitoring Well CAV-OW02, as shown in Table 7B-4. Total aromatic volatile organic compounds from the previous sample were reported to be 189 ug/l, which is greater than concentrations detected during the Remedial Investigation (42 ug/l).

A review of detected aromatic volatile organic compounds for shallow zone groundwater samples reported in Table 7B-3 indicates corresponding detected shallow zone PAH compounds at all seven well locations in Table 7B-1. Therefore, the shallow zone PAH concentrations are considered as representative shallow zone indicator compounds for the purpose of this section of the RI report.

A summary of the shallow zone groundwater inorganic concentrations is presented in Table 7B-5. However, evaluation of groundwater inorganic quality must be qualified to account for sample representativeness. The groundwater samples were not filtered, either in the field or in the laboratory, prior to analysis. In addition, the samples were placed into acidified containers prior to analysis. The resulting analyses are more representative of total inorganics due to the potential for both dissolved and suspended particulate materials present in the samples. The suspended particulates may yield results more representative of soil media than actual groundwater conditions.

A summary of the shallow zone groundwater inorganic indicator ranges is presented as follows and is compared with the results of an off-site background location (Monitoring Well SCK-MW07):

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## Shallow Zone Inorganic Indicators

| Constituent | Detected Range (ug/l) | Detected Background Concentration (ug/l) |
|---|---|---|
| Copper | BDL to 1340 | 17 |
| Chromium | BDL to 450 | 30 |
| Arsenic | BDL to 522 | 55 |
| Zinc | BDL to 1180 | 109 |
| Lead | BDL to 257 | 34 |

Total = 245 ug/l

Detected shallow zone groundwater total inorganic indicator (copper, chromium, arsenic, zinc, lead) concentrations range from below method detection limits to 2316 ug/l at Monitoring Well SCK-MW06. A review of the off-site background (upgradient) groundwater samples at Monitoring Well SCK-MW07 indicates a total inorganic indicator concentration of 245 ug/l. A total of 14 of the 29 shallow zone groundwater monitoring well locations disclosed total inorganic indicator concentrations greater than 245 ug/l and are presented as follows:

## Shallow Zone Wells - Inorganic Indicators

MW01
MW02
MW06
MW08
MW09
MW11
MW12
MW14
OW01
OW07
OW08
OW10
OW11
OW14

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A groundwater inorganic indicator concentration map is presented on Figure 7-3. The highest measured inorganic indicator totals were detected at Monitoring Well SCK-MW06 (2616 ug/l) located at the southern portion of the site, near the former plant process area.

Comparison with the results of two shallow zone groundwater samples from the previous Cavalcade Contaminant Survey disclosed concentrations of copper, cyanide, arsenic, and zinc at Monitoring Wells CAV-OW01 and CAV-OW02, as shown on Table 7B-6. Cyanide was detected at both monitoring wells at concentrations ranging from 10 to 700 ug/l, but was not detected in two sampling rounds during the Remedial Investiation.

A summary of the detected shallow zone groundwater pesticides/PCB compounds is presented in Table 7B-7. A total of three HSL pesticides were detected above the method detection limit and are presented as follows with the corresponding maximum detected concentrations:

1. Beta-BHC - 110 ug/l
2. 4,4'-DDE - 8.1 ug/l
3. Endosulfan I - 0.15 ug/l

A total of four shallow zone groundwater monitoring wells disclosed pesticide concentrations and are presented as follows:

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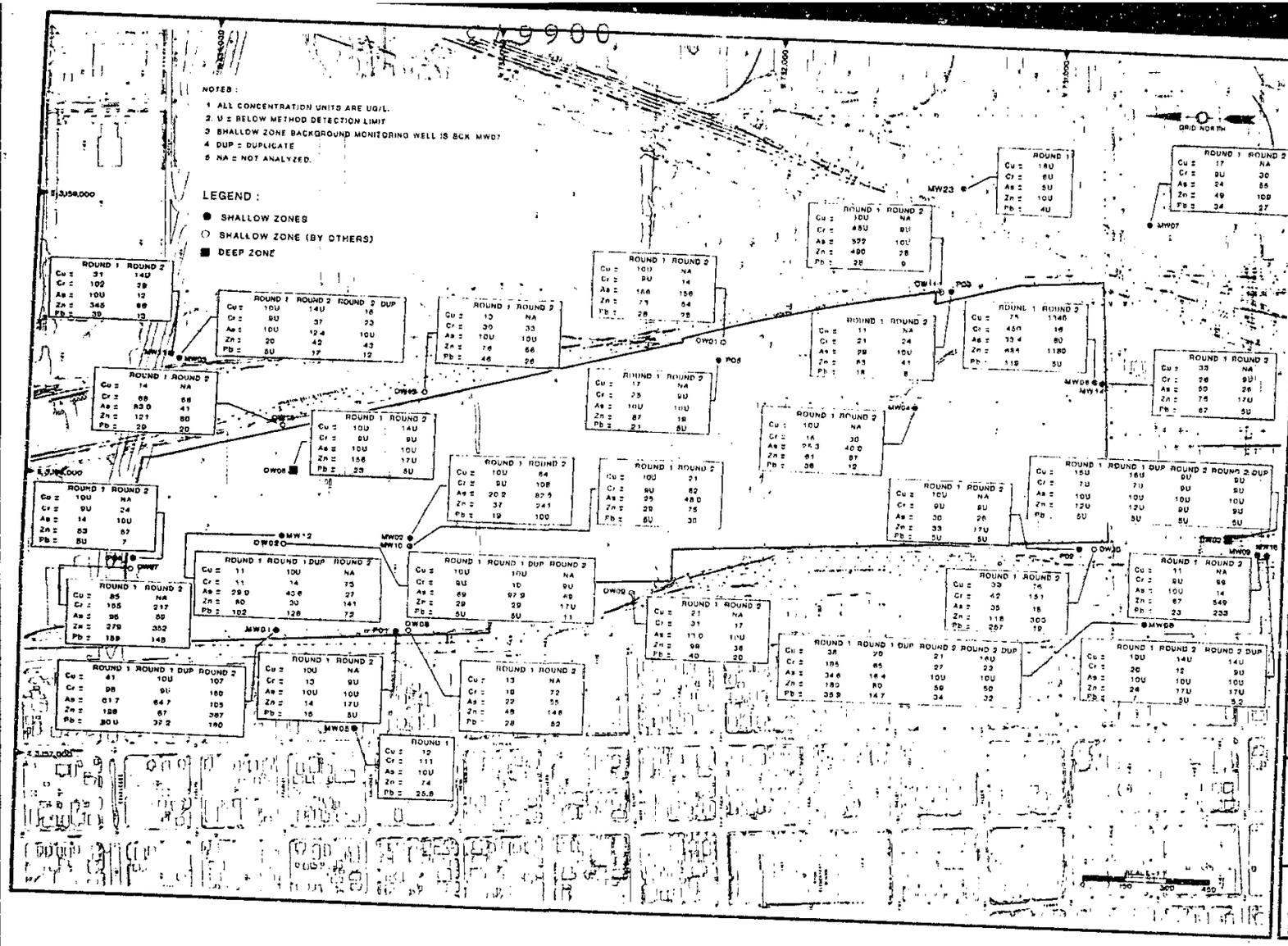


GROUNDWATER INORGANIC INDICATOR CONCENTRATIONS
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.

Page 7-28

FIGURE NO 7-3
PROJECT NO 85-317
DATE 4-14-88
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Shallow Zone Wells - Pesticides

MW02
MW06
MW14
OW01

A review of the listed shallow monitoring well locations shows no specific pesticide distribution pattern. No HSL PCB aroclors (7) were detected in any of the shallow zone groundwater samples.

## 7.7 Unit 2 Soil Quality Evaluation

An evaluation of Unit 2 soil quality was conducted to aid in the assessment of potential subsurface migration. The primary objective of the Unit 2 subsurface quality evaluation was to qualitatively assess potential PAH and metals distribution locations within the Unit 2 saturated deposits. Additional subsurface quality data from selected soil surrogate analytical testing was used in conjunction with the soil analytical data to complete data gaps. Valid (V) and qualified (Q) soil analytical data were utilized for delineation of subsurface PAH compounds and selected indicator metals.

7.7.1 Unit 2 Soil Quality. A summary of the detected Unit 2 soil semivolatile compounds is presented in Table 7A-3, located in Chapter 7.0 Appendix 7A. A total 14 of 30 Unit 2 soil samples analyzed for HSL semivolatile organics disclosed no detected PAH compounds. Detected Unit 2 soil PAH concentrations were disclosed at the following soil boring locations:

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## Unit 2 Soil PAH Concentrations

| Soil Boring | Total PAH Compounds (mg/kg) |
|---|---|
| A01-SB03 | 31 |
| A01-SB04 | 0.38 |
| A01-SB06 | 708 |
| A01-SB09 | 448 |
| A02-SB03 | 301 |
| A03-SB01 | 20 |
| A03-SB02 | 38 |
| A03-SB05 | 0.55 |
| A05-SB01 | 6 |
| A06-SB01 | 29 |
| A06-SB03 | 28 |
| A06-SB04 | 5 |
| A13-SB01 | 259 |

Total Unit 2 soil PAH concentrations ranged from below method detection limits to 708 mg/kg at Soil Boring A01-SB06. Soil analytical test reports are included in Appendix P, Volume 3.

A summary of the Unit 2 soil inorganic concentrations is presented in Table 7A-4. Soil inorganic indicator ranges are presented as follows and are compared wih the results of an off-site background sample (A01-SB13-08):

## Unit 2 Soil Inorganic Indicators

| Constituent | Detected Range (mg/kg) | Detected Background Concentration (mg/kg) |
|---|---|---|
| Copper | BDL to 14 | 8.38 |
| Chromium | BDL to 28 | 17.4 |
| Arsenic | BDL to 16 | 10.9 |
| Zinc | BDL to 64 | 40.1 |
| Lead | BDL to 44.5 | 2.52 |
| | TOTAL = | 79.3 mg/kg |

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Detected Unit 2 soil total inorganic indicator (copper, chromium, arsenic, zinc, lead) concentrations ranged from below method detection limits to 126 mg/kg at Soil Boring A26-SB08. A review of the off-site background sample at Soil Boring A01-SB13 indicates a total inorganic indicator concentration of 79.3 mg/kg. A total of four of the 31 Unit 2 soil samples analyzed for HSL metals disclosed total inorganic indicator concentrations greater than 79.3 mg/kg and are presented as follows:

Unit 2 Soil Borings - Inorganic Indicators

A01-SB09
A03-SB01
A26-SB08
A27-SB01

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## 7.8 Unit 3 Soil Quality Evaluation

An evaluation of Unit 3 soil quality was conducted to aid in the assessment of potential subsurface migration. The Unit 3 subsurface quality evaluation is based upon soil analytical test data. The primary objective of the Unit 3 subsurface quality evaluation was to assess the vertical extent of PAH and metals in the upper portion of Unit 3.

Additional subsurface quality data from selected soil surrogate analytical testing was used in conjunction with the soil analytical data to complete data gaps. Valid (V) and qualified (Q) soil analytical data were utilized for delineation of subsurface PAH compounds and selected indicator metals.

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7.8.1 Unit 3 Soil Quality. A summary of the detected Unit 3 soil semivolatile compounds is presented in Table 7A-5, located in Chapter 7.0 Appendix 7A. A total of 23 of 27 Unit 3 soil samples analyzed for HSL semivolatile organics disclosed no detected polynuclear aromatic hydrocarbon (PAH) compounds. Detected Unit 3 Soil PAH concentrations were disclosed at the following soil boring locations:

Unit 3 Soil PAH Concentrations

| Soil Boring | Total PAH Compounds (mg/kg) |
|---|---|
| A08-SB02 | 7 |
| A10-SB01 | 1416 |
| A14-SB01 | 0.57 |

Total Unit 3 soil PAH concentrations ranged from below method detection limits to 1416 mg/kg at Soil Boring A10-SB01. Soil analytical test reports are included in Appendix P, Volume 3.

A summary of the Unit 3 soil inorganic concentrations is presented in Table 7A-6. Soil inorganic indicator ranges are presented as follows and are compared with the results of an off-site background sample (A27-SB01-25):

Unit 3 Soil Inorganic Indicators

| Constituent | Detected Range (mg/kg) | Detected Background Concentration (mg/kg) |
|---|---|---|
| Copper | BDL to 20 | 11.0 |
| Chromium | BDL to 37 | 26.0 |
| Arsenic | BDL to 28 | 23.1 |
| Zinc | BDL to 210 | 68.9 |
| Lead | BDL to 44.8 | 44.8 |
| | TOTAL = | 173.8 mg/kg |

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Detected Unit 3 soil total inorganic indicator (copper, chromium, arsenic, zinc, lead) concentrations ranged from below method detection limits to 276 mg/kg at Soil Boring A17-SB02. A review of the off-site background sample at Soil Boring A27-SB01 indicates a total inorganic indicator concentration of 173.8 mg/kg. A total of one of the 30 Unit 3 soil samples analyzed for HSL metals disclosed a total inorganic indicator concentration greater than 173.8 mg/kg (A17-SB02).

## 7.9 Unit 4 Soil and Groundwater Quality Evaluation

A composite evaluation of Unit 4 soil and groundwater quality was conducted to aid in the assessment of the deep water-bearing zone. Unit 4 extends from 125 ft to an average depth of 200 ft and includes deposits from the deep zone. The Unit 4 subsurface quality evaluation is based upon (1) Unit 4 soil analytical test data; and (2) deep zone groundwater analytical test data. The primary objective of the Unit 4 subsurface quality evaluation was to assess groundwater quality of a deep water-bearing zone believed to be the upper-most unit capable of yielding sufficient quantities of groundwater for domestic and commercial use. Valid (V) and qualified (Q) soil and groundwater analytical data were utilized for assessment of subsurface quality.

7.9.1 Unit 4 Soil Quality. A total of five Unit 4 soil samples from two soil borings, including four located off-site, were analyzed for HSL semivolatile organic compounds. A review of the soil boring analytical test reports presented in Appendix P, Volume 3 indicates no detected PAH compounds.

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A summary of the Unit 4 soil inorganic concentrations is presented in Table 7A-7. Soil inorganic indicator ranges are presented as follows and are compared with the results of an off-site background sample from Unit 3 (A27-SB01-25):

Unit 4 Soil Inorganic Indicators

| Constituent | Detected Range (mg/kg) | Detected Background Concentration (mg/kg) |
|---|---|---|
| Copper | BDL to 9.71 | 11.0 |
| Chromium | BDL to 9.5 | 26.0 |
| Arsenic | BDL to 14 | 23.1 |
| Zinc | BDL to 20.9 | 68.9 |
| Lead | BDL to 95.8 | 44.8 |
| | | TOTAL = 173.8 mg/kg |

Detected Unit 4 soil total inorganic indicator (copper, chromium, arsenic, zinc, lead) concentrations ranged from 29 mg/kg to 118 mg/kg at Soil Boring SCK-DW02 and were less than the Unit 3 total inorganic indicator background concentration.

7.9.2 Deep Zone Groundwater Quality. A total of two groundwater monitoring wells located within the deep zone were sampled during the Remedial Investigation. Monitoring Well CAV-OW06 was installed during the previous Cavalcade Contaminant Survey and is located at the northern portion of the tract, in the area of the 1964 aerial photograph anomaly shown on Figure 1-5. Monitoring Well SCK-DW02 is located offsite at American Warehouses, Inc., and is downgradient from the site area based upon the groundwater contour map presented in Figure 4-16. Based upon the water well inventory conducted during Subtask 1D, the deep zone

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monitoring wells are believed to be screened in the upper-most unit capable of yielding sufficient quantities of groundwater for domestic and commercial use (Section 4.3.9).

A summary of the detected deep zone groundwater semivolatile organic compounds is presented in Table 7B-8, located in Chapter 7.0 Appendix 7B. A total of 2 HSL semivolatile organic compounds were reported below the method detection limit; therefore precise identification and quantification of these compounds is considered unreliable. Semivolatile compounds reported below the method detection are presented in the analytical data summary tables, unlike groundwater samples from shallow zone, because the deep zone is believed to represent the upper-most unit capable of yielding sufficient quantities of groundwater for domestic and commercial use. HSL compounds reported below the method detection limit in groundwater samples from the deep zone include naphthalene and p-chloro-m-cresol.

Naphthalene was reported below the method detection limit of 10 ug/l at Monitoring Well CAV-OW06 during the Round 2 sampling, but was not detected during the Round 1 sampling. The reported naphthalene concentration is below the method detection limit; therefore precise quantification is considered unreliable. Furthermore, naphthalene was not detected during the previous sampling for the Cavalcade Containment Survey (Table 7B-2).

P-chloro-m-cresol was reported below the method detection limit of 10 ug/l at Monitoring Well CAV-OW06 during the Round 1 Sampling, but was not detected during the Round 2 sampling. The reported p-chloro-m-cresol concentration is

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below the method detection limit; therefore precise quantification is considered unreliable. In addition, p-chloro-m-cresol is a chlorinated phenolic aromatic hydrocarbon not associated with polynuclear aromatic hydrocarbon compounds (Table 6-2).

No groundwater semivolatile organic compounds were detected at Monitoring Well SCK-DW02. Subsequent analyses of groundwater samples from both deep zone monitoring wells were performed using high performance liquid chromatography (HPLC) techniques for the following seven PAH compounds:

1. Benzo(a)anthracene
2. Chrysene
3. Benzo(b)fluoranthene
4. Benzo(k)fluoranthene
5. Benzo(a)pyrene
6. Dibenzo(ah)anthracene
7. Indeno(1,2,3-cd)pyrene

Results of HPLC analyses of groundwater samples from both deep zone monitoring wells, as presented in Table 7B-9, showed no detected PAH compounds, with a method detection limit of 1.00 ng/l. Comparison with the results of one groundwater sample from the previous Cavalcade Contaminant Survey disclosed no detected (<10 ug/l) PAH compounds at Monitoring Well CAV-OW06, as shown in Table 7B-2.

A summary of the detected deep zone groundwater volatile organic compounds is presented in Table 7B-10. A total of 4 HSL volatile organic compounds were reported, three of which were below the method detection limit and the remaining volatile organic compound was detected in the blank. Three of the volatile organic compounds are

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reported below the method detection limit; therefore precise identification and quantification is considered unreliable.

No volatile organic compounds were detected at Monitoring Well SCK-DW02. Comparison with the results of one deep zone groundwater sample from the previous Cavalcade Contaminant Survey disclosed 49 ug/l of toluene at Monitoring Well CAV-OW06, as shown in Table 7B-4 but was not detected in groundwater samples from two rounds during the Remedial Investigation.

A summary of the deep zone groundwater inorganic concentrations is presented in Table 7B-11. However, evaluation of groundwater inorganic quality must be qualified to account for sample representativeness. The groundwater samples were not filtered, either in the field or in the laboratory, prior to analysis. In addition, the samples were placed into acidified containers prior to analysis. The resulting analyses are more representative of total inorganics due to the potential for both dissolved and suspended particulate materials present in the samples. The suspended particulates may yield results more representative of soil media than actual groundwater conditions.

A total of four groundwater inorganics were detected and include iron, lead, nickel, and zinc. A summary of the deep zone groundwater inorganic indicator ranges is presented as follows:

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Deep Zone Inorganic Indicators

| Constituent | Detected Range (ug/l) |
|---|---|
| Copper | BDL |
| Chromium | BDL |
| Arsenic | BDL |
| Zinc | BDL to 156 |
| Lead | BDL to 23 |

Detected deep zone groundwater total inorganic indicator (copper, chromium, arsenic, zinc, lead) concentrations range from below method detection limits to 179 ug/l at Monitoring Well CAV-OW06.

Comparison with the results of one deep zone groundwater sample from the previous Cavalcade Contaminant Survey disclosed antimony, arsenic, and selenium at Monitoring Well CAV-OW06, as presented in Table 7B-6.

No HSL pesticides or PCB aroclors (7) were detected in the deep well groundwater samples.

## 7.10 Production Wells

Three production wells were previously sampled during the Cavalcade Contaminant Survey and are listed as follows:

Previous Production Well Sampling

| Well Number | Reported Screen Depth(ft) | Recorded Owner |
|---|---|---|
| LJ-65-14-406 | 1143 to 1970 | City of Houston |
| LJ-65-14-438 | 282 to 302 | Olds Press and Forge Co. |
| 2348 | 508 to 548 | Lone Star Industries, Inc. |

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The production wells are located within about a 1.5-mile radius from the site and are referenced on Figure 4-16. Previous analytical data from production well groundwater samples were reviewed to assess area deep groundwater quality.

A summary of the reported semivolatile and volatile organic analyses is presented on Tables 7B-2 and 7B-4 and indicates no detected compounds. Table 7B-6 lists the inorganic results which are summarized as follows:

Previous Production Well Inorganics

| Detected Constituent | Reported Concentration Range (mg/l) |
|---|---|
| Cadmium | BDL to 0.04 |
| Lead | 0.30 to 0.35 |
| Zinc | 0.28 to 0.58 |

Comparison with the deep zone inorganics from the Remedial Investigation also indicates detected zinc and lead constituents.

## 7.11 Vertical Soil Contaminant Distribution

An evaluation of the vertical distribution of subsurface soil (saturated zone) PAH compounds was performed to assess the attenuation characteristics of PAH concentrations with depth. Qualitative subsurface soil PAH attenuation profiles were developed using geologic profiles which were aligned to traverse the surficial soil staining areas shown on Figure 6-1. The geologic profile alignment shown on Figure 7-4 extends through the northern area of the site and transects the surficial soil staining areas. The geologic profile alignment shown on Figure 7-5 extends through the southern area of the site and transects the surficial soil staining areas.

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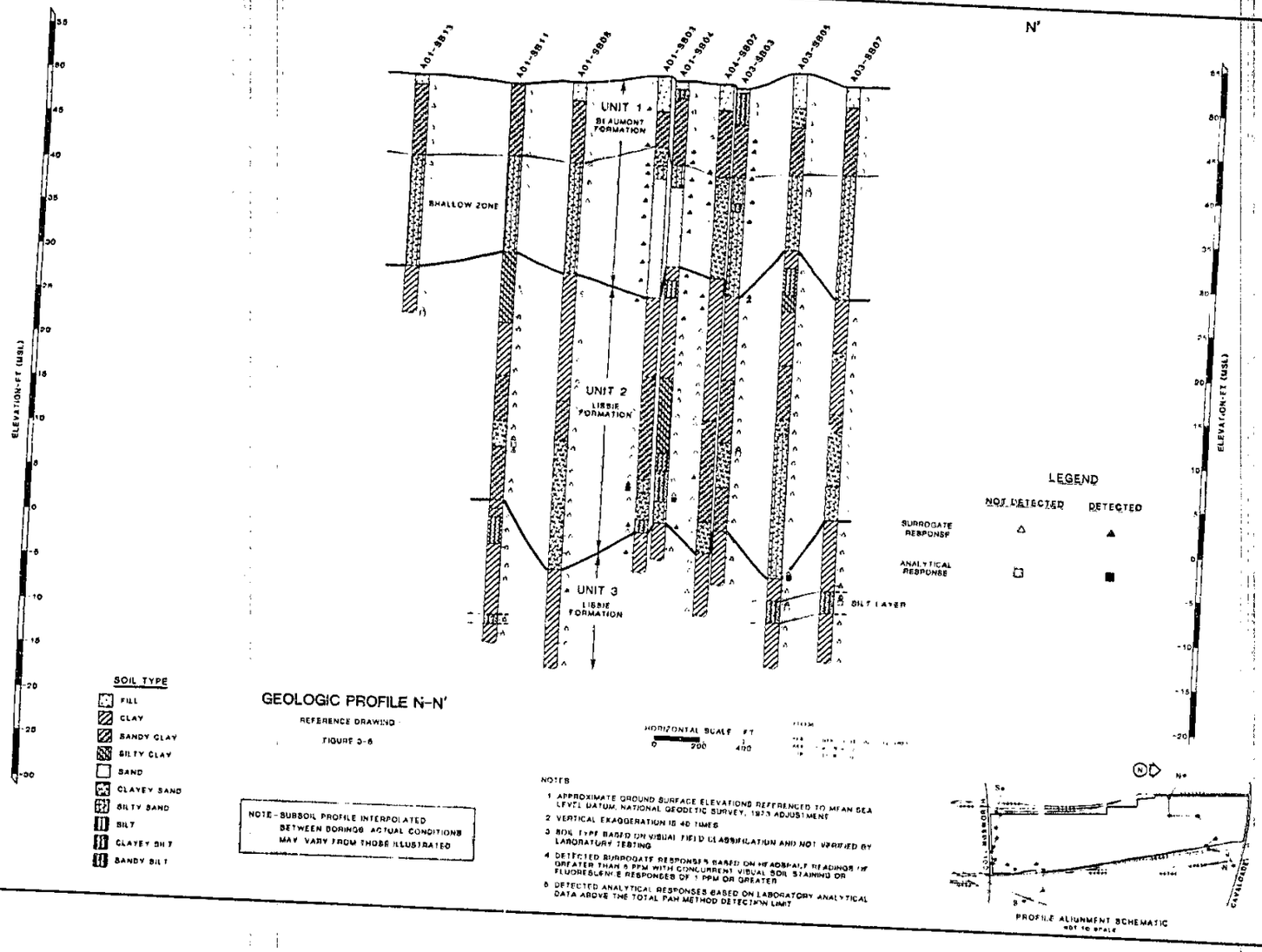


GEOLOGIC PROFILE N-N'

REFERENCE DRAWING

FIGURE 3-6

GENERALIZED GEOLOGIC PROFILE
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.

| | |
|---|---|
| FIGURE NO | 7-4 |
| PROJECT NO. | 85-317 |
| DATE: | 4-15-88 |
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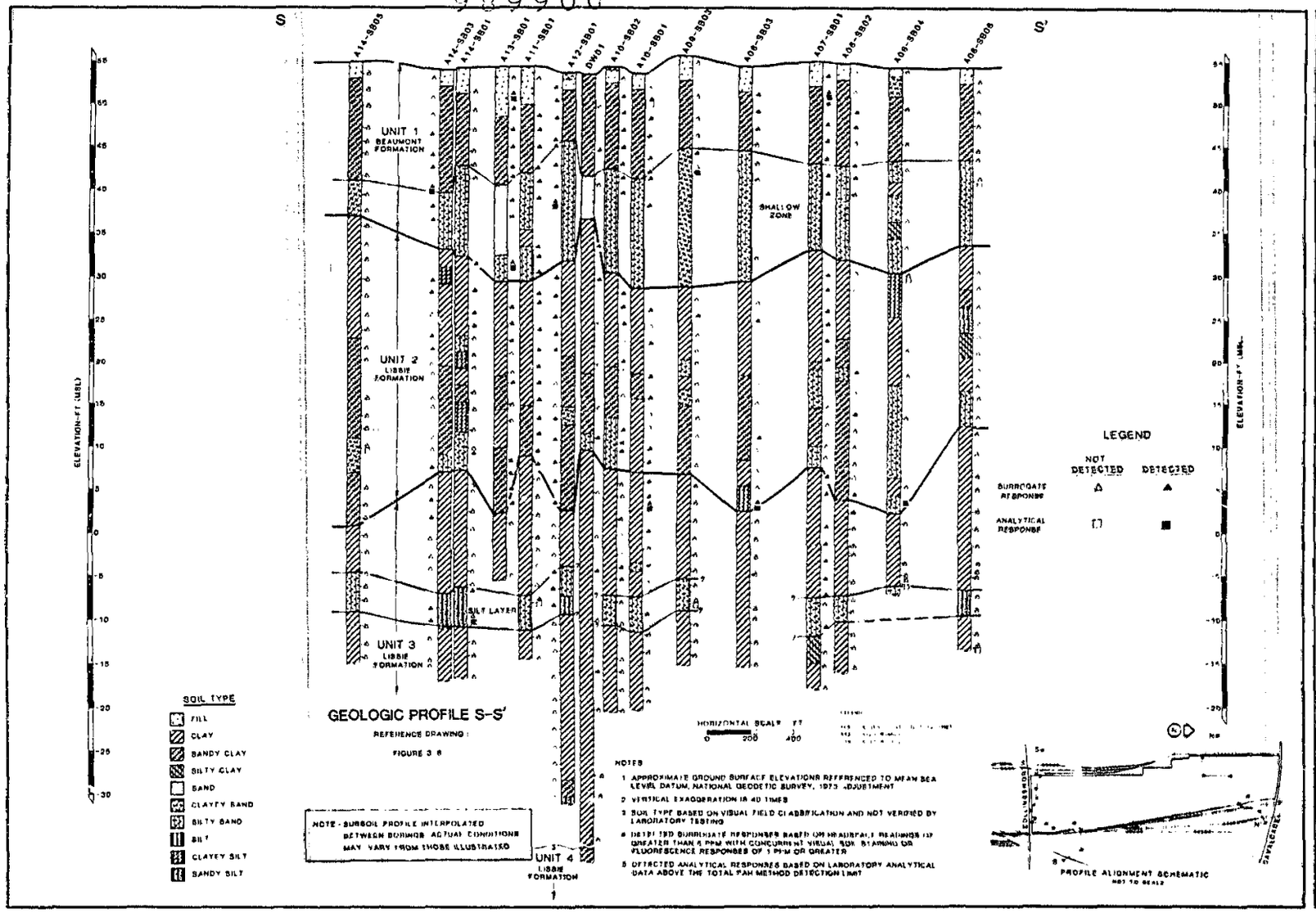


GENERALIZED GEOLOGIC PROFILE
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
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| | |
|---|---|
| FIGURE NO | 7-5 |
| PROJECT NO | 85-317 |
| DATE | 4-18-88 |
| ENGINEER | |
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The soil PAH attenuation profiles were constructed using both surrogate and analytical data. Symbols were placed adjacent to the geologic profiles corresponding to the depth of each sample analyzed by either surrogate methods or analytical methods, or both. Surrogate and analytical data criteria were organized into four categories as follows:

- Surrogate Responses Detected
- Surrogate Responses Not Detected
- Analytical Responses Detected
- Analytical Responses Not Detected

Detected surrogate responses are defined as headspace readings greater than 5 ppm with concurrent visual soil staining or fluorescence surrogate results of 1 ppm or greater. Detected analytical responses are defined as laboratory analytical results above the total PAH method detection limit.

As indicated on Figure 7-4, two PAH attenuation zones are discernible in Geologic Profile N-N' and are separated by a zone with no surrogate or analytical responses. Six soil borings included on the profile have detected surrogate results and/or analytical results and are presented as follows:

GEOLOGIC PROFILE N-N'

| Soil Boring | Approximate Upper PAH Attenuation Zone Depth (ft) |
|---|---|
| A01-SB03 | 25 |
| A01-SB04 | 27 |
| A01-SB08 | 27.5 |
| A03-SB03 | 23.5 |
| A04-SB02 | 25.5 |

Average Depth 26 ft

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| Soil Boring | Approximate Lower PAH Attenuation Zone Depth (ft) |
|---|---|
| A01-SB03 | 54 |
| A01-SB04 | 50 |
| A01-SB08 | 57.5 |
| A03-SB05 | 56.5 |
| A04-SB02 | 44.5 |

Average Depth 52.5 ft

The upper zone attenuation depths ranged from 23.5 ft to 27.5 ft, and the lower zone attenuation depths ranged from 44.5 ft to 57.5 ft. Average attenuation depths for the upper and lower attenuation zones were 26 ft and 51.5 ft, respectively. The lower boundary of the upper attenuation zone occurs within about the upper five feet of Unit 2, which generally consists of stiff to hard clays. The upper boundary of the lower attenuation zone occurs within about the lower eight feet of Unit 2, which generally consists of sandy silts, silty sands, and sandy clays. It appears from Figure 7-4 that the upper Unit 2 clays have inhibited vertical migration into the lower attenuation zone.

The presence of PAH compounds in the lower attenuation zone shown on Figure 7-4 appears to be due to lateral migration from a vertical pathway within the northern part of the site. Soil Borings A01-SB11 and A03-SB07, which are located adjacent to soil borings within the attenuation zones, do not indicate the presence of soil PAH compounds at depths corresponding to the upper or lower attenuation zones, or to the zone between them. The lower boundary of the lower attenuation zone occurs within about the upper three feet of Unit 3, which consists primarily of clays with interbedded clayey and sandy silts. It appears that the upper Unit 3 clays have inhibited further vertical contaminant migration below about an average depth of about 52.5 ft.

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As indicated on Figure 7-5, a generally continuous attenuation zone is discernible in Geologic Profile S-S'. Thirteen soil borings included on the profile have detected surrogate results and analytical results and are presented as follows:

GEOLOGIC PROFILE S-S'

| Soil Boring | Approximate PAH Attenuation Depth (ft) |
|---|---|
| A06-SB02 | 50.5 |
| A06-SB03 | 51.5 |
| A06-SB04 | 51 |
| A07-SB01 | 66 |
| A09-SB03 | 30.5 |
| A10-SB01 | 63 |
| A10-SB02 | 70 |
| A11-SB01 | 66.5 |
| A12-SB01 | 62.5 |
| A13-SB01 | 51.5 |
| A14-SB01 | 61 |
| A14-SB03 | 64.5 |
| DW01 | 69.5 |

Average Depth 58 ft

The attenuation zone depths ranged from 30.5 ft to 69.5 ft. The average attenuation depth was 58 ft. The lower boundary of attenuation zone occurs within about the upper 23 ft of the Unit 3, which generally consists of stiff to hard clays with a distinct silt layer at an approximate 60-ft depth. Three soil borings shown on Geologic Profile S-S' have detected surrogate results and analytical results slightly below the silt layer. Borings A14-SB05, A09-SB03, and A06-SB02 shown on Figure 7-5 do not indicate lateral migration through the silt layer.

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7.12 Subsurface Quality Evaluation

Evaluation of composite subsurface soil and groundwater quality included the following data base to develop a comprehensive assessment of the lateral extent of potential subsurface migration:

1. Visual notations of soil staining and soil sample total organic vapor measurements.
2. Soil surrogate total aromatic hydrocarbon responses (laboratory headspace measurements above 5 ppm and fluorescence results 1 ppm and above).
3. HSL soil and groundwater semivolatile organic constituents detected above the method detection limit.

Both soil and groundwater data were combined to provide an evaluation of subsurface soil and groundwater quality. PAH analytical data were used for the subsurface quality evaluation. There was no volatile organic data because volatiles were not analyzed in soil media. Metals analytical data were not used for the subsurface quality evaluation because they were not considered as representative of contaminant indications as were PAHs. Specifically, groundwater samples were not filtered, either in the field or the laboraotry, and are therefore not considered representative of dissolved metals. Approximate delineations of composite PAH distributions are presented on Figure 7-6. PAH distributions are plotted separately for (1) Unit 1; (2) Unit 2 soil, and (3) the lower silt layer. It should be noted that the boundaries presented on Figure 7-6 are approximate and do not reflect or depict an interpretation that these areas are considered for possible remedial action, either expressed or implied.

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7.12.1 Subsurface PAH Distribution. As shown on Figure 7-6, the distribution of subsurface PAH appears to form two discrete areas, one at the northern end of the site and the other throughout the southern portion of the site. The northern distribution area generally corresponds to the location of the 1964 aerial photograph anomaly (Figure 1-5). The Unit 1 northern area is interpolated to extend slightly off-site of the northeast property boundary. The Unit 2 northern areas are very similar to the Unit 1 distributions. One localized area of potential subsurface migration into the lower silt layer within the northern site area is shown on Figure 7-6.

The southern distribution area shown on Figure 7-6 encompasses the locations of the former process areas (Figure 1-4). The Unit 1 and Unit 2 southern areas appear to have relatively limited downgradient (shallow zone) distribution to the west and southwest. The Unit 2 southern area indicates possible limited off-site subsurface migration generally limited to the south and southwest. The lower silt layer soil distribution boundary in the southern area is shown to closely match the distributions in Unit 2.

A general assessment of the composite subsurface PAH compounds at the South Cavalcade Site indicates the following conclusions:

1. The highest measured total soil PAH concentrations were detected at Soil Boring A12-SB01 (Unit 1) at a concentration of 5020 mg/kg and at Soil Boring A01-SB06 (Unit 2) at a concentration of 708 mg/kg. The Unit 1 soil boring was

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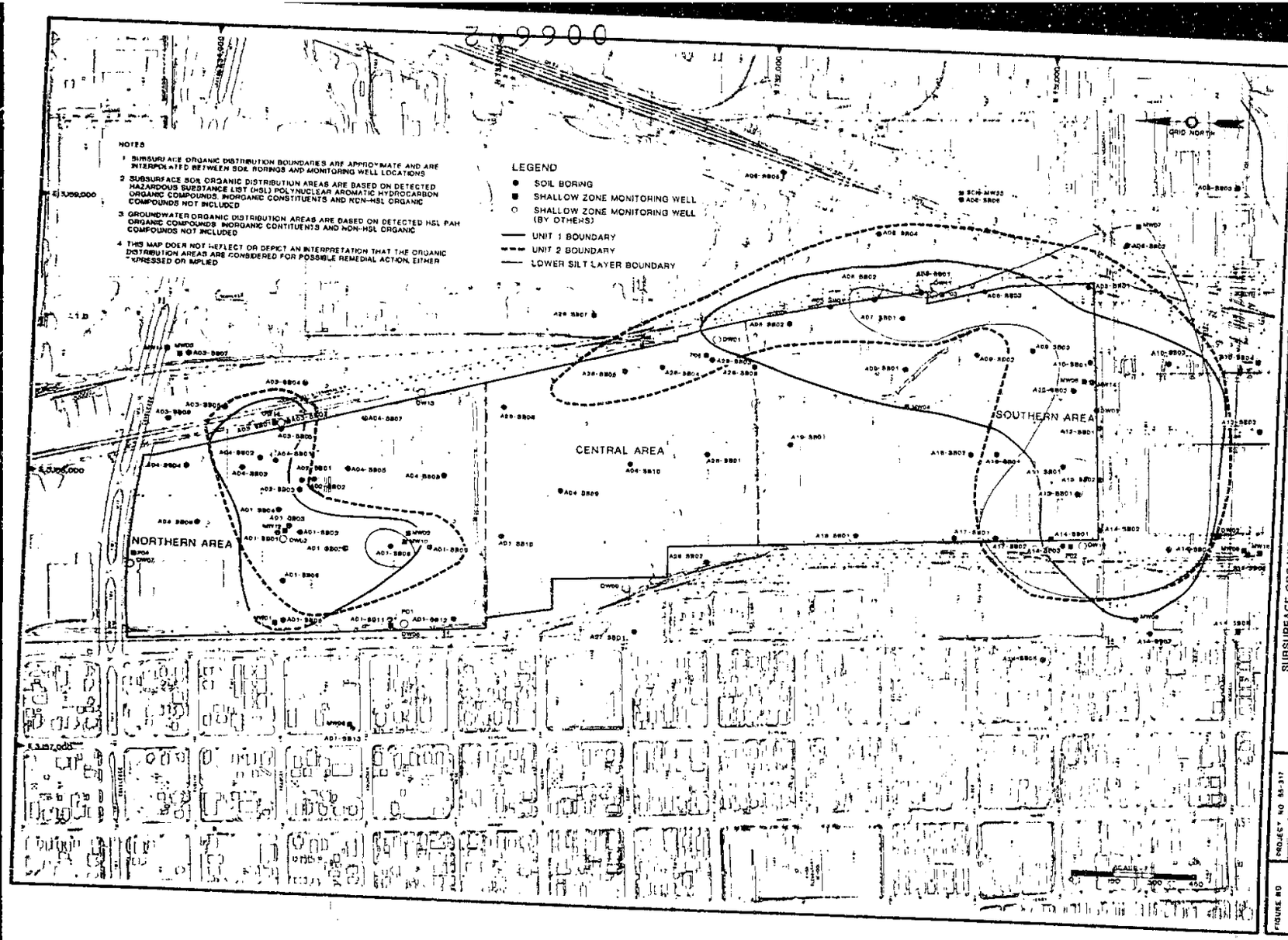


SUBSURFACE ORGANIC QUALITY MAP
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY, INC.

FIGURE NO 7-6
PROJECT NO 85-317
DATE 8-28-87
ENGINEER
DRAWN BY

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located at the southern portion of the site. The Unit 2 soil boring was located at the northern portion of the site. The highest measured total soil PAH concentration for Unit 3 was detected at Soil Boring A10-SB01 (1416 mg/kg) located at the southern portion of the site. No soil PAH compounds were detected in selected soil samples from Unit 4.

2. The highest measured total groundwater PAH concentrations were detected at Monitoring Well CAV-OW11 (shallow zone) at a concentration of 21950 mg/l. Non-aqueous phase liquids (NAPL) were noted at the southeast portion of the site in Monitoring Wells CAV-OW11, SCK-MW14, and SCK-P03.

3. Analytical testing of selected subsurface soil and groundwater samples did not detect the presence of pentachlorophenol (PCP).

4. The highest measured total groundwater inorganic indicator (copper, chromium, arsenic, zinc, lead) concentrations were detected at Monitoring Well SCK-MW06 (shallow zone) at a concentration of 2.616 mg/l. Groundwater inorganic samples were not filtered and therefore potential suspended particulate matter may result in sample variability and nonrepresentative results.

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5. Groundwater samples from Monitoring Wells CAV-OW06 and SCK-DW02 (deep zone) disclosed no concentrations of semivolatile organics above the method detection limits. HPLC analyses for selected PAH compounds did not disclose any constituents at a method detection limit of 1.00 ng/l from two deep zone wells.

6. The average soil attenuation depth at the northern area was measured to be approximately 51.5 ft; whereas the average attenuation depth at the southern area was about 58 ft.

7. Unit 1 and Unit 2 soil and groundwater PAH concentrations were generally distributed throughout the northern portion of the site near the 1964 aerial photograph anomaly and the southern and southeastern areas of the site near the former plant areas.

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## 7.13 Potentially Impacted Subsurface Areas

Figure 7-6 presents an approximate delineation of potential subsurface PAH boundaries. The composite subsurface quality map was used to estimate areas of potentially impacted subsurface quality. Area estimates of potentially impacted subsurface quality for each geologic unit are presented as follows based upon approximate PAH delineations presented in Figure 7-6:

Area Estimates of Potentially Impacted Subsurface Quality (acres)

| Area | Unit 1 | Unit 2 |
|---|---|---|
| Northern | 9.64 | 10.06 |
| Southern | 30.09 | 35.75 |
| Total | 39.73 | 45.81 |

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It should be noted that the potentially impacted subsurface quality areas are approximate and do not reflect or depict an interpretation that the potentially impacted groundwater volumes are considered for possible remedial action, either expressed or implied.

## 7.14 References


1. McBride-Ratcliff and Associates, Inc., Well Inventory, Subtask ID, MRA Report No. 85-195, July 5, 1985.

2. Koppers Company, Inc., Quality Assurance/Quality Control Plan for Remedial Investigation and Feasibility Study at the Koppers South Cavalcade Site, September, 1985.

3. Camp, Dresser and McKee; Cavalcade Contaminant Survey, Volume I - Engineering Report, July 11, 1983.


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# APPENDIX 7A - SUBSURFACE SOIL ANALYTICAL DATA SUMMARY TABLES

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TABLE 7A-1
SUMMARY OF UNIT 1 DETECTED SOIL SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)

| COMPOUND | A01-SB07-06 12' | A01-SB09-06 11.5' | A04-SB01-06 10.5' | A09-SB03-06 13.5' | A10-SB04-08 16' | A12-SB01-08 15.5' | A13-SB02-07 13.5' |
|---|---|---|---|---|---|---|---|
| ACENAPHTHENE | 0.4 U | 0.41 J | 12 U | 16 | 0.42 U | 570 | 190 |
| ACENAPHTHYLENE | 0.4 U | 0.41 U | 12 J | 11 U | 0.42 U | 12 U | 25 U |
| ANTHRACENE | 0.4 U | 0.41 J | 12 U | 11 U | 0.42 U | 240 | 120 |
| BENZO(A)ANTHRACENE | 0.4 U | 0.41 U | 65 | 11 U | 0.42 U | 93 | 33 |
| BENZO(B)FLUORANTHENE | 0.4 U | 0.41 U | 42 | 11 U | 0.42 U | 61 | 25 J |
| BENZO(GHI)PERYLENE | 0.4 U | 0.41 U | 12 J | 11 U | 0.42 U | 12 J | 25 U |
| BIS(2-ETHYLHEXYL)PHTHALATE | 0.4 U | 0.41 U | 12 U | 11 U | 0.42 J | 12 U | 25 U |
| CHRYSENE | 0.4 U | 0.41 U | 56 | 11 U | 0.42 U | 76 | 36 |
| DIBENZOFURAN | 0.4 U | 0.41 J | 190 | 11 J | 0.42 U | 340 | 160 |
| DIETHYL PHTHALATE | 0.67 | 0.41 U | 12 U | 11 U | 0.42 U | 12 U | 25 U |
| 2,4-DIMETHYLPHENOL | 0.4 U | 0.41 U | 12 U | 11 U | 0.42 U | 12 J | 25 U |
| FLUORANTHENE | 0.4 U | 0.41 U | 370 | 14 | 0.42 U | 420 | 240 |
| FLUORENE | 0.4 U | 0.41 J | 12 U | 11 | 0.42 U | 440 | 220 |
| INDENO(1,2,3-CD)PYRENE | 0.4 U | 0.41 U | 12 J | 11 U | 0.42 U | 12 J | 25 U |
| 2-METHYLNAPHTHALENE | 0.4 U | 0.41 J | 180 | 11 J | 0.42 U | 780 | 180 |
| NAPHTHALENE | 0.4 U | 0.41 J | 720 | 20 | 0.42 U | 1900 | 710 |
| PHENANTHRENE | 0.4 U | 0.41 U | 980 | 32 | 0.42 U | 940 | 560 |
| PYRENE | 0.4 U | 0.41 U | 270 | 11 J | 0.42 U | 280 | 160 |
| VALIDATION STATUS | V | V | V | V | V | V | V |
| TOTAL PAH COMPOUNDS | 0.4 U | 0.41 U | 2503 | 93 | 0.42 U | 5020 | 2269 |

NOTES:
1. V = Valid

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





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TABLE 7A-1 (continued)
SUMMARY OF UNIT 1 DETECTED SOIL SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)

| COMPOUND | A14-SB03-07 14' | A14-SB08-05 11.5' | A16-SB02-06 13' |
|---|---|---|---|
| ACENAPHTHENE | 12 J | 0.39 U | 0.41 U |
| ANTHRACENE | 12 J | 0.39 U | 0.41 U |
| BENZO(A)ANTHRACENE | 12 J | 0.39 U | 0.41 U |
| BIS(2-ETHYLHEXYL)PHTHALATE | 12 U | 0.39 J | 0.41 U |
| CHRYSENE | 12 J | 0.39 U | 0.41 U |
| DIBENZOFURAN | 13 | 0.39 U | 0.41 U |
| DIETHYL PHTHALATE | 12 U | 0.39 U | 0.41 J |
| FLUORANTHENE | 12 J | 0.39 U | 0.41 U |
| FLUORENE | 13 | 0.39 U | 0.41 U |
| 2-METHYLNAPHTHALENE | 14 | 0.39 U | 0.41 U |
| NAPHTHALENE | 84 | 0.39 U | 0.41 U |
| PHENANTHRENE | 36 | 0.39 U | 0.41 U |
| PYRENE | 12 J | 0.39 U | 0.41 U |
| VALIDATION STATUS | V | V | V |
| TOTAL PAH COMPOUNDS | 133 | 0.39 U | 0.41 U |

NOTES:
1. V = Valid

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





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TABLE 7A-2
SUMMARY OF UNIT 1 SOIL INORGANICS (mg/kg)

| | A01-SB07-06 12' | A01-SB09-06 11.5' | A01-SB12-06 11' | A03-SB05-06 13' | A04-SB01-06 10.5' | A06-SB06-07 13.5' | A08-SB02-06 13' |
|---|---|---|---|---|---|---|---|
| ARSENIC | 6.0 U | 6.1 U | 5 U | 5 U | 5.8 U | 6 U(Q) | 5 U |
| CHROMIUM | 5.4 U | 5.5 U | 4 U | 4 U | 5.2 U | 1.3 | 4.5 U |
| COPPER | 4.2 U | 4.3 U | 5 U | 5 U | 4.1 U | 2.0 | 5 U |
| CYANIDE | 1.8 U | 1.85 U | 1 U | 5 U | 1.7 U | 0.6 U(Q) | 1 U |
| IRON | 1660 | 3300 | 2600 | 2400 | 6090 | 934 | 1800 |
| LEAD | 3.0 U | 3.1 U | 4.4 | 2.5 | 2.9 U | 4.7 | 2.5 U |
| ZINC | 4.8 U | 4.9 U | 4 U | 4 U | 4.6 U | 1.7 | 4.5 U |
| VALIDATION STATUS | V | V | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 3 U | 3.1 U | 4.4 | 2.5 | 2.9 U | 9.7 | 2.5 U |

| | A09-SB03-06 13.5' | A10-SB03-08 15' | A10-SB04-08 16' | A12-SB01-08 15.5' | A12-SB02-07 15.5' | A13-SB02-07 13.5' | A14-SB03-07 14' |
|---|---|---|---|---|---|---|---|
| ARSENIC | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHROMIUM | 4 U | 4.5 U | 7 | 4.5 U | 7 | 5.5 | 5.5 |
| COPPER | 5 U | 5 U | 5 U | 3.5 U | 7 | 3.5 U | 5 |
| CYANIDE | 5 U | 1.5 U | 1 U | 1.5 U | 1.5 U | 1.9 U | 1.5 U |
| IRON | 1700 | 4700 | 5100 | 470 | 7200 | 1040 | 4480 |
| LEAD | 3.5 | 4.6 | 4.1 | 1.5 U | 6.2 | 1.5 U | 3.25 |
| ZINC | 4 U | 5.5 | 13 | 11.5 | 14 | 250 | 12.5 |
| VALIDATION STATUS | V | V | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 3.5 | 10 | 24 | 12 | 34 | 256 | 26 |

NOTE:
1. V = Valid
2. Q = Qualified

LEGEND:
U = Below Method Detection Limit





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TABLE 7A-2 (continued)
SUMMARY OF UNIT 1 SOIL INORGANICS (mg/kg)

| | A14-SB06-06 11.5' | A14-SB08-05 11.5' | A16-SB02-06 13' | A26-SB01-08 17.5' |
|---|---|---|---|---|
| ARSENIC | 5 U | 5 U | 5 U | 6.1 U |
| CHROMIUM | 5 | 4 U | 4.5 U | 10.4 |
| COPPER | 8 | 5 U | 5 U | 4.3 U |
| CYANIDE | 1.5 U | 5 U | 1 U | 1.83 U |
| IRON | 7900 | 3100 | 830 | 7530 |
| LEAD | 6 | 2.6 | 2.5 U | 3 U |
| ZINC | 12 | 4 U | 4.5 U | 22 |
| VALIDATION STATUS | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 31 | 2.6 | 2.5 U | 32 |

NOTE:
1. V = Valid

LEGEND:
U = Below Method Detection Limit





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TABLE 7A-3
SUMMARY OF UNIT 2 DETECTED SOIL SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)

| COMPOUND | A01-SB03-21 46' | A01-SB04-22 47' | A01-SB06-18(SOR) 47.5' | A37-SB04-12(DUP) 47.5' | A01-SB09-07 24' | A01-SB09-20 51.5' | A01-SB10-07 23' | A01-SB11- 40.5' |
|---|---|---|---|---|---|---|---|---|
| ACENAPHTHENE | 2.1 | 0.36 U | 23 U | 12 U | 0.82 J | 12 J | 0.43 U | 0.39 U |
| ANTHRACENE | 8.1 | 0.36 J | 49 | 23 | 22 | 12 U | 0.43 U | 0.39 U |
| BENZO(A)ANTHRACENE | 0.72 | 0.36 U | 23 U | 12 U | 0.82 U | 12 U | 0.43 U | 0.39 U |
| BENZO(B)FLUORANTHENE | 0.6 | 0.36 U | 23 U | 12 U | 0.82 U | 12 U | 0.43 U | 0.39 U |
| BENZOIC ACID | 1.95 U | 1.8 U | 115 U | 60 U | 4.1 J | 60 U | 2.15 U | 1.95 U |
| BIS(2-ETHYLHEXYL) PHTHALATE | 0.39 J | 0.36 U | 23 U | 12 U | 0.82 U | 12 U | 6.2 | 0.55 |
| CHRYSENE | 0.77 | 0.36 U | 23 U | 12 U | 0.82 U | 12 U | 0.43 U | 0.39 U |
| DIBENZOFURAN | 1.8 | 0.36 U | 74 | 31 | 1.5 | 12 J | 0.43 U | 0.39 U |
| DI-N-BUTYL PHTHALATE | 0.39 U | 0.36 U | 23 U | 12 U | 1.6 | 12 U | 0.43 U | 0.39 U |
| FLUORANTHENE | 3.8 | 0.36 J | 140 | 59 | 110 | 12 J | 0.43 U | 0.39 U |
| FLUORENE | 2 | 0.36 U | 23 U | 12 U | 0.82 J | 12 J | 0.43 U | 0.39 U |
| INDENO(1,2,3-CD)PYRENE | 0.39 J | 0.36 U | 23 U | 12 U | 0.82 U | 12 U | 0.43 U | 0.39 U |
| 2-METHYLNAPHTHALENE | 0.84 | 0.36 U | 100 | 41 | 0.82 J | 12 J | 0.43 U | 0.39 U |
| NAPHTHALENE | 1.4 | 0.36 U | 110 | 40 | 3.8 | 12 J | 0.43 U | 0.39 U |
| 3-NITROANILINE | 1.95 J | 1.8 U | 115 U | 60 U | 4.1 U | 60 U | 2.15 U | 0.39 U |
| PHENANTHRENE | 8.4 | 0.38 | 310 | 130 | 310 | 12 J | 0.43 U | 0.39 U |
| PYRENE | 3.2 | 0.36 J | 99 | 44 | 2.5 | 12 J | 0.43 U | 0.39 U |
| VALIDATION STATUS | V | V | V | V | V | Q | Q | V |
| TOTAL PAH COMPOUNDS | 31 | 0.38 | 708 | 296 | 448 | 12 U | 0.43 U | 0.39 U |

NOTES:
1. V = Valid
2. Q = Qualified
3. SOR = Sample of Record
4. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





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TABLE 7A-3 (continued)
SUMMARY OF UNIT 2 DETECTED SOIL SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)

| COMPOUND | A02-SB03-08 23.5' | A02-SB03-21 52.5' | A03-SB01-11 27.5' | A03-SB02-09 26' | A03-SB03-18 41' | A03-SB05-22 56.5' | A05-SE01-19 50.5' |
|---|---|---|---|---|---|---|---|
| ACENAPHTHENE | 25 | 12 J | 0.82 | 12 J | 0.34 U | 0.43 J | 0.4 J |
| ANTHRACENE | 12 U | 12 U | 4.4 | 12 J | 0.34 U | 0.43 U | 0.4 U |
| BENZO(A)ANTHRACENE | 12 J | 12 J | 1 | 12 U | 0.34 U | 0.43 J | 0.4 J |
| BENZO(A)PYRENE | 12 U | 12 U | 0.42 U | 12 U | 0.34 U | 0.43 U | 0.4 J |
| BENZO(B)FLUORANTHENE | 12 J | 12 J | 0.44 | 12 U | 0.34 U | 0.43 U | 0.4 J |
| BIS(2-ETHYLHEXYL)PHTHALATE | 12 U | 12 U | 0.42 J | 12 U | 0.34 J | 0.43 J | 0.4 U |
| CHRYSENE | 12 J | 12 J | 1.1 | 12 U | 0.34 U | 0.43 J | 0.4 J |
| DIBENZOFURAN | 19 | 12 J | 1 | 12 J | 0.34 U | 0.43 J | 0.4 J |
| FLUORANTHENE | 30 | 12 J | 2.3 | 12 J | 0.34 U | 0.43 J | 1.3 |
| FLUORENE | 21 | 12 J | 0.84 | 12 J | 0.34 U | 0.43 J | 0.64 |
| INDENO(1,2,3-CD)PYRENE | 12 U | 12 U | 0.42 J | 12 U | 0.34 U | 0.43 U | 0.4 J |
| 2-METHYLNAPHTHALENE | 26 | 12 J | 0.9 | 12 J | 0.34 U | 0.43 U | 0.4 J |
| NAPHTHALENE | 96 | 12 J | 2.8 | 21 | 0.34 U | 0.43 J | 0.4 J |
| 3-NITROANILINE | 60 U | 60 U | 2.1 J | 60 U | 1.7 U | 2.15 U | 2 U |
| PHENANTHRENE | 89 | 33 | 4.5 | 17 | 0.34 U | 0.55 | 2.7 |
| PYRENE | 40 | 12 J | 1.8 | 12 J | 0.34 U | 0.43 J | 1.3 |
| VALIDATION STATUS | V | V | V | V | V | V | V |
| TOTAL PAH COMPOUNDS | 301 | 33 | 20 | 38 | 0.34 U | 0.55 | 6 |

NOTES:
1. V = Valid

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





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TABLE 7A-3 (continued)
SUMMARY OF UNIT 2 DETECTED SOIL SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)

| COMPOUND | A06-SB01-19 45.5' | A06-SB03-19 51.5' | A06-SB04-07 25' | A06-SB04-12 51' | A13-SB01-10(SOR) 23' | A37-SB05-21(DUP) 23' |
|---|---|---|---|---|---|---|
| ACENAPHTHENE | 1.3 | 2.5 | 0.4 J | 0.46 | 27 | 19 |
| ACENAPHTHYLENE | 0.78 U | 1.5 U | 0.4 U | 0.41 U | 12 J | 12 J |
| ANTHRACENE | 1.1 | 1.5 U | 0.4 J | 0.41 J | 12 U | 12 J |
| BENZO(A)ANTHRACENE | 1.1 | 1.5 J | 0.4 J | 0.41 J | 12 J | 12 J |
| BENZO(A)PYRENE | 0.78 U | 1.5 J | 0.4 U | 0.41 J | 12 U | 12 U |
| BENZO(B)FLUORANTHENE | 0.78 U | 1.5 J | 0.4 U | 0.41 J | 12 U | 12 U |
| BENZO(K)FLUORANTHENE | 1.3 | 1.5 U | 0.4 U | 0.41 U | 12 U | 12 U |
| BIS(2-ETHYLHEXYL) PHTHALATE | 0.78 U | 1.5 U | 0.4 U | 0.41 J | 12 U | 12 U |
| CHRYSENE | 1.2 | 1.5 J | 0.4 J | 0.41 J | 12 J | 12 J |
| DIBENZOFURAN | 1 | 2.1 | 0.4 J | 0.41 J | 17 | 12 J |
| 2,4-DIMETHYLPHENOL | 0.78 U | 1.5 U | 0.4 U | 0.41 U | 12 J | 12 J |
| DI-N-BUTYL PHTHALATE | 0.41 U | 1.5 U | 0.4 U | 0.41 J | 12 U | 12 U |
| FLUORANTHENE | 5.6 | 4.3 | 0.4 J | 1.1 | 17 | 12 |
| FLUORENE | 1.4 | 2.1 | 0.4 J | 0.43 | 25 | 16 |
| 2-METHYLNAPHTHALENE | 0.78 J | 1.5 U | 0.4 U | 0.41 U | 18 | 12 J |
| 2-METHYLPHENOL | 0.78 U | 1.5 U | 0.4 U | 0.41 U | 12 J | 12 J |
| 4-METHYLPHENOL | 0.78 U | 1.5 U | 0.4 U | 0.41 U | 12 | 12 J |
| NAPHTHALENE | 2.2 | 4 | 0.4 J | 0.41 J | 110 | 77 |
| PHENANTHRENE | 10 | 11 | 0.4 J | 2.1 | 63 | 49 |
| PYRENE | 3.6 | 4.4 | 0.4 J | 0.8 | 17 | 13 |
| VALIDATION STATUS | Q | V | V | V | V | V |
| TOTAL PAH COMPOUNDS | 29 | 28 | 0.4 U | 5 | 259 | 186 |

NOTES:
1. V = Valid
2. Q = Qualified
3. SOR = Sample of Record
4. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





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TABLE 7A-3 (continued)
SUMMARY OF UNIT 2 DETECTED SOIL SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)

| COMPOUND | A14-SB08-21 45.5' | A26-SB05-19 50' | A26-SB08-15 39.5' |
|---|---|---|---|
| ACENAPHTHENE | 0.41 U | 0.4 J | 0.43 U |
| BIS(2-ETHYLHEXYL) PHTHALATE | 0.84 | 1.2 | 46 |
| DI-N-BUTYL PHTHALATE | 0.41 U | 0.4 J | 0.43 J |
| FLUORANTHENE | 0.41 U | 0.4 J | 0.43 U |
| FLUORENE | 0.41 U | 0.4 J | 0.43 U |
| NAPHTHALENE | 0.41 U | 0.4 J | 0.43 J |
| PHENANTHRENE | 0.41 U | 0.4 J | 0.43 J |
| PYRENE | 0.41 U | 0.4 J | 0.43 J |
| VALIDATION STATUS | Q | V | V |
| TOTAL PAH COMPOUNDS | 0.41 U | 0.4 U | 0.43 U |

NOTES:
1. V = Valid
2. Q = Qualified

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





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TABLE 7A-4
SUMMARY OF UNIT 2 SOIL INORGANICS (mg/kg)

| | A01-SB03-21 46' | A01-SB04-22 47' | A01-SB06-18 47.5' (SOR) | A37-SB04-12 47.5' (DUP) | A01-SB09-07 24' | A01-SB09-20 51.5' | A01-SB10-07 23' | A01-SB11-16 40.5' | A01-SB13-08 27' |
|---|---|---|---|---|---|---|---|---|---|
| ARSENIC | 5.9 U | 5.9 U | 5.8 U | 5.8 U | 4.7 U | 5.6 U | 6.5 U | 5.6 U | 10.9 |
| CHROMIUM | 5.3 U | 5 U | 9.2 | 5.2 U | 16.0 | 5.1 U | 21.3 | 5.1 U | 17.4 |
| COPPER | 4.1 U | 4.1 U | 4 U | 4 U | 5.55 | 4 U | 6.46 | 4 U | 8.38 |
| CYANIDE | 1.8 U | 1.8 U | 1.7 U | 1.7 U | 1.8 U | 1.69 U | 1.9 U | 1.69 U | 6 U |
| IRON | 1710 | 1240 | 2090 | 441 | 6290 | 2160 | 5290 | 2650 | 20000 |
| LEAD | 3 U | 3.2 U | 2.8 U | 2.9 U | 8.50 | 5.25 | 12.3 | 3.66 | 2.52 |
| ZINC | 4.7 U | 4.7 U | 4.6 U | 4.6 U | 51.2 | 6.21 | 6.2 | 4.9 U | 40.1 |
| VALIDATION STATUS | V | V | V | V | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 3 U | 3.2 U | 9.2 | 2.9 U | 81 | 11 | 46 | 3.7 | 79 |

| | A02-SB03-08 23.5' | A02-SB03-21 52.5' | A03-SB01-11 27.5' | A03-SB02-09 26' | A03-SB03-18 41' | A03-SB05-22 56.6' | A03-SB07-18 48' | A05-SB01-19 50.5' | A06-SB01-19 45.5' |
|---|---|---|---|---|---|---|---|---|---|
| ARSENIC | 5.9 U | 5.8 U | 16 | 10.2 | 5.6 U | 5 U | 5 U | 5.2 | 5.2 |
| CHROMIUM | 5.4 U | 5.2 U | 18.2 | 8.81 | 5.1 U | 4 U | 4 U | 10 | 14 |
| COPPER | 4.2 U | 4.1 U | 9.11 | 4.1 U | 3.9 U | 5 U | 5 U | 4 U | 7 |
| CYANIDE | 1.8 U | 1.7 U | 1.8 U | 1.8 U | 1.7 U | 5 U | 1 U | 1.5 U | 1.5 U |
| IRON | 8650 | 4400 | 36400 | 13700 | 4230 | 4500 | 3900 | 11000 | 20000 |
| LEAD | 8.6 | 2.9 U | 22.9 | 8.3 | 8.6 | 2.6 | 2.6 | 5.4 | 8.6 |
| ZINC | 12.5 | 9.3 | 50.4 | 18.8 | 4.5 U | 9 | 4 U | 4 U | 4 U |
| VALIDATION STATUS | V | V | V | V | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 21 | 9.3 | 117 | 46 | 8.6 | 12 | 2.6 | 21 | 35 |

NOTES:
1. V = Valid
2. SOR = Sample of Record
3. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit





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TABLE 7A-4 (continued)
SUMMARY OF UNIT 2 SOIL INORGANICS (mg/kg)

| | A06-SB03-19 51.5' | A06-SB04-07 25' | A06-SB04-12 51' | A08-SB02-17 42.5' | A13-SB01-10 23' (SOR) | A37-SB05-21 23' (DUP) |
|---|---|---|---|---|---|---|
| ARSENIC | 7.2 | 5 U | 5 U | 7.6 | 6.8 | 5 U |
| CHROMIUM | 15 | 4.5 U(Q) | 7.5(Q) | 7 | 7 | 7 |
| COPPER | 9 | 5 U | 5 U | 5 U | 5 | 3.5 U |
| CYANIDE | 1.5 U | 5 U | 5 U | 1 U | 1.8 U | 1.8 U |
| IRON | 14000 | 7130 | 6780 | 11000 | 4530 | 4020 |
| LEAD | 8.2 | 34 | 5.1 | 7.9 | 3.9 | 4.25 |
| ZINC | 4 U | 15 | 16 | 29 | 13.5 | 16.5 |
| VALIDATION STATUS | V | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 39 | 49 | 29 | 52 | 36 | 28 |

| | A14-SB05-22 45.5' | A14-SB08-21 45.5' | A17-SB01-18 50' | A26-SB05-19 50' | A26-SB06-19 46' | A26-SB08-15 39.5' | A27-SB01-13 34' |
|---|---|---|---|---|---|---|---|
| ARSENIC | 5 U | 5 U | 5 U | 6.8 | 5 U | 8.3 | 5.78 |
| CHROMIUM | 5.5 | 5.5 | 4.5 U | 16 | 4.5 U | 28 | 12.1 |
| COPPER | 6 | 5 U | 5.5 | 5 U | 5 U | 14 | 5.20 |
| CYANIDE | 1.5 U | 5 U | 1.5 U | 5 U | 1 U | 1 U | NA |
| IRON | 2200 | 4500 | 8000 | 12800 | 800 | 22000 | 8300 |
| LEAD | 5.4 | 4.7 | 7.1 | 9.6 | 4.4 | 12 | 44.5 |
| ZINC | 9 U | 5 | 10 | 26 | 7.5 | 64 | 12.1 |
| VALIDATION STATUS | V | V | V | V | V | V | NV |
| INORGANIC INDICATOR TOTALS | 17 | 15 | 23 | 58 | 12 | 126 | 80 |

NOTES:
1. V = Valid
2. Q = Qualified
3. NV = Not Validated
4. NA = Not Analyzed
5. SOR = Sample of Record
6. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit





006706

TABLE 7A-5
SUMMARY OF UNIT 3 DETECTED SOIL SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)

| COMPOUND | A01-SB03-25 54' | A01-SB06-24 59.5' | A01-SB09-24 59.5' | A03-SB05-24 60' | A03-SB07-23 58' | A04-SB03-27 61' | A06-SB04-16 60.5' | A06-SB05- 59' |
|---|---|---|---|---|---|---|---|---|
| ACENAPHTHENE | 0.42 U | 0.41 U | 0.41 U | 0.39 U | 0.41 U | 0.41 U | 0.42 J | 0.43 U |
| ANTHRACENE | 0.42 J | 0.41 U | 0.41 U | 0.39 U | 0.41 U | 0.41 U | 0.42 J | 0.43 U |
| BENZO(A)ANTHRACENE | 0.42 U | 0.41 U | 0.41 U | 0.39 U | 0.41 U | 0.41 U | 0.42 J | 0.43 U |
| BIS(2-ETHYLHEXYL) PHTHALATE | 0.42 U | 0.41 U | 0.41 J | 2.5 | 0.48 | 0.41 U | 0.42 U | 0.82 |
| CHRYSENE | 0.42 U | 0.41 U | 0.41 U | 0.39 U | 0.41 U | 0.41 U | 0.42 J | 0.43 U |
| DIBENZOFURAN | 0.42 U | 0.41 U | 0.41 U | 0.39 U | 0.41 U | 0.41 U | 0.42 J | 0.43 U |
| DIETHYL PHTHALATE | 0.42 U | 0.41 J | 0.41 U | 0.39 U | 0.41 U | 0.41 U | 0.42 U | 0.43 U |
| DI-N-BUTYL PHTHALATE | 0.42 U | 0.41 U | 0.41 U | 0.39 J | 0.41 U | 0.41 U | 0.42 U | 0.43 J |
| DI-N-OCTYL PHTHALATE | 0.42 U | 0.41 U | 0.41 J | 0.39 U | 0.41 U | 0.41 U | 0.42 U | 0.43 J |
| FLUORANTHENE | 0.42 J | 0.41 U | 0.41 J | 0.39 U | 0.41 U | 0.41 U | 0.42 J | 0.43 U |
| FLUORENE | 0.42 U | 0.41 U | 0.41 U | 0.39 U | 0.41 U | 0.41 U | 0.42 J | 0.43 U |
| NAPHTHALENE | 0.42 J | 0.41 U | 0.41 J | 0.39 U | 0.41 U | 0.41 U | 0.42 U | 0.43 U |
| PHENANTHRENE | 0.42 J | 0.41 J | 0.41 J | 0.39 U | 0.41 U | 0.41 J | 0.42 J | 0.43 U |
| PYRENE | 0.42 J | 0.41 U | 0.41 J | 0.39 U | 0.41 U | 0.41 U | 0.42 J | 0.43 U |
| VALIDATION STATUS | V | V | V | V | V | V | V | V |
| TOTAL PAH COMPOUNDS | 0.42 U | 0.41 U | 0.41 U | 0.39 U | 0.41 U | 0.41 U | 0.42 U | 0.43 U |

NOTES:
1. V = Valid

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





006707

TABLE 7A-5 (continued)
SUMMARY OF UNIT 3 DETECTED SOIL SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)

| COMPOUND | A08-SB02-27(SOR) 62' | A42-SB03-12(DUP) 62' | A08-SB03-27 55' | A09-SB03-24 64' | A10-SB01-21 50.5' | A10-SB04-31 61.5' | A11-SB01-3 62.5' |
|---|---|---|---|---|---|---|---|
| ACENAPHTHENE | 0.41 J | 0.41 J | 0.4 U | 0.41 U | 150 | 0.43 U | 0.41 U |
| ACENAPHTHYLENE | 0.41 U | 0.41 U | 0.4 U | 0.41 U | 11.5 J | 0.43 U | 0.41 U |
| ANTHRACENE | 0.41 J | 0.41 J | 0.4 U | 0.41 U | 84 | 0.43 U | 0.41 U |
| BENZO(A)ANTHRACENE | 0.41 J | 0.41 J | 0.4 U | 0.41 U | 40 | 0.43 U | 0.41 U |
| BENZO(B)PYRENE | 0.41 U | 0.41 U | 0.4 U | 0.41 U | 11.5 J | 0.43 U | 0.41 U |
| BENZO(B)FLUORANTHENE | 0.41 U | 0.41 U | 0.4 U | 0.41 U | 17 | 0.43 U | 0.41 U |
| BENZO(GHI)PERYLENE | 0.41 U | 0.41 U | 0.4 U | 0.41 U | 11.5 J | 0.43 U | 0.41 U |
| BENZO(K)FLUORANTHENE | 0.41 U | 0.41 U | 0.4 U | 0.41 U | 14 | 0.43 U | 0.41 U |
| BIS(2-ETHYLHEXYL) PHTHALATE | 0.41 U | 0.41 U | 1.4 | 0.41 U | 11.5 U | 0.43 J | 0.41 U |
| CHRYSENE | 0.41 J | 0.41 J | 0.4 U | 0.41 U | 31 | 0.43 U | 0.41 U |
| DIBENZOFURAN | 0.41 J | 0.41 J | 0.4 U | 0.41 U | 100 | 0.43 U | 0.41 J |
| DIETHYL PHTHALATE | 0.41 U | 0.41 U | 0.4 U | 0.41 U | 11.5 U | 0.43 U | 0.41 U |
| 2,4-DIMETHYLPHENOL | 0.41 U | 0.41 U | 0.4 U | 0.41 U | 11.5 U | 0.43 U | 0.41 U |
| FLUORANTHENE | 1.4 | 0.80 | 0.4 U | 0.41 J | 170 | 0.43 U | 0.41 U |
| FLUORENE | 0.58 | 0.41 J | 0.4 U | 0.41 U | 140 | 0.43 U | 0.41 J |
| INDENO(1,2,3-CD)PYRENE | 0.41 U | 0.41 U | 0.4 U | 0.41 U | 11.5 J | 0.43 U | 0.41 U |
| 2-METHYLNAPHTHALENE | 0.41 U | 0.41 U | 0.4 U | 0.41 U | 110 | 0.43 U | 0.41 U |
| NAPHTHALENE | 0.41 U | 0.41 U | 0.4 U | 0.41 J | 270 | 0.43 U | 0.41 J |
| PHENANTHRENE | 3.8 | 1.6 | 0.4 U | 0.41 J | 360 | 0.43 U | 0.41 J |
| PYRENE | 1.1 | 0.55 | 0.4 U | 0.41 J | 140 | 0.43 U | 0.41 U |
| VALIDATION STATUS | V | V | V | V | V | V | V |
| TOTAL PAH COMPOUNDS | 7 | 3 | 0.4 U | 0.41 U | 1416 | 0.43 U | 0.41 U |

NOTES:
1. V = Valid
2. SOR = Sample of Record
3. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





006708

TABLE 7A-5 (continued)
SUMMARY OF UNIT 3 DETECTED SOIL SEMIVOLATILE ORGANIC COMPOUNDS (mg/kg)

| COMPOUND | A14-SB01-27 64' | A26-SB01-22 45.5' | A26-SB04-26 62.5' | A26-SB07-33(SOR) 55.5' | A33-SB04-16(DUP) 55.5' | DW02-15 71' |
|---|---|---|---|---|---|---|
| ACENAPHTHENE | 0.41 J | 0.39 U | 0.41 U | 0.4 U | 0.39 U | 0.43 U |
| BIS(2-ETHYLHEXYL) PHTHALATE | 0.41 U | 0.39 U | 2.3 | 3.9 | 3.7 | 0.43 U |
| BUTYL BENZYL PHTHALATE | 0.41 U | 0.39 U | 0.41 U | 0.4 U | 0.39 U | 0.13 J |
| DIBENZOFURAN | 0.41 J | 0.39 U | 0.41 U | 0.4 U | 0.39 U | 0.43 U |
| DI-N-BUTYL PHTHALATE | 0.41 U | 0.39 U | 0.41 J | 0.4 U | 0.39 U | 0.43 U |
| FLUORANTHENE | 0.41 J | 0.39 U | 0.41 U | 0.4 U | 0.39 U | 0.43 U |
| FLUORENE | 0.41 J | 0.39 U | 0.41 U | 0.4 U | 0.39 U | 0.43 U |
| 2-METHYLNAPHTHALENE | 0.41 J | 0.39 U | 0.41 U | 0.4 U | 0.39 U | 0.39 U |
| NAPHTHALENE | 0.41 J | 0.39 U | 0.41 J | 0.4 U | 0.39 U | 0.43 U |
| N-NITROSODIPHENYLAMINE | 0.41 U | 0.39 J | 0.41 U | 0.4 J | 0.39 U | 0.43 U |
| PHENANTHRENE | 0.57 | 0.39 U | 0.41 J | 0.4 U | 0.39 U | 0.43 U |
| PYRENE | 0.41 J | 0.39 U | 0.41 J | 0.4 U | 0.39 U | 0.43 U |
| VALIDATION STATUS | V | V | V | V | V | V |
| TOTAL PAH COMPOUNDS | 0.57 | 0.39 U | 0.41 U | 0.4 U | 0.39 U | 0.43 U |

NOTES:
1. V = Valid
2. SOR = Sample of Record
3. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





006709

TABLE 7A-6
SUMMARY OF UNIT 3 SOIL INORGANICS (mg/kg)

| | A01-SB03-25 54' | A01-SB06-24 59.5' | A01-SB09-24 59.5' | A01-SB12-21 52' | A03-SB05-24 60' | A03-SB07-23 58' | A04-SB03-27 61' | A04-SB05-21 54' |
|---|---|---|---|---|---|---|---|---|
| ARSENIC | 18.3 | 15.3 | 6.1 U | 5 | 14 | 5.8 | 6 U | 28 |
| CHROMIUM | 28.2 | 19.8 | 23.1 | 7 | 12 | 9 | 5.5 U | 37 |
| COPPER | 7.53 | 4.3 U | 4.3 U | 5 | 5 U | 5 U | 4.3 U | 4.3 U |
| CYANIDE | 1.9 U | 1.8 U | 1.84 U | 1 U | 5 U | 1 U | 1.8 U | 1.8 U |
| IRON | 36300 | 28100 | 27300 | 4900 | 16000 | 10000 | 11900 | 45800 |
| LEAD | 12.9 | 11.61 | 9.15 | 3.6 | 8.4 | 4.8 | 3 U | 20 |
| ZINC | 60.2 | 48.8 | 46.9 | 12 | 28 | 15 | 12.2 | 75 |
| VALIDATION STATUS | V | V | V | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 127 | 96 | 79 | 33 | 62 | 35 | 12 | 160 |

| | A06-SB04-16 60.5' | A06-SB05-14 53.5' | A06-SB05-17 59' | A06-SB06-31 67.5' | A08-SB01-25 65.5' | A08-SB02-27 62' | A08-SB03-27 55' | A09-SB03-24 64' | A10-SB01-21 50.5' |
|---|---|---|---|---|---|---|---|---|---|
| ARSENIC | 9.1 | 5 U | 5 U | 24.6(Q) | 7.2 | 7.8 | 5 U | 5 | 5 U |
| CHROMIUM | 25(Q) | 9(Q) | 4.5 U(Q) | 15.3 | 20 | 12 | 8 | 4 U | 11 |
| COPPER | 7.5 | 5 U | 5 U | 20 | 5 | 5 U | 5 U | 5 U | 6 |
| CYANIDE | 5 U | 5 U | 5 U | 0.66 U(Q) | 1.5 U | 1 U | 1 U | 5 U | 1.5 U |
| IRON | 18400 | 7850 | 4680 | 16700 | 20000 | 8700 | 10000 | 4900 | 14700 |
| LEAD | 12 | 6.2 | 4.6 | 20.7 | 8.6 | 4.5 | 5.2 | 2.5 U | 6.2 |
| ZINC | 40 | 21 | 13 | 62.8 | 4 U | 20 | 17 | 4 U | 28 |
| VALIDATION STATUS | V | V | V | V | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 94 | 36 | 18 | 143 | 41 | 44 | 30 | 5 | 51 |

NOTES:
1. V = Valid
2. Q = Qualified

LEGEND:
U = Below Method Detection Limit





006710

TABLE 7A-6 (continued)
SUMMARY OF UNIT 3 SOIL INORGANICS (mg/kg)

| | A10-SB03-27 67.5' | A10-SB04-31 61.5' | A11-SB01-30 62.5' | A14-SB01-27 64' | A16-SB02-21 51.5' | A17-SB02-31 70' (SOR) | A35-SB09-15 70' (DUP) |
|---|---|---|---|---|---|---|---|
| ARSENIC | 10 | 5 U | 6.7 | 5.5 | 8.6 | 12 | 12 |
| CHROMIUM | 16 | 9 | 9.5 | 9 | 17 | 28 | 27 |
| COPPER | 9 | 5 U | 3.5 U | 3.5 U | 6.5 | 10 | 10 |
| CYANIDE | 1.5 U | 1 U | 1.8 U | 1.8 U | 1 U | 1.5 U | 1.5 U |
| IRON | 22000 | 7500 | 5990 | 7290 | 35000 | 38000 | 33000 |
| LEAD | 17 | 5 | 4.15 | 4.4 | 18 | 16 | 13 |
| ZINC | 48 | 16 | 13.5 | 17.5 | 50 | 210 | 59 |
| VALIDATION STATUS | V | V | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 100 | 30 | 34 | 36 | 100 | 276 | 121 |

| | A26-SB01-22 45.5' | A26-SB04-26 62.5' | A26-SB07-23 55.5' (SOR) | A33-SB04-16 55.5' (DUP) | A27-SB01-25 60' | DW02-15 71' |
|---|---|---|---|---|---|---|
| ARSENIC | 5.8 U | 6.2 | 5 U | 5 U | 23.1 | 1 U |
| CHROMIUM | 11.6 | 8.5 | 9 | 11 | 26.0 | 10.5 |
| COPPER | 4 U | 5 U | 5 U | 5 U | 11.0 | 18.4 |
| CYANIDE | 1.73 U | 5 U | 1 U | 1 U | NA | 6.6 U |
| IRON | 42300 | 13000 | 6700 | 8300 | 44000 | 167000 |
| LEAD | 2.9 U | 6 | 5.5 | 5.7 | 44.8 | 20 |
| ZINC | 39.9 | 26 | 20 | 22 | 68.9 | 43.4 |
| VALIDATION STATUS | V | V | V | V | NV | V |
| INORGANIC INDICATOR TOTALS | 52 | 47 | 35 | 39 | 174 | 92 |

NOTES:
1. V = Valid
2. NV = Not Validated
3. NA = Not Analyzed
4. SOR = Sample of Record
5. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit





006711

TABLE 7A-7
SUMMARY OF UNIT 4 SOIL INORGANICS (mg/kg)

| | DW01-28 143' | DW02-28 140' | DW02-36 185' | DW02-38 191' | DW02-42 209' |
|---|---|---|---|---|---|
| ARSENIC | 5 U | 1 U | 6.1 U(Q) | 5.6 U(Q) | 14(Q) |
| CHROMIUM | 9.5 | 9.10 | 4.3 | 8.46 | 4.4 U |
| COPPER | 5 U | 9.71 | 9.2 U | 8.5 U | 9.4 U |
| CYANIDE | 2 U | 6.1 U | 6.2 U | 5.6 U | 6.3 U |
| IRON | 5600 | 12900 | 3960 | 1060 | 2220 |
| LEAD | 5.2 | 19.2 | 26(Q) | 7.85(Q) | 95.8(Q) |
| ZINC | 14 | 14.4 | 7.4 U | 20.9 | 8.19 |
| VALIDATION STATUS | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 29 | 52 | 30 | 37 | 118 |

NOTES:
1. V = Valid
2. Q = Qualified

LEGEND:
U = Below Method Detection Limit





006712

# APPENDIX 7B - GROUNDWATER ANALYTICAL DATA SUMMARY TABLES

006713

TABLE 7B-1
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER SEMIVOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | MW01-001(SOR) | MW19-001(DUP) | MW01-002 | MW02-001 | MW02-002 | MW03-002(SOR) | MW19-002(DUP) | MW04-001 | MW04-002 | MW05-001 |
|---|---|---|---|---|---|---|---|---|---|---|
| ACENAPHTHENE | 110 J | 170 J | 170 | 540 | 460 | 10 U | 20 U | 150 | 79 | 10 U |
| ACENAPHTHYLENE | 400 U | 400 U | 9 J | 200 U | 100 U | 10 U | 20 U | 50 U | 10 U | 10 U |
| ANTHRACENE | 400 U | 400 U | 50 U | 41 J | 39 J | 10 U | 20 U | 8 J | 6 J | 10 U |
| BIS(2-ETHYLHEXYL) PHTHALATE | 400 U | 400 U | 50 U | 200 U | 100 U | 17 | 20 U | 50 U | 10 U | 10 U |
| DIBENZOFURAN | 65 J | 95 J | 88 | 370 | 340 | 10 U | 20 U | 77 | 46 | 10 U |
| 2,4-DIMETHYLPHENOL | 550 | 800 | 620 | 34 J | 36 J | 10 U | 20 U | 50 U | 10 U | 10 U |
| DI-N-BUTYL PHTHALATE | 400 U | 400 U | 50 U | 200 U | 100 U | 10 U | 20 U | 50 U | 10 U | 21 |
| FLUORANTHENE | 400 U | 400 U | 50 U | 45 J | 55 J | 10 U | 20 U | 50 U | 6 J | 10 U |
| FLUORENE | 47 J | 67 J | 64 | 220 | 200 | 10 U | 20 U | 84 | 55 | 10 U |
| 2-METHYLNAPHTHALENE | 110 J | 140 J | 170 | 530 | 560 | 10 U | 20 U | 7 J | 7 J | 10 U |
| 2-METHYLPHENOL | 110 J | 140 J | 130 | 31 J | 37 J | 10 U | 20 U | 50 U | 10 U | 10 U |
| 4-METHYLPHENOL | 64 J | 65 J | 95 | 200 U | 100 U | 10 U | 20 U | 50 U | 10 U | 10 U |
| NAPHTHALENE | 3100 | 3800 | 3400 | 11000 | 14000 | 10 U | 20 U | 540 | 280 | 10 U |
| PHENANTHRENE | 28 J | 40 J | 50 | 320 | 300 | 10 U | 20 U | 21 J | 11 | 10 U |
| PYRENE | 400 U | 400 U | 50 U | 34 J | 46 J | 10 U | 20 U | 50 U | 3 J | 10 U |
| VALIDATION STATUS | Q | Q | Q | Q | Q | Q | Q | Q | Q | Q,V |
| TOTAL PAH COMPOUNDS | 3100 | 3800 | 3684 | 12080 | 14960 | 10 U | 20 U | 774 | 425 | 10 U |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. MW = Monitoring Well
3. SOR = Sample of Record
4. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





006714

TABLE 7B-1 (continued)
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER SEMIVOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | MW06-001 | MW06-002 | MW08-001(SOR) | MW13-003(DUP) | MW08-002(SOR) | MW99(DUP) | MW09-002 | MW10-001 | MW10-002 | MW11- |
|---|---|---|---|---|---|---|---|---|---|---|
| ACENAPHTHENE | 210000 | 6100 | 22 | 10 U | 12 J | 5 J | 50 U | 680 | 240 | 10 |
| ACENAPHTHYLENE | 7300 J | 610 | 10 U | 10 U | 20 U | 20 U | 50 U | 200 U | 6 J | 10 |
| ANTHRACENE | 70000 | 3200 | 7 J | 10 U | 7 J | 3 J | 50 U | 50 J | 27 | 10 |
| BENZO(A)ANTHRACENE | 31000 J | 2600 | 10 U | 10 U | 20 U | 20 U | 50 U | 200 U | 9 J | 10 |
| BENZO(A)PYRENE | 40000 U | 570 | 10 U | 10 U | 20 U | 20 U | 50 U | 200 U | 10 U | 10 |
| BENZO(B)FLUORANTHENE | 9000 J | 1200 | 10 U | 10 U | 20 U | 20 U | 50 U | 200 U | 10 U | 10 |
| BENZO(GHI)PERYLENE | 4000 U | 100 | 10 U | 10 U | 20 U | 20 U | 50 U | 200 U | 10 U | 10 |
| BENZO(K)FLUORANTHENE | 12000 J | 100 U | 10 U | 10 U | 20 U | 20 U | 50 U | 200 U | 4 J | 10 |
| BIS(2-ETHYLHEXYL) PHTHALATE | 40000 U | 100 U | 10 U | 10 U | 44 | 20 U | 50 U | 200 U | 10 U | 10 |
| CHRYSENE | 31000 J | 1600 | 10 U | 10 U | 20 U | 20 U | 50 U | 200 U | 8 J | 10 |
| DIBENZOFURAN | 140000 | 4800 | 20 | 10 U | 9 J | 4 J | 50 U | 340 | 140 | 10 |
| DIETHYL PHTHALATE | 40000 U | 100 U | 10 U | 2 J | 20 U | 20 U | 50 U | 200 U | 10 U | 10 |
| 2,4-DIMETHYLPHENOL | 7100 J | 100 U | 10 U | 10 U | 20 U | 20 U | 50 U | 200 U | 10 U | 10 |
| DI-N-BUTYL PHTHALATE | 40000 U | 100 U | 39 | 10 U | 7 J | 4 J | 50 U | 200 U | 10 U | 1 |
| FLUORANTHENE | 200000 | 9400 | 19 | 10 U | 15 J | 7 J | 50 U | 56 J | 47 | 10 |
| FLUORENE | 170000 | 5300 | 20 | 10 U | 4 J | 20 U | 50 U | 210 | 110 | 10 |
| INDENO(1,2,3-CD)PYRENE | 4000 U | 120 | 10 U | 10 U | 20 U | 20 U | 50 U | 200 U | 10 U | 10 |
| 2-METHYLNAPHTHALENE | 130000 | 32000 | 7 J | 10 U | 20 U | 20 U | 50 U | 160 J | 100 | 10 |
| 2-METHYLPHENOL | 40000 U | 1400 | 10 U | 10 U | 20 U | 20 U | 50 U | 200 U | 10 U | 10 |
| 4-METHYLPHENOL | 40000 U | 280 | 10 U | 10 U | 20 U | 20 U | 50 U | 200 U | 10 U | 10 U |
| NAPHTHALENE | 820000 | 35000 | 24 | 10 U | 2 J | 20 U | 13 J | 3400 | 690 | 10 U |
| 4-NITROANILINE | 200000 U | 500 U | 50 U | 50 U | 100 U | 100 U | 250 U | 1000 U | 120 | 50 U |
| PHENANTHRENE | 480000 | 18000 | 57 | 10 U | 25 | 11 J | 50 U | 410 | 180 | 1 J |
| PHENOL | 4000 U | 470 | 10 U | 10 U | 20 U | 20 U | 50 U | 200 U | 10 U | 10 U |
| PYRENE | 160000 | 6500 | 13 | 10 U | 15 J | 6 J | 50 U | 41 J | 42 | 10 U |
| VALIDATION STATUS | Q | Q | Q,V | Q,V | V | V | V | Q | Q | V |
| TOTAL PAH COMPOUNDS | 2110000 | 90300 | 155 | 10 U | 25 | 20 U | 50 U | 4700 | 1336 | 10 U |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. MW = Monitoring Well
3. SOR = Sample of Record
4. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit

TABLE 7B-1 (continued)
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER SEMIVOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | MW12-001(SOR) | MW20-001(DUP) | MW12-002 | MW14-001 | MW14-002 | MW16-002(SOR) | MW13-002(DUP) | MW23-001 | P01-001 |
|---|---|---|---|---|---|---|---|---|---|
| ACENAPHTHENE | 650 | 880 J | 390 | 82000 | 8400 | 20 U | 50 U | 20 U | 10 U |
| ACENAPHTHYLENE | 11 J | 1000 U | 6 J | 2200 J | 310 J | 20 U | 50 U | 20 U | 10 U |
| ANTHRACENE | 96 J | 180 J | 31 | 29000 | 2300 | 20 U | 50 U | 20 U | 10 U |
| BENZO(A)ANTHRACENE | 28 J | 1000 U | 15 J | 13000 J | 1200 | 20 U | 50 U | 20 U | 10 U |
| BENZO(A)PYRENE | 200 U | 1000 U | 6 J | 20000 U | 480 J | 20 U | 50 U | 20 U | 10 U |
| BENZO(B)FLUORANTHENE | 200 U | 1000 U | 10 J | 8300 J | 950 | 20 U | 50 U | 20 U | 10 U |
| BIS(2-ETHYLHEXYL) PHTHALATE | 200 U | 1000 U | 20 U | 20000 U | 800 U | 20 U | 50 U | 45 | 19 |
| BUTYL BENZYL PHTHALATE | 200 U | 1000 U | 20 U | 20000 U | 800 U | 43 | 30 J | 20 U | 10 U |
| CHRYSENE | 26 J | 1000 U | 13 J | 13000 J | 1100 | 20 U | 50 U | 20 U | 10 U |
| DIBENZOFURAN | 410 | 600 J | 220 | 56000 | 5700 | 20 U | 50 U | 20 U | 10 U |
| 2,4-DIMETHYLPHENOL | 1400 | 1000 | 170 | 5500 J | 7800 | 20 U | 50 U | 20 U | 10 U |
| DI-N-OCTYL PHTHALATE | 200 U | 1000 U | 20 U | 20000 U | 4000 U | 20 U | 50 U | 75 | 10 U |
| FLUORANTHENE | 200 | 380 J | 93 | 83000 | 6900 | 20 U | 50 U | 20 U | 10 U |
| FLUORENE | 310 | 440 J | 160 | 67000 | 6100 | 20 U | 50 U | 20 U | 10 U |
| ISOPHORONE | 200 U | 1000 U | 20 U | 20000 U | 800 U | 20 U | 50 U | 20 U | 1 J |
| 2-METHYLNAPHTHALENE | 570 | 960 J | 250 | 55000 | 8900 | 20 U | 50 U | 20 U | 10 U |
| 2-METHYLPHENOL | 450 | 330 J | 80 | 3800 J | 5400 | 20 U | 50 U | 20 U | 10 U |
| 4-METHYLPHENOL | 720 | 610 J | 160 | 8500 J | 11000 | 20 U | 50 U | 20 U | 10 U |
| NAPHTHALENE | 7400 | 14000 | 7710 | 340000 | 70000 | 20 U | 50 U | 20 U | 10 U |
| PHENANTHRENE | 680 | 1100 | 370 | 200000 | 18000 | 20 U | 50 U | 20 U | 10 U |
| PHENOL | 140 J | 1000 U | 31 | 20000 U | 1500 | 20 U | 50 U | 20 U | 10 U |
| PYRENE | 166 J | 250 J | 94 | 66000 | 4300 | 20 U | 50 U | 20 U | 10 U |
| VALIDATION STATUS | Q | Q | V | Q | Q | V | V | V | V |
| TOTAL PAH COMPOUNDS | 9240 | 15100 | 8848 | 867000 | 119250 | 20 U | 50 U | 20 U | 10 U |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. MW = Monitoring Well
3. P = Piezometer
4. SOR = Sample of Record
5. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





006716

TABLE 7B-1 (continued)
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER SEMIVOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | P02-001 | P02-002 | P03-001 | P03-002 | P05-001 | OW01-001 | OW01-002 | OW02-001(SOR) | MW13-001(DUP) | OW02-002 | OW08-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ACENAPHTHENE | 1200 | 490 | 26000 | 1100 | 400 | 8 J | 100 U | 770 J | 940 J | 409 J | 10 U |
| ACENAPHTHYLENE | 17 J | 7 J | 10000 U | 500 U | 400 U | 6 J | 6 J | 1000 U | 2000 U | 500 U | 10 U |
| ANTHRACENE | 110 J | 33 | 8300 J | 310 J | 34 J | 35 J | 18 J | 1000 U | 2000 U | 500 U | 10 U |
| BENZO(A)ANTHRACENE | 200 U | 3 J | 5000 J | 180 J | 400 U | 42 | 34 J | 1000 U | 2000 U | 500 U | 10 U |
| BENZO(A)PYRENE | 200 U | 10 U | 2600 J | 500 U | 400 U | 38 J | 100 U | 1000 U | 2000 U | 500 U | 10 U |
| BENZO(B)FLUORANTHENE | 200 U | 10 U | 2200 J | 150 J | 400 U | 35 J | 62 J | 1000 U | 2000 U | 500 U | 10 U |
| BENZO(GHI)PERYLENE | 200 U | 10 U | 10000 U | 500 U | 400 U | 32 J | 35 J | 1000 U | 2000 U | 500 U | 10 U |
| BENZOIC ACID | 1000 U | 10 U | 10000 U | 500 U | 400 U | 40 U | 100 U | 500 U | 2000 U | 5700 | 10 U |
| BENZO(K)FLUORANTHENE | 200 U | 10 U | 2600 J | 500 U | 400 U | 46 | 100 U | 1000 U | 2000 U | 500 U | 10 U |
| BIS(2-ETHYLHEXYL) PHTHALATE | 200 U | 3 J | 10000 U | 500 U | 400 U | 40 U | 100 U | 1000 U | 2000 U | 500 U | 4 J |
| CHRYSENE | 200 U | 3 J | 4900 J | 170 J | 400 U | 42 | 40 J | 1000 U | 2000 U | 500 U | 10 U |
| DIBENZOFURAN | 620 | 10 U | 18000 | 500 U | 230 J | 40 U | 100 U | 450 J | 510 J | 231 J | 10 U |
| DIETHYL PHTHALATE | 200 U | 10 U | 10000 U | 500 U | 70 J | 40 U | 100 U | 1000 U | 2000 U | 500 U | 10 U |
| 2,4-DIMETHYLPHENOL | 200 U | 10 U | 10000 U | 500 U | 400 U | 40 U | 100 U | 4500 | 6300 | 500 U | 10 U |
| FLUORANTHENE | 130 J | 31 | 26000 | 850 | 64 J | 52 | 25 J | 1000 U | 2000 U | 500 U | 10 U |
| FLUORENE | 440 | 160 | 19000 | 730 | 150 J | 12 J | 100 U | 350 J | 390 J | 195 J | 10 U |
| INDENO(1,2,3-CD)PYRENE | 200 U | 10 U | 10000 U | 500 U | 400 U | 35 J | 27 J | 1000 U | 2000 U | 500 U | 10 U |
| 2-METHYLNAPHTHALENE | 400 | 10 U | 19000 | 500 U | 220 J | 4 J | 100 U | 1200 | 1400 J | 600 | 10 U |
| 2-METHYLPHENOL | 200 U | 10 U | 10000 U | 500 U | 400 U | 40 U | 100 U | 870 J | 1300 J | 390 J | 10 U |
| 4-METHYLPHENOL | 200 U | 10 U | 10000 U | 500 U | 400 U | 40 U | 100 U | 990 J | 1400 J | 390 J | 10 U |
| NAPHTHALENE | 6100 | 5200 | 140000 | 15000 | 2400 | 11 J | 10 J | 20000 | 26000 | 13000 | 1 J |
| PHENANTHRENE | 990 | 340 | 58000 | 2200 | 370 J | 63 | 26 J | 330 J | 380 J | 189 J | 10 U |
| PHENOL | 200 U | 10 U | 10000 U | 500 U | 400 U | 35 J | 35 J | 1000 U | 2000 U | 132 J | 10 U |
| PYRENE | 140 J | 20 | 19000 | 630 | 41 J | 40 | 35 J | 1000 U | 2000 U | 500 U | 10 U |
| VALIDATION STATUS | Q | V | V | Q | Q | V | Q | Q | Q | Q | V |
| TOTAL PAH COMPOUNDS | 8730 | 6274 | 288000 | 20510 | 2800 | 285 | 100 U | 20000 | 26000 | 13000 | 10 U |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. P = Piezometer
3. OW = Observation Well
4. MW = Monitoring Well
5. SOR = Sample of Record
6. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





006717

TABLE 7B-1 (continued)
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER SEMIVOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | OW09-001 | OW09-002 | OW10-001 | OW10-002 | OW11-001 | OW11-002 | OW14-001 | OW14-002 |
|---|---|---|---|---|---|---|---|---|
| ACENAPHTHENE | 10 U | 10 U | 6100 | 230 | 2600000 | 1200 | 1000 | 440 |
| ACENAPHTHYLENE | 10 U | 10 U | 290 J | 15 | 50000 J | 1000 U | 1000 U | 22 J |
| ANTHRACENE | 10 U | 10 U | 1700 J | 23 | 550000 | 280 J | 130 J | 30 J |
| BENZO(A)ANTHRACENE | 10 U | 10 U | 670 J | 7 J | 500000 | 1000 U | 1000 U | 50 U |
| BENZO(A)PYRENE | 10 U | 10 U | 4000 U | 3 J | 170000 J | 1000 U | 1000 U | 50 U |
| BENZO(B)FLUORANTHENE | 10 U | 10 U | 4000 U | 5 J | 500000 U | 1000 U | 1000 U | 50 U |
| BIS(2-ETHYLHEXYL)PHTHALATE | 2 J | 10 U | 4000 U | 10 U | 500000 U | 1000 U | 1000 U | 50 U |
| CHRYSENE | 10 U | 10 U | 620 J | 6 J | 420000 J | 1000 U | 1000 U | 50 U |
| DIBENZOFURAN | 10 U | 10 U | 4700 | 160 | 1300000 | 1000 U | 600 J | 230 |
| DIETHYL PHTHALATE | 10 U | 4 J | 4000 U | 10 U | 500000 U | 1000 U | 1000 U | 50 U |
| 2,4-DIMETHYLPHENOL | 10 U | 10 U | 2700 J | 270 | 500000 U | 1000 U | 1000 U | 50 U |
| DI-N-OCTYL PHTHALATE | 10 U | 10 U | 4000 U | 10 U | 500000 U | 1000 U | 1000 U | 50 U |
| FLUORANTHENE | 10 U | 10 U | 4300 | 38 | 2600000 | 800 J | 360 J | 52 |
| FLUORENE | 10 U | 10 U | 4800 | 160 | 1800000 | 680 J | 610 J | 230 |
| 2-METHYLNAPHTHALENE | 10 U | 10 U | 6500 | 400 | 1300000 | 9000 J | 350 J | 130 |
| 2-METHYLPHENOL | 10 U | 10 U | 2000 J | 310 | 500000 U | 1000 U | 1000 U | 50 U |
| 4-METHYLPHENOL | 10 U | 10 U | 1400 J | 140 | 500000 U | 100 U | 1000 U | 50 U |
| NAPHTHALENE | 10 U | 10 U | 66000 | 8100 | 7100000 | 19000 | 8200 | 2600 |
| PHENANTHRENE | 10 U | 10 U | 12000 | 220 | 4900000 | 1600 | 650 J | 180 |
| PHENOL | 10 U | 10 U | 4000 U | 37 | 500000 U | 1000 U | 1000 U | 50 U |
| PYRENE | 10 U | 10 U | 3100 J | 34 | 1900000 | 660 J | 230 J | 49 J |
| VALIDATION STATUS | V | V | Q | V,Q | Q | Q | Q | V |
| TOTAL PAH COMPOUNDS | 10 U | 10 U | 93200 | 8820 | 21950000 | 21800 | 9200 | 3502 |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. OW = Observation Well
3. SOR = Sample of Record
4. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





006718

TABLE 7B-2

SUMMARY OF PREVIOUS DETECTED GROUNDWATER SEMIVOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | Shallow Zone | | Deep Zone | Production Wells | | |
|---|---|---|---|---|---|---|
| | CAV-OW-01-05 | CAV-OW-02-04 | CAV-OW-06-001 | CAV-PW-01-001 | CAV-PW-02-002 | CAV-PW-03-003 |
| ACENAPHTHENE | 49 | 380 | 10 U | 10 U | 10 U | 10 U |
| ACENAPHTHYLENE | 17 | 30 | 10 U | 10 U | 10 U | 10 U |
| BENZO(A) PYRENE | 10 U | 29 | 10 U | 10 U | 10 U | 10 U |
| BIS(2-ETHYLHEXYL) PHTHALATE | 10 U | 17 | 10 U | 10 U | 10 U | 10 U |
| BUTYL BENZYL PHTHALATE | 10 U | 17 | 10 U | 10 U | 10 U | 10 U |
| 2,4-DIMETHYLPHENOL | 25 U | 680 | 25 U | 25 U | 25 U | 25 U |
| DI-N-BUTYL PHTHALATE | 10 U | 34 | 10 U | 10 U | 10 U | 10 U |
| FLUORANTHENE | 23 | 34 | 10 U | 10 U | 10 U | 10 U |
| FLUORENE | 73 | 300 | 10 U | 10 U | 10 U | 10 U |
| NAPHTHALENE | 670 | 17000 | 10 U | 10 U | 10 U | 10 U |
| PENTACHLOROPHENOL | 25 U | 66 | 25 U | 25 U | 25 U | 25 U |
| PHENANTHRENE | 160 | 240 | 10 U | 10 U | 10 U | 10 U |
| PHENOL | 25 U | 59 | 25 U | 25 U | 25 U | 25 U |
| PYRENE | 17 | 27 | 10 U | 10 U | 10 U | 10 U |

NOTES:
1. Analytical test data from Mead Compuchem report to CDM, dated February 24, 1983.
2. OW = Observation Well
3. PW = Production Well

LEGEND:
U = Below Method Detection Limit





006719

TABLE 7B-3
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER VOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | MW01-001(SOR) | MW19-001(DUP) | MW01-002 | MW02-001 | MW02-002 | MW04-001 | MW05-001 | MW06-001 | MW07-001 | MW09-001 |
|---|---|---|---|---|---|---|---|---|---|---|
| METHYLENE CHLORIDE | 5 U | 5 U | 5 U | 400 | 5 U | 180 | 4 J | 470 | 5000 U | 5 U |
| ACETONE | 10 U | 10 U | 10 U | 200 U | 10 U | 200 U | 10 U | 200 U | 5600 J | 9 J |
| BENZENE | 2 J | 14 | 15 | 90 | 77 | 50 J | 5 U | 930 | 5000 U | 5 U |
| TOLUENE | 3 J | 29 | 34 | 120 | 75 | 100 U | 5 U | 900 | 5000 U | 5 U |
| ETHYLBENZENE | 2 J | 18 | 21 | 160 | 65 | 100 U | 5 U | 170 | 5000 U | 5 U |
| STYRENE | 5 U | 5 J | 4 J | 100 U | 6 | 100 U | 5 U | 100 U | 5000 U | 5 U |
| XYLENE | 3 J | 28 | 38 | 400 | 110 | 100 U | 5 U | 680 | 5000 U | 5 U |
| VALIDATION STATUS | V | V | V | V | V | V | V | V | V | V |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. MW = Monitoring Well
3. V = Valid
4. SOR = Sample of Record
5. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





006720

TABLE 7B-3 (continued)
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER VOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | MW10-001 | MW10-002 | MW11-001 | MW11-002 | MW12-001(SOR) | MW20-001(DUP) | MW14-001 | MW16-001 | MW16-002(SOR) | MW13-002(D |
|---|---|---|---|---|---|---|---|---|---|---|
| ACETONE | 50 U | 10 U | 50 | 10 U | 1000 U | 240 | 490 J | 170 | 150 | 145 |
| BENZENE | 8 J | 5 U | 5 U | 5 U | 500 U | 100 U | 830 | 5 U | 5 U | 5 U |
| CHLOROFORM | 25 U | 5 U | 5 U | 5 U | 500 U | 100 U | 500 U | 5 U | 3 J | 5 U |
| TOLUENE | 25 U | 5 U | 5 U | 5 U | 500 U | 100 U | 640 | 5 U | 5 U | 5 U |
| ETHYLBENZENE | 25 U | 8 | 5 U | 3 J | 500 U | 100 U | 500 U | 5 U | 5 U | 5 U |
| XYLENE | 11 J | 5 U | 5 U | 5 U | 500 U | 46 J | 500 U | 5 U | 5 U | 5 U |
| VALIDATION STATUS | V | Q | V | Q | V | V | V | V | V | V |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. MW = Monitoring Well
3. V = Valid
4. Q = Qualified
5. SOR = Sample of Record
6. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit

TABLE 7B-3 (continued)
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER VOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | P02-001 | P03-001 | P05-001 | OW01-001 | OW02-002 | OW10-001 | OW10-002 |
|---|---|---|---|---|---|---|---|
| METHYLENE CHLORIDE | 100 U | 500 U | 50 U | 5 U | 5 U | 140 | 52 |
| ACETONE | 200 U | 1000 J | 78 J | 130 | 7 J | 200 U | 100 U |
| 2-BUTANONE | 200 U | 1000 U | 100 U | 18 | 10 U | 200 U | 100 U |
| BENZENE | 70 J | 800 | 50 U | 5 U | 4 J | 290 | 380 |
| TOLUENE | 33 J | 740 | 50 U | 5 U | 16 | 620 | 1000 |
| ETHYLBENZENE | 85 J | 500 U | 50 U | 5 U | 7 | 270 | 470 |
| STYRENE | 100 U | 500 U | 50 U | 5 U | 5 U | 100 U | 200 |
| XYLENE | 85 J | 500 J | 50 U | 5 U | 19 | 960 | 1100 |
| CHLOROFORM | 100 U | 500 U | 50 U | 5 U | 5 U | 100 U | 100 U |
| VALIDATION STATUS | V | V | V | V | V | V | V |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. MW = Monitoring Well
3. P = Piezometer
4. OW = Observation Well
5. V = Valid
6. SOR = Sample of Record
7. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





006722

TABLE 7B-3 (continued)
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER VOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | OW11-001 | OW11-002 | OW14-001 | OW14-002 |
|---|---|---|---|---|
| METHYLENE CHLORIDE | 500 U | 60 | 5 U | 5 U |
| ACETONE | 1000 J | 100 U | 12 | 10 U |
| BENZENE | 500 J | 300 | 5 U | 5 U |
| TOLUENE | 590 | 1000 | 9 | 11 |
| ETHYLBENZENE | 500 J | 480 | 10 | 13 |
| STYRENE | 500 U | 66 | 5 U | 5 U |
| XYLENE | 500 J | 850 | 37 | 30 |
| VALIDATION STATUS | V | V | V | V |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. OW = Observation Well
3. V = Valid

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





006723

TABLE 7B-4
SUMMARY OF PREVIOUS DETECTED GROUNDWATER VOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| | Shallow Zone | | Deep Zone | Production Wells | | |
|---|---|---|---|---|---|---|
| COMPOUND | CAV-OW-01-05 | CAV-OW-02-04 | CAV-OW-06-001 | CAV-PW-01-001 | CAV-PW-02-002 | CAV-PW-03-003 |
| BENZENE | 10 U | 21 | 10 U | 10 U | 10 U | 10 U |
| ETHYLBENZENE | 10 U | 58 | 10 U | 10 U | 10 U | 10 U |
| TOLUENE | 10 U | 110 | 49 | 10 U | 10 U | 10 U |

NOTES:
1. Analytical test data from Mead Compuchem report to CDM, dated February 24, 1983.
2. OW = Observation Well
3. PW = Production Well

LEGEND:
U = Below Method Detection Limit





006724

TABLE 7B-5
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER INORGANICS (ug/l)[1]

| INORGANIC | MW01-001(SOR) | MW19-001(DUP) | MW01-002 | MW02-001 | MW02-002 | MW03-001 | MW03-002 | MW19-002(DUP) | MW04-001 | MW04-002 | MW05-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ARSENIC | 61.7 | 64.7 | 105 | 20.2 | 82.5 | 10 U | 12.4 | 10 U | 25.3 | 40.0 | 10 U |
| BERYLLIUM | 3 U | 3 U | 14 | 3 U | 11 | 3 U | 3 U | 3 U | 4 | NA | 4 U |
| CHROMIUM | 98 | 9 U | 160 | 9 U | 108 | 9 U | 37 | 23 | 15 | 30 | 111 |
| COPPER | 41 | 10 U | 107 | 10 U | 64 | 10 U | 14 U | 15 | 10 U | NA | 12 |
| IRON | 100000 | 4920 | 181000(Q) | 4840 | 134000(Q) | 1420 | 18500(Q) | 19300(Q) | 7510 | NA | 38000 |
| LEAD | 80.0 | 37.2 | 160 | 19 | 100 | 5 U | 17 | 12 | 36 | 12 | 25.8 |
| NICKEL | 125 | 53 | 194 | 42 | 163 | 56 | 52 | 57 | 20 U | 72 | 127 |
| NITRATE | NA | NA | NA | NA | 100 | NA | 100 | 100 U | NA | NA | 500 |
| ZINC | 196 | 57 | 367 | 37 | 241 | 20 | 42 | 43 | 61 | 67 | 74 |
| VALIDATION STATUS | Q | Q | V | V | V | Q | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 477 | 159 | 899 | 76 | 596 | 20 | 108 | 93 | 137 | 149 | 223 |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. MW = Monitoring Well
3. V = Valid
4. Q = Qualified
5. SOR = Sample of Record
6. DUP = Duplicate
7. NA = Not Analyzed

LEGEND:
U = Below Method Detection Limit





006725

TABLE 7B-5 (continued)
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER INORGANICS (ug/l)[1]

| INORGANIC | MW06-001 | MW06-002 | MW07-001 | MW07-002 | MW08-001(SOR) | MW13-003(DUP) | MW08-002 | MW99(DUP) | MW09-001 | MW09-002 | MW10- |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ARSENIC | 33.4 | 80 | 24 | 55 | 34.6 | 16.4 | 10 U | 10 U | 10 U | 14 | 25 |
| BERYLLIUM | 15 U | 3 U | 3 U | NA | 4 | 2 U | 2 U | 2 U | 3 U | NA | 3 |
| CADMIUM | 25 U(Q) | 4 U | 6(Q) | NA | 5 U | 5 U | 5 U | 5 U | 5 U(Q) | NA | 5 |
| CHROMIUM | 450 | 16 | 9 U | 30 | 185 | 65 | 27 | 23 | 9 U | 99 | 9 |
| COPPER | 75 | 1340 | 17 | NA | 38 | 20 | 21 | 16 U | 11 | NA | 10 |
| IRON | 35600 | 13600(Q) | 5260 | NA | 78000 | 38400 | NA | NA | 3300 | NA | 2320 |
| LEAD | 119 | 5 U | 34 | 27 | 35.9(Q) | 14.7(Q) | 34 | 32 | 23 | 233 | 5 |
| NICKEL | 360 | 318 | 29 U | 85 | 231 | 136 | 35 | 21 U | 29 U | 53 | 29 |
| NITRATE | NA | 100 U | NA | NA | 200 | 100 | NA | NA | NA | NA | NA |
| ZINC | 685 | 1180 | 49 | 109 | 180 | 80 | 59 | 50 | 67 | 549 | 29 |
| VALIDATION STATUS | V | V | V | V | V | V | V | V | V | Q | V |
| INORGANIC INDICATOR TOTALS | 1362 | 2616 | 124 | 221 | 474 | 196 | 141 | 105 | 101 | 895 | 54 |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. MW = Monitoring Well
3. V = Valid
4. Q = Qualified
5. SOR = Sample of Record
6. DUP = Duplicate
7. NA = Not Analyzed

LEGEND:
U = Below Method Detection Limit





006726

TABLE 7B-5 (continued)
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER INORGANICS (ug/l)[1]

| INORGANIC | MW10-002 | MW11-001 | MW11-002 | MW12-001(SOR) | MW20-001(DUP) | MW12-002 | MW14-001 | MW14-002 | MW16-001 | MW16-002 | MW13-002(D |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ARSENIC | 48 | 10 U | 12 | 29.0 | 43.6 | 27 | 50 | 26 | 10 U | 10 U | 10 U |
| BERYLLIUM | 5 | 3 U | 3 U | 3 U | 3 U | NA | 3 U | NA | 3 U | 3 U | 3 U |
| CHROMIUM | 62 | 102 | 29 | 11 | 14 | 73 | 26 | 9 U | 20 | 12 | 9 U |
| COPPER | 21 | 31 | 14 U | 11 | 10 U | NA | 33 | NA | 10 U | 14 U | 14 U |
| IRON | 44700(Q) | 91900 | 21900(Q) | 9620 | 4240 | NA | 22100 | NA | 428 | 314(I) | 606 |
| LEAD | 30 | 39 | 13 | 102 | 128 | 72 | 67 | 5 U | 7 | 5 U | 5 |
| NICKEL | 70 | 131 | 24 U | 29 U | 29 U | 76 | 47 | 29 | 29 U | 24 U | 30 |
| NITRATE | 100 U | NA | NA | NA | NA | NA | NA | NA | NA | 200 | 200 |
| ZINC | 75 | 345 | 96 | 60 | 30 | 141 | 75 | 17 U | 24 | 17 U | 17 U |
| VALIDATION STATUS | V | V | V | V | V | V | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 236 | 517 | 150 | 213 | 216 | 313 | 251 | 26 | 51 | 12 | 5 |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. MW = Monitoring Well
3. V = Valid
4. Q = Qualified
5. I = Invalid
6. SOR = Sample of Record
7. DUP = Duplicate
8. NA = Not Analyzed

LEGEND:
U = Below Method Detection Limit





006727

TABLE 7B-5 (continued)
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER INORGANICS (ug/l)[1]

| INORGANIC | MW23-001 | P01-001 | P01-002 | P02-001 | P02-002 | P03-001 | P03-002 | P04-001 | P04-002 | P05-001 | P05-002 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ARSENIC | 5 U | 10 U | 10 U | 30 | 26 | 29 | 10 U | 14 | 10 U | 10 U | 10 U |
| CHROMIUM | 8 U | 13 | 9 U | 9 U | 9 U | 21 | 24 | 9 U | 24 | 25 | 9 U |
| COPPER | 16 U | 10 U | NA | 10 U | NA | 11 | NA | 10 U | NA | 17 | NA |
| IRON | 2720 | 4440 | NA | 7380 | NA | 20100 | NA | 6850 | NA | 14400 | NA |
| LEAD | 4 U | 15 | 5 U | 5 U | 5 U | 18 | 8 | 5 U | 7 | 21 | 5 U |
| NICKEL | 34 U | 30 | 24 U | 64 | 24 U | 29 U | 44 | 57 | 51 | 29 U | 24 U |
| NITRATE | 400 | NA | NA | 100 U | NA | 100 U | NA | NA | NA | NA | NA |
| ZINC | 10 U | 14 | 17 U | 33 | 17 U | 63 | 41 | 53 | 57 | 87 | 19 |
| VALIDATION STATUS | V | Q | V | Q | V | V | V | Q | V | V | V |
| INORGANIC INDICATOR TOTALS | 4 U | 42 | 5 U | 63 | 26 | 142 | 73 | 67 | 88 | 150 | 19 |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. MW = Monitoring Well
3. P = Piezometer
4. V = Valid
5. Q = Qualified
6. NA = Not Analyzed

LEGEND:
U = Below Method Detection Limit





006728

TABLE 7B-5 (continued)
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER INORGANICS (ug/l)[1]

| INORGANIC | OW01-001 | OW01-002 | OW02-001(SOR) | MW13-001(DUP) | OW02-002 | OW07-001 | OW07-002 | OW08-001 | OW08-002 | OW09-00 |
|---|---|---|---|---|---|---|---|---|---|---|
| ARSENIC | 165 | 156 | 69 | 97.9 | 69 | 95 | 59 | 22 | 55 | 13.0 |
| BERYLLIUM | 3 U | NA | 3 U | 3 U | NA | 20 | NA | 3 U | NA | 5 |
| CADMIUM | 5 U(Q) | NA | 5 U | 8 | NA | 10 | NA | 9 | NA | 5 U |
| CHROMIUM | 9 U | 14 | 9 U | 10 | 9 U | 155 | 217 | 19 | 72 | 31 |
| COPPER | 10 U | NA | 10 U | 10 U | NA | 85 | NA | 13 | NA | 21 |
| IRON | 6230 | NA | 4580 | 5110 | NA | 165000 | NA | 5340 | NA | 30400 |
| LEAD | 28 | 25 | 5 U | 5 U | 11 | 159 | 148 | 28 | 52 | 40 |
| NICKEL | 40 | 24 U | 29 U | 29 U | 37 | 187 | 241 | 29 U | 102 | 29 U |
| ZINC | 73 | 54 | 29 | 29 | 17 U | 279 | 352 | 48 | 146 | 99 |
| VALIDATION STATUS | V | V | V | V | V | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 267 | 249 | 98 | 137 | 80 | 773 | 776 | 130 | 325 | 204 |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. OW = Observation Well
3. V = Valid
4. Q = Qualified
5. SOR = Sample of Record
6. DUP = Duplicate
7. NA = Not Analyzed

LEGEND:
U = Below Method Detection Limit





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TABLE 7B-5 (continued)
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER INORGANICS (ug/l)[1]

| INORGANIC | OW09-002 | OW10-001 | OW10-002 | OW11-001 | OW11-002 | OW13-001 | OW13-002 | OW14-001 | OW14-002 |
|---|---|---|---|---|---|---|---|---|---|
| ANTIMONY | NA | 67 | 48 U | 220 U | NA | 44 U(Q) | NA | 44 U | NA |
| ARSENIC | 10 U | 35 | 15 | 522 | 10 U | 10 U | 10 U | 83.0 | 41 |
| BERYLLIUM | NA | 3 U | 9 | 15 U | NA | 3 U | NA | 6 | NA |
| CHROMIUM | 17 | 42 | 151 | 45 U | 9 U | 30 | 33 | 68 | 56 |
| COPPER | NA | 33 | 76 | 50 U | NA | 13 | NA | 14 | NA |
| IRON | NA | 35500 | 130000 | 10500 | NA | 10000 | NA | 39500 | NA |
| LEAD | 20 | 257 | 19 | 28 | 9 | 46 | 25 | 29 | 20 |
| NICKEL | 42 | 87 | 157 | 395 | 32 | 54 | 60 | 29 U | 66 |
| NITRATE | NA | 100 U | 400 | NA | NA | NA | NA | NA | NA |
| ZINC | 36 | 116 | 303 | 490 | 28 | 76 | 56 | 121 | 80 |
| VALIDATION STATUS | V | V | V | V | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 73 | 483 | 564 | 1040 | 37 | 165 | 114 | 315 | 197 |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. OW = Observation Well
3. V = Valid
4. Q = Qualified
4. NA = Not Analyzed

LEGEND:
U = Below Method Detection Limit





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TABLE 7B-6
SUMMARY OF PREVIOUS DETECTED GROUNDWATER INORGANICS (mg/l)[1]

| | Shallow Zone | | Deep Zone | Production Wells | | |
|---|---|---|---|---|---|---|
| INORGANIC | CAV-OW-01-05 | CAV-OW-02-04 | CAV-OW-06-001 | CAV-PW-01-001 | CAV-PW-02-002 | CAV-PW-03-003 |
| ANTIMONY | 0.05 U | 0.05 U | 0.10 | 0.05 U | 0.05 U | 0.05 U |
| ARSENIC | 0.05 U | 0.13 | 0.05 | 0.05 U | 0.05 U | 0.05 U |
| CADMIUM | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.04 | 0.02 U |
| COPPER | 0.06 | 0.1 U | 0.10 U | 0.1 U | 0.1 U | 0.1 U |
| CYANIDE | 0.70 | 0.01 | 0.01 U | 0.01 U | 0.01 U | 0.01 U |
| LEAD | 0.2 U | 0.2 U | 0.2 U | 0.35 | 0.35 | 0.30 |
| SELENIUM | 0.05 U | 0.05 U | 0.26 | 0.05 U | 0.05 U | 0.05 U |
| ZINC | 0.12 | 0.20 | 0.02 U | 0.58 | 0.52 | 0.28 |

NOTES:
1. Analytical test data from Mead Compuchem report to CDM, dated February 24, 1983.
2. OW = Observation Well
3. PW = Production Well

LEGEND:
U = Below Method Detection Limit





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TABLE 7B-7
SUMMARY OF SHALLOW ZONE DETECTED GROUNDWATER PESTICIDES/PCB (ug/l)[1]

| COMPOUND | MW02-002 | MW06-001 | MW06-002 | MW14-002 | OW01-001 | OW01-002 |
|---|---|---|---|---|---|---|
| BETA-BHC | 0.05 U | 2.50 U | 0.25 U | 0.25 U | 110 | 0.57 |
| 4,4'-DDE | 0.10 U | 5.00 U | 8.1 | 1.7 | 1.00 U | 0.50 U |
| ENDOSULFAN I | 0.15 | 2.50 U | 0.25 U | 0.25 U | 0.50 U | 0.25 U |
| GAMMA-BHC(LINDANE) | 0.05 U | 2.50 J | 0.25 U | 0.25 U | 0.50 U | 0.25 U |
| VALIDATION STATUS | V | V | V | V | V | V |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. MW = Monitoring Well
3. OW = Observation Well
4. V = Valid

LEGEND:
U = Below Method Detection Limit





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TABLE 7B-8
SUMMARY OF DEEP ZONE DETECTED GROUNDWATER SEMIVOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | OW06-001 | OW06-002 |
|---|---|---|
| NAPHTHALENE | 10 U | 4 J |
| P-CHLORO-M-CRESOL | 7 J | 20 U |
| VALIDATION STATUS | V | Q |
| TOTAL PAH COMPOUNDS | 10 U | 20 U |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. OW = Observation Well
3. V = Valid
4. Q = Qualified

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit





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TABLE 7B-9

SELECT DEEP ZONE HPLC SEMIVOLATILE ORGANIC COMPOUNDS

| COMPOUND | DW02-001(ng/l) | DW06-003(ng/l) |
|---|---|---|
| BENZO(A)ANTHRACENE | <1.00 | <1.00 |
| CHRYSENE | <1.00 | <1.00 |
| BENZO(B)FLUORANTHENE | <1.00 | <1.00 |
| BENZO(K)FLUORANTHENE | <1.00 | <1.00 |
| BENZO(A)PYRENE | <1.00 | <1.00 |
| DIBENZO(AH)ANTHRACENE | <1.00 | <1.00 |
| INDENO(1,2,3-CD)PYRENE | <1.00 | <1.00 |

Note:

1. HPLC = High Performance Liquid Chromatography.

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TABLE 7B-10

SUMMARY OF DEEP ZONE DETECTED GROUNDWATER VOLATILE ORGANIC COMPOUNDS (ug/l)[1]

| COMPOUND | OW06-001 | OW06-002 |
|---|---|---|
| ACETONE | 51 B | 10 U |
| BENZENE | 5 J | 5 U |
| METHYLENE CHLORIDE | 5 U | 3 J |
| STYRENE | 5 U | 3 J |
| VALIDATION STATUS | V | Q |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. OW = Observation Well
3. V = Valid
4. Q = Qualified

LEGEND:
U = Below Method Detection Limit
J = Detected Below Method Detection Limit
B = Detected in Blank





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TABLE 7B-11
SUMMARY OF DEEP ZONE DETECTED GROUNDWATER INORGANICS (ug/l)[1]

| INORGANIC | OW06-001 | OW06-002 | DW02-001(SOR) | DW03-001(DUP) | DW02-002(SOR) | DW02-003(DUP) |
|---|---|---|---|---|---|---|
| IRON | 35700 | 1430 | 80 | 78 | 78 U | 240 |
| LEAD | 23 | 5 U | 5 U | 5 U | 5 U | 5 U |
| NICKEL | 68 | 42 | 25 U | 25 U | 25 U | 25 U |
| ZINC | 156 | 17 U | 12 U | 12 U | 9 U | 9 U |
| VALIDATION STATUS | Q | V | V | V | V | V |
| INORGANIC INDICATOR TOTALS | 179 | 5 U | 5 U | 5 U | 5 U | 5 U |

NOTES:
1. Data for field blanks and rinseate blanks not presented.
2. OW = Observation Well
3. DW = Deep Well
4. V = Valid
5. Q = Qualified
6. SOR = Sample of Record
7. DUP = Duplicate

LEGEND:
U = Below Method Detection Limit





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# SECTION 8.0 – AIR QUALITY INVESTIGATION

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# 8.0 AIR QUALITY INVESTIGATION

## 8.1 Introduction

As part of the South Cavalcade Site Remedial Investigation, an air quality investigation has been conducted to characterize the nature and extent of potential air contaminants, if any, in the vicinity of the site. The air quality investigation is outlined in Subtask 2G of the RI/FS work plan and was conducted in accordance with Section 8.0 of the Field Sampling and Analytical Plan. Field measurements made during the survey were compared to established Multimedia Environmental Goals (MEG), which set guideline concentrations of specific compounds in the ambient air based upon health effects. This investigation has shown that the majority of compounds identified at the site were well below the MEG levels established by EPA.

## 8.2 Field Survey

Field work was performed by Keystone Environmental Resources, Inc., during the week of November 10, 1985, and consisted of measuring ambient concentrations of organic compounds at 1 upwind and 2 downwind locations on three consecutive days.

Organic compounds present in both the particulate phase and vapor phase were determined by the selected procedure. Each fraction was later analyzed separately by EPA Methods 604 and 610 for specific priority pollutant phenolics and polynuclear aromatic hydrocarbons (PAH).

A Model 2133 Windicator portable wind indicating system was utilized each day to aid in the selection of upwind and downwind sampling positions and to validate the alignment of the sampling stations with respect to the wind direction over the test period. Wind speed and direction data were recorded at ten-minute intervals by the field technician at

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the downwind position No. 2, where the wind instrument was operated. Wind direction remained constant during the three-day test series with southeast winds recorded for Tests 1 and 2, and south-southeast winds recorded for Test 3. Wind speed averaged 7 miles per hour for each of the three tests. Table 8-1 summarizes wind data for each test and verifies the consistency of wind direction over the period.

Selection of the upwind position was made in an attempt to characterize the background ambient air at the upwind perimeter before crossing the site. Downwind stations were chosen to be representative of the air quality near the downwind perimeter. Due to the constant wind direction, the same upwind and downwind stations were employed for the entire test program.

Under these conditions, the upwind station was located near the southeast corner of the Palletized Trucking Company property line just north of Collingsworth Street. Downwind Station No. 1 was located in an open field on the southwest corner of the Transcon Lines property. The downwind No. 2 sampling station was located in an abandoned parking lot on the northeast corner of the Transcon property. Figure 8-1 illustrates the location of the sampling stations and the predominant wind direction for each test.

All samples were collected in duplicate and operation and field clean up of sampling trains were performed in accordance with the specified operating procedure. Chain-of-custody forms, blank analyses, recovery efficiencies, series canisters, and co-located samples were employed to document quality assurance. Validation of sample analyses was not performed, as it was not required according to the specified procedure.

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TABLE 8-1
SOUTH CAVALCADE SITE
WIND SPEED AND DIRECTION DATA

| Test 1, 11-12-85 | | |
|---|---|---|
| Time | Speed, MPH | Direction |
| 1345 | 5 | South |
| 1355 | 5 | Southeast |
| 1405 | 5 | Southeast |
| 1415 | 10 | Southeast |
| 1425 | 5 | Southeast |
| 1435 | 10 | Southeast |
| 1445 | 8 | Southeast |
| 1455 | 8 | Southeast |
| 1505 | 8 | South Southeast |
| 1515 | 5 | Southeast |
| 1525 | 5 | Southeast |
| 1535 | 8 | East Southeast |
| 1545 | 5 | Southeast |
| | 7 | Southeast |

| Test 2, 11-13-85 | | |
|---|---|---|
| Time | Speed, MPH | Direction |
| 1130 | 7 | South |
| 1140 | 7 | Southeast |
| 1150 | 5 | Southeast |
| 1200 | 5 | South |
| 1210 | 8 | South |
| 1220 | 5 | Southeast |
| 1230 | 8 | Southeast |
| 1240 | 7 | Southeast |
| 1250 | 7 | South Southeast |
| 1300 | 10 | Southeast |
| 1310 | 8 | South |
| 1320 | 5 | Southeast |
| 1330 | 5 | Southeast |
| | 7 | Southeast |

| Test 3, 11-14-85 | | |
|---|---|---|
| Time | Speed, MPH | Direction |
| 0945 | 10 | South Southeast |
| 0955 | 10 | South |
| 1005 | 5 | South |
| 1015 | 5 | South |
| 1025 | 10 | South |
| 1035 | 8 | South |
| 1045 | 4 | Southeast |
| 1055 | 5 | Southeast |
| 1105 | 7 | South |
| 1115 | 5 | South |
| 1125 | 8 | Southeast |
| 1135 | 5 | Southeast |
| 1145 | 5 | Southeast |
| | 7 | South Southeast |



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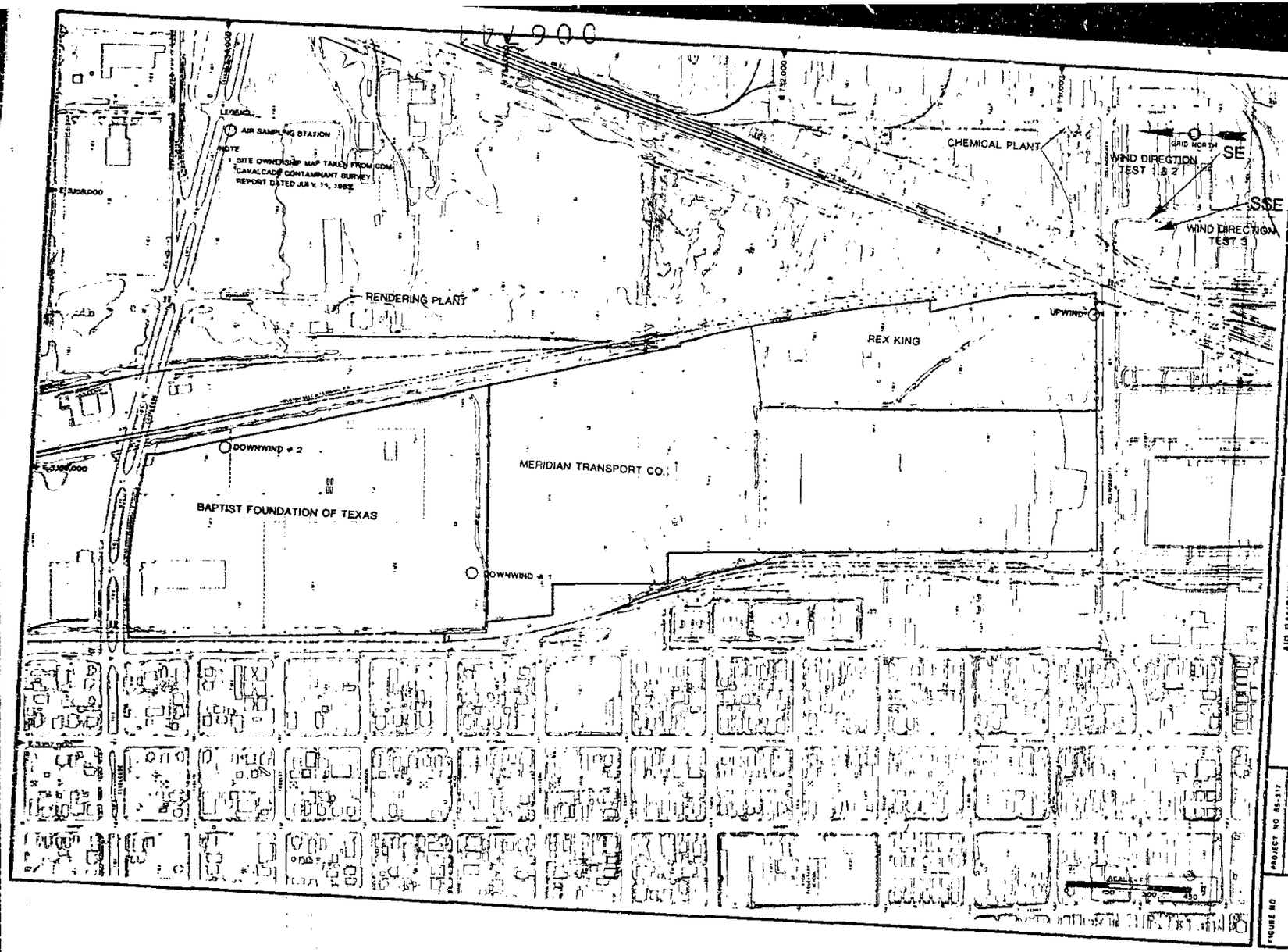


AIR SAMPLING LOCATION MAP
SOUTH CAVALCADE SITE
KOPPERS COMPANY, INC.
HOUSTON, TEXAS

PROJECT NO 85-517
DATE 7-13-87
ENGINEER
DRAWN BY LLD

FIGURE NO 8-1

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A small quantity of condensate (atmospheric moisture) was noted in the glass connector at the outlet of the XAD-2 adsorbent canister for all tests. This liquid was retained for subsequent analysis with the XAD-2 resin fraction.

During Test 2, a leak developed in the glass joint at the outlet of XAD-2 canister No. SCK-AR02-001 for the upwind sampler. The leakage rate and time of occurrence were determined and the volume of air leakage was deducted from the measured meter volume.

Pertinent field parameters, including time of collection, sample volume, average wind speed and direction, and ambient air temperature, are summarized in Tables 8-2 through 8-4 for each test.

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## 8.3 Laboratory Analysis

Upon receipt of samples at the analytical laboratory, all containers were inspected for any evidence of damage. The condition of all samples was satisfactory.

Both filter and XAD-2 resin were separately soxhlet extracted for 24 hours with methylene chloride. The methylene chloride solutions were next dried through a sodium sulfate drying column and concentrated by use of a steam bath to a final volume of 25 ml. Identical extraction procedures were performed for all field samples and blanks.

The extracts were submitted for chromatographic analysis. Analysis for polynuclear aromatic hydrocarbons (PAH) was performed by a liquid chromatographic technique in accordance with the applicable specifications of EPA Method 610.

Phenolic compounds were determined by capillary gas chromatography in accordance with the applicable specification of EPA Method 604.

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TABLE 8-2

**SOUTH CAVALCADE SITE AIR QUALITY INVESTIGATION**
**FIELD SAMPLING SUMMARY**

| Date | Sample Location | Test No. | Sample ID No. | Time Collected | Sample Vol.(SCFD) | Wind Speed,(MPH) | Wind Direction | Ambient Temp.°F | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 11-12-85 | Upwind (Rex King, SE Corner) | 1 | SCK-AR01-001 | 1345-1546 | 71.75 | 7 | SE | 82 | Cloudy |
| 11-12-85 | Upwind, Duplicate (Rex King, SE Corner) | 1 | SCK-AR01-002 | 1345-1546 | 72.27 | 7 | SE | 82 | Cloudy |
| 11-12-85 | Downwind #1 (Transcon, SW Corner | 1 | SCK-AR04-001 | 1345-1550 | 74.74 | 7 | SE | 82 | Cloudy |
| 11-12-85 | Downwind #1, Dup. (Transcon, SW Corner) | 1 | SCK-AR04-003 | 1345-1550 | 78.42 | 7 | SE | 82 | Cloudy |
| 11-12-85 | Downwind #2 (Transcon, NE Corner) | 1 | SCK-AR04-002 | 1345-1545 | 75.39 | 7 | SE | 82 | Cloudy |
| 11-12-85 | Downwind #2, Dup. (Transcon, NE Corner) | 1 | SCK-AR04-004 | 1350-1550 | 66.18 | 7 | SE | 82 | Cloudy |





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TABLE 8-3
SOUTH CAVALCADE SITE AIR QUALITY INVESTIGATION
FIELD SAMPLING SUMMARY

| Date | Sample Location | Test No. | Sample ID No. | Time Collected | Sample Vol.(SCFD) | Wind Speed, (MPH) | Wind Direction | Ambient Temp.°F | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 11-13-85 | Upwind (Rex King, SE Corner) | 2 | SCK-AR02-001 | 1130-1332 | 72.61 | 7 | SE | 84 | Leak developed at outlet of canister, volume corrected |
| 11-13-85 | Upwind, Duplicate (Rex King, SE Corner | 2 | SCK-AR02-002 | 1130-1332 | 75.21 | 7 | SE | 84 | Cloudy |
| 11-13-85 | Downwind #1 (Transcon, SW Corner) | 2 | SCK-AR05-001 | 1130-1322 | 81.06 | 7 | SE | 84 | In series with SCK-AR09-001 |
| 11-13-85 | Downwind #1, Dup. (Transcon, SW Corner) | 2 | SCK-AR05-003 | 1130-1332 | 67.42 | 7 | SE | 84 | Cloudy |
| 11-13-85 | Downwind #2 (Transcon, NE Corner) | 2 | SCK-AR05-002 | 1130-1330 | 78.22 | 7 | SE | 84 | Cloudy |
| 11-13-85 | Downwind #2 Dup. (Transcon, NE Corner) | 2 | SCK-AR05-004 | 1135-1335 | 71.60 | 7 | SE | 84 | Cloudy |
| 11-13-85 | Blank | 2 | SCK-AR07-001 | | | 7 | SE | 84 | Unused Filter and canister |
| 11-13-85 | Blank | 2 | SCK-AR08-001 | | | 7 | SE | 84 | Unused Filter and Canister |
| 11-13-85 | Series Canister (Transcon, SW Corner) | 2 | ACK-AR09-001 (2nd Canister) | 1130-1322 | 81.06 | 7 | SE | 84 | In Series Following SCK-AR05-001 |



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TABLE 8-4
SOUTH CAVALCADE SITE AIR QUALITY INVESTIGATION
FIELD SAMPLING SUMMARY

| Date | Sample Location | Test No. | Sample ID No. | Time Collected | Sample Vol.(SCFD) | Wind Speed,(MPH) | Wind Direction | Ambient Temp.°F | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 11-14-85 | Upwind (Rex King, SE Corner) | 3 | SCK-AR03-001 | 0955-1202 | 79.48 | 7 | SSE | 77 | Overcast Threatening Rain |
| 11-14-85 | Upwind, Duplicate (Rex King, SE Corner) | 3 | SCK-AR03-002 | 1000-1201 | 76.45 | 7 | SSE | 77 | Overcast Threatening Rain |
| 11-14-85 | Downwind #1 (Transcon, SW Corner) | 3 | SCK-AR06-001 | 0945-1146 | 83.32 | 7 | SSE | 77 | Overcast Threatening Rain |
| 11-14-85 | Downwind #1, Dup. (Transcon, SW Corner) | 3 | SCK-AR06-003 | 0945-1146 | 78.69 | 7 | SSE | 77 | Overcast Threatening Rain |
| 11-14-85 | Downwind #2 (Transcon , NE Corner) | 3 | SCK-AR06-002 | 0945-1145 | 77.57 | 7 | SSE | 77 | Overcast Threatening Rain |
| 11-14-85 | Downwind #2, Dup. (Transcon, NE Corner) | 3 | SCK-AR06-004 | 0950-1150 | 75.10 | 7 | SSE | 77 | Overcast Threatening Rain |





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All component identifications were made on the basis of retention data. Detection limits for both procedures were chosen such that the resulting concentration of undetected compounds would be below the compounds MEG level.

## 8.4 Test Results

Tables 8-5 and 8-6 summarize the results of the batch and field blank analysis and series canister test for each of the EPA Method 604 and 610 components. Batch blank data was derived from analysis of unused XAD-2 resin from four separate laboratory lots employed during the survey. Field blank data was obtained from analysis of unused filter and XAD-2 resin taken into the field, stored, and handled as other samples. The series canister was placed downstream of the primary XAD-2 resin canister for Test 2 at the down-wind No. 1 location to validate the collection efficiency of the absorbent.

Component values appearing as N.D. were not detected and are assumed to be below the stated detection limit. For purposes of calculating component air concentrations in micrograms per cubic meter (ug/$M^3$), the sum of the filter and XAD-2 mass was divided by the air volume sampled in standard cubic meters. Where both filter and XAD-2 values are shown as N.D., the total component mass is assumed to be less than the sum of the individual detection limits. The component concentration calculated for this case is prefixed with a "less than" (<) symbol indicating that any amount present would be less than the stated concentration. Where an approximate (~) value is reported, there was obvious interference from a closely eluting unknown component. Also, some values are reported as "less than" (<) indicating that the component was detected but could not be measured accurately.

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TABLE 8-5
South Cavalade Site
Laboratory Batch and Field Blank Analytical Results

| Date<br>Identification<br>Sample No. | | 12-5-85<br>Batch Blank<br>XAD-2 KPX-15 | 12-5-85<br>Batch Blank<br>XAD-2 KPX-16 | 12-5-85<br>Batch Blank<br>XAD-2 KPX-17 | 12-5-85<br>Batch Blank<br>XAD-2 KPX-18 | 11-13-85<br>Field Blank<br>SCK-ARO7-001 | | 11-13-85<br>Field Blank<br>SCK-ARO8-0 | |
|---|---|---|---|---|---|---|---|---|---|
| **Method 604 Component** | Detection Limit, ug Sample | Total ug XAD-2 | Total ug XAD-2 | Total ug XAD-2 | Total ug XAD-2 | Total ug Filter | XAD-2 | Total ug Filter | XAD-2 |
| Phenol | 0.5 | 3.5 | 4 | 20 | 3 | N.D. | 6 | N.D. | N.D. |
| 2-Chorophenol | 0.5 | 5 | N.D. | 1.5 | 4 | N.D. | N.D. | N.D. | N.D. |
| 2-Nitrophenol | 0.5 | N.D. | N.D. | 11 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 2,4-Dimethylphenol | 0.5 | 5 | N.D. | 5.5 | 5 | N.D. | N.D. | N.D. | 2 |
| 2,4-Dichlorophenol | 0.5 | 3 | 3.5 | 14 | 2.5 | N.D. | 11 | N.D. | 10 |
| 4-Chloro-3-methylphenol | 0.5 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| 2,4,6-Trichlorophenol | 0.5 | N.D. | N.D. | 3 | N.D. | <1 | N.D. | <1 | 2.5 |
| 2,4-Dinitrophenol | 0.5 | 5.5 | 7.5 | N.D. | N.D. | 5 | N.D. | 5 | 8 |
| 4-Nitrophenol | 0.5 | N.D. | N.D. | 1.5 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 2-Methyl-4,6-dinitrophenol | 0.5 | N.D. | N.D. | 1 | N.D. | N.D. | N.D. | N.D. | 1 |
| Pentachlorophenol | 0.5 | N.D. | N.D. | 2 | N.D. | 7 | ~4.5 | 3 | 3 |
| **Method 610 Component** | | | | | | | | | |
| Naphthalene | 50 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Acenaphthylene | 50 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Acenaphthene | 50 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Fluorene | 10 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Phenanthrene | 10 | N.D. | N.D. | 10 | N.D. | N.D. | N.D. | N.D. | N.D. |
| Anthracene | 10 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Fluoranthene | 10 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Pyrene | 10 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Benzo(a)anthracene | 0.5 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Chrysene | 1 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Benzo(b)fluoranthene | 1 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Benzo(k)fluoranthene | 1 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Benzo(a)pyrene | 1 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Dibenzo(a,h)anthracene | 0.5 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Benzo(g,h,i)perylene | 1 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| Indeno(1,2,3-c,d)pyrene | 1 | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |

N.D. = Below Stated Detection Limit



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TABLE 8-6

South Cavalcade Site
Comparison Between Primary and Series XAD-2 Canister
Analytical Results

| Date, Test No. | | 11-13-85, Test 2 | |
|---|---|---|---|
| Position | | Downwind 1, Primary | Downwind 1, Series |
| Sample No. | | SCK-AR05-001 | SCK-AR09-001 |
| **Method 604 Component** | **Detection Limit, ug Sample** | **Total ug XAD-2** | **Total ug XAD-2** |
| Phenol | 0.5 | N.D. | 14.5 |
| 2-Chorophenol | 0.5 | N.D. | 3 |
| 2-Nitrophenol | 0.5 | N.D. | 6 |
| 2,4-Dimethylphenol | 0.5 | N.D. | 2 |
| 2,4-Dichlorophenol | 0.5 | 3.5 | 5.5 |
| 4-Chloro-3-methylphenol | 0.5 | N.D. | N.D. |
| 2,4,6-Trichlorophenol | 0.5 | 3 | 4 |
| 2,4-Dinitrophenol | 0.5 | 18.5 | 23.5 |
| 4-Nitrophenol | 0.5 | 0.5 | N.D. |
| 2-Methyl-4,6-dinitrophenol | 0.5 | 3 | 3.5 |
| Pentachlorophenol | 0.5 | 17.5 | 37.5 |
| **Method 610 Component** | | | |
| Naphthalene | 50 | N.D. | N.D. |
| Acenaphthylene | 50 | N.D. | N.D. |
| Acenaphthene | 50 | N.D. | N.D. |
| Fluorene | 10 | N.D. | N.D |
| Phenanthrene | 10 | N.D. | N.D. |
| Anthracene | 10 | N.D. | N.D. |
| Fluoranthene | 10 | N.D. | N.D. |
| Pyrene | 10 | N.D. | N.D. |
| Benzo(a)anthracene | 0.5 | N.D. | N.D. |
| Chrysene | 1 | N.D. | N.D. |
| Benzo(b)fluoranthene | 1 | N.D. | N.D. |
| Benzo(k)fluoranthene | 1 | N.D. | N.D. |
| Benzo(a)pyrene | 1 | N.D. | N.D. |
| Dibenzo(a,h)anthracene | 0.5 | N.D. | N.D. |
| Benzo(g,h,i)perylene | 1 | N.D. | N.D. |
| Indeno(1,2,3-c,d)pyrene | 1 | N.D. | N.D. |

N.D. = Below Stated Detection Limit

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Low background levels of phenol, 2,4-dichlorophenol and 2,4-dinitrophenol were detected in the majority of batch and field blanks. Pentachlorophenol was identified at concentrations of 7 and 3 ug per filter respectively for the two field blanks. Phenanthrene was identified in a single batch blank at the detection limit of 10 ug per total sample.

The only compound present in sufficient background quantities to interfere with the measured field values was 2,4-dinitrophenol. This compound was identified in 5 of the 8 resin and filter blanks analyzed. Background levels of 2,4-dinitrophenol on the order of 5 ug per sample were determined for each of the two filter blanks. On the average, the blank background contribution of 2,4-dinitrophenol from the filter and XAD-2 would result in an equivalent ambient concentration of 4.2 ug/$M^3$ based upon a sample volume of 2 $M^3$. These background levels would exceed the MEG concentration for 2,4-dinitrophenol of 2.4 ug/$M^3$. No attempt was made to mathematically correct field samples for these background levels due to between blank variations and the complete absence of 2,4-dinitrophenol in some samples.

Both the primary and series XAD-2 canister showed small measurable quantities of several phenolic compounds (Table 8-6). No PAH compounds were identified in either sample. Both phenol and 2,4-dichorophenol were identified in the series canister (SCK-AR09-001) at levels equal to or below the levels found in the batch blank (Batch KPX-17) from which the sample material was obtained. These levels are, therefore, thought to be attributable to background contamination of the adsorbent or due to interferences

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introduced during extraction. Pentachlorophenol and 2,4-dinitrophenol were identified in both canisters with higher levels of pentachlorophenol found in the series canister. Because of the relatively low concentration of the EPA Method 604 and 610 compounds in the ambient air at the test site, it is impossible to evaluate the collection efficiency of the primary adsorbent canister.

The results of the field survey are summarized in Tables 8-7 through 8-9 for Tests 1 through 3 respectively. Where published, the MEG for each specific compound are reported in column 3 for comparison with the measured ambient concentration. Of 17 phenolic and PAH compounds investigated which have MEG, only 2 exceeded their respective MEG. Out of 288 analysis performed for specific PAH compounds, during the survey only ten times were compounds detected at or above the detection limit. These occurred for phenanthrene and naphthalene on the first and second days of testing. MEG were not exceeded, however, for any of the select 16 PAH compounds included in Table 6-2.

The MEG for 2-methyl-4,6-dinitrophenol and 2,4-dinitrophenol of 0.5 ug/$M^3$ and 2.4 ug/$M^3$ respectively were exceeded during each day of testing by at least one co-located sampler at each position. Ambient concentrations ranging from 0.73 to 3.8 ug/$M^3$ (0.089 to 0.46 PPBV) for 2-methyl-4,6-dinitrophenol and from 2.4 to 18.3 ug/$M^3$ (0.31 to 2.4 PPBV) for 2,4-dinitrophenol were recorded during the survey (PPBV=parts per billion by volume). On the first two days of testing, however, upwind concentrations were higher than the average concentration for both

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TABLE 8-7

SOUTH CAVALCADE SITE

TEST 1, ANALYTICAL RESULTS AND AMBIENT CONCENTRATIONS

| Date, Test No. | | | 11-12-85, Test 1 | | | | | | 11-12-85, Test 1 | | | | | | 11-12-85, Test 1 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Position | | | Upwind | | | Upwind, Dup. | | | Downwind 1 | | | Downwind 1, Dup. | | | Downwind 2 | | | Downwind 2, Dup. | | |
| Sample No. | | | SCK-AR01-001 | | | SCK-AR01-002 | | | SCK-AR04-001 | | | SCK-AR04-003 | | | SCK-AR04-002 | | | SCK-AR04-004 | | |
| Method 610 Component | Detection Limit, ug Sample | MFG ug/M$^3$ | Total ug Filter | Total ug XAD-2 | Conc. ug/M$^3$ | Total ug Filter | Total ug XAD-2 | Conc. ug/M$^3$ | Total ug Filter | Total ug XAD-2 | Conc. ug/M$^3$ | Total ug Filter | Total ug XAD-2 | Conc. ug/M$^3$ | Total ug Filter | Total ug XAD-2 | Conc. ug/M$^3$ | Total ug Filter | Total ug XAD-2 | Conc. ug/M$^3$ |
| Phenol | 0.5 | 46 | N.D. | 23.5 | 12 | N.D. | N.D | <.5 | N.D. | 12.5 | 6.1 | N.D. | 95 | 43 | N.D. | 17 | 8.2 | N.D. | 11 | 6.1 |
| 2-Chorophenol | 0.5 | 54 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | 3 | 1.6 | N.D. | 4.5 | 2.2 | N.D. | 4 | 2.1 | N.D. | N.D. | <.6 |
| 2-Nitrophenol | 0.5 | 105 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.6 |
| 2,4-Dimethylphenol | 0.5 | | N.D. | 10.5 | 5.4 | 5 | N.D | 5.5 | N.D. | 13 | 6.4 | N.D. | 151 | 68.3 | N.D. | 9 | 4.4 | N.D. | N.D. | <.6 |
| 2,4-Dichlorophenol | 0.5 | 47 | N.D. | 6.5 | 3.4 | N.D. | N.D | <.5 | N.D. | 5 | 2.6 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.6 |
| 4-Chloro-3-methylphenol | 0.5 | | N.D. | N.D. | <.5 | 1.5. | N.D. | .98 | N.D. | 2 | 1.2 | N.D. | N.D. | <.5 | N.D. | N.D | <.5 | N.D. | N.D. | <.6 |
| 2,4,6-Trichlorophenol | 0.5 | | N.D. | N.D. | <.5 | 1.5 | 3 | 2.2 | N.D. | 2 | 1.2 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.6 |
| 2,4-Dinitrophenol | 0.5 | 2.4 | 9.5 | 19 | 14.0 | 19.5 | 4 | 11.5 | N.D. | N.D. | <.5 | N.D. | 40 | 18.2 | N.D. | N.D. | <.5 | N.D. | 4 | 2.4 |
| 4-Nitrophenol | 0.5 | 28 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | 3 | 1.6 | N.D. | N.D. | <.5 | N.D. | 1.5 | 1.1 |
| 2-Methyl-4,6-dinitrophenol | 0.5 | 0.5 | N.D. | 5.5 | 3.0 | 1 | N.D. | .73 | N.D. | N.D. | <.5 | N.D. | 1.5 | .90 | N.D. | 3 | 1.6 | N.D. | 1 | .80 |
| Pentachlorophenol | 0.5 | | N.D. | 25 | 12.6 | 10.5 | N.D. | 5.4 | N.D. | N.D. | <.5 | 1.5 | 25.5 | 12.2 | N.D. | 30 | 14.3 | 3.5 | 28.5 | 17.1 |
| **Method 610 Component** | | | | | | | | | | | | | | | | | | | | |
| Naphthalene | 50 | 119 | N.D. | N.D. | <49 | N.D. | N.D. | <49 | N.D. | 73 | 58.2 | N.D. | 250 | 113 | N.D. | N.D. | <47 | N.D. | N.D. | <54 |
| Acenaphthylene | 50 | | N.D. | N.D. | <49 | N.D. | N.D. | <49 | N.D. | N.D. | <48 | N.D. | N.D. | <46 | N.D. | N.D. | <47 | N.D. | N.D. | <54 |
| Acenaphthene | 50 | | N.D. | N.D. | <49 | N.D. | N.D. | <49 | N.D. | N.D. | <48 | N.D. | N.D. | <46 | N.D. | N.D. | <47 | N.D. | N.D. | <54 |
| Fluorene | 10 | | N.D. | N.D. | <9.8 | N.D. | N.D. | <9.8 | N.D. | N.D. | <9.5 | N.D. | N.D. | <9.1 | N.D. | N.D. | <9.4 | N.D. | N.D. | <11 |
| Phenanthrene | 10 | 57 | N.D. | 11 | 10 | N.D. | 10 | 9.8 | N.D. | N.D. | <9.5 | N.D. | 15 | 11.3 | N.D. | N.D. | <9.4 | N.D. | N.D. | <11 |
| Anthracene | 10 | 133 | N.D. | N.D. | <9.8 | N.D. | N.D. | <9.8 | N.D. | N.D. | <9.5 | N.D. | N.D. | <9.1 | N.D. | N.D. | <9.4 | N.D. | N.D. | <11 |
| Fluoranthene | 10 | | N.D. | N.D. | <9.8 | N.D. | N.D. | <9.8 | N.D. | N.D. | <9.5 | N.D. | N.D. | <9.1 | N.D. | N.D. | <9.4 | N.D. | N.D. | <11 |
| Pyrene | 10 | 556 | N.D. | N.D. | <9.8 | N.D. | N.D. | <9.8 | N.D. | N.D. | <9.5 | N.D. | N.D. | <9.1 | N.D. | N.D. | <9.4 | N.D. | N.D. | <11 |
| Benzo(a)anthracene | 0.5 | .81 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.6 |
| Chrysene | 1 | 5.3 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1.1 |
| Benzo(b)fluoranthene | 1 | 2.1 | N.D | N.D | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1.1 |
| Benzo(k)fluoranthene | 1 | | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1.1 |
| Benzo(a)pyrene | 1 | 4.1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1.1 |
| Dibenzo(a,h)anthracene | 0.5 | .81 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.6 |
| Benzo(g,h,i)perylene | 1 | | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1.1 |
| Indeno(1,2,3-c,d) pyrene | 1 | 3.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <1.1 |

N.D. = Below Stated Detection Limit



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TABLE 8-8
SOUTH CAVALCADE SITE
TEST 2, ANALYTICAL RESULTS AND AMBIENT CONCENTRATIONS

| Date, Test No. | | | 11-13-85, Test 2 | | | | | | 11-13-85, Test 2 | | | | | | 11-13-85, Test 2 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Position | | | Upwind | | | Upwind, Dup. | | | Downwind 1 | | | Downwind 1, Dup. | | | Downwind 2 | | | Downwind 2, Dup. | | |
| Sample No. | | | SCK-AR02-001 | | | SCK-AR02-002 | | | SCK-AR05-001 | | | SCK-AR05-003 | | | SCK-AR05-002 | | | SCK-AR05-004 | | |
| Method 604 Component | Detection Limit, ug Sample | MEG ug/M³ | Total ug Filter | Total ug XAD-2 | Conc ug/M³ | Total ug Filter | Total ug XAD-2 | Conc ug/M³ | Total ug Filter | Total ug XAD-2 | Conc ug/M³ | Total ug Filter | Total ug XAD-2 | Conc ug/M³ | Total ug Filter | Total ug XAD-2 | Conc ug/M³ | Total ug Filter | Total ug XAD-2 | Conc ug/M³ |
| Phenol | 0.5 | 46 | N.D. | N.D. | <.5 | 2.5 | 15.5 | 8.4 | N.D. | N.D. | <.5 | N.D. | 8 | 4.4 | N.D. | 9.5 | 4.5 | 1.5 | 19.5 | 10.4 |
| 2-Chorophenol | 0.5 | 54 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.6 | N.D. | 2 | 1.1 | N.D. | N.D. | <.5 |
| 2-Nitrophenol | 0.5 | 105 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.6 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 |
| 2,4-Dimethylphenol | 0.5 | | N.D. | 19.5 | 9.7 | N.D. | 12.5 | 6.1 | N.D. | N.D. | <.5 | N.D. | 6.5 | 3.7 | N.D. | 6.5 | 3.2 | N.D. | 6.5 | 3.4 |
| 2,4-Dichlorophenol | 0.5 | 47 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | 3.5 | 1.7 | 2 | 7.5 | 5.0 | N.D. | 2.5 | 1.4 | N.D. | 4 | 2.2 |
| 4-Chloro-3-methylphenol | 0.5 | | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | 14 | 7.6 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 |
| 2,4,6-Trichlorophenol | 0.5 | | 3 | N.D. | 1.7 | 3.5 | 3.5 | 3.3 | N.D. | 3 | 1.5 | 3 | N.D. | 1.8 | N.D. | 2.5 | 1.4 | 3.5 | 3.5 | 3.4 |
| 2,4-Dinitrophenol | 0.5 | 2.4 | 14 | 13.5 | 13.4 | 4.5 | 34.5 | 18.3 | 8.5 | 18.5 | 11.8 | N.D. | N.D. | <.6 | N.D. | 15 | 7.0 | N.D. | 21 | 10.6 |
| 4-Nitrophenol | 0.5 | 28 | N.D. | N.D. | <.5 | N.D. | 1 | .70 | N.D. | 0.5 | .44 | N.D. | N.D. | <.6 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 |
| 2-Methyl-4,6-dinitrophenol | 0.5 | 0.5 | N.D. | 7 | 3.6 | N.D. | 7.5 | 3.8 | N.D. | 3 | 1.5 | N.D. | N.D. | <.53 | N.D. | 1.5. | .90 | N.D. | N.D. | <.5 |
| Pentachlorophenol | 0.5 | | 1.5 | N.D. | .97 | N.D. | 29.5 | 14.1 | 5.5 | 17.5 | 10.0 | 5.5 | N.D. | 3.1 | 3 | 14 | 7.7 | N.D. | 23.5 | 11.8 |
| **Method 610 Component** | | | | | | | | | | | | | | | | | | | | |
| Naphthalene | 50 | 119 | N.D. | N.D. | <49 | N.D. | N.D. | <47 | N.D. | N.D. | <44 | N.D. | N.D. | <53 | N.D. | N.D. | <46 | N.D. | N.D. | <50 |
| Acenaphthylene | 50 | | N.D. | N.D. | <49 | N.D. | N.D. | <47 | N.D. | N.D. | <44 | N.D. | N.D. | <53 | N.D. | N.D. | <46 | N.D. | N.D. | <50 |
| Acenaphthene | 50 | | N.D. | N.D. | <49 | N.D. | N.D. | <47 | N.D. | N.D. | <44 | N.D. | N.D. | <53 | N.D. | N.D. | <46 | N.D. | N.D. | <50 |
| Fluorene | 10 | | N.D. | N.D. | <9.8 | N.D. | N.D. | <9.4 | N.D. | N.D. | <8.8 | N.D. | N.D. | <10.5 | N.D. | N.D. | <9.1 | N.D. | N.D. | <9.9 |
| Phenanthrene | 10 | 57 | N.D. | 12 | 10.7 | N.D. | 13 | 6.3 | N.D. | N.D. | <8.8 | N.D. | N.D. | <10.5 | 15 | 11 | 11.7 | N.D. | 14 | 7.2 |
| Anthracene | 10 | 133 | N.D. | N.D. | <9.8 | N.D. | N.D. | <9.4 | N.D. | N.D. | <8.8 | N.D. | N.D. | <10.5 | N.D. | N.D. | <9.1 | N.D. | N.D. | <9.9 |
| Fluoranthene | 10 | | N.D. | N.D. | <9.8 | N.D. | N.D. | <9.4 | N.D. | N.D. | <8.8 | N.D. | N.D. | <10.5 | N.D. | N.D. | <9.1 | N.D. | N.D. | <9.9 |
| Pyrene | 10 | 556 | N.D. | N.D. | <9.8 | N.D. | N.D. | <9.4 | N.D. | N.D. | <8.8 | N.D. | N.D. | <10.5 | N.D. | N.D. | <9.1 | N.D. | N.D. | <9.9 |
| Benzo(a)anthracene | 0.5 | .81 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.6 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 |
| Chrysene | 1 | 5.3 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1.1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 |
| Benzo(b)fluoranthene | 1 | 2.1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1.1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 |
| Benzo(k)fluoranthene | 1 | | N.D. | N.D. | <1 | N.D. | [illegible] | <1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1.1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 |
| Benzo(a)pyrene | 1 | 4.1 | N.D. | N.D. | <1 | N.D. | [illegible] | <1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1.1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 |
| Dibenzo(a,h)anthracene | 0.5 | .81 | N.D. | N.D. | <.5 | N.D. | | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.6 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 |
| Benzo(g,h,i)perylene | 1 | | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1.1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 |
| Indeno(1,2,3-c-d)pyrene | 1 | 3.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1.1 | N.D. | N.D. | <1 | N.D. | N.D. | <1 |

N.D. = Below Stated Detection Limit





006752

TABLE 8-9
SOUTH CAVALCADE SITE
TEST 3, ANALYTICAL RESULTS AND AMBIENT CONCENTRATIONS

| Date, Test No. | | | 11-14-85, Test 3 | | | | | | 11-14-85, Test 3 | | | | | | 11-14-85, Test 3 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Position | | | Upwind | | | Upwind, Dup. | | | Downwind 1 | | | Downwind 1, Dup. | | | Downwind 2 | | | Downwind 2, Dup. | | |
| Sample No. | | | SCK-AR03-001 | | | SCK-AR03-002 | | | SCK-AR06-001 | | | SCK-AR06-003 | | | SCK-AR06-002 | | | SCK-AR06-004 | | |
| Method 604 Component | Detection Limit, ug Sample | MEG $ug/M^3$ | Total ug Filter | XAD-2 | Conc $ug/M^3$ | Total ug. Filter | XAD-2 | Conc $ug/M^3$ | Total ug Filter | XAD-2 | Conc $ug/M^3$ | Total ug. Filter | XAD-2 | Conc $ug/M^3$ | Total ug. Filter | XAD-2 | Conc $ug/M^3$ | Total ug. Filter | XAD-2 | Conc $ug/M^3$ |
| Phenol | 0.5 | 45 | N.D. | N.D. | <.5 | N.D | N.D. | <.5 | 4 | 7 | 4.7 | N.D. | 18 | 8.3 | 17 | 16 | 15.0 | 6 | 20 | 12.2 |
| 2-Chorophenol | 0.5 | 54 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | 7.5 | 3.6 | 2.5 | 2.5 | 2.3 | N.D. | 9 | 4.5 |
| 2-Nitrophenol | 0.5 | 105 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | 6.5 | 3.1 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 |
| 2,4-Dimethylphenol | 0.5 | | N.D. | 9.5 | 4.4 | N.D. | 8 | 3.9 | N.D. | N.D. | <.5 | N.D. | N.D. | <5 | 11 | 10.5 | 9.8 | N.D. | N.D. | <.5 |
| 2,4-Dichlorophenol | 0.5 | 47 | N.D. | N.D. | <.5 | N.D. | 1.5 | .92 | N.D. | N.D. | <.5 | N.D. | 23.5 | 10.8 | 5 | 5.5 | 4.8 | N.D. | 11.5 | 5.6 |
| 4-Chloro-3-methylphenol | 0.5 | | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | 2 | 1.1 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 |
| 2,4,6-Trichlorophenol | 0.5 | | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | 2 | 1.1 | 4 | 3 | 3.2 | N.D. | 1.5 | .94 |
| 2,4-Dinitrophenol | 0.5 | 2.4 | 8.5 | 14 | 10.0 | 10 | 26 | 16.6 | 10 | 9.5 | 8.3 | 12 | 27.5 | 17.7 | 12 | 19 | 14.1 | 11.5 | 22 | 15.8 |
| 4-Nitrophenol | 0.5 | 28 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | 1 | .67 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 |
| 2-Methyl-4,6-dinitrophenol | 0.5 | 0.5 | N.D. | 3.5 | 1.8 | N.D. | 3 | 1.6 | N.D. | 2 | 1.1 | N.D. | 4.5 | 2.2 | 2.5 | 2.5 | 2.3 | N.D. | 2.5 | 1.4 |
| Pentachlorophenol | 0.5 | | N.D. | N.D. | <.5 | 4.5 | 10 | 6.7 | 7.5 | 13.5 | 8.9 | 1.5 | 19 | 9.2 | 36 | 27.5 | 28.9 | 2.5 | 2 55 | 13.2 |
| **Method 610 Component** | | | | | | | | | | | | | | | | | | | | |
| Naphthalene | 50 | 119 | N.D. | N.D. | <45 | N.D. | N.D. | <47 | N.D. | N.D. | <47 | N.D. | N.D. | <45 | N.D. | N.D. | <46 | N.D. | N.D. | <48 |
| Acenaphthylene | 50 | | N.D. | N.D. | <45 | N.D. | N.D. | <47 | N.D. | N.D. | <47 | N.D. | N.D. | <45 | N.D. | N.D. | <46 | N.D. | N.D. | <48 |
| Acenaphthene | 50 | | N.D. | N.D. | <45 | N.D. | N.D. | <47 | N.D. | N.D. | <47 | N.D. | N.D. | <45 | N.D. | N.D. | <46 | N.D. | N.D. | <48 |
| Fluorene | 10 | | N.D. | N.D. | <8.9 | N.D. | N.D. | <9.3 | N.D. | N.D. | <9.3 | N.D. | N.D. | <9.0 | N.D. | N.D. | <9.2 | N.D. | N.D. | <9.5 |
| Phenanthrene | 10 | 57 | N.D. | N.D. | <8.9 | N.D. | N.D. | <9.3 | N.D. | N.D. | <9.3 | N.D. | N.D. | <9.0 | N.D. | N.D. | <9.2 | N.D. | N.D. | <9.5 |
| Anthracene | 10 | 133 | N.D. | N.D. | < 8.9 | N.D. | N.D. | <9.3 | N.D. | N.D. | <9.3 | N.D. | N.D. | <9.0 | N.D. | N.D. | <9.2 | N.D. | N.D. | <9.5 |
| Fluoranthene | 10 | | N.D. | N.D. | <8.9 | N.D. | N.D. | <9.3 | N.D. | N.D. | <9.3 | N.D. | N.D. | <9.0 | N.D. | N.D. | <9.2 | N.D. | N.D. | <9.5 |
| Pyrene | 10 | 556 | N.D. | N.D. | <8.9 | N.D. | N.D. | <9.3 | N.D. | N.D. | <9.3 | N.D. | N.D. | <9.0 | N.D. | N.D. | <9.2 | N.D. | N.D. | <9.5 |
| Benzo(a)anthracene | 0.5 | .81 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 |
| Chrysene | 1 | 5.3 | N.D. | N.D. | <.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 |
| Benzo(b)fluoranthene | 1 | 2.1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 |
| Benzo(k)fluoranthene | 1 | | N.D. | N.D. | <.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 |
| Benzo(a)pyrene | 1 | 4.1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 |
| Dibenzo(a,h)anthracene | 0.5 | .81 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 | N.D. | N.D. | <.5 |
| Benzo(g,h,i)perylene | 1 | | N.D. | N.D. | <.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 |
| Indeno(1,2,3-c,d) pyrene | 1 | 3.9 | N.D. | N.D. | <.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 | N.D. | N.D. | <.9 | N.D. | N.D. | <1 | N.D. | N.D. | <1 |

N.D. = Below Stated Detection Limit





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downwind stations. For the third day of testing, upwind and downwind concentrations were essentially the same with regard to each compound. It is, therefore, concluded that 2-methyl-4,6-dinitrophenol and 2,4-dinitrophenol are either components of the upwind background air or are present in the XAD-2 adsorbent and filter as random blank contamination. While significant background levels of 2,4-dinitrophenol were identified in some blank resin and filter samples (Table 8-5), deduction of the average blank background contribution from the field sample values would not account for the total sample mass collected. Also, in the majority of cases, the resultant adjusted concentration would still exceed the MEG.

Several potential sources of organic air contaminants, located in close proximity to the upwind site perimeter, are noted in Figure 8-1. These include a meat rendering plant, and a chemical manufacturing facility, as well as diesel locomotive traffic associated with the Houston Belt and Terminal Railroad and tractor trailer activity from the trucking terminals onsite. Also, during the survey, meat rendering odors, the smell of diesel exhaust, and a chemical smell of unknown origin were frequently detected. In view of these and other potential sources upwind of the South Cavalcade Site, the measured concentrations of 2-methyl-4,6-dinitrophenol and 2,4-dinitrophenol are believed attributable to existing background levels of these compounds.

With the exception of phenol and pentachlorophenol, little variation is seen between upwind and downwind concentrations for the remaining compounds. Phenol exhibited slightly higher average downwind concentrations for Test 1 and 3; however, all values were below the MEG.

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For Test 1 and 3, slightly higher average concentrations were recorded for pentachlorophenol at the downwind stations. While a MEG has not been established for this compound, a threshold limit value-time weighted average (TLV-TWA) of 500 ug/$M^3$ has been set by the American Conference of Governmental Industrial Hygienists. This limit establishes the airborne concentration of a substance in the workplace to which it is believed all workers may be repeatedly exposed day after day without adverse effect. Deduction of the average upwind concentration (6.7 ug/$M^3$) from the average downwind concentration (11.4 ug/$M^3$) yields a net concentration of 4.7 ug/$M^3$ for the site. This value is 100 times lower than the TLV-TWA for pentachlorophenol.

A comparison of concentration values between co-located samplers shows fair agreement, especially in light of the low ambient concentrations present. Examination of the mode of compound collection shows the majority of components identified to be present in the vapor phase (collection on XAD-2) as opposed to solid particulate matter (collection on filter). For 2,4-dinitrophenol and pentachlorophenol, however, collection was more evenly distributed between the two modes.

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## 8.5 Conclusions

An air quality investigation has been performed at the South Cavalcade Site. Upwind and downwind sampling stations were utilized over a three-day period to assess the degree of potential organic air contaminants, if any, at the site.

Analysis was performed for specific priority pollutant phenolic and PAH compounds by EPA Methods 604 and 610. These results have been compared to MEG for ambient air established by EPA for the preservation of public health.

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Of 17 phenolic and PAH compounds analyzed which have MEG's, only two exceeded their respective limits. The two compounds, 2,4-dinitrophenol and 2-methyl-4,6-dinitrophenol, exhibited upwind concentrations equalling or exceeding downwind MEG's; thus, indicating a higher upwind background concentration for the compounds or possible contamination of the XAD-2 resin and filter.

In view of several potential sources of organic air contaminants located upwind from the site, these compounds are believed attributable to the existing background air quality.

A slight increase in the concentration of pentachlorophenol was noted at the downwind stations for Tests 1 and 3. The average net increase (4.7 ug/$M^3$), however, for the survey was 100 times less than the TLV-TWA for pentachlorophenol. Pentachlorophenol was also detected in the batch blank and field blank.

A review of air contaminant data supplied by the USEPA Region VI (Appendix G, Volume 2) for the Houston area has been made for comparison with the South Cavalcade Air Quality Investigation. The Gulf Coast Community Exposure Study and the Toxic Air Monitoring System Program have compiled data largely for volatile organic compounds (VOC) and four PAHs at two locations near the North Cavalcade Superfund Site during the period of 1985 through 1986. As the compounds of interest at the South Cavalcade Site are semi-volatile in nature, the concentration of VOC was not determined.

Trace quantities as high as 0.1 ug/$M^3$ of the PAH compounds chrysene, pyrene, benzo-a-pyrene, and benzo(ghi)

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perylene were detected during the Gulf Coast Community Exposure Study. No detectable amount of these compounds were found during the South Cavalcade Remedial Investigation.

The vast majority of compounds in the ambient air of the South Cavalcade Site have been shown to be below the method detection limit as well as the established MEG for ambient air. The results of this survey indicate that the site in its present state should pose no health threat with regard to air transport of the potential contaminants from the site.

## 8.6 References


1. Camp Dresser & McKee, Inc., Work Plan for South Cavalcade Street Remedial Investigation/Feasibility Study, Document No. 143-WP1-WP-ATEW-3, April 4, 1985.

2. Koppers Company, Inc.; Field Sampling and Analytical Plan, Remedial Investigation and Feasibility Study, Koppers South Cavalcade Site, October 1985.

3. Cleland, J. G. and Kingsbury, G.J., Multimedia Environmental Goals for Environmental Assessment, Volume 1, EPA-600/7-77-136, 1977.

4. Threshold Limit Values and Biological Exposure Indices for 1986-1987, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio, 1986.


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# 9.0 - PRELIMINARY PUBLIC HEALTH AND ENVIRONMENTAL ASSESSMENT

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# 9.0 PRELIMINARY PUBLIC HEALTH AND ENVIRONMENTAL ASSESSMENT

## 9.1 General

This Preliminary Public Health and Environmental Assessment (Preliminary PHEA) discusses areas of interest and identifies potential contaminants of concern at the South Cavalcade Site. This information, together with characteristics of the site, is synthesized with the expected land-use patterns for the site to identify potential exposure pathways and potential receptors.

The Preliminary PHEA was done in accordance with the Superfund Public Health Evaluation Manual (SPHEM) and the U.S. EPA Endangerment Assessment Handbook. This Preliminary PHEA will form the foundation for a Final Public Health and Environmental Assessment (Final PHEA), which will be included in the Feasibility Study for the South Cavalcade Site. Both the Preliminary PHEA and Final PHEA will address the potential for constituents identified at the South Cavalcade Site to affect public health or the environment, either now or in the future, if no remedial action is taken. The Final PHEA will also provide information for developing clean up criteria for the South Cavalcade Site should the "no action" alternative prove unacceptable.

The components of this Preliminary PHEA include:

- identification of areas of interest,
- identification of potential contaminants of concern,
- identification of potential exposure pathways, and

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- identification of potential receptors.

This Preliminary PHEA is divided into six subsections. Subsection 9.2 reviews past site investigation work and uses this information to identify areas of interest. Subsection 9.3 identifies potential contaminants of concern (PCOC), which are compounds found at the site that have the potential to affect human health and the environment. Section 9.4 addresses potential human exposure pathways and receptors and Section 9.5 addresses potential environmental exposure pathways and receptors. Both sections include a preliminary screening of potential exposure pathways to present and potential future site use scenarios. Subsection 9.6 summarizes the results of the Preliminary PHEA. Toxicological profiles for the potential contaminants of concern are presented in Appendix S, Volume 3.

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## 9.2 Areas of Interest

Data from the investigations that have been conducted at the site have been reviewed. Environmental media that were investigated included surface water and sediments; surficial soils; subsurface soils; shallow and deep groundwater; and air. Analytical data used for assessment of the PCOCs were limited to valid (V) test results.

For the purposes of the Preliminary PHEA, the site surficial and subsurface soils have been partitioned into three areas, the northern, central and southern areas, as shown on Figure 9-1. As discussed in Section 2.4, the northern area is occupied by Transcon Lines, a transportation company. This section is fenced and a major part of the area is covered with buildings, reinforced concrete, or asphalt.

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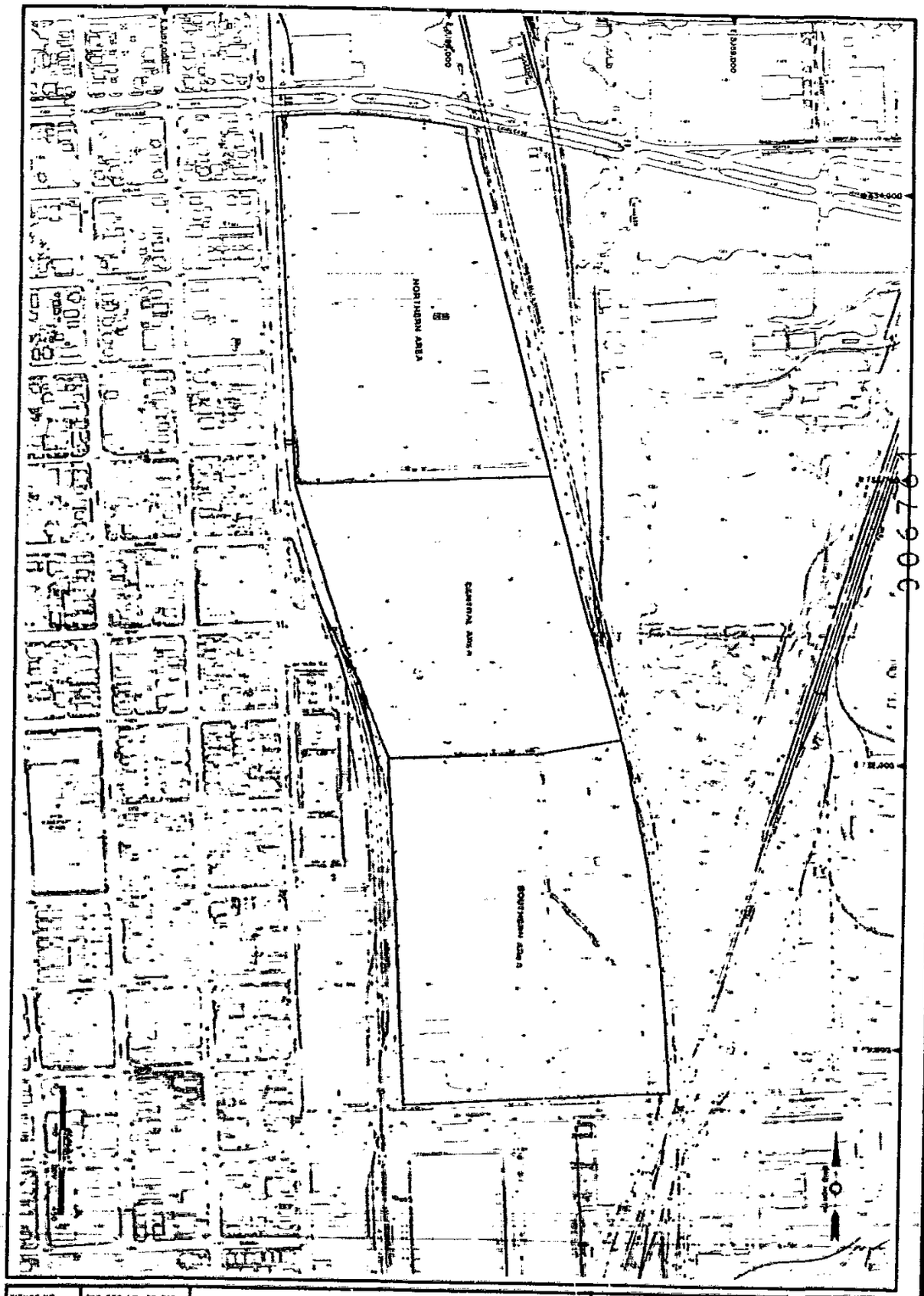


| FIGURE NO | PROJECT NO. | AREAS OF SITE<br>SOUTH CAVALCADE SITE<br>HOUSTON, TEXAS<br>KOPPERS COMPANY, INC. | Page 9-3 |
|---|---|---|---|
| 9-1 | DATE<br>ENGINEER<br>DRAWN BY | | |

The central area is currently unoccupied and, is a vegetated area. The southern area is similar to the northern area and is currently occupied by two transportation concerns (Palletized Trucking and Meridian Transport Company). This area is also fenced and much of the area is covered with buildings, reinforced concrete, or asphalt.

9.2.1 Surface Water and Sediments. Sections 5.2.1 and 5.2.2 discuss regional and site drainage features for the South Cavalcade Site. The site is located within the Hunting Bayou District in the San Jacinto River Basin. Regional drainage is provided by the east-southeast flowing Hunting Bayou. Several streams are located in the immediate area, although none pass directly through the site.

As stated in Section 5.2.2, surface runoff is managed by a system of drainage ditches and storm sewers. Water is collected in catch basins and diverted into the City of Houston's storm sewer system. Surface water and sediment samples were collected at various points within this system (Figure 5-3). Concentrations of PCOCs in surface water and sediment samples collected as part of the RI are presented in Tables 9-1, 9-2, and 9-3. PAHs and light aromatics (benzene, ethylbenzene, toluene, total xylenes) were not detected in any surface water samples. Five of the 12 sediment samples had detectable levels of PAH compounds. As with the organics, concentrations of metals in surface waters were two to three orders of magnitude below concentrations found in the sediments.

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TABLE 9-1
SURFACE WATER DATA-OVERALL SUMMARY OF OCCURRENCES

| COMPOUND | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (ug/l) | MINIMUM CONCENTRATION (ug/l) |
|---|---|---|---|---|---|
| PAHs | | | | | |
| NAPHTHALENE | 0 | 0 | 10 | 20 U | 10 U |
| ACENAPHTHYLENE | 0 | 0 | 10 | 20 U | 10 U |
| ACENAPHTHENE | 0 | 0 | 10 | 20 U | 10 U |
| FLUORENE | 0 | 0 | 10 | 20 U | 10 U |
| PHENANTHRENE | 0 | 1 | 10 | 20 J | 10 U |
| ANTHRACENE | 0 | 0 | 10 | 20 U | 10 U |
| FLUORANTHENE | 0 | 1 | 10 | 20 U | 10 U |
| PYRENE | 0 | 1 | 10 | 20 U | 10 U |
| BENZO(A)ANTHRACENE | 0 | 0 | 10 | 20 U | 10 U |
| CHRYSENE | 0 | 0 | 10 | 20 U | 10 U |
| BENZO(B)FLUORANTHENE | 0 | 0 | 9 | 20 U | 10 U |
| BENZO(K)FLUORANTHENE | 0 | 0 | 9 | 20 U | 10 U |
| BENZO(A)PYRENE | 0 | 0 | 10 | 20 U | 10 U |
| INDENO(1,2,3-CD)PYRENE | 0 | 0 | 10 | 20 U | 10 U |
| DIBENZO(AH)ANTHRACENE | 0 | 0 | 10 | 20 U | 10 U |
| BENZO(GHI)PERYLENE | 0 | 0 | 10 | 20 U | 10 U |
| LIGHT AROMATICS | | | | | |
| BENZENE | 0 | 1 | 4 | 5 J | 5 U |
| TOLUENE | 0 | 1 | 4 | 5 J | 5 U |
| ETHYLBENZENE | 0 | 0 | 4 | 5 U | 5 U |
| TOTAL XYLENES | 0 | 0 | 4 | 5 U | 5 U |

POSITIVE DETECTIONS INCLUDE ALL CONCENTRATIONS DETECTED ABOVE THE METHOD DETECTION LIMIT.
J VALUES ARE THOSE CONCENTRATIONS DETECTED, BUT BELOW THE METHOD DETECTION LIMIT.
U VALUES ARE UNDETECTED.

TABLE 9-2
SEDIMENT DATA-OVERALL SUMMARY OF OCCURRENCES

| COMPOUND | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (ug/kg) | MINIMUM CONCENTRATION (ug/kg) |
|---|---|---|---|---|---|
| PAHs | | | | | |
| NAPHTHALENE | 0 | 0 | 8 | 25,000 U | 460 U |
| ACENAPHTHYLENE | 0 | 1 | 8 | 25,000 U | 460 U |
| ACENAPHTHENE | 0 | 0 | 8 | 25,000 U | 460 U |
| FLUORENE | 0 | 0 | 8 | 25,000 U | 460 U |
| PHENANTHRENE | 0 | 1 | 8 | 25,000 U | 460 U |
| ANTHRACENE | 0 | 1 | 8 | 25,000 U | 460 U |
| FLUORANTHENE | 0 | 6 | 8 | 25,000 U | 460 U |
| PYRENE | 1 | 5 | 8 | 2,700 | 460 J |
| BENZO(A)ANTHRACENE | 0 | 3 | 8 | 25,000 U | 460 U |
| CHRYSENE | 0 | 5 | 8 | 25,000 U | 460 U |
| BENZO(B)FLUORANTHENE | 1 | 4 | 8 | 5,000 | 460 J |
| BENZO(K)FLUORANTHENE | 0 | 0 | 8 | 25,000 U | 460 U |
| BENZO(A)PYRENE | 0 | 3 | 8 | 25,000 U | 460 U |
| INDENO(1,2,3-CD)PYRENE | 0 | 4 | 8 | 25,000 U | 460 U |
| DIBENZO(AH)ANTHRACENE | 0 | 1 | 8 | 25,000 U | 460 U |
| BENZO(GHI)PERYLENE | 0 | 4 | 8 | 25,000 U | 460 U |
| LIGHT AROMATICS | | | | | |
| BENZENE | 0 | 0 | 7 | 12 U | 7 U |
| TOLUENE | 0 | 0 | 7 | 12 U | 7 U |
| ETHYLBENZENE | 0 | 0 | 7 | 12 U | 7 U |
| TOTAL XYLENES | 0 | 0 | 7 | 12 U | 7 U |

POSITIVE DETECTIONS INCLUDE ALL CONCENTRATIONS DETECTED ABOVE THE METHOD DETECTION LIMIT.
J VALUES ARE THOSE CONCENTRATIONS DETECTED, BUT BELOW THE METHOD DETECTION LIMIT.
U VALUES ARE UNDETECTED.

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TABLE 9-3
INORGANIC CONSTITUENTS IN SURFACE WATER AND SEDIMENT-OVERALL
SUMMARY OF OCCURRENCES

| SURFACE WATER | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (ug/l) | MINIMUM CONCENTRATION (ug/l) |
|---|---|---|---|---|---|
| INORGANICS | | | | | |
| ARSENIC | 9 | 0 | 10 | 56 | 16 U |
| CADMIUM | 0 | 0 | 10 | 5 U | 4 U |
| CHROMIUM | 0 | 0 | 10 | 9 U | 9 U |
| COPPER | 2 | 0 | 10 | 17 | 10 U |
| LEAD | 8 | 0 | 10 | 31 | 5 U |
| MERCURY | 0 | 0 | 10 | 0.2 U | 0.2 U |
| NICKEL | 2 | 0 | 10 | 36 | 20 U |
| SILVER | 1 | 0 | 10 | 11 | 9 U |
| THALLIUM | 0 | 0 | 10 | 10 U | 10 U |
| ZINC | 10 | 0 | 10 | 140 | 31 |
| CYANIDE | 0 | 0 | 10 | 100 U | 10 U |

| SEDIMENT | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (mg/kg) | MINIMUM CONCENTRATION (mg/kg) |
|---|---|---|---|---|---|
| INORGANICS | | | | | |
| ARSENIC | 10 | 0 | 12 | 34 | 6.8 |
| CADMIUM | 2 | 0 | 12 | 3 | 2 U |
| CHROMIUM | 10 | 0 | 12 | 72 | 4 U |
| COPPER | 10 | 0 | 12 | 76 | 0.05 U |
| LEAD | 12 | 0 | 12 | 340 | 10 |
| MERCURY | 2 | 0 | 12 | 1.23 | 0.05 U |
| NICKEL | 4 | 0 | 12 | 19 | 10 U |
| SILVER | 0 | 0 | 12 | 5 U | 4 U |
| THALLIUM | 1 | 0 | 12 | 9 | 5 U |
| ZINC | 12 | 0 | 12 | 1200 | 58 |
| CYANIDE | 0 | 0 | 12 | 5 U | 1 U |

POSITIVE DETECTIONS INCLUDE ALL CONCENTRATIONS DETECTED ABOVE THE METHOD DETECTION LIMIT.
J VALUES ARE THOSE CONCENTRATIONS DETECTED, BUT BELOW THE METHOD DETECTION LIMIT.
U VALUES ARE UNDETECTED.

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9.2.2 Surface Soils. Site investigation work indicates that the only areas with exposed soils potentially containing PCOCs are located in the northern and southern areas of the site. Both areas are covered with grass and fenced so that access is restricted. These areas are shown in Figure 9-2 and are based on the surficial soils quality map presented in Figure 6-1. Figure 9-2 includes approximate areal distributions of surface soil staining based on visual observations during a site reconnaissance. The surface soil staining areas presented on Figure 9-2 do not reflect or depict an interpretation that the areas and their corresponding soil volumes are considered for possible remedial action, either expressed or implied.

9.2.3 Subsurface Soils. Four vertical soil units were sampled in this investigation, Units 1 to 4 (Section 4.1.4). Unit 1 extends roughly from the surface to an average of 21 feet below the surface, Unit 2 extends from about 21 feet to an average of 50 feet below the surface, and Unit 3 extends from about 50 feet to an average of 125 feet below the surface. Unit 4 extends from about 125 feet to an average of 200 feet. Tables 9-4 and 9-5 summarize concentrations of total PAH, light aromatics, and metals in each of these units. Areas of interest for subsurface soils are located in the northern and southern portions of the site and are currently paved over for the most part.

9.2.4 Groundwater. Three hydrogeologic water-bearing zones are identified in Section 4.3. The shallow water-bearing zone, starts approximately 10 feet below the surface and extends to an average of 21 feet. The intermediate water-bearing zone, ranges from about 115 feet to an

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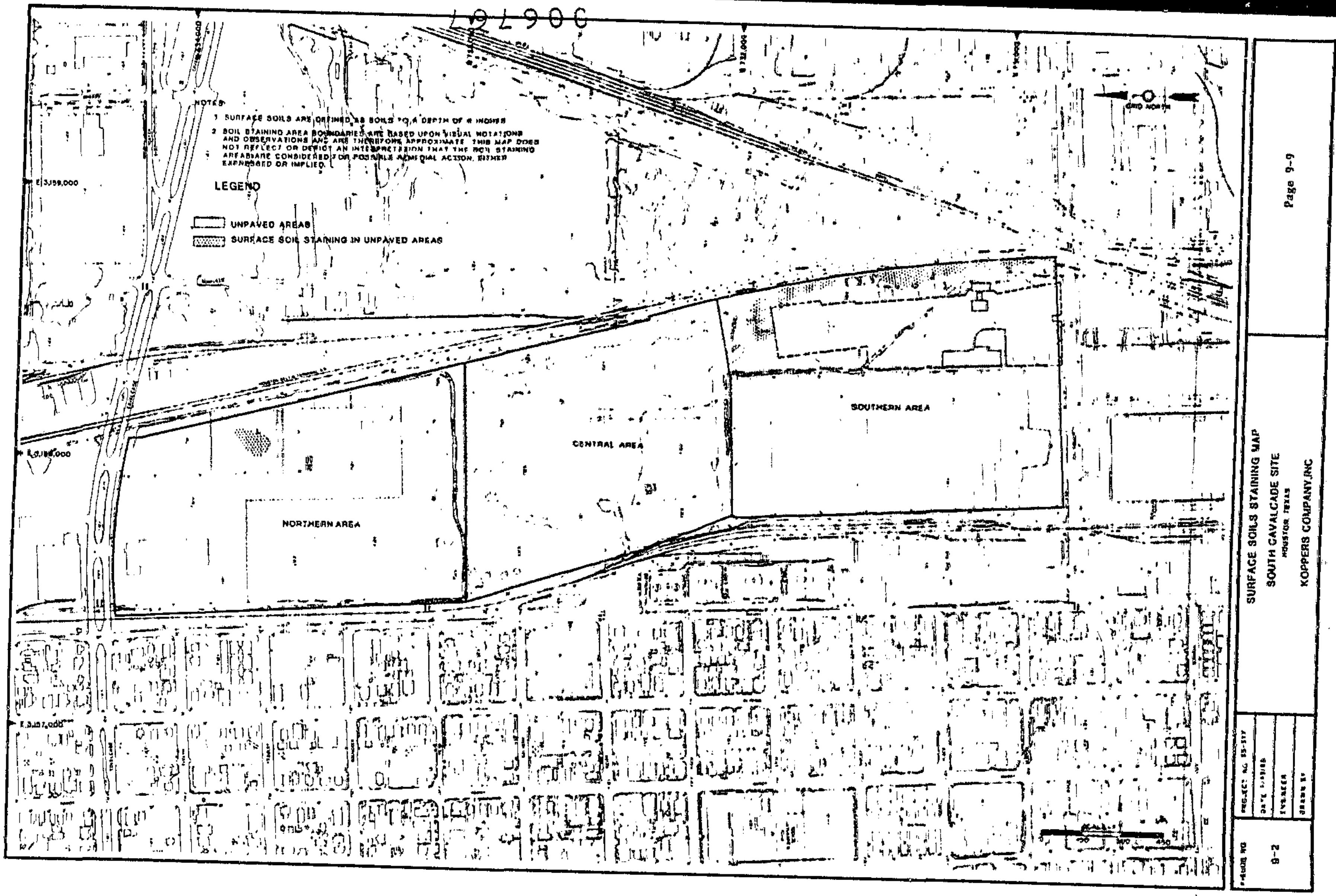
NOTES
1 SURFACE SOILS ARE DEFINED AS SOILS TO A DEPTH OF 6 INCHES
2 SOIL STAINING AREA BOUNDARIES ARE BASED UPON VISUAL NOTATIONS AND OBSERVATIONS AND ARE THEREFORE APPROXIMATE. THIS MAP DOES NOT REFLECT OR DEPICT AN INTERPRETATION THAT THE SOIL STAINING AREAS ARE CONSIDERED FOR POSSIBLE REMEDIAL ACTION, EITHER EXPRESSED OR IMPLIED.
LEGEND
UNPAVED AREAS
SURFACE SOIL STAINING IN UNPAVED AREAS
NORTHERN AREA
CENTRAL AREA
SOUTHERN AREA
GRID NORTH
SURFACE SOILS STAINING MAP
SOUTH CAVALCADE SITE
HOUSTON, TEXAS
KOPPERS COMPANY,INC
Page 9-9
FIGURE NO
9-2

TABLE 9-4
ORGANIC CONSTITUENTS IN SOIL DATA-OVERALL SUMMARY OF OCCURRENCES

SOURCE: UNIT 1

| COMPOUND | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (ug/kg) | MINIMUM CONCENTRATION (ug/kg) |
|---|---|---|---|---|---|
| PAHs | | | | | |
| NAPHTHALENE | 5 | 1 | 20 | 1,900,000 | 330 U |
| ACENAPHTHYLENE | 0 | 1 | 20 | 25,000 U | 380 U |
| ACENAPHTHENE | 3 | 2 | 20 | 570,000 | 380 U |
| FLUORENE | 4 | 1 | 20 | 440,000 | 380 U |
| PHENANTHRENE | 5 | 0 | 20 | 980,000 | 380 U |
| ANTHRACENE | 2 | 2 | 20 | 240,000 | 380 U |
| FLUORANTHENE | 4 | 1 | 20 | 420,000 | 380 U |
| PYRENE | 3 | 3 | 20 | 280,000 | 380 J |
| BENZO(A) ANTHRACENE | 3 | 1 | 20 | 93,000 | 380 U |
| CHRYSENE | 3 | 2 | 20 | 76,000 | 380 J |
| BENZO(B) FLUORANTHENE | 2 | 1 | 20 | 61,000 | 380 U |
| BENZO(K) FLUORANTHENE | 0 | 1 | 20 | 25,000 U | 380 J |
| BENZO(A) PYRENE | 0 | 1 | 20 | 25,000 U | 380 J |
| INDENO(1,2,3-CD) PYRENE | 0 | 2 | 20 | 25,000 U | 380 U |
| DIBENZO(AH) ANTHRACENE | 0 | 0 | 20 | 25,000 U | 380 U |
| BENZO(GHI) PERYLENE | 0 | 2 | 20 | 25,000 U | 380 U |

SOURCE: UNIT 2

| COMPOUND | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (ug/l) | MINIMUM CONCENTRATION (ug/l) |
|---|---|---|---|---|---|
| PAHs | | | | | |
| NAPHTHALENE | 8 | 7 | 24 | 110,000 | 340 U |
| ACENAPHTHYLENE | 0 | 1 | 24 | 23,000 U | 340 U |
| ACENAPHTHENE | 6 | 7 | 24 | 27,000 | 340 U |
| FLUORENE | 7 | 5 | 24 | 25,000 | 340 U |
| PHENANTHRENE | 13 | 3 | 24 | 310,000 | 340 U |
| ANTHRACENE | 4 | 4 | 24 | 49,000 | 340 U |
| FLUORANTHENE | 9 | 6 | 24 | 140,000 | 340 U |
| PYRENE | 9 | 6 | 24 | 99,000 | 340 U |
| BENZO(A) ANTHRACENE | 2 | 8 | 24 | 1,000 | 340 U |
| CHRYSENE | 2 | 8 | 24 | 1,100 | 340 U |
| BENZO(B) FLUORANTHENE | 2 | 5 | 24 | 600 | 340 U |
| BENZO(K) FLUORANTHENE | 0 | 0 | 24 | 23,000 U | 340 U |
| BENZO(A) PYRENE | 0 | 3 | 24 | 23,000 U | 340 U |
| INDENO(1,2,3-CD) PYRENE | 0 | 3 | 24 | 23,000 U | 340 U |
| DIBENZO(AH) ANTHRACENE | 0 | 0 | 24 | 23,000 U | 340 U |
| BENZO(GHI) PERYLENE | 0 | 0 | 24 | 23,000 U | 340 U |

POSITIVE DETECTIONS INCLUDE ALL CONCENTRATIONS DETECTED ABOVE THE METHOD DETECTION LIMIT.
J VALUES ARE THOSE CONCENTRATIONS DETECTED, BUT BELOW THE METHOD DETECTION LIMIT.
U VALUES ARE UNDETECTED.

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TABLE 9-4 (continued)
ORGANIC CONSTITUENTS IN SOIL DATA-OVERALL SUMMARY OF OCCURRENCES

SOURCE: UNIT 3

| COMPOUND | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (ug/kg) | MINIMUM CONCENTRATION (ug/kg) |
|---|---|---|---|---|---|
| PAHs | | | | | |
| NAPHTHALENE | 1 | 5 | 26 | 270,000 | 390 U |
| ACENAPHTHYLENE | 0 | 1 | 26 | 11,500 J | 390 U |
| ACENAPHTHENE | 1 | 3 | 26 | 150,000 | 390 U |
| FLUORENE | 2 | 3 | 26 | 140,000 | 390 U |
| PHENANTHRENE | 3 | 7 | 26 | 360,000 | 390 U |
| ANTHRACENE | 1 | 3 | 26 | 84,000 | 390 U |
| FLUORANTHENE | 2 | 5 | 26 | 170,000 | 390 U |
| PYRENE | 2 | 5 | 26 | 140,000 | 390 U |
| BENZO(A)ANTHRACENE | 1 | 2 | 26 | 40,000 | 390 U |
| CHRYSENE | 1 | 2 | 26 | 31,000 | 390 U |
| BENZO(B)FLUORANTHENE | 1 | 0 | 26 | 17,000 | 390 U |
| BENZO(K)FLUORANTHENE | 1 | 0 | 26 | 14,000 | 390 U |
| BENZO(A)PYRENE | 0 | 1 | 26 | 11,500 J | 390 U |
| INDENO(1,2,3-CD)PYRENE | 0 | 1 | 26 | 11,500 J | 390 U |
| DIBENZO(AH)ANTHRACENE | 0 | 0 | 26 | 11,500 U | 390 U |
| BENZO(GHI)PERYLENE | 0 | 1 | 26 | 11,500 J | 390 U |

SOURCE: UNIT 4

| COMPOUND | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (ug/kg) | MINIMUM CONCENTRATION (ug/kg) |
|---|---|---|---|---|---|
| PAHs | | | | | |
| NAPHTHALENE | 0 | 0 | 5 | 410 U | 370 U |
| ACENAPHTHYLENE | 0 | 0 | 5 | 410 U | 370 U |
| ACENAPHTHENE | 0 | 0 | 5 | 410 U | 370 U |
| FLUORENE | 0 | 0 | 5 | 410 U | 370 U |
| PHENANTHRENE | 0 | 0 | 5 | 410 U | 370 U |
| ANTHRACENE | 0 | 0 | 5 | 410 U | 370 U |
| FLUORANTHENE | 0 | 0 | 5 | 410 U | 370 U |
| PYRENE | 0 | 0 | 5 | 410 U | 370 U |
| BENZO(A)ANTHRACENE | 0 | 0 | 5 | 410 U | 370 U |
| CHRYSENE | 0 | 0 | 5 | 410 U | 370 U |
| BENZO(B)FLUORANTHENE | 0 | 0 | 5 | 410 U | 370 U |
| BENZO(K)FLUORANTHENE | 0 | 0 | 5 | 410 U | 370 U |
| BENZO(A)PYRENE | 0 | 0 | 5 | 410 U | 370 U |
| INDENO(1,2,3-CD)PYRENE | 0 | 0 | 5 | 410 U | 370 U |
| DIBENZO(AH)ANTHRACENE | 0 | 0 | 5 | 410 U | 370 U |
| BENZO(GHI)PERYLENE | 0 | 0 | 5 | 410 U | 370 U |

POSITIVE DETECTIONS INCLUDE ALL CONCENTRATIONS DETECTED ABOVE THE METHOD DETECTION LIMIT.
J VALUES ARE THOSE CONCENTRATIONS DETECTED, BUT BELOW THE METHOD DETECTION LIMIT.
U VALUES ARE UNDETECTED.

TABLE 9-5
INORGANIC CONSTITUENTS IN SOIL - OVERALL SUMMARY OF OCCURRENCES

SOURCE: UNIT 1

| INORGANICS | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (mg/kg) | MINIMUM CONCENTRATION (mg/kg) |
|---|---|---|---|---|---|
| ARSENIC | 1 | 0 | 21 | 8.8 | 5 U |
| CYANIDE | 0 | 0 | 21 | 5 U | 1 U |
| CHROMIUM | 10 | 0 | 22 | 10.4 | 4 U |
| COPPER | 4 | 0 | 22 | 8 | 3.5 U |
| LEAD | 12 | 0 | 22 | 30.4 | 1.5 U |
| ZINC | 12 | 0 | 22 | 3480 | 4 U |

SOURCE: UNIT 2

| INORGANICS | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (mg/kg) | MINIMUM CONCENTRATION (mg/kg) |
|---|---|---|---|---|---|
| ARSENIC | 10 | 0 | 28 | 16 | 4.7 U |
| CYANIDE | 0 | 0 | 28 | 6 U | 1 U |
| CHROMIUM | 15 | 0 | 26 | 28 | 4 U |
| COPPER | 10 | 0 | 28 | 14 | 3.9 U |
| LEAD | 21 | 0 | 28 | 34 | 2.8 U |
| ZINC | 16 | 0 | 28 | 64 | 4 U |

POSITIVE DETECTIONS INCLUDE ALL CONCENTRATIONS DETECTED ABOVE THE METHOD DETECTION LIMIT.
J VALUES ARE THOSE CONCENTRATIONS DETECTED, BUT BELOW THE METHOD DETECTION LIMIT.
U VALUES ARE UNDETECTED.

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TABLE 9-5 (continued)
INORGANIC CONSTITUENTS IN SOIL - OVERALL SUMMARY
OF OCCURRENCES

SOURCE: UNIT 3

| | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (mg/kg) | MINIMUM CONCENTRATION (mg/kg) |
|---|---|---|---|---|---|
| INORGANICS | | | | | |
| ARSENIC | 16 | 0 | 26 | 28 | 1 U |
| CYANIDE | 0 | 0 | 26 | 6.6 U | 1 U |
| CHROMIUM | 22 | 0 | 24 | 37 | 4 U |
| COPPER | 9 | 0 | 27 | 18.4 | 3.5 U |
| LEAD | 27 | 0 | 27 | 20 | 2.5 U |
| ZINC | 27 | 0 | 27 | 210 | 4 U |

SOURCE: UNIT 4

| | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (mg/kg) | MINIMUM CONCENTRATION (mg/kg) |
|---|---|---|---|---|---|
| INORGANICS | | | | | |
| ARSENIC | 0 | 0 | 2 | 5 U | 1 U |
| CYANIDE | 0 | 0 | 5 | 6.1 U | 2 U |
| CHROMIUM | 3 | 0 | 5 | 9.10 | 9.5 |
| COPPER | 1 | 0 | 5 | 9.71 | 5 U |
| LEAD | 2 | 0 | 2 | 19.2 | 5.2 U |
| ZINC | 4 | 0 | 5 | 14.4 | 14 U |

POSITIVE DETECTIONS INCLUDE ALL CONCENTRATIONS DETECTED ABOVE THE METHOD DETECTION LIMIT.
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U VALUES ARE UNDETECTED.

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average of 127 feet. The deep water-bearing zone, extends from about 174 feet to an average of 200 feet. Concentrations of total PAH, light aromatics, and metals in groundwater are listed in Tables 9-6 and 9-7.

9.2.5 Ambient Air. The air quality investigation indicated that ambient concentrations of priority pollutant phenolics and PAHs were below the method detection limits as well as Multimedia Environmental Goals (Section 8.0).

## 9.3 Potential Contaminants of Concern

The site investigation focused primarily on constituents potentially present at the site, given the previous use of the property as a wood preserving facility and coal-tar distillation plant. Creosote and treating salts were the principal preservatives reportedly used for wood preservation. Creosote and coal tar distillation by products were produced at the coal tar plant. Pentachlorophenol is not known to have been used at the plant.

Potential contaminants of concern are compounds found at a particular site, which because of their prevalence, persistence and potential toxicity, have the potential to affect human health or the environment. After reviewing existing data and considering the past use of the site, the following compounds have been selected as the potential contaminants of concern ("PCOC") at the South Cavalcade Site:

- polynuclear aromatic hydrocarbons (PAH) (total PAH and potentially carcinogenic PAH)
- metals - arsenic, chromium, copper, zinc, lead, mercury
- light aromatics - benzene, ethylbenzene, toluene, total xylenes

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TABLE 9-6
GROUNDWATER DATA - OVERALL SUMMARY OF OCCURRENCES

ZONE: SHALLOW

| COMPOUND | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (ug/l) | MINIMUM CONCENTRATION (ug/l) |
|---|---|---|---|---|---|
| PAHS | | | | | |
| NAPHTHALENE | 4 | 4 | 24 | 7710 | 1 J |
| ACENAPHTHYLENE | 0 | 4 | 24 | 50 U | 6 J |
| ACENAPHTHENE | 4 | 2 | 24 | 490 | 8 J |
| FLUORENE | 4 | 1 | 24 | 230 | 10 U |
| ANTHRACENE | 1 | 3 | 24 | 33 | 8 J |
| FLUORANTHENE | 3 | 2 | 24 | 52 | 10 U |
| PYRENE | 3 | 2 | 24 | 94 | 10 U |
| BENZO(A)ANTHRACENE | 1 | 2 | 24 | 42 | 3 J |
| CHRYSENE | 3 | 2 | 24 | 42 | 3 J |
| BENZO(B)FLUORANTHENE | 1 | 2 | 24 | 50 U | 10 U |
| BENZO(K)FLUORANTHENE | 1 | 0 | 24 | 46 | 10 U |
| BENZO(A)PYRENE | 0 | 2 | 24 | 50 U | 6 J |
| INDENO(1,2,3-CD)PYRENE | 0 | 1 | 24 | 50 U | 10 U |
| DIBENZO(AH)ANTHRACENE | 0 | 0 | 24 | 50 U | 10 U |
| BENZO(GHI)PERYLENE | 0 | 1 | 24 | 50 U | 10 U |
| PHENANTHRENE | 5 | 2 | 24 | 370 | 1 J |
| LIGHT AROMATICS | | | | | |
| BENZENE | 7 | 6 | 34 | 930 | 2 J |
| TOLUENE | 10 | 3 | 34 | 1000 | 3 J |
| ETHYLBENZENE | 7 | 4 | 34 | 480 | 2 J |
| TOTAL XYLENES | 8 | 5 | 34 | 1100 | 3 J |

POSITIVE DETECTIONS INCLUDE ALL CONCENTRATIONS DETECTED ABOVE THE METHOD DETECTION LIMIT.
J VALUES ARE THOSE CONCENTRATIONS DETECTED, BUT BELOW THE METHOD DETECTION LIMIT.
U VALUES ARE UNDETECTED.

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TABLE 9-6 (continued)
GROUNDWATER DATA - OVERALL SUMMARY OF OCCURRENCES

ZONE: DEEP

| COMPOUND | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (ug/l) | MINIMUM CONCENTRATION (ug/l) |
|---|---|---|---|---|---|
| PAHS | | | | | |
| NAPHTHALENE | 0 | 0 | 3 | 10 U | 10 U |
| ACENAPHTHYLENE | 0 | 0 | 3 | 10 U | 10 U |
| ACENAPHTHENE | 0 | 0 | 3 | 10 U | 10 U |
| FLUORENE | 0 | 0 | 3 | 10 U | 10 U |
| ANTHRACENE | 0 | 0 | 3 | 10 U | 10 U |
| FLUORANTHENE | 0 | 0 | 3 | 10 U | 10 U |
| PYRENE | 0 | 0 | 3 | 10 U | 10 U |
| BENZO(A) ANTHRACENE | 0 | 0 | 3 | 10 U | 10 U |
| CHRYSENE | 0 | 0 | 3 | 10 U | 10 U |
| BENZO(B) FLUORANTHENE | 0 | 0 | 3 | 10 U | 10 U |
| BENZO(K) FLUORANTHENE | 0 | 0 | 3 | 10 U | 10 U |
| BENZO(A) PYRENE | 0 | 0 | 3 | 10 U | 10 U |
| INDENO(1,2,3-CD) PYRENE | 0 | 0 | 3 | 10 U | 10 U |
| DIBENZO(AH) ANTHRACENE | 0 | 0 | 3 | 10 U | 10 U |
| BENZO(GHI) PERYLENE | 0 | 0 | 3 | 10 U | 10 U |
| PHENANTHRENE | 0 | 0 | 3 | 10 U | 10 U |
| LIGHT AROMATICS | | | | | |
| BENZENE | 0 | 1 | 1 | 5 J | 5 J |
| TOLUENE | 0 | 0 | 1 | 5 U | 5 U |
| ETHYLBENZENE | 0 | 0 | 1 | 5 U | 5 U |
| TOTAL XYLENES | 0 | 0 | 1 | 5 U | 5 U |

POSITIVE DETECTIONS INCLUDE ALL CONCENTRATIONS DETECTED ABOVE THE METHOD DETECTION LIMIT.
J VALUES ARE THOSE CONCENTRATIONS DETECTED, BUT BELOW THE METHOD DETECTION LIMIT.
U VALUES ARE UNDETECTED.

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TABLE 9-7
INORGANIC CONSTITUENTS IN GROUNDWATER-OVERALL SUMMARY OF OCCURRENCES

ZONE: SHALLOW

| COMPOUND | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (ug/l) | MINIMUM CONCENTRATION (ug/l) |
|---|---|---|---|---|---|
| INORGANICS | | | | | |
| SILVER | 0 | 0 | 21 | 50 U | 5 U |
| ARSENIC | 32 | 0 | 47 | 522 | 5 U |
| BERYLLIUM | 8 | 0 | 31 | 14 | 2 U |
| CADMIUM | 2 | 0 | 21 | 9 | 4 U |
| CYANIDE | 0 | 0 | 22 | 5000 U | 10 U |
| CHROMIUM | 34 | 0 | 48 | 450 | 9 U |
| COPPER | 20 | 0 | 31 | 1340 | 10 U |
| MERCURY | 0 | 0 | 25 | 0.2 U | 0.2 U |
| NICKEL | 28 | 0 | 48 | 395 | 24 U |
| LEAD | 38 | 0 | 40 | 257 | 4 U |
| ANTIMONY | 1 | 0 | 15 | 67 | 44 U |
| SELENIUM | 0 | 0 | 19 | 25 U | 4 U |
| THALLIUM | 0 | 0 | 28 | 50 U | 5 U |
| ZINC | 42 | 0 | 48 | 1180 | 17 U |

ZONE: DEEP

| COMPOUND | TOTAL NUMBER OF POSITIVE OCCURRENCES | TOTAL NUMBER OF J VALUES | NUMBER OF VALID SAMPLES ANALYZED | MAXIMUM CONCENTRATION (ug/l) | MINIMUM CONCENTRATION (ug/l) |
|---|---|---|---|---|---|
| INORGANICS | | | | | |
| SILVER | 0 | 0 | 3 | 8 U | 8 U |
| ARSENIC | 0 | 0 | 3 | 10 U | 10 U |
| BERYLLIUM | 0 | 0 | 3 | 3 U | 2 U |
| CADMIUM | 0 | 0 | 3 | 5 U | 3 U |
| CYANIDE | 0 | 0 | 2 | 10 U | 10 U |
| CHROMIUM | 0 | 0 | 3 | 9 U | 7 U |
| COPPER | 0 | 0 | 3 | 15 U | 9 U |
| MERCURY | 0 | 0 | 2 | 0.2 U | 0.2 U |
| NICKEL | 1 | 0 | 3 | 42 | 25 U |
| LEAD | 0 | 0 | 3 | 5 U | 5 U |
| ANTIMONY | 0 | 0 | 2 | 50 U | 48 U |
| SELENIUM | 0 | 0 | 3 | 5 U | 5 U |
| THALLIUM | 0 | 0 | 1 | 10 U | 10 U |
| ZINC | 0 | 0 | 3 | 17 U | 9 U |

POSITIVE DETECTIONS INCLUDE ALL CONCENTRATIONS DETECTED ABOVE THE METHOD DETECTION LIMIT.
J VALUES ARE THOSE CONCENTRATIONS DETECTED, BUT BELOW THE METHOD DETECTION LIMIT.
U VALUES ARE UNDETECTED.

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The occurrence of the PCOC at the South Cavalcade Site can be summarized as follows:

1. PAH compounds were present in detectable levels in all environmental media sampled, except air, and were present in higher concentrations in soils and sediments than surface water or groundwater.

2. Light aromatics were detected in groundwater. Surface water and sediments did not contain detectable levels of light aromatics. Soils were not analyzed for light aromatics.

3. Metals were detected at levels an order of magnitude higher in surface sediments and soils than in surface water or groundwater.

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## 9.4 Potential Human Exposure Pathways and Receptors

Potential exposure pathways (PEP) are routes whereby PCOC can migrate from a potential source to a potential receptor. Exposure to a PCOC is dependent upon the existence of a pathway which starts with a potential source and ends with intake by a potential receptor. These PEP require four basic elements: 1) a source; 2) the release of a PCOC from the source and subsequent migration through an environmental medium; 3) contact between a potential receptor and a contaminated medium; and 4) an uptake mechanism associated with the potential receptor.

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In identifying and evaluating PEP, potential current as well as potential future uses of the site must be considered. Hypothetical future uses examined include potential exposures to utility workers during construction activities; potential exposures to construction workers related to hypothetical future development of the site; and potential exposures to hypothetical future occupants of the site, if developed.

For the areas of interest identified previously - surficial and subsurface soils, surface water and sediment, and groundwater - potential human exposure pathways are presented in Table 9-8. A brief description and preliminary evaluation of each PEP is presented as follows.

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9.4.1 Surface Water and Sediment. The on-site drainage ditches are not utilized for any industrial activity that would require a worker to enter a ditch. Thus, dermal contact by a worker with the surface water and sediments in the drainage ditches is extremely unlikely and, consequently, this PEP will not be retained for quantitative evaluation in the Final PHEA.

While workers are unlikely to ever enter the drainage ditches, non-workers could potentially contact these ditches on occasion while in the central section of the site, which is currently vegetated and unoccupied by any commercial venture, or along the boundaries of the northern and southern sections of the site. These individuals could potentially be exposed to PCOC present in surface water and sediment. As indicated in Table 9-8, PEP for surface water and sediment include:

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TABLE 9-8
INITIAL POTENTIAL HUMAN EXPOSURE PATHWAYS

| Media | Current or Future | Potential Exposure Pathway | Potential Receptor | Complete/Incomplete |
|---|---|---|---|---|
| SURFACE WATER AND SEDIMENTS | | | | |
| | Current and Future | dermal contact | on-site workers | Not complete. Work activities do not require workers to enter ditches. |
| | | inadvertant ingestion, dermal contact | non-workers | Potentially complete. |
| SURFACE AND SURFICIAL SOILS | | | | |
| | Current | inadvertant ingestion, dermal contact | on-site workers | Not complete. Surficial soil contamination away from current work areas. |
| | | inadvertant ingestion, dermal contact | trespassers | Not complete. Fences prevent contact with contaminated soils by unauthorized personnel. |
| | | inadvertant ingestion, dermal contact, inhalation of dust | utility workers | Potentially complete. |
| | Future | inadvertant ingestion, dermal contact, inhalation of dust | construction workers | Potentially complete. |
| | | inadvertant ingestion, dermal contact | hypothetical residential occupants | Potentially complete. |
| | | inadvertant ingestion, dermal contact | hypothetical commercial occupants | Potentially complete. |





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TABLE 9-8 (cont.)

| Media | Current or Future | Potential Exposure Pathway | Potential Receptor | Complete/Incomplete |
|---|---|---|---|---|
| GROUNDWATER | | | | |
| | Current | None | ——— | ——— |
| | Future | ingestion | off-site residential and commercial occupants | Potentially complete. |
| | | ingestion | hypothetical residential occupants | Potentially complete. |
| | | ingestion | hypothetical commercial occupants | Potentially complete. |
| AIR | ——— | None | None | ——— |





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- inadvertant ingestion of surface water and sediments
- absorption via dermal contact with surface water and sediments

For intake to occur via inadvertant ingestion or dermal contact, direct contact with surface water or sediment must occur. Since no light aromatics or PAH were detected in surface water samples, potential intakes of these PCOC via direct contact with water is not possible.

Arsenic, copper, and zinc were detected in surface water; therefore, potential intake of these elements by direct contact could potentially occur. However, because the drainage ditches are extremely shallow and stagnant, inadvertant ingestion of surface water is not plausible. With respect to sediments, direct contact is unlikely in ditches overgrown with vegetation; however exposure to sediments containing PAH and metals in ditches containing sparse vegetation is possible. Thus, PEP associated with current and future non-workers encountering, the drainage ditches will be retained for quantitative evaluation in the Final PHEA. It should be noted that hypothetical future development of the site is not addressed for surface water and sediment PEPs. Development of the site would either eliminate potential contact by restricting access or eliminate the drainage ditches altogether by use of storm sewers and catch basins.

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9.4.2 Surface and Surficial Soils. As stated previously, there are only two detected areas of the site with exposed surficial soils containing PCOC. Both areas are located on commercial facilities, one in the northern area and one in the southern area. Direct contact intake exposures

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could potentially occur to either non-workers, workers at the commercial facilities, utility workers, or potential future construction if the site is developed in the future. PEPs for soils include:

- inadvertant ingestion of soil
- absorption via dermal contact with soil
- inhalation of fugitive dust emissions from soil as a result of potential construction activities.

The potential ingestion of PCOC from soils may occur indirectly by oral contact with hands or arms to which soil particles have adhered. Potential dermal intakes could result following dermal contact with PCOC adsorbed to soils. Fugitive dust emissions at the site may result from activities associated with repair of existing utility lines or installation of new lines, or from potential future construction activities should the site be developed.

With regard to potential direct contact exposures to non-workers, both detected areas with exposed surface soil are currently on commercial property surrounded by fences. In addition, these properties operate under security systems. Consequently, the likelihood of an unauthorized individual gaining access to the site and being exposed to the surface soils is very remote. Therefore, potential direct contact PEP for non-workers will not be retained for quantitive evaluation in the Final PHEA.

With regard to potential direct contact PEP for on-site workers, the areas with exposed surface soil are generally small patches, in localized areas within both the northern and southern sections. These areas are located away from

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the areas of most worker activity. Thus, it is likely the workers seldom, if ever, come into direct contact with these soils. Therefore, potential direct contact PEP for on-site workers will not be retained for quantitative evaluation in the Final PHEA.

While exposed surface soil areas are small in size and away from the normal flow of worker activity, the results of the site investigation indicate that portions of soil in the northern and southern sections of the site which are currently under buildings, reinforced concrete, or asphalt, contain detectable levels of PCOC. If utility workers engage in activity that requires excavation of surficial soils, then direct contact intake exposure could potentially occur to these workers. In addition, if future site development occurs, which includes the demolition of buildings and removal of asphalt or reinforced concrete, direct contact intake exposures could potentially occur to construction workers during site development activities. Finally, direct contact PEP could potentially occur to, hypothetical future occupants of the site if developed. While future development will most likely be commercial, future residential development is a possibility. Consequently, direct contact exposure to utility workers, future construction workers, and hypothetical residential or commercial occupants of the site will be retained for quantitative evaluation in the Final PHEA.

<u>9.4.3 Groundwater</u>. The water-bearing units directly beneath the site are not currently used for domestic or commercial purposes. However, migration of PCOC through old wells to the deeper aquifer which could potentially be used as a drinking source by off-site commercial or residential occupants will be retained for quantitative

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evaluation in the Final PHEA. While groundwater beneath the site is not currently used for domestic or commercial purposes, it is conceivable, although unlikely, given the ready and economic availability of potable water from the City of Houston, that wells could be installed in the water-bearing units in the future. Subsequently, exposure to PCOC could occur from using this water as a hypothetical source of consumption. Consequently, PEP for people from hypothetical future uses of groundwater as a drinking water source will be retained for quantitative evaluation in the Final PHEA at the request of EPA.

## 9.5 Potential Environmental Exposure Pathways and Receptors

With regard to PEP for environmental populations, two areas of interest, surface soils and surface water and sediment, are relevant, since wildlife cannot be directly exposed to groundwater or subsurface soils. For the two relevant areas of interest, PEP are presented in Table 9-9.

9.5.1 On-site Wildlife Populations. The only portions of the South Cavalcade Site which can support a significant wildlife population are the central section and the drainage ditches. As described earlier, the northern and southern sections are currently used for commercial ventures. Both the northern and southern sections have substantial portions which are paved with reinforced concrete or asphalt or covered with buildings, thereby restricting direct contact to wildlife. In addition, these sections have fences in place which further restrict site access.

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TABLE 9-9

POTENTIAL ENVIRONMENTAL EXPOSURE PATHWAYS

Surface Soils

Potential exposures to terrestrial and amphibious wildlife from ingesting or dermally contacting exposed surface soils containing PCOCs

Surface Water and Sediment

Potential exposures to terrestrial, amphibious and aquatic wildlife from ingesting or dermally contacting surface water in drainage ditches

Potential exposures to terrestrial, amphibious and aquatic wildlife from ingesting or dermally contacting sediments in drainage ditches

Potential exposures to terrestrial, amphibious and aquatic wildlife from ingesting organisms containing PCOCs

Groundwater

None

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An environmental assessment conducted by the U.S. EPA for the North Cavalcade Site investigated environmental receptors in the Harris County area. A tentative list of these species was presented and is included in this Preliminary PHEA (Table 9-10). Four rare or endangered species, including one plant species, were reported to potentially inhabit this area: Texas bitterweed (plant species), the buttermilk racer, the golden-cheeked warbler, and the black capped vireo. However, correspondence from the U.S. Fish and Wildlife Service indicates that no endangered species currently inhabit the site (Appendix G, Volume 2). It should be noted that the drainage ditches only flow when it rains, and therefore, support no aquatic populations.

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9.5.2 Surface Soils. As just discussed, the central area of the site is the only part of the site which currently supports a wildlife population. Site investigations indicate no evidence of PCOC in the surface soils in the central section of the site. Consequently, no exposure to wildlife from this part of the site can occur, therefore, PEP for wildlife from surface soils will not be retained for quantitative evaluation in the Final PHEA.

9.5.3 Surface Water and Sediments. Wildlife could potentially be exposed to PCOC via either direct contact with surface water and sediment, or ingestion of organisms inhabiting sediments containing PCOC. PCOC were detected in the drainage ditch surface waters, although no organics were identified. The majority of metals were at levels below water quality criteria, except for copper, lead, and zinc. Consequently, direct contact exposures to wildlife from surface water will be retained for quantitative evaluation in the Final PHEA.

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TABLE 9-10

TENTATIVE LIST OF SPECIES IN HARRIS COUNTY POTENTIALLY INHABITING THE SOUTH CAVALCADE STREET SITE

Vegetation

Little bluestem grass
Eastern boxcress
Chinese tallow
Loblolly pine
Southern red oak
Post Oak
Hawthorn
Texas bitterweed*

Amphibians/Reptiles

Leopard frog
Eastern tiger salamander
Central newt
Garter snake
Buttermilk racer*

Mammals

Harvest mouse
Field mouse
Cotton rat
Norway rat
Eastern mole
Gray squirrel
Fox squirrel
Mexican free-tail bats
Evening bats
Hoary bats
Possum
Racoon
Armadillo
Red fox
Eastern cottontail
Striped skunk

Birds

Common grackle
Starling
Red-winged blackbird
Morning dove
Killdeer
Eastern bluebird
Eastern & western meadowlark
Sparrows - song
- field
- white throated
- white crowned
- lark
Rufous-sided towhee
Downy woodpecker
Red bellied woodpecker
Flicker
Golden-cheeked warbler*
Black-capped vireo*
American kestrel
Hawks - Red tailed
- Red-shouldered
- Swainson's
- Broadwing

* Endangered or rare.

Source: North Cavalcade Remedial Investigation Report, ICF Clement Assoc., 1987.

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PCOCs were detected in sediments in the drainage ditches. Direct contact with sediments could occur among burrowing animals inhabiting the site as well as amphibians or reptiles. Bioaccumulation may also occur by the ingestion of other insects or animals that have accumulated PCOC by ingestion or dermal exposure. These pathways will be retained for further evaluation in the Final PHEA.

## 9.6 Summary

This section has:

- identified areas of interest,
- identified potential contaminants of concern,
- identified and screened potential exposure pathways, and
- identified potential receptors.

The areas of interest included: the surface and subsurface soils in the northern and southern sections of the site, the surface water and sediment in the drainage ditches running through the site and along its boundaries, and groundwater beneath the site. For each area of interest, potential exposure pathways were identified and screened. Those pathways surviving the screening process will be subjected to a quantitative exposure assessment and risk characterization in the Final PHEA. Table 9-11 presents the list of potential human exposure pathways that have been retained for the Final PHEA. Table 9-12 presents similar information for the potential environmental exposure pathways.

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TABLE 9-11
RETAINED POTENTIAL HUMAN EXPOSURE PATHWAYS

| Media | Current or Future | Potential Exposure Pathway | Potential Receptor | PCOCs |
|---|---|---|---|---|
| SEDIMENTS | | | | |
| | Current and Future | inadvertant ingestion | non-workers | PAHs, metals |
| | | dermal contact | non-workers | PAHs, metals |
| SURFACE AND SURFICIAL SOILS | | | | |
| | Current | inadvertant ingestion, dermal contact, inhalation of dust | utility workers | PAHs, metals |
| | Future | inadvertant ingestion, dermal contact, inhalation of dust | construction workers | PAHs, metals |
| | | inadvertant ingestion, dermal contact | hypothetical residential occupants | PAHs, metals |
| | | inadvertant ingestion, dermal contact | hypothetical commercial occupants | PAHs, metals |



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TABLE 9-11 (cont.)

| Media | Current or Future | Potential Exposure Pathway | Potential Receptor | POCCs |
|---|---|---|---|---|
| GROUNDWATER | | | | |
| | Current | ingestion | off-site residential and commercial occupants | potentially complete |
| | Future | ingestion | hypothetical residential occupants | light aromatics, PAHs, metals |
| | | ingestion | hypothetical commercial occupants | light aromatics, PAHs metals |





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TABLE 9-12

RETAINED POTENTIAL ENVIRONMENTAL EXPOSURE PATHWAYS

Surface and Subsurface Soils

None

Surface Water and Sediment

Potential exposures to terrestrial, amphibious and aquatic wildlife from ingesting or dermally contacting sediments in drainage ditches

Potential exposures to terrestrial, amphibious and aquatic wildlife from ingesting organisms containing PCOCs

Groundwater

None

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## 9.7 References

1. Environmental Protection Agency, Superfund Public Health Evaluation Manual, EPA/S40/1-86/060, October, 1986.

2. Planning Research Corporation, The Endangerment Assessment Handbook, August, 1985.

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