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REMEDIAL INVESTIGATION REPORT

FOR

FISHER-CALO CHEMICAL SITE
KINGSBURY, INDIANA

MAY 1989

VOLUME 1 OF 3

****Company Confidential****

REM II

PERFORMANCE OF REMEDIAL RESPONSE ACTIVITIES AT UNCONTROLLED HAZARDOUS WASTE SITES

U.S. EPA CONTRACT NO. 68-01-6939

CDM Federal Programs Corporation
CAMP DRESSER & McKEE INC.
ROY F. WESTON INC.
WOODWARD-CLYDE CONSULTANTS
CLEMENT ASSOCIATES, INC.
ICF INCORPORATED
C.C. JOHNSON & MALHOTRA, P.C.

EPA Region 5 Records Ctr.
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REMEDIAL INVESTIGATION REPORT

FOR

FISHER-CALO CHEMICAL SITE
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MAY 1989

VOLUME 1 OF 3

****Company Confidential****

Prepared for:

U.S. Environmental Protection Agency
Emergency and Remedial Response Branch
Region V
230 South Dearborn Street
Chicago, Illinois 60604

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Document No.: 209-RI2-RT-HDFZ

Work Assignment No.: 108.5L13

20909/44

CDM

environmental engineers, scientists, planners, & management consultants

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May 30, 1989

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Subject: Remedial Investigation Report for the Fisher-Calo Chemical Site

Work Assignment No.: 108.5L13

Project: REM II - EPA Contract No. 68-01-6939

Document No.: 209-RI2-RT-HDFZ

Dear Ms. Kush and Mr. Bradley:

Camp Dresser and McKee Inc. is pleased to submit for your review, the Remedial Investigation Report for the Fisher-Calo Chemical site in Kingsbury, Indiana.

Comments received from the U.S. EPA on the previously submitted Draft RI Report have been addressed, and incorporated into this revised copy of the report. Due to the termination of the REM II contract, our ability to respond to any additional comments will be limited. Therefore, your prompt review of this document would be appreciated.

20914/15

If you have any questions or need additional information, please contact the Site Manager, Jil Line.

Very truly yours,

CAMP DRESSER & McKEE INC.

Jun Yoshitani, P.E.
Vice President
Region V Manager

JY:wg

Enclosure

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PERFORMANCE OF REMEDIAL RESPONSE
ACTIVITIES AT UNCONTROLLED HAZARDOUS
WASTE SITES (REM II)

U.S. EPA CONTRACT NO. 68-01-6939

REMEDIAL INVESTIGATION REPORT
FOR
FISHER-CALO CHEMICAL SITE

MAY 1989

EPA Work Assignment No.: 108.5L13
REM II Document No.: 209-RI2-RT-HDFZ

Prepared By: Jeanette I. Line Date: May 30, 1989
Jeanette I. Line
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EXECUTIVE SUMMARY

The Fisher-Calo Chemical site is located in the Kingsbury Industrial Development Park (KIDP) in La Porte County, Indiana. The Fisher-Calo properties occupy two parcels of land on approximately 270 acres; approximately 30 acres at the main plant site along One-Line Road and 240 acres at the Two-Line Road facility. The KIDP is located in the southeast section of La Porte County, approximately 12 miles southeast of La Porte, Indiana.

Fisher-Calo Chemical (FCC) in Kingsbury, Indiana was formed in 1978 through the merger of Fisher-Calo Chemical Solvents Incorporated, Midwest Ammonia Corporation, Midwest Chlorine Corporation, and Wallace Warehouse. In 1970, Midwest Chlorine Corporation began operations at the One-Line facility. At this time, the disposal of solid wastes and liquid wastes at the site began. In 1972, Midwest Ammonia Corporation and Fisher-Calo Chemical Solvents Incorporated began solvent reclamation operations at the One-Line facility. Still bottom waste drums were primarily stored at the One-Line facility. However, by 1973, drum storage, disposal and burial activities were occurring at the Space Leasing Company, located approximately 1000 feet northeast of the Two-Line facility. Also, by 1973, chemical processing activities in the buildings at the southern section of the Two-Line facility had begun.

Throughout the history of these firms at the One-Line and the Two-Line facilities, there have been numerous inspections of the operations by the State of Indiana, USEPA, and other regulatory agencies with numerous citations being issued by these regulatory agencies. In the years of operation at the site, several significant events occurred at or near the site as a result of Fisher-Calo's operations.

In June 1979, the Indiana State Board of Health (ISBH) excavated buried drums from a location in the northeast corner of the Fisher-Calo Two-Line

facility. During these activities, other potential burial and waste disposal areas were identified. In July 1980, the USEPA filed suit under Section 7003 of RCRA to eliminate the hazards posed by the previous activities at the Fisher-Calo sites.

In 1982, the USEPA's FIT contractor conducted an investigation of the site. Results of the sampling program indicated elevated levels of organic compounds in the groundwater, and heavy metals in surface soils. FIT also identified a magnetic anomaly in the area where all buried wastes had reportedly been removed by FCC. Additional sampling was recommended to define this source and the potential for further contaminant migration.

In August 1982, the USEPA and Fisher-Calo entered into a Consent Decree. This Consent Decree required Fisher-Calo to monitor on a quarterly basis three (3) selected monitoring wells to determine if the contaminant concentration would decrease with time. Following several years of monitoring, it became apparent that the contaminant levels had not decreased in the selected monitoring wells, thereby suggesting the continued presence of a contamination source. In April 1985, the USEPA issued a Work Assignment to the REM II Contractor, CDM, to conduct and perform a Remedial Investigation/Feasibility Study at the Fisher-Calo site. A Work Plan detailing the proposed RI/FS activities for the site was approved by the USEPA in July 1986.

In December 1986, the USEPA reuested that the scope of work at the FCC site be expanded. The increased scope of work included field investigation sampling in selected areas adjacent to the FCC site, and in suspected areas of past disposal. Work plans were developed to perform remedial investigation activities in two phases. Phase I RI activities were to be conducted per the Work Plan approved in July 1986; Phase II RI activities were to include the expanded scope of work as requested by the USEPA in December 1986.

Phase I RI activities began in May 1987 and continued until August 31, 1987 when an arson fire at the FCC site trailer halted Phase I field activities. Phase II RI activities were conducted from May through November 1988.

The primary objective of the RI was to evaluate the nature and extent of contamination at the FCC site. In order to meet this objective, the following tasks were performed:

- Geophysical surveys were conducted by the U.S. EPA in 1987 and 1988 to identify locations where drums or tanks may have been buried.

- Monitoring well installation and soil sampling from the deep well borings occurred in both Phase I and II. A total of 68 monitoring wells were installed - 25 in Phase I and 43 in Phase II. Deep well soil samples were collected at incremental depth intervals and analyzed for chemical contaminants.

- Analytical samples were also collected from surface and runoff soil, surface water/sediment, and shallow subsurface soil boring locations.

- Groundwater samples were collected from the monitoring wells and from water supply (production) wells used by the KIDP. These groundwater samples were analyzed for contaminants.

- A soil gas field screening survey was conducted in potential source areas. The soil gas samples were analyzed for TCE and toluene, using a portable gas chromatograph.

- Hydrogeologic testing and aquifer measurements were performed to determine aquifer parameters.

- Monitoring well casings were surveyed to determine the elevation of each point. Additional surveys were performed to establish soil sampling grid areas, and to develop topographic maps of the site and adjacent ateas.

A total of 77 samples were collected for laboratory analysis during Phase I; 759 samples were collected for laboratory analysis during Phase II.

Based on the results of Phase I and II RI activities, the following general results and conclusions were determined:

- o Surface water samples from Travis Ditch, Kingsbury Creek and the Kankakee River do not contain elevated concentrations of contaminants. Sediment samples collected at the same locations contain higher levels of contaminants, but only one location showed significant levels of contamination (DCA-570 ug/l, TCE-720 ug/l and 1,2-DCE 1600 ug/l).

- o The surface water sample collected from the discharge lagoon on the Cardinal Chemical property (Area C) contained high concentrations of a number of inorganic compounds including aluminum, barium, chromium, copper, iron, manganese, nickel, potassium, sodium and zinc. The sediment sample at the same location had elevated levels of PCB-1260, chloroform, and bis(2-ethylhexyl)phthalate.

- o The sediments in the pond at the Space Leasing facility (Area F) showed elevated concentrations of toluene, aluminum, and potassium. Toluene is known to have been stored at the Fisher-Calo site.

- o The sediments in the wetland area contained high concentrations of aluminum, barium, chromium, lead, potassium, selenium, silver, sodium and vanadium.

- Surface soils at the site were most heavily contaminated with the following compounds: acetone, methylene chloride, bis(2-ethylhexyl/phthalate, isophorone, chlorobenzene, ethylbenzene, total PAHs, PCB-1260, cyanide, chromium and zinc. These compounds were identified as contaminants of concern due to their detection at high concentration levels. Other VOCs were found, but at lower concentrations. Pesticides were detected in Areas B, C, D and E. Area A (Fisher-Calo) and Area C (Cardinal Chemical) were the most heavily contaminated areas.

- Many of the contaminants detected in the surface soils were also detected in the subsurface soil and groundwater samples. Additional contaminants were found in the subsurface that were not detected in high concentrations at the surface, including highly volatile compounds such as TCE, PCE, toluene, and xylene.

- Five subsurface soil samples locations were identified as having highly contaminated soils that may be contributing sources for contamination of the groundwater. These locations are the soil borings SB-8, 23, 33, and 36 located in Study Areas C, A, B, and F, respectively, and Soil Gas Area A-1 (located within Study Area A). These locations contain very high concentrations of chlorinated organic solvents (greater than 50,000 ppb total), non-chlorinated organic solvents (toluene, xylenes, and ethylbenzene; greater than 100,000 ppb total, and ketones (acetone and related compounds), as well as high concentrations of semivolatiles and inorganics.

- The contaminants present in the saturated zone compared fairly well between soils and groundwater. Sampling shows that contamination almost exclusively affects the upper and middle portions of the shallow aquifer at discrete locations across the project study area.

- The contaminants of concern in groundwater are the chlorinated organics 1,1,1-trichloroethane (TCA), trans-1,2-dichloroethene (DCE), 1,1-dichloroethane (DCA), trichloroethene (TCE), and methylene chloride which are present at concentrations as high as 5900 ppb; other contaminants of concern are the volatiles, 2-hexanone (up to 590 ppb), acetone (400 ppb), 4-methyl-2-pentanone (360 ppb), benzene (28 ppb), and the semivolatile isophorone (210 ppb). Several chlorinated organic and phenolic constituents were detected at concentrations less than 30 ppb. Several inorganics were detected in unfiltered groundwater samples, but their concentrations in filtered samples were well below applicable standards.

- There appear to be several contributing sources of volatile (VOC) contamination to the groundwater. At least three different resulting plumes have been identified.

  - One is located downgradient of the old waste disposal area at the Fisher-Calo Plant near MW5 and MW6. Contaminants found in MW5 and MW6 included DCA, DCE, TCA, TCE, 2-hexanone, and 4-methyl-2-pentanone.

  - The second plume originates near the National Packaging facility with VOCs detected in MW35 in Round I and the same compounds detected in MW36 of Round II. VOCs found included TCA, DCE, and TCE.

  - Based on the compounds detected in each well nest, it is apparent that several individual plumes may be present near the Cardinal Chemical Company facility. VOCs found in these wells include DCA, DCE, TCA, TCE, acetone, and methylene chloride.

Conclusions based upon fate and transport of contaminants in the study area are as follows:

- The VOCs of concern appear to have migrated downward through the unsaturated zone into groundwater where they are transported through the saturated zone downgradient (south) with the groundwater.

- Contaminants left behind in the soil pore spaces as residuals will most likely act as continuing sources of contamination.

- Groundwater movement and contaminant behavior indicate that advective groundwater transport is the primary transport mechanism for contaminants in the aquifer of concern.

- Estimates of the rate of contaminant migration indicate the maximum contaminant migration rate may be 211 ft/yr, equal to the calculated groundwater flow velocity in the upper portion of the aquifer. An estimate based on an assumed organic carbon content of the soils at the Fisher-Calo site yields retarded transport velocities ranging from 75 to 210 ft/yr in the upper portion of the aquifer of concern, based on the contaminant.

- The downgradient residential wells in Tracy, Kingsford Heights, and surrounding areas are the primary potential receptors of groundwater contamination.

1.0 INTRODUCTION

1.1 SITE BACKGROUND INFORMATION

1.1.1 SITE LOCATION

The Fisher-Calo Chemical site is located in the Kingsbury Industrial Development Park (KIDP) in LaPorte County, Indiana. The Fisher-Calo properties occupy two parcels of land on approximately 270 acres; approximately 30 acres at the main plant site along One-Line Road and 240 acres at the Two-Line Road site. The location of the site is shown in Figures 1.2-1 and 1.2-2 contained in Volume II, Appendix A. The KIDP is located in the southeast section of LaPorte County, approximately 12 miles southeast of LaPorte, Indiana. The communities of Kingsbury, 1.9 miles to the northwest, and Kingsford Heights, 1.6 miles to the southwest, are the population centers located near the site.

1.1.2 SITE DESCRIPTION

The Fisher-Calo One-Line Road facility is bordered to the north and south by grasslands and buildings. The area between the One-Line facility and the Two-Line facility (east of the One-Line facility) is under cultivation with corn and soybeans. The area west of the One-Line facility contains scattered woodlands and fields with Travis Ditch and Kingsbury Creek paralleling the western border of the facility. The Two-Line Road facility is situated in surroundings similar to the One-Line facility, and has adjacent buildings located to the south and to the northwest.

The land west and east of the Two-Line facility, as well as along the eastern boundary and on the southern side of the Fisher-Calo Two-Line Road property, is also under cultivation. The area north of the Two-Line facility, and across Hupp Road (the main road in and out of the industrial park complex) was the site of munitions bunkers and is basically

grasslands with the aforementioned bunkers spaced throughout the area. To the south of the facility, the land consists of scattered woodlands and grasslands. At the southeast corner of the Two-Line Road facility is a wetland area. To the east, at the end of Hupp Road and approximately 15,000 feet from the site, is the Kingsbury Fish and Wildlife area operated by the Indiana Department of Natural Resources.

Fisher-Calo Chemical was primarily involved in the packaging, storage, and distribution of industrial chemicals as well as reclamation of waste paint and metal finishing solvents. Midwest Chlorine and Midwest Ammonia, which shared the One-Line facility, were involved in the production of sodium hypochlorite and the packaging of liquid chlorine, anhydrous ammonia, sulfur dioxide, anhydrous hydrogen chloride, and methyl chloride for sale to commercial users of these materials.

1.1.3 SITE HISTORY AND CHRONOLOGY OF REGULATORY ACTION

Fisher-Calo Chemical Company in Kingsbury, Indiana was formed in 1978 through the merger of Fisher-Calo Chemical Solvents Incorporated, Midwest Chlorine Corporation, Midwest Ammonia Corporation and Wallace Warehouse. Fisher-Calo Chemical based its operations in the Kingsbury Industrial Development Park, near Kingsbury, Indiana. In 1970, Midwest Chlorine Corporation began operations at the One-Line facility. At this time, the disposal of solid wastes and liquid wastes began at this facility. In 1972, Midwest Ammonia Corporation and Fisher-Calo Chemical Solvents Incorporated began operations at the One-Line Facility. These three firms and a fourth, Wallace Warehouse, were merged as part of Fisher-Calo on August 31, 1978.

Solvent reclamation activities were started at the One-Line facility in late 1972. Still bottom wastes from the solvent reclamation process were stored onsite in 55 gallon drums. An incinerator unit was installed at this time, but was never utilized because permits could not be obtained from state and county health departments.

Solvent reclamation activities at the One-Line facility were in operation from 1973 through 1985. The amount of waste drums stored at this location reached a peak in 1980 when new processing and pressure tanks were added. By 1984, waste drum storage and disposal had declined, but still exceeded 1973 levels.

Still bottom waste drums were primarily stored at the One-Line facility. However, by 1973, drum storage, disposal and burial activities were occurring at the Space Leasing Company, located approximately 1000 ft. northeast of the Two-Line facility. Aerial photographs indicate that by 1973 chemical processing activities in the buildings at the southern section of the Two-Line facility had also begun. At this time, vertical storage and pressure tanks and a small disposal pit were evident in this southern section, and a waste disposal area was located in the northeastern corner of the Two-Line facility.

Between 1980 and 1984 activity in the northern section of the Two-Line facility increased significantly, and by 1984 large numbers of drums, numerous processing tanks, and tank trucks were visible in the area. At this time wastes "stains" and stressed vegetation were evident in the area of the processing tanks and in disposal areas.

Throughout the history of these firms at the One-Line and the Two-Line facilities, there have been numerous inspections of the operations by the State of Indiana, USEPA, and other regulatory agencies with numerous citations being issued by these regulatory agencies. In the years of operation at the site, several significant events occurred at or near the site as a result of Fisher-Calo's operations.

In September 1974, a fire of unknown origin occurred on property owned by Space Leasing, Inc., approximately 1000 ft. northeast of the Fisher-Calo Two-Line facility. The materials contributing to this fire were buried drums of paint pigments and other wastes, disposed of at this location by FCC and used as fill material at Space Leasing. From all acccounts,

approximately 700 to 1,000 drums were buried at this site. The resulting fire was allowed to burn itself out since the local fire department could not bring it under control.

In March 1978, a more significant fire occurred at the north end of the Fisher-Calo One-Line facility. The source of this fire was also unknown. At this time, in excess of 20,000 drums of waste, consisting primarily of still bottoms from the solvent recovery distillation unit of the Fisher-Calo operation, were destroyed by this fire. In the course of this fire, the smoke plume reached heights of over 8,000 feet, resulting in the evacuation of over 10,000 residents from the area. The resulting debris from this fire was not cleaned up for over a year. Fisher-Calo was eventually required to remove the debris and the top 6 inches of soil from the burn area under a consent decree entered in State court with the Indiana State Board of Health in 1982.

In June 1979, the Indiana State Board of Health (ISBH) excavated buried drums from a location in the northeast corner of the Fisher-Calo Two-Line facility. During these activities, other potential burial and waste disposal areas were identified. In July 1980, the USEPA filed suit under Section 7003 of RCRA to eliminate the hazards posed by the previous activities at the Fisher-Calo sites.

In 1982, the USEPA's FIT Contractor conducted an investigation at the site and identified a narrow plume of contaminated groundwater apparently emanating from the buried drum area previously located by the State in 1979 at the Two-Line facility. The plume of contamination extended to the southwest under the One-Line facility. FIT also identified a magnetic anomaly in the area in which all buried wastes had reportedly been removed by FCC. Additional sampling was recommended to define this source and the potential for further contaminant migration to the southwest.

In August 1982, the USEPA and Fisher-Calo entered into a Consent Decree. This Consent Decree required Fisher-Calo to conduct groundwater monitoring on a quarterly basis.

Samples collected from three (3) selected monitoring wells were used to determine if the contaminant concentrations decreased with time. This monitoring program was based upon the FIT report, which stated that the contaminant levels should exhibit a steady decline if the entire source of contamination had been removed. Following several years of monitoring, it became apparent that the contaminant levels had not decreased in the selected monitoring wells, thereby suggesting the continued presence of a contamination source. In April 1985, the USEPA issued a Work Assignment to the REM II Contractor, CDM, to conduct and perform a Remedial Investigation/Feasibility Study at the Fisher-Calo site. A Work Plan detailing the proposed RI/FS activities for the site was approved by the USEPA in July 1986.

In December 1986, the USEPA requested that the study area for the RI/FS be expanded to include the areas identified as Wallace Warehouse, the Drum Storage/Fire Area; an old disposal area at the eastern perimeter in the southern section of the Two-Line Facility; an old disposal area on Space Leasing property located north of Hupp Road, approximately 1 mile east of FCC Two-Line Facility; suspected areas of waste disposal from previous property owners; and the miscellaneous drums, tanks, containers, and area of visibly stressed vegetation located throughout the site and on adjacent properties on One-Line Road. A comprehensive hydrogeological characterization of the site vicinity and additional geophysical studies were also included in the expanded scope of work, so that the RI/FS objectives could be met. Later contract negotiations reduced the scope of work to include only those tasks related to the completion of the RI.

Phase I RI activities were begun in May 1987 and continued until August 31, 1987 when an arson fire at the Fisher-Calo site trailer halted site investigation activities. Phase II activities were conducted from May until November 1988.

Remedial action at the Two-Line facility is being conducted under a Unilaterial Removal Order issued by the U.S. EPA. The removal action will be carried out in a two-phase program: Phase one (April-May, 1989) will involve the staging of drums for removal during phase two. Phase two (summer 1989) will include the excavation of contaminated soils and buried tanks or drums located on site. The contaminated soils, tanks, and drums will be removed from the site and transported to an appropriate disposal facility.

1.2 NATURE AND EXTENT OF THE CONTAMINATION PROBLEM

1.2.1 KNOWN WASTE DISPOSAL AREAS

The Fisher-Calo Corporation was primarily engaged in the reclamation of spent solvents. Therefore, the bulk of hazardous wastes received at their facility consisted of various spent liquid solvents. From transporter records, paint solvents made up the majority of these wastes.

Constituents of these paint solvents were toluene, xylene, and benzene as well as other organic compounds. Other solvents received at Fisher-Calo from examination of transporter records include:

- 1,1,1,-Trichloroethane
- Acetone
- Methylene Chloride
- Trichloroethylene
- Other Waste Solvents

Additionally, acidic and caustic metal finishing wastes, containing cyanide and metals, were received at the Fisher-Calo facility. Many of the solvent wastes were reclaimed by use of a thin film evaporator, while others were stored at the site. Caustic and acidic wastes were initially dumped on the ground; later those wastes were neutralized and discharged into the industrial complex sewers. Cyanide wastes were stored at the site until final disposal at other facilities in the early 1980's. Primary constituents of the metal treating wastes included heavy metals such as chromium, nickel, lead, copper, zinc, and cadmium and also included arsenic and cyanide. Organic constituents of these wastes included toluene, phenolics, tetrachloroethylene, 1,1-dichloroethane, dichloroethylene, benzene, 1,1,-trichloroethane, as well as other organics commonly found in paint wastes and organic solvents used by industry.

As part of their solvent reclamation operations, Fisher-Calo produced a still bottom waste which was accumulated in 55 gallon drums. From previous investigations conducted at the Fisher-Calo facility, it was determined that these wastes were stored, buried, dumped, or spilled at various locations at the One-Line and Two-Line Road facilities. In the course of its operations, approximately 700 to 1,000 drums were received per month at these facilities. It is estimated that less than one percent of these drums contained cyanide. An exact number and quantity of wastes as delivered, processed and/or disposed of at the facility is unavailable. Many of these waste drums were destroyed in the March 1978 fire which occured at the One-Line facility. Areas of known or suspected disposal by dumping and/or burial are shown in Figures 1.2-1 and 1.2-2 (Volume II).

1.2.2 CURRENT SITUATION

The Fisher-Calo Chemical solvent reclamation facilities ceased operation in January 1985 when Fisher-Calo Industries divested itself from its various divisions. In February 1985, Fisher-Calo filed for protection in the United States Bankruptcy Court of Northern Illinois under Chapter 11.

No new waste materials were received at the facility since 1985. However, drummed wastes and tanks containing wastes are still being stored at both the north and south sections of the Two-Line facility. Some solid waste and drummed waste materials are also still being stored at the One-Line facility.

The Fisher-Calo properties are presently occupied by several independent companies which are actively doing business. A map showing the current site facilities is shown in Volume II, Appendix A, Figure 1.2-3. The Fisher-Calo properties located at the south end of One-Line Road were sold, and are operated by their current owners. The remaining Fisher-Calo properties are leased and are used for warehousing, packaging or production. The currently operating facilities occupying the Fisher-Calo site and adjacent (minor) properties include:

One-Line Road

- National Packaging: product packaging and distribution;
- Cardinal Chemical: chemical manufacturing, including chlorine, anhydrous ammonia, methylene chloride and others; and
- KCI Chemical.

Two-Line Road

- Fisher-Calo Chemical Plant: warehousing and blending of non-hazardous liquids.
- New Plant Life: manufacture plant food, fertilizers and various products.

Other areas outside of the Fisher-Calo properties in adjacent Kingsbury Industrial Development Park areas are occupied by actively operating

independent industries. From information and data collected to date, some of these areas of active operations are within the areas of contamination and potential contamination. The major task of the RI study conducted by CDM was to characterize the concentration and extent of the contaminants at the overall site including the Fisher-Calo properties, adjacent properties, and downgradient areas; and to locate and characterize the continuing source of groundwater contamination exhibited by the monitoring wells.

The areas selected for study during the RI include suspected past waste storage/disposal areas, areas where miscellaneous drums, tanks, and containers are currently remaining, and areas of visibly stressed vegetation located throughout the site and on adjacent properties along One-Line Road. Six study areas were selected based on the past activities related to these areas, and on the current conditions existing in these areas, (i.e., visible stains or stressed vegetation; excavated areas, or soil piles, areas where tanks or drums recently or currently stored, etc.). The current site features for these selected study areas are shown in Figures 1.2-4 through 1.2-9 (Volume II).

Remedial action at the Two-Line facility is being conducted under a Unilateral Removal Order issued by the U.S. EPA. The removal action will be carried out in a two-phase program: Phase one (April-May, 1989) will involve the staging of drums for removal during phase two. Phase two (summer 1989) will include the excavation of contaminated soils and buried tanks or drums located onsite. The contaminated soils, tanks and drums will be removed from the site and transported to an appropriate disposal facility.

1.3 REMEDIAL INVESTIGATION SUMMARY

1.3.1 PURPOSE AND OBJECTIVES OF THE REMEDIAL INVESTIGATION

The primary objective of the remedial investigation was to evaluate the extent of contamination at the Fisher-Calo site. From previous studies, it

was determined that heavy metals were present in the soils and groundwater. Also, unknown quantities of organic contaminants had infiltrated the groundwater aquifer underlying the site, resulting in high organic concentrations in some site areas.

The objectives originally identified for the Phase I RI were to acquire data necessary to determine the extent of contamination and the exposure potential.

Based upon the existing conditions at the site and the history of waste disposal practices, investigation of additional Phase II study areas was deemed necessary to determine the nature and extent of the contamination problem and to further assist with the analysis and development of appropriate remedial clean-up actions.

The objectives of the Phase II activities were to conduct field investigation activities in the additional study areas to:

- Determine the nature and extent of contamination in surface soils, subsurface materials, groundwater and runoff waters;
- Define the relationship between the additional study areas and contamination on or emanating from the Fisher-Calo properties identified in the original Work Plan;
- Acquire additional information needed to assess feasible remedial actions.

The objectives of the Phase II activities were also to conduct additional investigative activities within the original study area in order to:

- Determine the level of cleanup effected by soil/debris removal undertaken by the property owners;

- Determine the nature and extent of contamination resulting from the operations of previous and current property owners in the on site areas of concern and in areas adjacent to the site;

- Characterize the nature and extent of contamination which might present potential exposure and human/health environmental risks associated with existing on-site contamination; and

- Acquire additional information needed to develop feasible remedial actions.

1.3.2 REMEDIAL INVESTIGATION FIELD ACTIVITIES

1.3.2.1 Field Surveys and Field Screening Activities

Geophysical Survey

Geophysical surveys consisting of frequency domain electromagnetic induction and proton precession magnetometer gradient measurements were conducted at the Fisher-Calo site from March 9 to 11, 1987. A second round of geophysical surveys consisting of ground penetrating radar were conducted in March 1988. The surveys were completed by personnel from the USEPA's Technical Support Unit, assisted by representatives from Camp Dresser and Mckee, who provided the initial survey grid and base maps. The survey request was initiated through Brad Bradley of the USEPA, CERCLA Enforcement Section, Region V. The purpose of the surveys was to investigate eleven specific areas and attempt to identify locations where drums may have been deposited and buried in excavated trenches. Data was also utilized for placement of the Phase II monitoring wells, and for defining soil gas survey study areas.

Soil Gas Survey

The Camp Dresser & McKee REM II Team conducted a soil gas survey at the Fisher-Calo site from October 6 thru November 16, 1988. Data from the soil gas survey was collected in support of field screening activities to identify and characterize the extent of contamination in suspected areas of waste disposal and buried tanks or drums.

The objectives of the soil gas survey were:

- To locate potential contaminant source areas onsite; and
- To delineate the contamination levels at both onsite and offsite locations.

Selection of study areas for the soil gas field screening activities were based on past evidence of waste disposal activities and/or buried tanks or drums. The results of geophysical surveys conducted by the USEPA during 1987 and 1988 were also used to identify suspected source areas. A Photovac 10S50 portable gas chromatograph was used to analyze soil gas samples which were collected from both on and offsite locations. Samples were analyzed for the presence of trichloroethylene (TCE) and toluene. The actual sampling and analysis of the soil gas was subcontracted to ATEC Associates, Inc. of Griffith, Indiana. The soil gas samples collected were analyzed onsite, at the CDM field trailer.

Preliminary ambient air monitoring was conducted from June 3 to 5, 1987, in order to establish adequate levels of personnel protection required for site work. A combination of direct reading instruments (HNu and Foxboro, MIRAN 1B Air Analyzer) and colorimetric detector tubes were used to conduct a survey of selected site work areas. The air monitoring survey areas were selected on the basis of the expected occurrence of field investigation activities within study areas which were located in the vicinity of

suspected contamination source areas and operating facilities that were suspected sources of air emissions.

Results of the air monitoring were used to establish the minimum personnel protection required for site work in the areas surveyed. All field investigation activities conducted by CDM were performed in accordance with the protocol and requirements specified in the Site Health and Safety Plan.

1.3.2.2 Analytical Samples

Surface Soils

Surface soil sample locations were selected from five study areas within the Fisher-Calo site and from an offsite (background) area.

Onsite soil sample locations were selected in areas where past waste disposal or spills had occurred, in areas that were adjacent to currently operating facilities and areas where drummed waste materials were located. Surface soil samples were collected from excavated soil piles; areas where stressed vegetation was noted; from surface areas that showed obvious waste stains or spills; and from locations along established grid lines in order to define the extent of contamination present. Samples were also collected from low spots, ditches and drain pipe openings, and from depression areas where surface water runoff would collect. Background surface and runoff soil samples were collected from offsite locations and from a selected onsite location, outside of the areas of suspected disposal.The actual surface soil sampling activities were subcontracted to ATEC Associates of Griffith, Indiana.

Surface soil samples were collected at depths up to 24 inches. At locations where concentrations of organic vapors were noted at levels above 5 ppm (using an HNu or OVA), discrete samples were obtained at intervals of 0-6" and 6-12", or from 0-12" and 12-24" in areas where soils were plowed or disturbed.

Samples were collected using a stainless steel scoop, spoon or hand auger. The samples were placed on a clean stainless steel tray, screened for organic vapors, and then placed into the appropriate sample containers.

Subsurface Soil Borings

Subsurface soil samples were collected from deep monitoring well boring locations and from shallow soil borings located on and offsite. The actual sample collection activities were subcontracted to ATEC Associates, Inc. of Griffith, Indiana.

The deep well subsurface soil samples were collected during Phase I and Phase II monitoring well installation activities. Phase I deep well soil samples were collected from July to September, 1987; Phase II samples were collected from May to July, 1988.

Subsurface soil samples from the deep well borings were collected at depth intervals of 0 feet (surface), 5 feet, 15 feet and every 10 feet thereafter, to a depth of approximately 75 feet. The maximum sample depth was determined by the depth at the top of the semi-confining silty/clay layer, or the depth at the bottom of the borehole, depending on field conditions and the location of the monitoring well.

Additionally, samples were collected from shallow soil borings at 33 onsite locations and two offsite locations. Samples were collected during Phase II soil investigation activities using a 2" diameter split spoon device. Samples from 14 soil boring locations were collected at 18" intervals to a depth of approximately 20 feet (to the water table or saturated zone). The background soil boring sample was collected from an offsite location.

Surface Water/Sediment

Surface water samples were collected from six points along Kingsbury Creek and Travis Ditch, from two onsite water bodies (a pond and a discharge

lagoon), one location along the Kankakee River and from a pretreated wastewater effluent drainage pipe. Sediment samples were collected from corresponding locations along Kingsbury Creek and Travis Ditch, the Kankakee River, and the onsite water bodies. Additionally, two sediment samples were collected from a wetland area located southeast of the Two-Line Road property. All surface water and sediment sample collection activities were conducted by ATEC Associates, Inc. of Griffith, Indiana.

Surface water samples were collected by submerging the sample containers into the water until they were filled to the appropriate level. For samples taken from the stream locations, the mouth of the sample container was positioned to face upstream, with the sampling personnel standing downstream, to minimize contamination from sediments which were stirred up upon entry into the stream. Samples collected from Kingsbury Creek and Travis Ditch were taken from locations above and below the confluence of these streams. Surface water samples were collected from the center of the stream at each location. Pond samples were collected from near the shore or edge of the water body.

Sediment samples were collected from the top 6" of material using a stainless steel scoop or 2" diameter split-spoon device. The method of collection depended on the field conditions at the sample location. Two sediment samples were collected at each location selected from the streams, one from the center of the stream (sample "A") and another from along the edge or bank of the stream (sample "B"). Samples collected at these locations were assigned the same location number, and used the letter A and B designations to distinguish the point of sample collection (i.e., SD-06A and SD-06B).

Groundwater

Samples were collected from monitoring wells and water supply (production) wells located on- and offsite. These wells provided samples from onsite

locations, as well as locations upgradient and downgradient from the site.

Monitoring wells installed during the RI (Phase I and II) had screened intervals at 3 depths: shallow wells were installed with a screened interval from approximately 25 to 40 feet below land surface; intermediate well screen depths were from 40 to 60 feet; and the deep well screened intervals were from 60 to 80 feet deep, with one well screen set at approximately 105 feet. This configuration of the well screen intervals provided data to characterize the extent of contamination throughout the upper aquifer.

The objectives of the groundwater sampling were to:

- Determine levels of contamination in groundwater from wells located adjacent to (both up and downgradient)the previously defined FCC site;

- Verify the position and configuration of the water table onsite and in the adjacent downgradient offsite areas;

- More fully determine potentiometric heads, groundwater flow and contaminant conditions throughout the aquifer underlying the site;

- Determine the presence, character and extent of groundwater and contamination, both onsite and in the adjacent downgradient offsite area.

The CDM REM II Team supervised two rounds of groundwater sampling performed by ATEC Associates, Inc. at the FCC site. Round I groundwater samples were collected between August 8 - 24, 1988; and Round II groundwater samples were collected between November 7 - 22, 1988.

Groundwater samples were obtained using the following procedure:

- Five well volumes were purged from each well using a Brainard Kilman pump.

- After 5 well volumes had been removed from each well, the groundwater was tested to determine pH, temperature and conductivity. Once these three test parameters had stabilized, the groundwater samples were collected using a teflon bailer.

1.4 OVERVIEW OF REMEDIAL INVESTIGATION REPORT

This report has been prepared in accordance with the procedures outlined in the EPA Draft Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (document published in March 1988). The report is presented in three volumes: Volume I contains the written text prepared to document the tasks and activities performed during the RI, and to present a discussion of the findings and results of the RI activities. Volume II contains the figures and various data tables developed in support of the text contained in Volume I. Volume III contains the technical memoranda prepared for the various site field investigation activities conducted and also contains analytical data result tables that list the contaminant levels found at sample locations for all media sampled. These data tables were compiled after an evaluation of the laboratory data results to determine the validity and accuracy of contamination detections reported.

Section 2.0 of this report describes the existing characteristics of the study area. This includes discussion of the site area demography, land use, natural resources, climatology, physiography, ecology, and physical characteristics of site soils and geology. Particular consideration is given to those elements necessary to evaluate the applicability of remedial alternatives at the Fisher-Calo site.

Section 3.0 of this report describes the REM II field activities associated with site characterization. Activities included physical and/or chemical monitoring of surface and subsurface soils, surface water, sediments, groundwater, surface features and contaminant transport in various physical media. Technical memoranda documenting field activities were prepared as interim deliverables during the course of the investigation. These are included in Volume III, Appendix A. Section 3.0 also presents the results of the hydrogeologic investigation conducted at and around the site.

Section 4.0 of this report addresses the nature and extent of contamination, based on the results of site characterization work. Media addressed include surface and runoff area soils and the vadose zone, subsurface soils, groundwater, and surface water and sediments.

Section 5.0 of this report discusses contaminant fate and transport, including: potential migration routes; persistence in physical media; and, factors affecting migration in selected media.

Section 6.0 presents a summary of the Remedial Investigation findings discussed in Sections 4.0 through 5.0, presents the conclusions based on these findings, and discusses the need for additional data required in order to develop the Feasibility Study and Public Health Evaluation for the site.

2.0 SITE FEATURES INVESTIGATION

2.1 DEMOGRAPHICS

Based on 1980 U.S. Census data, LaPorte County had a population of 105,000. A three-mile radius from the Fisher-Calo site includes the towns of Kingsford Heights, Kingsbury, Tracy, South Center and Union Center, which have a combined approximate total population of 2,500. The majority of this population is found in Kingsford Heights, which is located to the southwest of the site and has a population of 1,618. LaPorte, the county seat, has a population of approximately 39,000 people, and is located 12 miles north of the Fisher-Calo site.

2.2 CLIMATE

LaPorte County has a generally continental climate, so that it is cold and snowy in winter and warm in summer. Areas nearest to Lake Michigan are markedly cooler in summer than the rest of the county. Precipitation is well distributed throughout the year. From late fall through the winter, snow squalls are frequent and total snowfall is normally heavy. In some years, a single prolonged storm can produce more than 2 feet of snow on the ground, and strong winds create deep drifts.

The average temperature in winter is 27°F and the average daily minimum temperature is 19°F. The lowest temperature on record, which occurred at LaPorte on February 2, 1951, is -23°F. In summer the average temperature is 72°F, and the average daily maximum temperature is 83°F. The highest recorded temperature, which occurred on September 1, 1953, is 104°F.

The average annual precipitation is approximately 36 inches. Of this total amount, 25 inches, or 60 percent, usually falls from April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall from April through September is less than 21

inches. The heaviest 1-day rainfall during the period of record was 5.52 inches at LaPorte on October 10, 1954. Thunderstorms occur on about 45 days each year, with most occurring from late spring through summer.

Average seasonal snowfall is 72 inches. The greatest depth of snow at any one time during the period of record was 38 inches. On the average, 21 days have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 65 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The percentage of possible sunshine is 70% in summer and 35% in winter. The prevailing wind is from the south-southwest. Average wind speed is highest, 12 miles per hour, in March.

2.3 NATURAL RESOURCES/LAND USE

The Fisher-Calo Chemical site is located approximately 12 miles south of LaPorte, in LaPorte County, Indiana. LaPorte County is located in the northwestern section of Indiana. The site location is shown in Figure 2.2-1, Volume II, Appendix A. LaPorte County has a total of 608 square miles, or 389, 120 acres. Approximately 67 percent of the county is actively farmed with corn, soybeans, and wheat as the principal crops. Numerous dairy farms and wooded areas are also found throughout the county, primarily where crop farming is not feasible or where zoning prohibits agricultural use. In addition to the widespread agricultural land use, various small industries, generally located near urban areas, are found throughout the county.

Land use in the vicinity of the Fisher-Calo site reflects countywide use. The Fisher-Calo site is located in the Kingsbury Industrial Park. Other industries within the industrial park include chemical manufacturing plants, a rolled-steel finishing plant, warehousing facilities and various light industries. However, large areas within the industrial park are

utilized for agriculture, with numerous wooded areas, open meadows and grass fields surrounding the various buildings and industrial facilities.

The Kingsbury Fish and Wildlife Area, operated by the Indiana Department of Natural Resources, is located along the eastern, northeastern and southern boundaries of the industrial park. The wildlife area is used for year-round recreational activities including camping, boating, fishing and some limited hunting.

The wildlife area, combined with the large amount of agricultural land, wooded areas, meadows, open fields and wetlands surrounding the Fisher-Calo site, provides a wide variety of habitats suitable for wildlife and vegetation. Major forested areas in the region are a mixture of hardwood deciduous and conifer trees. Trees in the area of the Fisher-Calo site are primarily oak, maple, white pine, red pine and cedar.

The most common wild plants found at the site include species of grasses and legumes. Common plants include grasses, composites, trilliums and asters. Domestic plants such as corn, soybeans and alfalfa are most common agricultural plants grown in the vicinity of the site (IDNR, 1989).

Wildlife in the vicinity of the Fisher-Calo site include deer, raccoon, opossum, weasel, eastern cottontail, red fox, grey and red squirrels, mink and skunks. Common birds found in the area include red-winged blackbirds, warblers, finches, bluebirds, sparrows, towhees and various hawks. The Kankakee River and surrounding wetlands provide habitat for great blue heron, little green heron, Canada geese and a variety of ducks. Endangered species found in the area of the Kingsbury Industrial Park include bald eagles, the upland sandpiper, Franklin's ground squirrels, the Indiana bat and badgers (IDNR, 1989).

The streams, river and wetlands surrounding the site also provide excellent habitat for various fishes, amphibians and reptiles. Common reptiles and amphibians in the site vicinity include corn snakes, king snakes, box and painted turtles, bullfrogs, and toads. Common fish species found in the

Kankakee River and Kingsbury Creek include yellow perch, sunfish, catfish, smallmouth bass, carp, suckers, shiners and darters.

2.4 SURFACE HYDROLOGY

The study area is located 2 to 3 miles from the Kankakee River Valley. From 1909 to 1920, the Kankakee River was dredged in order to facilitate drainage of the swampy flood plain. Also, an intricate network of drainage ditches leading to the Kankakee River were constructed to increase tillable acreage. The outwash plain in central LaPorte County is transected by four streams that flow into the Kankakee Valley. A number of these streams converge with the drainage ditches. One in particular, Kingsbury Creek converges with Travis Ditch approximately 3100 feet southwest of the industrial park One-Line Road facility. These two waterways are the major surface water courses in the vicinity of the study area.

Travis Ditch and Kingsbury Creek flow generally to the south and are located west of the industrial park. The confluence of these two streams is located approximately one-half mile north of Detonator Road. Travis Ditch is located 1100 to 2300 feet west of One-Line Road. It is a man-made ditch, with a generally straight, narrow and deep channel. Travis Ditch is a receiving stream for the effluent from the LaPorte wastewater treatment plant. Kingsbury Creek is a meandering stream that flows from the west to the southeast and is located 2600 to 4500 feet west of the One-Line Road facility.

The stream channel width and depth of both Kingsbury Creek and Travis Ditch varies widely. The average stream width is between 1-15 feet wide, and stream depth varies from approximately 6" to 4' deep. The stream bottom is comprised largely of sandy silty materials with some small stones. Heavy soil erosion and dense vegetation cover in the area surrounding the streams results in thick sedimentary deposits along the stream channels. The combined waterways, known as Travis-Long Ditch, continue to flow to the south and eventually discharge into the Kankakee River.

Surface or overland flow in the study area is virtually nonexistent to minimal due to the relatively flat topography and high permeability of the soils. Surface runoff generally occurs when the infiltration capacity (the limit to which water can be readily absorbed in a soil) of the soil is exceeded, especially during high precipitation events. In these instances, ponding or depression filling may result, followed by slow infiltration into the soil.

Surface runoff that does occur from the One- and Two-Line Road facility areas would tend to follow two drainage patterns (Figure 2.4-1, Vol. II). Runoff east of the Two-Line facility is directed along a drainage ditch that trends parallel to Three-Line Road and flows to the south. This surface runoff flows into a depressed area located along Central Road, at the northwest corner of the intersection of Two-Line Road and Central Road. Surface runoff collects in this low area creating a wetland at the southeast border of the Two-Line Road facility, where the water table is at or just below the surface, and where standing water is present during periods of increased precipitation. This wetland area acts as a natural recharge system, allowing surface runoff to collect and then percolate downward to the aquifer. Surface drainage in the rest of the study area is variable, especially within roadside ditches, but generally trends to the south and west.

Only one perennial pond located at Space Leasing, is present in the study area. This man-made pond was excavated below the water table and appears to have no natural drainage. It is filled by a combination of direct precipitation, surface water runoff and groundwater discharge. The potential for ponding also exists in numerous excavation pits and depression areas located in the study areas. The base of these pits, some containing solid waste, are above the water table and are usually dry. These depressions, however, act as natural recharge systems to the aquifer, allowing stormwater to collect and then percolate downward to the aquifer.

2.5 SOILS

The study area is mantled by four dominant soil types which include the Coupee, Tracy, Elston, and Chelsa soils. These soils are nearly level to gently sloping, well drained, and are situated on outwash plains. Surface runoff on these soils is generally slow as the result of relatively high infiltration rates.

The Coupee (CoA) silty loam is the most dominant soil type in the study area. It has a surface layer consisting of silty loam to a depth of 16 inches. The subsoil ranges in thickness from 26 to 29 inches and consists of clay loam to sandy clay loam. Below these two layers the substratum is composed of sand. The permeability of the surface and subsoil layers range from 4.23×10^{-4} to 1.41×10^{-3} cm/sec. The next largest soil type in the study area is the Tracy (TcA) sandy loam. It is located between One- and Two- Line Roads and extends from Cardinal Chemical to the north of Hupp Road. The surface layer of the Tracy soil is 8 inches thick and consists of sandy loam. The subsoil, 38 to 45 inches thick, contains layers of sandy loam, sandy clay loam, and gravelly clay loam. The subsoil is underlain by a loamy sand to sand substratum to a depth of 60 inches. The permeability of the Tracy soil ranges from 4.23×10^{-4} to 1.41×10^{-3} cm/sec in the surface and subsoil layers. The substratum exhibits a permeability of 1.41×10^{-2} cm/sec. The Tracy soils are noted as having moderate to severe limitations for activities resulting in the generation of an effluent or leachate (Soil Conservation Service).

The Elston (EsA) loam is located south of the Tracy sandy loam and extends 2000 feet south of Central Road. The surface layer is 19 inches thick and is composed of loamy material. The subsoil is generally 29 inches thick and consists of sandy loam, loam, and sandy clay loam. These deposits overlie a sandy substratum. The permeability of the Elston loam ranges from 1.41×10^{-3} to 4.23×10^{-3} cm/sec.

The last major soil type in the study area is the Chelsa (CLB) fine sand. This soil is located in the west-southwest portion of the study area along Travis Ditch. The Chelsa soil consists of fine sand and loamy sand to a depth of 80 inches. The permeability of the soil is relatively high ranging from 4.23×10^{-3} to 1.41×10^{-2} cm/sec.

Localized or minor soil deposits in the study area include the Bourbon sandy loam, Gilford fine sandy loam, and Histosols. These soils are poorly drained and occur in depressional areas scattered throughout the study area. The Histosols, in particular, are associated with the wetland areas and consist of thick deposits of decomposed organic material. A detailed description and locations of the various soil types in LaPorte County can be found in the report of a soil survey conducted by the U.S.D.A. Soil Conservation Service, in cooperation with Purdue University and the IDNR (Furr, 1982).

2.6 GEOLOGIC SETTING

The study area is located along the northeastern flank of the Kankakee Arch where bedrock dips gradually towards the Michigan Basin. The bedrock topography exhibits a relatively gentle undulating surface as illustrated in Figure 2-6.1 (Volume II). It has been dissected by preglacial valleys located along the east border and northwest corner of LaPorte County.

The Ellsworth and Antrim shales, Late Devonian to Mississippian in age, are exposed at the bedrock surface in LaPorte County. The contact between these two shales trending east-west below the study area, poses no significant impact on the conclusions of this investigation. The entire bedrock surface is overlain by a thick sequence of glacial drift deposits. Unconsolidated glacial deposits consisting of sand, silt, and clay are Wisconsonian in age. The glacial deposits range in thickness from 25 to 350 feet thick in the county. Figure 2-6.2 (Volume II) illustrates the generalized stratigraphy in LaPorte County.

LaPorte County is subdivided into three physiographic provinces referred to as the Calument Lacustrine Plain, the Valparaiso Morainal Area, and the Kankakee Outwash and Lacustrine Plain (Figure 2-6.3, Volume II). The province of particular concern to this investigation is the Kankakee Outwash and Lacustrine Plain. It is the largest province, covering approximately two-thirds of the county, and resulted from glacio-fluvial deposition from the retreating Huron-Saginaw glacier (Hill, et al., 1979).

The three physiographic provinces reflect the geologic and hydrogeologic framework in the county. The unconsolidated deposits are subdivided into four hydrologic units consisting of two sand and gravel aquifers and two confining till units (Rosenshein and Humm, 1968). The hydrologic units of primary concern to this investigation consist of a sand and gravel aquifer with isolated thick clays (unit 3) and a hard, clayey silty till unit (unit 4). These two deposits are identified as units 3 and 4, respectively, and are shown in Figure 2-6.4 (Volume II).

The sand and gravel aquifer (unit 3) overlies a hard clayey silty till (unit 4) and ranges in thickness from 0 to 250 feet thick. Unit 3 is exposed at the surface over the entire areal extent of the Kankakee Outwash and Lacustrine Plain. To the south of the Valparaiso Morainal Area, unit 3 is an unconfined aquifer with a relatively shallow water table (0 to 20 feet). It is the principal groundwater resource in LaPorte County.

The hard clayey silt till, (unit 4) underlies unit 3 and mantles the majority of the bedrock surface in the county. It is a low permeability till and contains isolated sand and gravel lenses. These lenses provide only limited amounts of groundwater for potential use (Rosenshein and Humm, 1968).

The relatively thick shales, 25 to 290 feet, in the upper bedrock surface provide a barrier to vertical flow (Hill et al., 1979) to the overlying unconsolidated deposits. Therefore, the hydrogeologic nature of the underlying bedrock sequences does not impact the groundwater flow in the unconsolidated aquifers, and will not be discussed in this report.

3.0 REMEDIAL INVESTIGATION FIELD STUDIES

The scope of work at the Fisher-Calo Chemical site included the preparation of current topographic maps of the site area; performance of a hydrogeologic investigation including monitoring well sampling; production well sampling; surface soil sampling; surface water and sediment sampling; and a contaminant source field screening investigation. These RI field activities were conducted in two phases. The description of each phase is as follows:

Phase I

- Geophysical Survey conducted by U.S. EPA
  March 1987

- Ambient Air Monitoring
  June 3-5, 1987

- Monitoring Well Installation
  July 7, 1987 - September 1, 1987

Phase II

- Geophysical Survey conducted by U.S. EPA
  March 1988

- Monitoring Well Installation
  May 9 - June 29, 1988

- Surface Water/Sediment Sampling
  June 30 - July 6, 1980

- Soil Boring Sampling
  June 14 - 28, 1988

- Surface Soil and Runoff Sampling
  July 11 - August 3, 1988

- Monitoring Well and Production Well Sampling - Round 1
  August 8 - September 20, 1988

- Field Screening Samples - Soil Gas Survey
  September 12 - November 16, 1988

- Monitoring Well and Production Well Sampling - Round 2
  November 7-22, 1988

The type and number of analytical samples from each matrix collected during each phase are presented in Table 3-1. All sampling during the Phase I activities was performed by a field team consisting of REM II contractor personnel. During Phase II, sample collection was done by a REM II subcontractor, with contractor personnel responsible for sample handling and paper work. The methodologies utilized to implement the above tasks are summarized in the following sections and detailed in the Technical Memoranda in Volume III, Appendix A.

3.1 SITE SURVEYING AND TOPOGRAPHIC MAPPING

Separate topographic base maps of the Fisher-Calo Chemical site and the surrounding area were prepared from aerial photography and ground control surveying conducted in March and April, 1987. These maps, (contained in Volume II, Appendix A) present site topography in sufficient detail to accurately locate all points pertinent to this investigation and any future work to be performed at the site.

TABLE 3-1

SUMMARY OF ANALYTICAL SAMPLES COLLECTED DURING THE RI

Sample Matrix	Total Number of Samples	
	Phase I	Phase II
Surface Water	-	10
Sediments	-	22
Deep Monitoring Well Soil Boring	77	143
Shallow Soil Boring	-	238
Surface Soil	-	192
Runoff (Soil)	-	54
Drill Water	-	18
Groundwater[1]	-	79
Production Well[2]	-	3

[1] 79 samples were collected twice, in two Rounds of sampling - in August and in November 1988.

[2] Only 2 production wells were sampled in Round 1 (8/88); 3 production wells were sampled in Round 2 (11/88).

All elevations were determined from a permanent benchmark, located onsite, and additional temporary benchmarks established over the survey area. Specific points were located by means of a horizontal coordinate system referenced to a local recoverable baseline at the site. The permanent benchmark was installed during Phase II activities as a control point for wellhead elevation surveying and for any future activities at the site.

3.2 AMBIENT AIR MONITORING

Preliminary ambient air monitoring was conducted from June 3-5, 1987, in order to establish adequate levels of personnel protection required for site work. A combination of direct reading instruments (Hnu and Foxboro MIRAN 1B Air Analyzer) and colorimetric detector tubes were used to conduct a survey of the site work areas. The air monitoring survey areas were selected on the basis of the expected occurance of field investigation activities within these site work areas.

Air monitoring surveys were conducted in work areas which were located downwind from suspected contamination source areas, and downwind from operating facilities that were suspected sources of air emissions. Five onsite work areas and one offsite (background) location were surveyed during the air monitoring activities. Locations of the air monitoring survey areas are shown in Figure 3.2-1, Vol. II. Surveys were conducted in the following manner:

- Each work area was scanned using an HNu.

- Both hand-pump and long duration colorimetric detector tubes were used to check for the presence of the following compounds:

Hand Pump	Long Duration	
Methylene Chloride	10 minutes:	Nickel
Methyl Chloride		Arsenic
Ammonia	1-4 hours:	Ammonia
Chlorine		Chlorine
TCE		Hydrogen Cyanide
PCE		
VCL		
NOX		

- Each work area was scanned using the Foxboro MIRAN 1B air analyzer. The MIRAN provided a direct-reading of concentration levels detected over a 2-minute sample interval. Concentration levels for selected compounds were detected, based on a comparison of compound standards stored in the computer memory of the MIRAN air analyzer. Sample scans were conducted for ammonia, methylene chloride, vinyl chloride, TCE and HCN.

Results of the air monitoring surveys are shown in Appendix B-1, Vol. II. The air monitoring results were used to establish the minimum personnel protection required for site work in the areas surveyed.

These results were not included in the assessment of analytical data used to characterize the nature and extent of contamination found at the FCC site.

3.3 SOIL INVESTIGATION

INTRODUCTION

The soil investigation phase of the RI involved the collection and analysis of surface and subsurface samples. In addition, a soil gas survey was conducted for field screening purposes. The primary objective of this

investigation was to determine the horizontal and vertical extent of soil contamination at the site. Sample locations and intervals were selected on the basis of known or suspected areas of contamination, areas downgradient from point-source contamination, and surface runoff paths. Detailed descriptions of the sampling and screening activities are presented in Volume III - Appendix A.3, A.4 and A.5 Technical Memorandum.

3.3.1 SURFACE SOIL SAMPLING

Surface soil and runoff sample locations were selected from five study areas within the FCC site and from an offsite (background) area. The study areas were identified as being suspected past disposal areas and areas where waste drums and tanks were stored during the RI field activities which occurred in 1988. Samples were collected from 191 locations within the five on-site study areas and the offsite area, as shown in Volume II - Appendix A, Figures 3.3-1 through 3.3-6.

On-site soil sample locations were selected in areas where past waste disposal or spills had occurred, in areas that were adjacent to currently operating facilities and areas where drummed waste materials were located. Surface soil samples (SS) were collected from excavated soil piles; areas where stressed vegetation was noted; from surface areas that showed obvious waste stains or spills; and from locations along established grid lines in order to define the extent of contamination present. Samples were also collected from low spots, ditches and drain pipe openings, and from depression areas where surface water runoff would collect. Soil samples taken at these locations were identified as run-off (RO) samples, even though no standing water was present at the time of sample collection.

Background surface and runoff soil samples were collected from offsite locations and from locations selected outside the points of suspected disposal within a study area. The background sample locations are indicated on the study area maps shown in Volume II, Figures 3.3-1. through 3.3-6.

Surface and runoff soil samples (SS and RO) were collected at depth intervals from the ground surface down to 12 inches in undisturbed soils, and down to 24 inches at locations where the soils had been disturbed (plowed or excavated). At locations where concentrations of organic vapors in the soils were detected (using an HNu or OVA) at levels above 5 ppm, discreet samples were obtained at intervals of 0-6" and 6-12" (or 0-12" and 12-24" in areas of disturbed soils). These samples were identified using "A" and "B" depth for interval designations (i.e., SS-12A and SS-12B). The sample depth intervals and soil vapor monitoring results are shown in Vol. II, Appendix B-2.

Surface and runoff soil samples were collected using a stainless steel scoop, spoon or hand auger. The samples were placed on a clean stainless steel tray, screened for organic vapors, and then placed into the appropriate sample containers.

3.3.2 SUBSURFACE BORINGS

Subsurface soil samples were collected from 35 soil boring locations from June 14 through June 28, 1988. The locations are shown in Figures 3.3-7 to 3.3-13. A total of 168 samples were collected from 18 deep borings to a depth of 20 feet. A total of 45 samples were collected from 15 shallow borings to a depth of 4.5 feet. Samples from one deep boring, SB01, were collected to obtain data on background conditions.

All samples were collected using a 3 inch split-spoon sampler. Sample depth intervals at each soil boring location are presented in Volume II - Appendix B-3.

3.3.3 SOIL GAS SURVEY

A soil gas survey was conducted from September 12 through November 16, 1988. Data from the soil gas survey was collected in support of field

screening activities to identify and characterize the extent of contamination in suspected areas of waste disposal and buried tanks or drums.

Soil gas samples were collected from a total of 30 locations. These locations are shown in Volume II, Appendix A, Figures 3.3-14 to 3.3-18. The survey was conducted in support of the soil sampling program as a field screening process to identify potential or known point-source areas of contamination. Samples were collected using galvanized steel probes at depths ranging from 1 to 10 feet. Soil gas samples were analyzed for TCE and Toluene using a Photovac 10S50 portable gas chromatograph. Samples were collected at Space Leasing (SG01) and White Oak Park (SG-04) in order to monitor background conditions in the study area. Details concerning gas calibration, sampling procedures, and sample intervals are presented in Volume III, Appendix A.3.

3.4 SURFACE WATER/SEDIMENT INVESTIGATION

Surface water and sediment samples were collected from June 30 to July 11, 1988 in order to identify areas of potential contaminant entry into streams and standing bodies of water. A total of 10 surface water and 22 sediment samples were collected. Sample locations are shown in Volume II, Appendix A, Figure 3.4-1. Upstream surface water and sediment samples (SW-01, SD-01, SW-02, SD-02, SW-03, SD-03, SW-11, and SD-11) were collected from Travis Ditch, Kingsbury Creek, and the Kankakee River to obtain background data from these waterways. Three downstream surface water and six sediment samples (SW-04 to SW-06 and SD-04 to SD-06) were collected in the vicinity of the confluence between Kingsbury Creek and Travis Ditch. One surface water sample (SW-07) was collected from a discharge pipe used for pre-treated wastewater effluent from the Roll Coater facility. This wastewater effluent is discharged into Travis Ditch. Two surface water and four sediment samples (SW-10, SD-10, SW-12, and SD-12) were collected from a pond and an effluent discharge lagoon at Space Leasing and Cardinal Chemical, respectively. Two sediment samples (SD-08 and SD-09) were collected from a wetland area located southeast of the Two-line facility.

Surface water samples were collected directly from the center of the stream and along the edge of the ponds at each location. Surface water sample SW-07, however, was collected by lowering a stainless steel bucket down a vertical port into the sewer pipe to obtain the sample. Sediment samples were collected using a stainless steel scoop and a split-spoon sampler. One sediment sample was collected along the bank of a stream and another was collected at the center of the stream. Samples were collected from the top 6 inches of material.

The pH, temperature, and specific conductivity of the stream water was measured at each sample location. Details of the sampling procedures are presented in Volume III, Appendix A.2.

3.5 HYDROGEOLOGIC INVESTIGATION

A hydrogeologic investigation of the Fisher-Calo Chemical site was implemented in two phases: Phase I activities occurred from July 1987 through September 1987; and Phase II activities occurred from May through November 1988. Monitoring wells were sampled on two occasions - August and November 1988.

The objectives of the hydrogeological investigation were as follows:

- To determine the levels of contamination in groundwater from wells located onsite and adjacent to (both up and downgradient) the Fisher-Calo site.

- To verify the configuration of the water table in the area of the site and in offsite downgradient areas.

- To determine potentiometric heads, groundwater flow directions and contaminant conditions throughout the aquifer underlying the site.

- To determine the presence, character and extent of groundwater contamination within the Fisher-Calo site area, and the potential for contamination migration offsite.

A variety of investigative techniques were used to achieve these objectives, including monitoring well installation and groundwater sampling, subsurface soil sampling, downhole geophysical logging, water level measurements, and hydraulic conductivity testing of local aquifers.

Results of Phase I and II hydrogeologic activities conducted at the Fisher-Calo site are presented in the following sections. Physical data obtained from these activities includes soil boring logs, water level measurements, and hydraulic conductivity measurements. The information collected in this investigation provides data needed to characterize the geologic and hydrogeologic conditions at the site. This data includes: the spatial and temporal distribution of the sedimentary deposits; the configuration of the water table; the rate and direction of groundwater flow; the spatial variations in hydraulic conductivities of the aquifer; and the interaction between groundwater and surface water. The locations of Phase I and II monitoring wells and existing production wells are shown in Volume II, Appendix A, Figure 3.5-1.

3.5.1 SITE STRATIGRAPHY

Correlation and analysis of Phase I and II boring logs (contained in Volume III, Appendix A.1-Attachment B) reveal a thick and extensive sand and gravel deposit of varying thicknesses. The sand and gravel deposit is at least 44 to 97 feet thick at monitoring well locations MW-13 and MW-07, respectively, and is underlain by a relatively thin silty clay. This silty clay layer is at least 9 to 17 feet thick and is encountered throughout much of the study area. However, the exact thickness and lateral extent of this layer is presently unknown. The silty clay layer also exhibits an uneven or erosional surface which is illustrated in Figure 3.5-2 (Vol. II). The silty clay layer is underlain by another sand and gravel deposit

(MW-01, 13, 15, 18, 21, 29, and 30) which separates the sand and gravel deposit into an upper and lower sequence. Isolated thin lenses of silt, silty clay, sandy silt, and gravel are also common. Interbedded and alternating thin beds of sand, silt, and silty clay are less common and occur sporadically above and below the fine-grained layer. The units described above are analogous to unit 3 as described by Rosenshein and Hubb (1968), and shown in Figure 3.5-3, Volume II.

A hard to dense clayey silt deposit was encountered at a depth of 150 feet at MW-21. This deposit is believed to be the basal till deposit (unit 4, Figure 3.5-3) described by Rosenshein and Hubb (1968). Therefore, the combined thickness of the upper and lower sand and gravel and silty clay deposits (Unit 3) is at least 150 feet thick. The thickness of the basal clayey silt unit is presently unknown. The depth to bedrock in the area is estimated to be 180 to 225 feet deep, based on ground elevations at monitoring well locations and elevation of the bedrock surface in the study area (Figure 3.5-4, Volume. II). Geologic cross-sections A to A', B to B', and C to C' define the site stratigraphy as illustrated in Figures 3.5-5 through 3.5-7, Volume II.

3.5.2 LITHOFACIES

A description of the various lithofacies present at the site are discussed in this section. A lithofacies is defined as a sedimentary deposit that can be distinguished from other deposits on the basis of its physical and mineralogic characteristics.

Three major and four minor sedimentary lithofacies were identified within the study area. All but one of the lithofacies identified are present within unit 3 (Rosenshein and Hubb, 1968), the exception being the clayey silt till (unit 4, shown in Figure 3.5-3). Identification and classification of lithofacie types was performed based on the standard *Unified Soil* Classification System.

3.5.2.1 Top Soil

Top soil within the study area consists of deposits of silty sand to sandy loam (Section 2.5). The deposits are fine to medium grained and contain varying abundances of silt and clay. Fine to coarse pebbles are less common to rare. The top soil layers also contain rootlet zones and oxidation stringers. Bedding in the top soil deposits is rare to absent.

3.5.2.2 Sand and Gravel

The sand and gravel lithofacies consist of thin to massive beds of fine to coarse grained sands with varying abundances (1 to 30%) of fine to coarse pebbles. The sand deposits are generally medium grained and exhibit moderate to good distribution in the grain sizes. Sand grains are generally subangular to subrounded. Varying traces of silt and clay are also common. The gravel fraction consists primarily of fine pebbles and granules. The gravel clasts are subangular to subrounded and consist primarily of sedimentary rock fragments. Gravel clasts composed of igneous or metamorphic rock fragments are rare.

The sand and gravel deposits exhibit weak laminations to distinct thin beds (.3cm to 10cm thick) and horizontal to low-angle cross-laminations are also common. The sand deposits are composed primarily of quartz (85-95%) with minor abundances of feldspar and lithic rock fragments, typically sedimentary rock fragments. The character or appearance of this unit indicates a glacio-fluvial environment of deposition.

3.5.2.3 Silty Clay/Clayey Silt

The silty clay/clayey silt lithofacies consist of thin to massive beds of olive gray to moderate gray deposits of silty clay to clayey silt. The deposits contain traces of angular to subangular clasts ranging in size from fine to coarse pebbles. Some deposits exhibit weak to distinct laminations (MW-07,21,30,37, and 48). Very thin sand or silt seams and

lenses are common. The character of this lithofacies suggests either a lacustrine or ablation (melt-out) till deposit.

3.5.2.4 Basal Clayey Silt

The basal clayey silt lithofacies consists of a dense, greenish gray, clayey silt till. It is composed of 65% silt, 15% clay, 10% sand, and 10% gravel. Gravel clasts, up to 2cm, are angular to subangular and consist of shale and limestone fragments. Thin sand lenses are common. This deposit was only observed in the deepest boring drilled at MW-21. The character and disposition of this lithofacies suggests a lodgement till deposit.

3.5.2.5 Miscellaneous Lithofacies

The minor lithofacies identified in the study area include isolated deposits of silt, silty sand, gravel, and interbedded combinations of silt, sand, and clay. These deposits typically occur as isolated lenses with thin to medium beds of unknown extent. A detailed description of these deposits is found in the drilling logs (Volume III, Appendix A.1-Attachment A).

3.5.3 HYDROGEOLOGY-RESULTS

The hydraulic parameters used to evaluate the aquifer system were derived from the collection and analysis of soil boring samples, water level measurements, and hydraulic conductivity tests. The results of these field activities are presented in the following sections. Details of the hydrogeologic field activities are presented in Volume III, Appendix A.1.

3.5.3.1 Hydraulic Conductivity

Physical data for determining the hydraulic conductivity values of the aquifer materials was obtained from performing falling and rising head slug tests at each monitoring well location. Hydraulic conductivity values were

calculated based upon the change in water levels with time. These values are representative of the hydraulic properties in the vicinity of the screened interval of each well. Other hydraulic properties of the aquifer also can be inferred from the slug test data. Time draw-down and recovery graphs were produced for both falling and rising head tests at each well location. The values of hydraulic conductivity were then computed using the method of Horslev as described by Freeze and Cherry (1979). Hydraulic conductivities calculated from slug test data and by the Horslev method represent values in the horizontal direction only. The hydraulic conductivity values are presented in Appendix B-4, Volume II.

3.5.3.2 Water Table Configuration

During the Phase II investigation, four sets of groundwater static water elevations were measured at the 68 RI wells. The static water elevations for August 8 through August 24, October 7, November 3, and November 15, 1988 are shown in Table 3-2. The water table configuration of three recording periods in August, October, and November 1988 are illustrated in Figures 3.5-9 through 3.5-10 (Volume II).

3.5.4 HYDROGEOLOGY-DISCUSSION

3.5.4.1 Aquifer Occurrence

Aquifer Boundaries - Two aquifers have been identified at the Fisher-Calo site. These aquifers are composed primarily of medium-grained sand and are separated by a semi-confining layer of unknown extent. The upper aquifer is unconfined and extends from the top of the water table (3 to 20 feet below the ground surface) to the top of a glacial till. The saturated thickness of the upper aquifer ranges approximately from 40 to 75 feet thick.

The glacial till consisting of silt to silty clay and isolated silty sand (MW-21) acts as an aquitard or semi-confining layer that separates the

TABLE 3-2

GROUNDWATER ELEVATIONS (FEET ABOVE MSL)

WELL	ELEVATION TOP OF CASING	STATIC WATER LEVEL AUG. 1988(1)	10/07/88	11/03/88	11/15/88
MW 1	736.25	717.07	717.00	716.95	716.86
MW 2	737.19	717.47	716.98	717.37	716.84
MW 3	737.56	-	716.87	718.18	716.67
MW 4	736.62	714.62	714.59	714.49	714.43
MW 5	737.48	714.92	714.61	715.35	714.44
MW 6	737.28	714.86	714.59	715.20	714.43
MW 7	727.47	712.15	711.33	711.33	711.20
MW 8	728.26	711.62	711.31	711.25	711.42
MW 9	727.21	711.76	711.29	711.21	711.19
MW 10	732.35	707.15	706.95	707.77	706.89
MW 11	732.37	707.31	706.92	707.24	706.82
MW 12	731.72	708.83	706.79	-	706.68
MW 13	709.18	703.50	703.35	-	703.62
MW 14	709.26	701.36	700.99	-	700.98
MW 15	732.36	710.72	710.40	710.43	710.28
MW 16	732.26	710.72	710.36	710.35	710.26
MW 17	732.48	710.73	710.36	710.61	710.27
MW 18	726.34	709.21	709.07	708.96	709.05
MW 19	727.20	709.18	708.84	708.79	708.82
MW 20	726.24	708.43	708.87	708.82	708.85

TABLE 3-2 (Continued)

GROUNDWATER ELEVATIONS (FEET ABOVE MSL)

WEL	ELEVATION TOP OF CASING	STATIC WATER LEVEL AUG. 1988(1)	10/07/88	11/03/88	11/15/88
MW 21	731.34	706.40	706.01	705.96	706.03
MW 22	730.34	706.18	705.92	705.62	705.88
MW 23	730.63	706.37	705.97	705.82	705.94
MW 24	733.20	-	711.57	-	711.44
MW 25	730.86	711.36	711.17	-	711.10
MW 26	733.26	-	707.24	706.86	707.13
MW 27	731.56	706.88	706.49	706.40	706.41
MW 28	727.19	704.19	704.91	705.80	705.05
MW 29	727.08	706.40	706.06	605.96	706.03
MW 30	724.73	709.35	709.27	713.85	709.70
MW 31	725.02	714.31	714.25	714.30	714.68
MW 32	725.72	714.19	714.20	714.38	714.66
MW 33	731.40	713.40	712.44	712.87	712.60
MW 34	725.80	710.43	710.33	709.91	710.20
MW 35	725.68	710.40	710.09	710.15	710.16
MW 36	725.56	710.40	710.09	-	710.16
MW 37	730.59	708.65	708.27	708.46	708.15
MW 38	730.71	708.70	708.28	708.14	708.17
MW 39	730.52	708.66	708.27	708.09	708.17
MW 42	735.88	713.59	713.46	714.88	713.49

TABLE 3-2 (Continued)

GROUNDWATER ELEVATIONS (FEET ABOVE MSL)

WELL	ELEVATION TOP OF CASING	STATIC WATER LEVEL AUG. 1988(1)	10/07/88	11/03/88	11/15/88
MW 43	735.80	713.64	713.46	713.65	713.48
MW 44	735.80	713.63	713.49	713.70	713.51
MW 45	735.30	712.92	712.60	713.48	712.50
MW 46	734.64	712.88	712.59	712.45	712.51
MW 47	734.48	712.80	712.59	712.96	712.52
MW 48	728.38	712.75	712.61	712.48	712.53
MW 49	727.94	712.75	712.48	712.32	712.40
MW 50	728.00	712.74	712.47	712.30	712.39
MW 51	730.46	710.14	709.83	709.76	709.78
MW 53	727.11	706.46	706.04	706.03	706.02
MW 54	727.33	706.44	706.05	705.91	706.04
MW 55	727.78	707.59	706.97	706.89	707.01
MW 56	732.12	711.64	710.54	710.25	710.48
MW 57	731.34	710.97	710.52	710.34	710.46
MW 58	731.48	711.03	710.52	710.58	710.46
MW 59	730.98	711.23	710.82	710.77	710.74
MW 60	730.67	711.32	710.81	711.22	710.73
MW 61	730.59	711.26	710.76	710.76	710.76
MW 62	734.66	714.08	712.90	711.68	712.81
MW 63	733.90	713.07	712.85	712.98	712.76

TABLE 3-2 (Continued)

GROUNDWATER ELEVATIONS (FEET ABOVE MSL)

WELL	ELEVATION TOP OF CASING	STATIC WATER LEVEL AUG. 1988(1)	10/07/88	11/03/88	11/15/88
MW 64	733.85	712.94	712.86	712.13	712.78
MW 65	738.64	720.14	719.60	719.74	719.88
MW 66	739.08	719.96	719.58	720.18	719.85
MW 67	738.80	719.86	719.60	720.88	719.88
MW 68	730.31	719.74	719.37	719.59	719.80
MW 69	730.14	719.68	719.34	719.68	719.77
MW 70	734.78	719.38	718.79	719.26	719.32
MW 71	737.18	716.69	716.22	715.28	716.16

- No water level measurement taken.

(1) Water level measurements collected by ATEC and Associates, Inc. during Round 1 groundwater sampling

upper and lower aquifers. The semi-confining layer is at least 9 to 17 feet thick. The upper and lower aquifers are locally interconnected through a silty sand deposit that grades laterally with the till layer. The overall continuity of the till layer is presently unknown.

The lower aquifer is predominantly confined throughout the study area and its thickness is uncertain, however, it is at least 15 feet thick at MW-21. The lower aquifer is underlain by a laterally continuous and dense glacial till composed of clayey silt. In addition, this till layer is underlain by bedrock consisting of thick shales. Both the till and shale provide a hydraulic boundary to the overlying aquifers. Figures 3.5-5 through 3.5-8 (contained in Volume II) illustrate the aquifers and till layers present at the site.

Aquifer Properties - The aquifer hydraulic conductivity results are presented in Appendix B-4, Volume II. The average hydraulic conductivity of the upper aquifer is 2.23×10^{-2} cm/sec (63.29 ft/day). In general, hydraulic conductivity decreases by two orders of magnitude from the top to the base of the upper aquifer. This decrease suggests a textural change in the aquifer materials where the deposits become finer with depth. Lateral changes in hydraulic conductivity also occur and are attributed to textural variations associated with changes within the environment of deposition. The hydraulic conductivity of the lower aquifer, measured at MW-21 and MW-13, ranges from 4.19×10^{-3} to 4.62×10^{-3} cm/sec (11.87 to 13.10 ft./day), respectively. These values are consistent with the values derived from the base of the upper aquifer. The vertical hydraulic conductivities of the upper and lower aquifers are presently unknown.

The hydraulic conductivity values of the upper and lower aquifers are typical of sand and silty sand deposits (Freeze and Cherry, 1979). The average hydraulic conductivity value of the upper aquifer is consistent with the average estimated value of 2.8×10^{-2} cm/sec presented by the Indiana State Board of Health (ISBH) in its December 18, 1989 assessment of groundwater conditions at the Fisher-Calo site.

Hydraulic conductivity of the semi-confining layer and basal till boundary was not measured during the Phase I and Phase II investigations. However, the vertical hydraulic conductivity of the semi-confining layer was estimated to be 1.4×10^{-7} cm/sec in the ISBH memo mentioned above. The hydraulic conductivity of the basal till boundary is presently unknown. Typical hydraulic conductivity values for glacial till deposits, excluding silty sand, range from 10^{-10} to 10^{-6} cm/sec (Freeze and Cherry, 1979).

Average transmissivity values of the unconfined aquifer ranged from 2,500 to 4,700 ft^2/day. These values were based on an average hydraulic conductivity of 63.29 ft/day and a range of 40 to 75 feet in the saturated thickness of the unconfined aquifer. The transmissivity of an unconfined aquifer is defined as the quantity of water that is horizontally transmitted by the full saturated thickness of the aquifer (Fetter, 1988). In addition, it is the product of the hydraulic conductivity and the saturated thickness of the aquifer. The transmissivity of the lower aquifer, assuming an hydraulic conductivity of 11.87 ft/day and a saturated thickness of 15 ft at MW-21, is 178 ft^2/day. The transmissivity of the upper aquifer is one order of magnitude greater than the lower aquifer.

The porosity of the aquifer materials was not measured by quantitative methods during this investigation. However, an effective porosity of 0.30 (no units) (Freeze and Cherry, 1979) is estimated for the sand and gravel deposits.

3.5.4.2 Groundwater Movement

Groundwater Direction - Based upon the groundwater level measurements (Table 3-3) and water table maps (Figures 3.5-8, 3.5-9, and 3.5-10, Volume II), the groundwater flow direction in the unconfined upper aquifer is south to southwest across the Fisher-Calo site towards Travis Ditch. The direction of groundwater flow in the upper aquifer remained relatively consistent from August through November, 1988. Groundwater flow in the lower aquifer was not determined but is assumed to follow regional flow south towards the Kankakee River, located 5 to 6 miles from the site.

Horizontal gradients across the Fisher-Calo site, measured in the direction of groundwater flow, have been calculated and are presented in Table 3-3. Horizontal gradients, for the shallow wells (see Table 3-3), ranged from 0.0011 ft/ft at the northeast corner of the site to 0.0027 ft/ft at the southwest corner of the study area. The horizontal gradients remained relatively unchanged during the three recording periods. The average horizontal gradient for the shallow wells during the Phase II RI was 0.0019 ft/ft.

Vertical hydraulic gradients between shallow and deep wells have been calculated and are presented in Table 3-4. Vertical hydraulic gradients in the study area exhibit a slight to negligible upward component ranging from 0.0001 to 0.007 ft/ft. In general, fluctuations in vertical gradients were minor during the recording periods. In some instances, however, upward gradients changed to downward gradients, and vice versa, at a number of well locations. Locations exhibiting zero gradients indicate horizontal flow.

A relatively strong upward gradient of 0.045 to 0.065 ft/ft was observed at MW-13/MW-14 during the three recording periods. These values could reflect confining pressures of the lower aquifer at MW-13 and/or upward flow gradients attributed to discharge in the area of Kingsbury Creek/Travis Ditch. Conversely, relatively low upward gradients, 0.0003 to 0.001 ft/feet, at MW-21/MW-23 suggest either very low confining pressures or the absence of an effective confining layer between the upper and lower aquifer.

Groundwater Velocity - For all 65 wells screened in the upper aquifer, using an average hydraulic conductivity of 63.29 ft/day, an average effective porosity of 0.30, and an average hydraulic gradient of 0.0019, the average linear groundwater velocity in the upper aquifer was 146 ft/yr. For wells screened in the shallow, intermediate, and deep portions of the upper aquifer, the average linear groundwater flow velocities were 211, 131, and 41 ft/yr (Table 3-5); respectively. Groundwater flow travels 2 to

TABLE 3-3

HORIZONTAL HYDRAULIC GRADIENTS

	AUGUST 1988		OCTOBER 7, 1988		NOVEMBER 15, 1988	
WELL SET	DIRECTION OF FLOW	GRADIENT (FT/FT)	DIRECTION OF FLOW	GRADIENT (FT/FT)	DIRECTION OF FLOW	GRADIENT (FT/FT)
MW-03 MW-27 MW-55	- (1)	-	SW	.0020	SW	.0019
MW-04 MW-67 MW-71	S	.0012	S	.0011	S	.0012
MW-28 MW-36 MW-55	SW	.0027	SW	.0026	SW	.0026
	Average = .0019		Average = .0019		Average = .0019	

(1) No water-level measurement was recorded.

TABLE 3-4

VERTICAL HYDRAULIC GRADIENTS

WELL PAIR	VERTICAL GRADIENT (FT/FT)		
	AUGUST 1988	OCTOBER 7, 1988	NOVEMBER 15, 1988
MW-01/MW-03	-	-.004	-.006
MW-04/MW-06	+.006	0	0
MW-07/MW-09	-.006	-.0006	-.0001
MW-10/MW-12	+.050*	-.005	-.007
MW-13/MW-14	-.045	-.050	-.060
MW-15/MW-17	+.0002	-.0008	-.0002
MW-18/MW-20	-.015*	-.004	-.004
MW-21/MW-23	-.0003	-.0005	-.001
MW-29/MW-54	+.0007	-.0002	+.0002
MW-31/MW-32	-.002	-.001	-.0004
MW-34/MW-36	-.0007	-.005	-.0009
MW-37/MW-39	+.0002	0	+.0005
MW-42/MW-44	+.0009	+.0007	+.0004
MW-45/MW-47	-.003	-.0002	+.0005
MW-48/MW-50	-.0002	-.002	-.002
MW-56/MW-58	-.016*	-.0005	-.0005
MW-59/MW-61	+.0006	-.001	+.0004
MW-62/MW-64	-.003	-.001	-.0007
MW-65/MW-67	-.007	0	0

NOTE: + = Downward gradient

- = Upward gradient

* Possible measurement error

- No water level measurement taken

TABLE 3-5

HORIZONTAL GROUNDWATER VELOCITIES

OF THE UNCONFINED AQUIFER

SCREEN PLACEMENT	AVERAGE HYDRAULIC CONDUCTIVITY (FT/DAY)	AVERAGE HYDRAULIC GRADIENT(1) (FT/FT)	AVERAGE POROSITY*	VELOCITY (FT/YR)
Shallow	91.58	.0019	0.30	211
Intermediate	56.69	.0019	0.30	131
Deep	17.71	.0019	0.30	41
			Average =	146

* Estimated average porosity (Freeze and Cherry, 1979)

(1) Values calculated from water elevations at MW-03, MW-27, and MW-55; MW-02, MW-11, and MW-53; and MW-03, MW-27, and MW-5

5 times faster in the upper 30 feet of the aquifer than in the middle and deep parts of the upper aquifer. Groundwater flow velocity in the lower aquifer, assuming an average hydraulic conductivity of 12.48 ft/day, an average hydraulic gradient of .0019, and an average effective porosity of 0.30, is 29 ft/yr.

3.5.4.3 Groundwater Recharge/Discharge

Given the large areal extent and high hydraulic conductivities of the unconfined (upper) aquifer the majority of groundwater recharge is by direct infiltration from precipitation. The location of a recharge mound or divide was not observed in the study area. Wetland areas located southeast of the Two-Line Facility and northwest of Space Leasing may act as potential recharge areas for the upper aquifer. These areas occur in depressional areas and contain organic matter and fine sandy to clayey loam deposits of moderately slow permeability (Furr, 1982). Any standing water not lost due to evapotranspiration would slowly infiltrate into the upper aquifer over a long period of time.

Discharge zones in the study area are located along Kingsbury Creek and Travis Ditch. Based on a comparison of topographic data and groundwater level measurements, it appears that a hydraulic connection exists between the unconfined aquifer and these surface water bodies in areas where the water table intersects topographically low areas. Shallow groundwater flow discharges into Travis Ditch and Kingsbury Creek since the depth of these streams only intersects the upper portion of the aquifer (depth to the water table is between 3 to 20 feet below land surface). Travis Ditch is a relatively shallow manmade waterway, that was 4 to 6 feet deep during Phase II RI field investigation activities. Kingsbury Creek did not exceed 3 feet in depth during this time. The actual depth of groundwater capture flow in these streams is presently unknown but is considered to be very shallow. Thus, deeper groundwater flow will most likely continue towards the Kankakee River. Discharge and recharge zones for the lower aquifer are also presently unknown.

3.6 GROUNDWATER SAMPLING

Samples were collected from monitoring wells and water supply (production) wells located on- and off-site. These wells provide samples from on-site locations, as well as locations up-gradient and down-gradient from the site. The locations of the wells sampled are shown in Figure 3.5-1 (Volume II). These groundwater monitoring locations were chosen to provide monitoring data within the expected plume area and to help define the boundaries of the plume in the shallow aquifer. The deep aquifer was also monitored to determine if contamination was present.

Groundwater sampling was conducted in two rounds during 1988 - in August and in November. Details of the sampling locations and procedures are described in the Technical Memorandum, Volume III, Appendix A.6.

4.0 EXTENT OF CONTAMINATION

4.1 INTRODUCTION

Fisher-Calo Chemical Corporation was primarily engaged in the reclamation of spent solvents. Therefore, the bulk of hazardous wastes received at their facility consisted of various spent liquid solvents. From transporter records, paint solvents made up the majority of these wastes.

Constituents of these paint solvents were toluene, xylene, and benzene as well as other organic compounds. Based on the transporter records, other solvents received at Fisher-Calo Chemical include:

- 1,1,1-Trichloroethane
- Acetone
- Methylene Chloride
- Trichloroethylene
- Other Waste Solvents

Additionally, acidic and caustic metal finishing wastes, containing cyanide and metals, were received at the Fisher-Calo facility. Caustic and acidic wastes were initially dumped on the ground; later disposal methods included neutralizing these wastes and then discharging them into the industrial park sewers. Primary constituents of the metal treating wastes included heavy metals such as chromium, nickel, lead, copper, zinc, and cadmium and also included arsenic and cyanide. Organic constituents of these wastes included toluene, 2-butanone, phenolics, tetrachloroethylene, 1,1-dichloroethane, dichloroethylene, benzene, 1,1,1-trichloroethane, as well as other organics commonly found in paint wastes and organic solvents used by industry. Many of the solvent wastes were reclaimed by use of a thin film evaporator while others were stored at the site. As part of their reclaimation operations, Fisher-Calo produced a still bottom waste which was accumulated in 55-gallon drums until the March 1978 fire which

destroyed the majority of these containers. Cyanide wastes were stored at the site until final disposal at other facilities in the early 1980's.

From previous investigations conducted at the Fisher-Calo facility, it was determined that these wastes were stored, buried, dumped or spilled at various locations at both the One-Line and Two-Line facilities. In the course of its operations, approximately 700 to 1,000 drums were received per month at these facilities, however, an exact number and quantity of wastes as delivered, processed and/or disposed of at the facility is unavailable.

During the remedial investigation, sample analysis were performed by the U.S. EPA Contract Laboratory Program (CLP). Appendix B in Volume III presents the analytical data for those compounds detected in samples collected during the RI. This data has been used to prepare the following subsections, and Sections 5.0 and 6.0 of this report. All qualifiers assigned to data values have been considered in the following discussions. Within the data base used to assess the nature and extent of contamination are analytical results that are estimated values (J); results that have spike recoveries out of control limits (J or N); have associated laboratory blanks contaminated with compounds of interest (B or UJ) or were affected by interferences that raised detection limits. Additional quality control information that has been used to assess the data are the agreement of field duplicate results and the presence of contaminants in field blank samples.

An important consideration in the data assessment process was the detection of common laboratory contaminants in the sample results, that are also contaminants of concern at the site. Included in this list are acetone, toluene, 2-butanone and methylene chloride, because it is suspected that these compounds were disposed of at the site in the past, and they are being used or produced by currently operating facilities at the site. Compounds in the phthalate category, most commonly, bis(2-ethylhexyl)-phthalate and di-n-butylphthalate, because they also are likely to be

present at the site as a component of plastic materials and containers used for acid storage. Sample results for these compounds and any other compounds found in the laboratory blanks were generally considered valid if they were present at greater than five times the blank concentration for the compound. If the compound was also detected in the field blank, five times that concentration (if greater than the lab blank concentration) was used to determine if the value was valid. This conservative approach is warranted, based on the past data and the disposal information available for the site.

A variety of contaminants have been identified at the site. These contaminants are presented in Volume II, Appendix B-5 and are listed according to the matrix in which they were detected. From this list of contaminants, compounds of potential concern (target compounds) were identified for each matrix sampled. The following factors were considered when identifying the target compounds:

- Relation to known or suspected site activities;
- Frequency of detection above background levels and/or relevant standards and criteria;
- Frequency of detection above the Contract Required Quantitation Limits (CRQL) for the CLP;
- Presence of compound in laboratory and/or field blanks.

For example, compounds detected infrequently below the CRQL in a matrix were not considered to be compounds of concern for that matrix. Additionally, compounds detected in blanks that were not related to site activities were not included as compounds of concern. Table 4-1 lists the compounds of concern for each matrix sampled in each site area. This information was used primarily in preparing Section 5.0 (Contaminant Fate and Transport) so that the scope of the review could be refined to include the most relevant compounds for the site.

TABLE 4-1

TARGET COMPOUNDS

AREA A

COMPOUND	GROUND-WATER	SURFACE SOIL	SUBSUR-FACE SOIL
ORGANIC COMPOUNDS			
1,1,1-TRICHLOROETHANE	X	X	X
1,1-DICHLOROETHANE	X		
2,METHYLNAPHTHALENE			X
2-BUTANONE			X
4-METHYL-2-PENTANONE	X	X	
ACETONE			X
AROCLOR-1254		X	
AROCLOR-1260		X	
BIS(2-ETHYLHEXYL)PHTHALATE		X	X
BUTYL BENZYL PHTHALATE			X
CIS-1,3-DICHLOROPROPENE			X
DI-n-BUTYLPHTHALATE			X
ETHYLBENZENE			X
ISOPHORONE	X	X	X
METHYLENE CHLORIDE			X
NAPHTHALENE			X
TETRACHLOROETHENE			X
TOLUENE			X
TOTAL PAH'S		X	X
TRANS-1,2-DICHLOROETHANE	X		
TRICHLOROETHENE	X		X
XYLENES			X
INORGANICS			
ANTIMONY			X
CADMIUM			X
CYANIDE		X	X
NICKEL			X

TABLE 4-1

TARGET COMPOUNDS

AREA B

COMPOUND	GROUND-WATER	SURFACE SOIL	SUBSURFACE SOIL
ORGANIC COMPOUNDS			
1,1,1-TRICHLOROETHANE		X	
ACETONE		X	
AROCLOR-1260		X	X
BIS(2-ETHYLHEXYL)PHTHALATE		X	X
DI-n-BUTYLPHTHALATE			X
ETHYLBENZENE			X
ISOPHORONE		X	X
METHYLENE CHLORIDE		X	X
TETRACHLOROETHENE			X
TOLUENE			X
XYLENES			X
INORGANICS			
ALUMINUM		X	
CADMIUM			X
COPPER		X	X
CYANIDE		X	X
LEAD			X
NICKEL			X

TABLE 4-1

TARGET COMPOUNDS

AREA C

COMPOUND	GROUND-WATER	SURFACE SOIL	SUBSURFACE SOIL	SURFACE WATER	SEDIMENT
ORGANIC COMPOUNDS					
1,1,1-TRICHLOROETHANE	X	X	X		
1,1-DICHLOROETHANE	X				
4-METHYL-2-PENTANONE	X	X			
ACETONE			X		
AROCLOR-1260		X	X		X
BENZENE	X				
BIS(2-ETHYLHEXYL)PHTHALATE		X	X		X
BUTYL BENZYL PHTHALATE			X		X
CHRYSENE					X
DI-n-BUTYLPHTHALATE			X		
ETHYLBENZENE			X		
ISOPHORONE		X	X		
METHYLENE CHLORIDE	X		X		
NAPHTHALENE			X		
PHENANTHRENE					X
TETRACHLOROETHENE		X			
TOLUENE		X	X		
TRANS-1,2-DICHLOROETHENE	X				
TRICHLOROETHENE	X	X	X		
XYLENES		X	X		
INORGANICS					
ALUMINUM		X	X		X
ANTIMONY			X		
ARSENIC		X	X		
CADMIUM			X		
CHROMIUM		X	X		
COBALT			X		
COPPER			X		
CYANIDE		X	X		
LEAD		X	X		X
MERCURY			X		
NICKEL			X		X
SILVER		X	X		
SODIUM		X	X		X
ZINC		X	X		

TABLE 4-1

TARGET COMPOUNDS

AREA D

COMPOUND	GROUND-WATER	SURFACE SOIL	SUBSUR-FACE SOIL
ORGANIC COMPOUNDS			
1,1,1-TRICHLOROETHANE	X	X	
1,1-DICHLOROETHANE	X	X	
4,4-DDD		X	
4,4-DDE		X	
4,4-DDT		X	
ACETONE			X
BIS(2-ETYHLHEXYL)PHTHALATE			X
ENDRIN KETONE		X	
TRICHLOROETHENE	X		X
INORGANICS			
ANTIMONY			X
CADMIUM			X
COPPER			X
LEAD			X
MERCURY			X
NICKEL			X

TABLE 4-1

TARGET COMPOUNDS

AREA E

COMPOUND	GROUND-WATER	SURFACE SOIL	SUBSUR-FACE SOIL
ORGANIC COMPOUNDS			
1,1,1-TRICHLOROETHANE	X	X	X
ACETONE		X	
ALDRIN		X	
AROCLOR-1260			X
BIS(2-ETHYLHEXYL)PHTHALATE		X	
HEPTACHLOR EPOXIDE		X	
ISOPHORONE		X	
INORGANICS			
MERCURY			X

TABLE 4-4A

CONTAMINANT CONCENTRATIONS IN SURFACE WATER AT FISHER-CALO

Volatile Organics (ppb)	*CAS*	*Hits / Samples*	*Min Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	1 / 10	52 - 52	52.0	
CHLOROFORM	67-66-3	2 / 10	3 - 440	221.5	309.0
METHYLENE CHLORIDE	75-09-2	3 / 10	2 - 14	9.0	6.2
1,1-DICHLOROETHANE	75-34-3	2 / 10	1 - 3	2.0	1.4
CARBON TETRACHLORIDE	56-23-5	1 / 10	130 - 130	130.0	
1,2-DICHLOROETHENE	540-59-0	2 / 10	3 - 8	5.5	3.5
TRICHLOROETHENE	79-01-6	1 / 10	7 - 7	7.0	
Base-Neutral-Acids (ppb)					
No Detects					
Pesticides and PCBs (ppb)					
No Detects					
Inorganics (ppm)					
Aluminum	7429-90-5	10 / 10	14,000	1,551.3	4,377.4
Antimony	7440-36-0	1 / 10	53.9	53.9	
Arsenic	7440-38-2	1 / 10	2.8	2.8	
Barium	7440-39-3	10 / 10	394	91.4	108.6
Beryllium	7440-41-7	1 / 10	4	4.0	
Calcium	7440-70-2	10 / 10	286,000	100,010.0	71,995.0
Chromium	7440-47-3	4 / 10	47.5	20.8	17.9
Cobalt	7440-48-4	2 / 10	140	74.8	92.2
Copper	7440-50-8	1 / 10	230	230.0	
Cyanide	74-90-8	3 / 10	17.4	13.8	3.4
Iron	7439-89-6	10 / 10	35,200	4,316.8	10,859.7
Lead	7439-92-1	3 / 10	19.6	7.8	10.2
Magnesium	7439-95-4	10 / 10	47,900	23,308.0	13,665.4
Manganese	7439-96-5	10 / 10	1,120	197.6	330.5
Mercury	7439-97-6	1 / 10	0.3	0.3	
Nickel	7440-02-0	2 / 10	184	108.6	106.6
Potassium	7440-09-7	10 / 10	37,500	6,312.0	11,027.2
Sodium	7440-23-5	10 / 10	17,800	1,623,741.0	4,647,505.7
Vanadium	7440-62-2	1 / 10	22.9	22.9	
Zinc	7440-66-6	9 / 10	1,460	274.5	500.0

minr

TABLE 4-4B

CONTAMINANT CONCENTRATIONS IN SEDIMENT SAMPLES AT FISHER-CALO

Volatile Organics (ppb)	*CAS*	*Hits / Samples*	*Min Max*	*Average*	*St. Dev.*
1,1-DICHLOROETHANE	75-34-3	1 / 22	570 - 570		
1,2-DICHLOROETHENE	540-59-0	1 / 22	1,600 - 1,600		
2-HEXANONE	591-78-6	1 / 22	0.9 - 0.9		
4-METHYL-2-PENTANONE	108-10-1	1 / 22	0.2 - 0.2		
ACETONE	67-64-1	3 / 22	11 - 110	77.0	57.1
BROMOMETHANE	74-83-9	1 / 22	7 - 7		
CARBON TETRACHLORIDE	56-23-5	1 / 22	20 - 20		
CHLOROETHANE	75-00-3	1 / 22	13 - 13		
CHLOROFORM	67-66-3	1 / 22	260 - 260		
METHYLENE CHLORIDE	75-09-2	7 / 22	4 - 82	32.4	32.3
STYRENE	100-42-5	1 / 22	10 - 10		
TETRACHLOROETHENE	127-18-4	1 / 22	3 - 3		
TOLUENE	108-88-3	2 / 22	3 - 340	171.5	238.2
TRICHLOROETHENE	79-01-6	1 / 22	720 - 720		
Base-Neutral-Acids (ppb)					
2-Methylnapthalene	91-57-6	2 / 22	57 - 120	88.5	44.5
2-Methylphenol	95-48-7	1 / 22	1,100 - 1,100	1,100.0	
4-Methylphenol	106-44-5	2 / 22	71 - 2,200	1,135.5	1,505.4
Acenaphthene	83-32-9	1 / 22	170 - 170	170.0	
Acenaphthylene	208-96-8	1 / 22	72 - 72	72.0	
Anthracene	120-12-7	2 / 22	630 - 1,700	1,165.0	756.6
Benzoic acid	65-85-0	3 / 22	81 - 320	207.0	120.0
Benzo(a)anthracene	56-55-3	5 / 22	47 - 800	300.2	314.7
Benzo(a)pyrene	50-32-8	5 / 22	49 - 230	176.2	77.9
Benzo(b)fluoranthene	250-99-2	5 / 22	70 - 750	235.4	290.4
Benzo(g,h,i)perylene	191-24-2	4 / 22	56 - 310	132.7	119.0
Benzo(k)fluoranthene	207-08-9	4 / 22	52 - 750	363.0	321.7
bis(2-ethylhexyl)phthalate	117-81-7	6 / 22	200 - 2,800	1,145.0	1,008.5
Butyl benzyl phthalate	85-68-7	2 / 22	41 - 44	42.5	2.1
Chrysene	218-01-9	3 / 22	96 - 550	328.0	168.1
Dibenzo(a,h)anthracene	53-70-3	2 / 22	78 - 94	86.0	11.3
Di-n-butylphthalate	84-74-2	4 / 22	47 - 98	73.7	25.5
Fluoranthene	206-44-0	4 / 22	170 - 2,200	1,065.0	795.5
Fluorene	86-73-7	1 / 22	220 - 220	220.0	
Indeno(1,2,3-cd)pyrene	193-39-5	3 / 22	80 - 210	124.3	74.2
Isophorone	78-59-1	1 / 22	110 - 110	110.0	
Napthalene	91-20-3	1 / 22	260 - 260	260.0	
Phenanthrene	85-01-8	3 / 22	120 - 1,000	463.3	469.2
Phenol	108-95-2	3 / 22	170 - 270	223.3	50.3
Pyrene	129-00-0	4 / 22	120 - 830	375.0	312.2
Pesticides and PCBs (ppb)					
beta-BHC	319-84-6	2 / 22	16 - 38	27.0	15.5
Dieldrin	60-57-1	1 / 22	5.6 - 5.6	5.6	
AROCLOR-1260	11096-82-5	1 / 22	2,300 - 2,300	2,300.0	
Inorganics (ppm)					
Antimony	7440-36-0	3 / 22	22.5	15.4	6.19
Arsenic	7440-38-2	1 / 22	38	38.0	
Calcium	7440-70-2	4 / 22	333,000	116,025.0	144,829.9
Copper	7440-50-8	2 / 22	150	137.0	18.4
Lead	7439-92-1	5 / 22	243	112.4	74.1
Sodium	7440-23-5	1 / 22	473,000	473,000.0	
Zinc	7440-66-6	7 / 22	988	439.5	303.2

compared to SW-05. For SW-06, located downstream of the confluence of Travis Ditch and Kingsbury Creek, analytical data were compared against the background concentration among samples SW-01, SW-02 and SW-03, since all three were from tributaries upstream of the confluence of these two water bodies.

The samples used as a background for the stream sediment samples were established in the same manner as discussed above, with the upstream samples used as background for the downstream samples. Since two sediment samples were collected at each stream sample location, one from the center and the other from the bank, the highest concentration for each parameter from the two locations were used as background comparison.

The surface water and sediment samples collected from locations SW/SD-08, SW/SD-09, SW/50-10 and SW/SD-12 (the onsite standing water bodies and wetland area) were compared to the upstream (background) samples and contaminants detected at high levels are identified. The results from SW-07, the effluent discharge pipe, were compared against the background concentrations in Travis Ditch to determine if the treated effluent was impacting the ditch.

did not compare to "local background" samples

The background surface water samples take from the streams were also compared to the State Water Quality Standards. For two of the parameters, iron and zinc, the background concentrations exceeded those of the state standards. Iron was detected at 1570 ug/l and zinc was detected at 33.8 ug/l with the state standard being 10 ug/l. All other parameters were below the state standards.

Volatiles

In all three of the upstream or background surface water samples for Kingsbury Creek and Travis Ditch, no volatile organics were detected. The downstream surface water samples in the creek and ditch contained only a few detected volatiles organics, but all were at low concentrations with a

maximum of 8 ug/l for total volatile contaminants. Of the onsite surface water impoundments at SW/SD-10 and SW/SD-12, only the results from station SW/SD-10 are usable for the surface water volatile analysis (due to data quality problems). This sample had a low concentration of methylene chloride (11 ug/l) present at a concentration just above the detection limit and may be due to laboratory contamination.

In the background stream sediment samples, the only organic compound detected above 10 ug/l was acetone. The downstream sediment samples at SD-05 and SD-06 were comparable to the results from the background samples SD-01, SD-02, and SD-03 in that methylene chloride was detected at a concentration within 20 ug/l of the background concentration. Such concentrations as these, which are less than 10 times the detection limit of 5 ug/l, are typically associated with laboratory or field contamination. The sample from the Kankaee River, SW-11, also had a very high level of methylene chloride which may be due to laboratory contamination.

The sediment sample taken at SD-04 contained 1,1-dichloroethane (DCA), total-1,2-dichloroethene, (1,2-DCE) and trichloroethene (TCE) at concentrations up to 90 times the detection limit. High concentrations of DCA (570 ug/l), 1-2 DCE (1600 ug/l) and TCE (720 ug/l) were found in SD-04B (along the bank), but not in SD-04A (center of stream flow). This difference in concentrations levels may be the result of dilution due to faster moving water at the center of the stream, or it may indicate the presence of a source point along the bank of the stream. It should be noted that these compounds have been found in most of the groundwater samples exhibiting volatile contamination. Therefore, the volatile contaminants at the bank at SD04 may be related to the discharge of contaminated groundwater into the ditch.

The onsite sediment samples had few volatile organic compounds (VOC) detected. The two samples from the dry wetlands area, SD-08 and SD-09, both had one compound detected, chloroform, but at low levels. Sample SD-10, taken from a pond on the Space Leasing Inc. property, had a

high level of toluene (340 ug/kg), the only VOC detected. The only significant volatile organic compound detected at an elevated concentration was in sample SD-12, which had chloroform at 260 ug/kg.

BNAs/Extractables

For all surface water samples, no BNA, pesticides, or PCB compounds were detected. However, approximately 20 BNA compounds were detected at low concentrations in the three background stream sediment samples. BNA compounds detected at high concentrations in the background sediment samples include 2-methylphenol, anthracene, flouranthene, benzo(a)anthracene, bix(2-ethylhexyl)phthalate and benzo(a)pyrene. BNA compounds were not detected in the majority of the downstream sediment samples. The only locations where BNA compounds were detected are SW-06, and SD-11, but the values detected are estimated values, and were found at low concentrations.

The two onsite sediment samples from the wetland area, (samples SD-08 and SD-09) had no significant compound detections. Sample SD-10, taken from the pond on the Space Leasing property, contained concentrations of 4-methylphenol at 2200 ug/kg and phenol at 270 ug/kg. Sediment sample SD-12, taken from the discharge lagoon on the Cardinal Chemical property, contained chrysene, bis(2-ethylhexyl)phthalate, flouranthene, and phenanthrene. Various other compounds were detected at low concentrations.

Pesticides/PCB's

In the pesticide/PCB analysis, nothing was detected in any of the upstream (background) surface water/sediment stream samples. The only stream sample with a compound at a significant concentration is SD-04, with betabenzene hexachloride (lindane) at 38 ug/kg. The onsite surface water/sediment samples had no pesticide/PCB compounds detected, except sample SD-12 with 2300 ug/kg of PCB-1260.

Inorganics

Background concentrations in upstream surface water samples collected from Travis Ditch and Kingsbury Creek were low. The downstream sample concentrations detected were higher than background at only a few locations and only two locations had parameters at concentrations 20 percent greater than background. These locations, SW-05 (duplicate) and SW-06, both had elevated concentrations of zinc and sodium.

Location SW-11, collected from the Kankakee River, showed elevated concentrations of aluminum only. All other parameters were at concentrations similar to those detected in Travis Ditch and Kingsbury Creek.

Onsite surface water samples contained several parameters at high concentrations. Sample SW-07, collected from the wastewater effluent discharge pipe from the Roll Coater facility, contained a number of elevated concentrations, including antimony, calcium, cobalt, sodium and zinc. Results from sample SW-12, taken from the Cardinal Chemical discharge lagoon, showed high concentrations of the following inorganic compounds: aluminum, barium, chromium, copper, iron, manganese, nickel, potassium, sodium and zinc. Sample SW-10 from the Space Leasing property showed elevated concentrations of aluminum. All the other parameters detected at Space Leasing were at the low levels anticipated for the area, and compared to background surface water sample concentrations.

Inorganic results from the upstream (background) sample locations (SD-01A, SD-02A and B, SD-03A and B) were consistent, except for sample SD-01B, which showed much higher inorganic concentrations than the other upstream samples. The downstream sediment samples were compared to the upstream sediment samples, by taking the worst case concentration of each parameter in the upstream samples, and adding 20 percent. If the concentrations found in samples downstream exceeded this derived value, contamination was noted as being present.

In sample SD-04B, aluminum, iron, lead, vanadium and zinc were more than 20% greater than the background concentrations. None of the concentrations in sample SD-04A exceeded the background readings. Sample SD-05A and B had similar results, each having elevated concentrations of arsenic, barium, iron, manganese and zinc. Duplicate results at the same locations also exhibited similar concentrtions. Magnesium was found at elevated levels in sample SD-06A. The samples collected from the Kankakee River, SW-11A and B, exhibited no elevated readings when compared to other stream surface water samples.

The onsite sediment samples all contained elevated concentrations of various parameters, when compared to the background stream sediment samples. The two samples from the wetland area, SD-08 and SD-09, both had elevated concentrations of aluminum, barium, chromium, lead, potassium, selenium, silver, sodium and vanadium. Sample SD-10 showed elevated readings of aluminum and potassium, while sample SD-12 had high concentrations of aluminum, barium, iron, lead, magnesium, nickel, potassium sodium and zinc.

SAS Parameters

Special Analytical Services (SAS) parameters were analyzed in the surface water samples. The three ions analyzed were chloride, sulfate and ammonia. The upgradient (background) samples were all below the surface water standards for the State of Indiana (see Table 4-3). The results from samples SW-04 and SW-06 were similar when compared to the background samples SW-01 and SW-02. Sample SW-05 also did not exhibit elevated concentrations when compared to the background sample SW-03. The remaining stream surface water sample, SW-11, had similar results to the other stream surface water samples.

The onsite surface water body samples exhibited elevated concentrations of the above SAS parameters. Sample SW-07, collected from a pretreated wastewater effluent pipe flowing from the Roll Coater facility, had elevated readings for all three parameters, but the concentrations detected

were all under the state standards. Sample SW-12 had elevated levels of chloride, but the level was also below standards.

The sediments samples from all stream and onsite locations were also analyzed for the SAS parameter leachability of metals. The results of these samples correlated with the inorganic data results obtained.

4.2.4 SUMMARY AND CONCLUSIONS

The surface water samples from flowing water sources were all below background concentrations except for two cases. The SW-05 duplicate sample had a very high concentration of zinc, however the corresponding SW-05 sample had a zinc concentration below background. Zinc was also detected in the sediment sample at location SD-05 at above background concentrations. Surface water sample SW-06 had a high concentration of sodium, but the sediment sample at the same location did not exhibit a concentration above background.

The only other surface water sample with elevated concentrations was SW-12, which may be considered a source sample since it was collected from a discharge lagoon on the Cardinal Chemical property. The sample contained high concentrations of a number of inorganic compounds including aluminum, barium, chromium, copper, iron, manganese, nickel, potassium, sodium and zinc. A few of these compounds, aluminum, nickel, potassium, and sodium, as well as lead and magnesium, were also detected at greater than 20 percent above background in the sediment sample at the same location. PCB-1260, chloroform and bis(2-ethylhexyl) phthalate were also found at high levels in this sediment sample. The remaining surface water samples, SW-10 and SW-11, showed no elevated concentrations when compared to the Indiana State Water Quality Standards or to the other surface water samples collected.

The sediment samples contained higher concentrations than did the surface water samples. In addition to samples SD-05, SD-06 and SD-12 having elevated concentrations, four other sediment samples contained high

readings for various compounds. Sample SD-04 from Travis Ditch showed high readings above background for lindane, 1,2-dichloroethene, trichloroethene, 1,1-dichloroethane, aluminum, iron, lead, vanadium and zinc. These readings may be a result of the wastewater discharge effluent from the Roll Coater facility, however, a sediment sample was not taken at the outfall of the pipe. Location SD-04, however, is just downstream of the pipe.

Sample SD-10, located on the Space Leasing property, contained elevated concentrations of toluene, aluminum and potassium. Toluene is known to have been stored at the Fisher-Calo site, but the source of its presence at this location is uncertain.

The two sediment samples collected from the wetland area, SD-08 and SD-09, both contained high concentration of inorganics including aluminum, barium, lead, potassium, selenium and sodium. Sample SD-09 also contained chromium, silver and vanadium at elevated concentrations.

The onsite surface water body samples should be considered a separate sample matrix from the flowing water and sediment samples. Location 12 should be defined as a source sample since it was collected from the discharge lagoon located on Cardinal Chemical property.

4.3 SURFACE SOIL AND RUNOFF SAMPLES

Surface soil and runoff sampling activities occurred from July 11 through August 3, 1988. Sample locations were selected from five study areas within the Fisher-Calo site and from an offsite (background) area. The areas selected for sampling were identified as being suspected past disposal areas and areas where waste drums and tanks were being stored during the RI field activities which occurred in 1988. A total of 246 samples were collected from 191 locations within the five onsite study areas and an offsite area. The sample locations are shown in Figures 4.3-1 through 4.3-7 (in Volume II, Appendix A).

Onsite soil sample locations were selected in areas where past waste disposal or spills had occurred, in areas that were adjacent to currently operating facilities and areas where drummed waste materials were located. Surface soil samples (SS) were collected from excavated soil piles; areas where stressed vegetation was noted; from surface areas that showed obvious waste stains or spills; and from locations along established grid lines in order to define the extent of contamination present. Samples were also collected from low spots, ditches and drain pipe openings, and from depression areas where surface water runoff could collect. Soil samples taken at these locations were identified as runoff (RO) samples, even though no standing water was present at the time of sample collection.

Background surface and runoff soil samples were collected from offsite locataions. The locations of background samples RO-55 and SS-194 are indicated on the study area maps shown in Volume II, Appendix A, Figures 4.3-1 through 4.3-7.

Surface soil and runoff samples (SS and RO) were collected at depth intervals from the ground surface down to 12 inches in undisturbed soils, and down to 24 inches at locations where the soils had been disturbed (plowed or excavated). At location where concentrations or organic vapors were noted (using an HNu or OVA) at levels above 5 ppm, discreet samples were obtained from depth intervals of 0-6" and 6-12" (or 0-12" and 12-24" in areas of disturbed soils). These samples were identified using "A" and "B" for depth intervals designations (i.e., SS-12A (0-6 inches), and SS-12B (6-12 inches). The sample depth intervals and ambient air monitoring results are described in the Technical Memoranda, Appendix A.4, contained in Volume III.

The surface soil and runoff samples were analyzed for Routine Analytical Services (RAS) parameters which included full organics, inorganics and cyanide. Samples were also analyzed for various Special Analytical Services (SAS) parameters. SAS analysis was performed to eliminate interferences from unknown hydrocarbons in the BNA fraction. The Phase II

TABLE 4-1

TARGET COMPOUNDS

AREA F

COMPOUND	GROUND-WATER	SURFACE SOIL	SUBSURFACE SOIL	SURFACE WATER	SEDIMENT
ORGANIC COMPOUNDS					
1,1,1-TRICHLOROETHANE			X		
1,2-DICHLOROETHENE			X		
4-METHYLPHENOL					X
ARCLOR-1260			X		
BIS(2-ETHYLHEXYL)PHTHALATE			X		
BUTYL BENZYL PHTHALATE			X		
METHYLENE CHLORIDE			X		
TETRACHLOROETHENE			X		
TOLUENE					X
TRICHLOROETHENE			X		
INORGANICS					
CADMIUM			X		

TABLE 4-1

TARGET COMPOUNDS

SURFACE WATER AND SEDIMENT

COMPOUND	SURFACE WATER	SEDIMENT
ORGANIC COMPOUNDS		
1,1-DICHLOROETHANE		X
TRANS-1,2-DICHLOROETHANE		X
TRICHLOROETHENE		X
INORGANICS		
ALUMINUM		X
LEAD		X
ZINC		X

See Comment #2 - did not address

4.2 SURFACE WATER AND SEDIMENT SAMPLES

Surface water and sediment samples were collected by ATEC Associates, Inc., under the supervision of the CDM REM II team. A total of 12 surface water samples were collected from 8 locations along Kingsbury Creek and Travis Ditch; from 1 location on the Kankakee River; from 2 surface water bodies located onsite; and from a treated waste water effluent pipe located onsite, which flows into Travis Ditch. Surface water samples were collected from the center of the stream or water body at each location. Sampling locations are shown in Figure 4.2-1 (Vol. II). The surface water samples were analyzed by the CLP for Routing Analytical Service (RAS) analysis for full organics, inorganics/metals and cyanide. CLP Special Analytical Service (SAS) analyses were also performed for nitrate/nitrite, ammonia, chloride and sulfate. Field measurements taken during sample collection include pH, specific conductance, and temperature. The results of these measurements are shown in Table 4-2.

A total of 11 sediment samples were collected from the same locations along Kingsbury Creek, Travis Ditch, the Kankakee River and from surface water bodies onsite (no sediment sample was collected from the waste water effluent pipe). At each stream location, two sediment samples were collected, one from the center of the stream (Sample A) and the other from along the edge or bank of the stream (Sample B). Samples collected at these locations were assigned the sample location number corresponding to the surface water sample collected at the same location. The A and B designations were used to identify where the sediment sample had been collected (from the bank or the center of the stream).

The sediment sample locations are also shown in Figure 4.2-1 (Vol. II). These samples were analyzed for the same RAS parameters as the surface water samples. In addition, sediment samples were analyzed by CLP SAS request for the leachability of metals. Field measurements taken during sample collection included qualitative organic vapor screening by an OVA and/or HNu.

TABLE 4-2

MEASUREMENT OF SURFACE WATER PARAMETERS

SAMPLE LOCATION	pH	TEMPERATURE (°C)	SPECIFIC CONDUCTIVITY (mmhos)
SW-01	7.81	20	710
SW-02	7.41	17	610
SW-03	8.20	20	470
SW-04	7.70	17	550
SW-05	8.10	15	380
SW-06	7.83	16	590
SW-07	6.97	28	990
SW-08*	-	-	-
SW-09*	-	-	-
SW-10	6.24	33	150
SW-11	7.86	21	590
SW-12 (1)	-	-	-

* No surface water sample collected

(1) No measurement taken

4.2.1 STANDARD AND CRITERIA

The standards for surface water quality were taken from the Indiana State Water Laws. These standards are shown in Table 4-3. Currently, the State of Indiana has not established standards or criteria for sediments.

In both the surface water and sediment samples collected from flowing surface waters, the upstream or background samples were compared to the State Water Quality Standards, when applicable. The downstream samples were then compared to the background samples. The samples collected from the surface water body areas onsite were compared against the Indiana State Water Quality Standards, with one another, and assumed source of their contamination.

4.2.2 DATA PROBLEMS AND QA/QC RESULTS

Surface water samples from flowing streams/creeks were compared to both the background samples and to the State Water Quality Standards. The sediment samples from flowing water bodies were also used to establish an upstream/downstream relationship for comparison. Surface water sample results from the 2 onsite water bodies were compared against State Water Quality Standards. Sediment sample results from these locations were compared to levels of contamination detected in the upstream sediment and contaminants detected at high levels are identified. No comparison of the sample results was made between the 2 onsite water bodies, since they are located in distinct areas at the site, and are the result of different sources (wetland area, pond and discharge lagoon).

The overall quality of the analytical results were evaluated through the field blank and duplicate samples. For organics analyses, the field blanks were generally free of organic contaminants. Methylene chloride and chloroform were detected in two of the surface water samples at estimated concentrations less than the contract required detection limit. In the inorganics, aluminum, iron, and lead were detected in the surface water

TABLE 4-3

PROPOSED STATE OF INDIANA WATER QUALITY STANDARDS

Ammonia (un-ionized)	0.05	mg/l
Arsenic	0.05	mg/l*
Barium	1.0	mg/l*
Cadmium	0.01	mg/l*
Chloride	250	mg/l
Chromium (hexavalent)	0.05	mg/l
Copper	0.1	x 96 hr LC_{50}*
Cyanide	0.025	mg/l
Dissolved Solids		
Maximum Monthly Average	500	mg/l
Maximum Allowable	750	mg/l
Flouride	1.0	mg/l
Lead (dissolved)	0.05	mg/l
Nitrite-N	1.0	mg/l
Nitrite-N + Nitrite-N	10	mg/l
Phenolic Compounds	0.01	mg/l
Selenium	0.01	mg/l*
Silver	0.05	mg/l*
Sulfate	250	mg/l
Zinc	0.01	x 96 hr LC_{50}*
Mercury	0.2	ug/l*
Polychlorinated Biphenyl	0.001	ug/l

*Total Recoverable Concentrations

Source: Environment Reporter, 1988

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field blanks, but were at concentrations below those in the background samples and should, therefore, not impact the data analysis. All other inorganic parameters were not detected in the field blanks.

The duplicate sample analysis indicated good qualitative and quantitative comparison. In all the sediment sample analyses, the concentrations detected in the duplicates were very close to those detected in the investigative samples. The surface water sample analysis was also comparable with only a few exceptions. The inorganic duplicates were all within seven percent (7%) of the investigative sample at the same location, except for aluminum and zinc. Also, most concentrations of contaminants detected in the duplicates were higher than those detected in the investigative samples.

Due to a laboratory problem, the analytical results for SW-12 are inconclusive regarding the volatile contaminants detected and their concentrations. The laboratory results report an initial analysis with no detectable levels of volatiles and a subsequent diluted sample analysis with detections of chloroform (440 ug/l), carbon tetrachloride (130 ug/l), methylene chloride (14 ug/l, estimated) and trichloroethene (7 ug/l). Therefore, these results cannot be used to assess site attributable contamination.

4.2.3 ANALYTICAL RESULTS

A summary of the concentration ranges for compounds detected in the surface water and sediment samples is shown in Table 4-4.

For the analysis of the surface water and sediment sample data, the background samples were paired with specific investigative sample locations (i.e., samples taken from the creek and ditch were compared against upstream background samples). Results from the sample SW-04 were compared to the highest parameter concentrations from either sample SW-01 or sample SW-02, both upstream of location SW-04. The background sample SW-03 was

SAS BNA samples were washed with a solvent to clean the hydrocarbons from the sample. The remaining portion of the sample was analyzed for BNAs by Routine Analytical Services (RAS) methods. Samples obtaind from approximately 20 percent of the sample locations were analyzed for SAS parameters including Volatile Solids, Toxic Compound Leaching Procedure (TCLP), leachability of metals, nitrate/nitrite, ammonia, chloride and sulfate. Volatile solids indicate the organic carbon content of the samples. The TCLP method was used to indicate whether the organic contaminants in the unsaturated zone are susceptible to leaching. Leachability of metals indicates the amount of metals which may be leached from the soil. The leachability test performed for this study was not the standared EP Toxicity method using acidic conditions, but rather a method using neutral conditions with water. SAS analysis for nitrate/nitrite, ammonia, chloride and sulfate was performed in order to detect the concentration levels present in the soils. This analysis was necessary due to the active facilities in the area that were known to manufacture or utilize these compounds in their operations. Verification of the concentration levels found in the soils was used to determine the potential for interference from high levels of these compounds, on the RAS soil sample analysis performed. Field duplicate samples were collected in accordance to the protocol described in the site Sampling and Analysis Plan (SAP).

Due to differing analytical methods, results from the TCLP analysis cannot be quantitatively compared to results from RAS analyssis; however, the qualitative comparisons are useful. Most TCLP organic results were lower than the organic results for RAS analysis. When the RAS results for organic compounds were high, many of the same organic compunds were detected by the TCLP method, although at lower concentrations. Due to the low solubility of many organic compounds, TCLP results for organic compounds would be expected to be low. In many TCLP surface soil samples 1,1,1-trichloroethane and 4-methyl-2-pentanone were the only compounds detected, and they were detected at the same narrow range each time.

These compounds were usually not present in the RAS analysis for the same sample. For these reasons, the presence of 1,1,1-trichloroethane and 4-methyl-2-pentanone detected in the TCLP samples and not in the RAS results, probably indicates laboratory contamination. Therefore, only RAS detection of 1,1,1-trichloroethane and 4-methyl-2-pentanone will be considered compound detections and any TCLP detections of these organic compounds will be considered laboratory contamination. 1,1,1-Trichloroethane and 4-methyl-2-pentanone were the only compounds in the TCLP samples that displayed this behavior.

4.3.1 STANDARDS AND CRITERIA

Very few regulatory standards apply to soils. However, the contaminants found in soils are of concern due to their potential for migration to groundwater, surface waters, and air.

In assessing the chemical results for surface soils and runoff soils, the chemical constituents were compared to the results from the background samples. This procedure was followed for the volatile organics, BNAs and pesticide/PCB analysis. As a general guideline, most organic priority pollutants are not present naturally in soils. The exceptions are benzoic acid (from animal excrement and plant decay) and the PAHs (from coal tars and shales).

The inorganic results were compared to the observed range of concentrations for each compound as established in the U.S. Geological Survey paper titled "Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States" by Shacklette and Boerngen, 1984. The inorganic constituents found in the background samples (RO-55 and SS-104) are at concentrations lower than the high end of the ranges for the Eastern United States soil averages. Therefore, the results for Eastern United States soils were used to assess the inorganic soils data for the Fisher-Calo site.

4.3.2 DATA PROBLEMS AND QA/QC RESULTS

A comparison of the data results obtained at locations where two sample intervals were collected indicated that there was no significant difference between the samples from each depth interval (0-6" and 6-12", or 0-12" and 12-24"). Therefore, at locations where two depth intervals had been sampled, the data was combined, and the highest concentration for each sample location was reported. Thus, the sample depth interval was not considered in the assessment of surace soil and runoff sample data. All sample data results were evaluated as though the soil had been collected from one sample depth interval (0-12" or 0-24" below the ground surface).

No blanks (trip or field) were collected during the soil sampling activities. Field duplicate samples were collected to provide a means of checking the laboratory's analytical procedures and methods, and also to check sampling procedures and equipment. Field duplicates were collected at a frequency of approximately one duplicate per 10 samples. Soils are heterogeneous by nature, therefore, it is difficult to collect identical samples and duplicates. For this reason, the samples and duplicates do not compare as closely as would be expected for groundwater duplicates. RPDs of 50% or greater were found in some of the duplicates for VOC, SVOCs, SVOCs, pesticides, and PCBs. Overall, the duplicate samples had RPDs that compared well, although some duplicates had RPDs of 50% or more. Although there was some variance in the duplicate samples, this variance can be attributed to the heterogeniety of the soil and nature of sampling with regard to the amount of material needed for analysis, and not to analytical procedures. Therefore, the higher RPDs for these surface soil samples do not significantly affect the overall surface soil data. Samples SS-56, RO-54 and RO-49 had significant variations between sample and duplicates and will be discussed below.

In sample SS-56, PCB-1260 wa detected at 17,000 ug/kg. In sample SS-56A, no PCB compounds were detected. In sample SS-56A (duplicate), PCB-1260 was found at 13,000 ug/kg. This error may have occurred due to mislabeling

samples or in poor field technique so that the soil placed in each sample container may not have been composited correctly. Additionally, in sample SS-56A, isophorone was detected at 9,400 ug/kg, while in sample SS-56A (duplicate) this compound was not detected.

No volatile organics were detected in sample RO-54, but in the duplicate sample RO-54, toluene (3,900 ug/kg), ethylbenzene (1,900 ug/kg) and total xylenes (75,000 ug/kg) were all detected. Additionally, sample RO-54 had inorganic compounds detected at significantly higher concentrations (almost double for some compounds) than those found in the duplicate sample.

In sample RO-49 (duplicate), isophorone and phenol were detected at 36,000 ug/kg and 330 ug/kg, respectively. However, sample RO-49 had isophorone at only 5,500 mg/kg and phenol was not detected.

4.3.3 SURFACE SOIL AND RUNOFF SOIL RESULTS: AREA A

Study Area A encompasses the Fisher-Calo Two-Line Road Facility and adjacent areas. This area includs old tanks, buried tank cars, a tank farm, old drum storage areas, excavated pits, soil piles, empty acid containers, partially exposed tanks, and other debris. The surface soil and runoff soil samples collected in Area A were SS-76 to SS-82, SS-84 to SS-103, SS-105 to SS-106, SS-108 to SS-126, SS-133 to SS-136, RO-33 and RO-39 to RO-54. Surface and runoff soil organic samples results are summarized in tables 4-5A and 4-5B. Figure 4.3-7 illustrates the general distribution of total organic (VOC + SVOC) contamination in Area A. A brief summary of the results for each area is presented in Section 4.3.8.

4.3.3.1 Volatiles

Volatile organic compounds (VOCs) of significant concentrations (greater than 10 ug/kg were detected in less than one-quarter of the 69 surface soil samples collected in Area A. The majority of samples with elevated

volatile organic concentrations were from locations that are currently or were formerly drum storage areas, waste disposal areas, tank farms, or excavated soil pile areas.

There were 14 different VOCs detected in the surface soils in Area A. These volatile organic constituents can be divided into three groups: 1) chlorinated organic solvents including 1,1,1-trichloroethane (1,1,1-TCA), chloroform, methylene chloride, tetrachloroethene (PCE), trans-2-dichloroethene (trans-1,2-DCE), and vinyl chloride; 2) non-chlorinated solvents including 2-butanone (methyl ethyl ketone), ethylbenzene, toluene and xylene; and 3) ketones including acetone, 4-methyl-2-pentanone and 2-butanone. Carbon disulfide and styrene were also present. Table 4-5A and 4-5B summarize the VOC hits for runoff soil samples and surface soil samples.

The chlorinated solvents are used as degreasers and for dry-cleaning operations. The non-chlorinated solvents are found in gasoline, paints, paint thinner, degreasing solvents, adhesive solvents and are used in the synthesis of organic chemicals. Ketones are used as solvents in explosives and as ingredients in paints and coatings.

Organic compounds that were detected in only one sample at low levels (below 10 ug/kg) or in only a few samples at low concentrations (below 10 ug/kg) will not be discussed further. These VOCs include chloroform, trans-1,2-dichloroethene, vinyl acetate, and styrene. The other compounds detected in Area A were found at higher levels and were detected frequently enough to warrant further discussion. VOC compounds detected in Area A at relatively high concentrations include acetone, methylene chloride, xylenes, 2-butanone, ethylbenzene, tetrachloroethene, and toluene.

The surface soil samples collected in and around the soil pile located north of the chemical plant include sample numbers SS-117, RO-53, SS-102, RO-54, RO-47, SS-118, SS-119, and RO-52. Only samples RO-54, SS-118 and SS-119 contained significant VOC detects. Sample RO-54, located just north

TABLE 4-5A

ORGANIC CONTAMINANT CONCENTRATIONS IN SURFACE SOILS AT FISHER-CALO
Summary of Surface Soil Samples (ppb)

Area A

Volatile Organics	*CAS*	*Hits / Samples*	*Min Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	9 / 52	4 - 5,500	1,429.3	2,424.3
TETRACHLOROETHENE	127-18-4	5 / 52	0.4 - 2,100	626.4	904.7
4-METHYL-2-PENTANONE	108-10-1	2 / 52	7 - 16	11.5	6.4
CHLOROFORM	67-66-3	8 / 52	1 - 4	1.7	1.1
CARBON DISULFIDE	75-15-0	10 / 52	1 - 36	8.3	10.9
1,1,1-TRICHLOROETHANE	71-55-6	7 / 52	6 - 55	31.4	12.5
METHYLENE CHLORIDE	75-09-2	2 / 52	4 - 58	31.0	38.1
STYRENE	100-42-5	1 / 52	1 - 1	1.0	
1,2-DICHLOROETHENE	540-59-0	1 / 52	13 - 13	13.0	
VINYL ACETATE	108-05-4	2 / 52	11 - 11	11.0	0.0
XYLENES	1330-20-7	2 / 52	30 - 1,200	615.0	827.3
TRICHLOROETHENE	79-01-6	3 / 52	3 - 96	41.3	47.4
Base-Neutral-Acids					
Phenol	108-95-2	2 / 52	7 - 330	168.5	228.4
Isophorone	78-59-1	9 / 52	74 - 5,700	2,651.0	2,103.0
Phenanthrene	85-01-8	4 / 52	97 - 680	231.2	252.6
Di-n-butylphthalate	84-74-2	27 / 52	59 - 3,000	402.5	609.9
Fluoranthene	206-44-0	5 / 52	38 - 390	136.0	145.0
Pyrene	129-00-0	4 / 52	36 - 500	176.3	217.3
Benzo(a)anthracene	56-55-3	1 / 52	120 - 120	120.0	
bis(2-ethylhexyl)phthalate	117-81-7	17 / 52	86 - 150,000	10,264.4	36,072.8
Chrysene	218-01-9	4 / 52	66 - 5,200	1,654.0	2,406.5
Benzo(b)fluoranthene	250-99-2	4 / 52	52 - 250	132.7	91.4
Benzo(k)fluoranthene	207-08-9	2 / 52	69 - 160	114.5	64.3
Benzo(a)pyrene	50-32-8	1 / 52	130 - 130	130.0	
Indeno(1,2,3-cd)pyrene	193-39-5	1 / 52	63 - 63	63.0	
2,4,6-Trichlorophenol	88-06-2	1 / 52	550 - 550	550.0	
2,4-Dimethylphenol	105-67-9	1 / 52	260 - 260	260.0	
2,6-Dinitrotoluene	606-20-2	2 / 52	460 - 520	490.0	42.4
2-Methylnapthalene	91-57-6	5 / 52	50 - 330	161.0	125.6
4-Methylphenol	106-44-5	1 / 52	240 - 240	240.0	
Benzo(g,h,i)perylene	191-24-2	1 / 52	120 - 120	120.0	
Bis(2-chloroisopropyl)ether	39638-32-9	1 / 52	52 - 52	52.0	
Butyl Benzyl Phthalate	85-68-7	4 / 52	58 - 15,000	3,927.0	7,384.4
Dibenzofuran	132-64-9	1 / 52	390 - 390	390.0	
Di-n-octyl Phthalate	117-84-0	2 / 52	59 - 1,000	529.5	665.3
Napthalene	91-20-3	4 / 52	79 - 310	169.7	100.6
N-nitrosodiphenylamine	86-30-6	2 / 52	340 - 490	415.0	106.8
Pentachlorophenol	87-86-5	1 / 52	96 - 96	96.0	
Pesticides and PCBs					
AROCLOR-1254	11097-69-1	1 / 52	49 - 49	49.0	
AROCLOR-1260	11096-82-5	2 / 52	180 - 120,000	60,090.0	84,725.5

TABLE 4-5B

ORGANIC CONTAMINANT CONCENTRATIONS IN SURFACE SOILS AT FISHER-CALO
Summary of Soil Runoff Samples (ppb)

Area A

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	5 / 17	2 - 25,000	5,305	11,029
TETRACHLOROETHENE	127-18-4	1 / 17	5,000 - 5,000	5,000	
4-METHYL-2-PENTANONE	108-10-1	3 / 17	9 - 19	14	5
CHLOROFORM	67-66-3	5 / 17	2 - 3	2	1
TOLUENE	108-88-3	1 / 17	3,900 - 3,900	3,900	
CARBON DISULFIDE	75-15-0	5 / 17	2 - 15	5	6
1,1,1-TRICHLOROETHANE	71-55-6	7 / 17	8 - 200	40	71
METHYLENE CHLORIDE	75-09-2	1 / 17	7 - 7	7	
ETHYLBENZENE	100-41-4	2 / 17	1 - 1,900	9,505	1,343
TRANS-1,2-DICHLOROETHENE	156-60-5	4 / 17	3 - 5	4	1
VINYL ACETATE	108-05-4	3 / 17	11 - 11	11	
XYLENES	1330-20-7	1 / 17	75,000 - 75,000	75,000	
2-BUTANONE	78-93-3	1 / 17	17,000 - 17,000	17,000	
Base-Neutral-Acids					
Phenol	108-95-2	2 / 17	7 - 330	169	228
4-Methylphenol	106-44-5	1 / 17	370 - 370	370	
Isophorone	78-59-1	9 / 17	2 - 36,000	6,319	11,377
Napthalene	91-20-3	1 / 17	170 - 170	170	
2-Methylnaphthalene	91-57-6	1 / 17	82 - 82	82	
Phenanthrene	85-01-8	1 / 17	110 - 110	110	
Di-n-butylphthalate	84-74-2	7 / 17	70 - 400	173	140
Di-n-octyl phthalate	117-84-0	1 / 17	58 - 58	58	
Fluoranthene	206-44-0	1 / 17	300 - 300	300	
Pyrene	129-00-0	2 / 17	86 - 260	173	123
Benzo(a)anthracene	56-55-3	2 / 17	110 - 280	195	120
bis(2-ethylhexyl)phthalate	117-81-7	9 / 17	150 - 33,000	6,102	11,623
Chrysene	218-01-9	3 / 17	120 - 460	250	184
Benzo(b)fluoranthene	250-99-2	2 / 17	360 - 650	505	205
Benzo(k)fluoranthene	207-08-9	2 / 17	150 - 360	255	149
Benzo(a)pyrene	50-32-8	2 / 17	140 - 460	300	227
Pesticides and PCBs					
AROCLOR-1254	11097-69-1	5 / 17	12 - 550	219	271
AROCLOR-1260	11096-82-5	3 / 17	34 - 2,400	843	1,349

of the soil pile, had the highest concentrations of VOCs detected, in this area with toluene at 3,900 ug/kg, ethylbenzene at 1,900 ug/kg and total xylenes at 75,000 ug/kg. Samples SS-119 and SS-118 contained mainly acetone (380 ug/kg) and tetrachloroethene (130 ug/kg).

Samples RO-50, RO-51, SS-116, S-111, and SS-115 are located in or adjacent to an excavation pit that was formerly a waste disposal area located east of the Fisher-Calo Chemical Facility. Samples RO-51 and SS-116 had elevated concentrations of tetrachloroethene. Sample RO-51 had the highest concentrations of this compound with a concentration of tetrachloroethene at 5,000 ug/kg. Sample RO-51 also contained 2-butanone at 17,000 ug/kg. Sample SS-116 contained 150 ug/kg of acetone.

Areas east of the plant were used for drum storage and tank storage. Sample SS-113, SS-112, SS-110, SS-136, SS-106, RO-49, and RO-48 were collected in this area. Samples Ss-110 and RO-49 contained acetone at 25,000 ug/kg. The rest of the samples in this area were relatively clean.

Most of the VOC contamination was found in the northeast portion of Area A. There were 11 samples that had total VOC concentrations greater than 150 ug/kg. The maximum total VOC concentration in this area was 81,078 ug/kg. This portion of Area A contained an excavated pit which had previously been a disposal lagoon and drum tank storage area. The rest of Area A contained sporadic contamination.

4.3.3.2 Semivolatiles and Pesticides/PCBs

In study area A, the majority of contaminated samples were located east of the Fisher-Calo Plant. Isophorone, bis(2-ethylhexyl)phthalate and PAHs were detected in the majority of thse samples. Bis (2-ethylhexyl)phthalate was detected in one of the background samples at a concentration of 160 ug/kg. Tables 4-5A and 4-5B indicate which semivolatiles were detected in Area A.

The semivolatile organic constituents (SVOCs) found at Fisher-Calo can be divided into three broad chemical groups: 1) aromatic compounds, 2) polycyclic aromatic hydrocarbons (PAHs) and 3) phthalates.

The aromatic compounds found at this site include di- and trichlorobenzenes, hexachlorobenzene, phenol, methylphenols, nitrophenols, pentachlorophenol, dibenzofuran, and isphorone. These aromatic compounds have a variety of industrial and laboratory uses. The most common uses for aromatic compounds are solvents; paint, lacquer, and varnish thinners; intermediates in the manufacture of dyes and resins; aviation gasoline and high octane stock; explosives; manufacturing intermediates for detergents, plastics and nylon; degreasers, metal polishers; pesticides and insecticides; and a number of other commerical applications.

The polycyclic aromatic hydrocarbons (PAHs) found at Fisher-Calo include: naphthalene, anthracene, phenanthrene, fluorene, fluoranthene, pyrene, benzo(b)fluoranthene, benzo(k)fluoranathene, and benzo(g,h,i) perylene. PAHs are found naturally in shale and coal tars (from coal and oil deposits). The disposal of waste oils and creosote is a common source of PAHs contamination. PAHs also result from the combustion of wood and oil with the resultant airborne particles traveling some distances, and then settling out in another area. PAH contamination therefore may result from the dumping of waste oil, the burning of garbage and debris, from airborne contamination, or from naturally occurring shales and coal deposits.

The phthalates found at Fisher-Calo include: bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, di-n-octyl phthalate, butyl phthalate, diethyl phthalate, butylbenzylphthalate, and dimethyl phthalate. Phthalates are used as plasticizers with widespread applications. Phthalates are common laboratory collection contaminants. Therefore, many of the low level detections can be attributed to laboratory contamination. However, due to the presence of plastic waste and old acid containers in many areas at the site, phthalates can be considered legitimate detections. Phthalate detections were considered contamination when they were present at high concentrations and were found in samples with other contamination.

A number of target compounds (Table 4-1) were found in Area A. A total of nine surface soil samples and nine runoff soil samples showed isophorone at concentrations ranging from 2/ug/kg to 36,000 ug/kg. Bis(2-ethylhexyl)phthalate was detected in 26 samples at concentrations ranging from 86 ug/kg up to 150,00 ug/kg in sample SS-101. Total PAHs were also detected in eleven surface soil samples ranging from 129 ug/kg up to 5,760 ug/kg found in sample SS-100. Also detected in sample SS-100 were phenol (2,400 ug/kg), 4-methylphenol, and 2,4-dimethylphenol (2,600 ug/kg).

The most contaminated location in Area A was sample SS-101, located next to the Fisher-Calo Plant in the area of the tank farm. Compounds detected in this sample include phenol (600 ug/kg), 2,4,6-trichlorophenol (550 ug/kg) butylbenzylphthalate, di-n-octylphthalate (15,000 ug/kg each) bis(2-ethylhexyl)phthalate, dibenzofuran (390 ug/kg) and a number of PAHs.

BNA compounds were detected in five runoff samples, RO-45, RO-47, RO-49, RO-50 and RO-51. These five samples are located in or near the excavated pit, and from the soil pile taken from the excavated pit area. Isophorone was found in all these samples with a maximum concentration of 36,000 ug/kg in sample RO-49. Bis(2-ethylhexyl)phthalate was detected in sample RO-51 at 33,000 ug/kg. The other compounds found in the runoff samples were phenol, 4-methylphenol and PAHs.

No pesticide compounds were detected in any of the surface soil or runoff samples in study area A. Two PCB compounds were detected in the surface soil samples collected from this area. PCB-1254 was detected in the following seven samples: SS-111, SS-121, RO-47, RO-49, RO-50, RO-52 and RO-53. These samples were located in and near the excavation pit and soil pile northeast of the Fisher-Calo Two-Line Facility. The concentrations ranged from 12 ug/kg up to 550 ug/kg. PCB-1260 was also detected in seven other soil samples. None of the samples containing PCB-1254 showed any detection of PCB-1260. The concentrations of PCB-1260 ranged from 34 ug/kg found in sample RO-45 up to 120,000 ug/kg detected in sample SS-105. These

samples were located adjacent to the Fisher-Calo Chemical Plant on the east side of the building. PCBs are used in oil for electrical transformers.

4.3.3.3 Inorganics

All Areas

As discussed earlier, there were two background surface and runoff soil samples identified for this study. These samples were RO-55 and SS-104. The inorganic data for the surface and runoff soils will be compared to the normal range of soil inorganic concentrations in the eastern United States and to the background sample location inorganic concentrations shown in Table 4-6. A summary of the surface and runoff sample results is shown in Table 4-6A and 4-6B. The background samples all had inorganic constituents lower than normal eastern United States soil ranges except for the following compounds: antimony, cadmium, calcium, silver, thallium, and zinc. There were no eastern United States ranges reported for cadmium, silver, thallium and cyanide. Therefore, the only background samples that had detections greater than the normal eastern United States ranges were antimony, calcium, and zinc.

For the purpose of this investigation, the inorganic data will be compared to the normal eastern United States ranges; any detection higher than the high end of these ranges will be considered a contaminant. For inorganic compounds that have no reported normal ranges, anything above 5 ppm will be considered a contaminant, except for cyanide; anything above 2 ppm will be condisered a contaminant due to cyanide's greater health risk. Antimony was noted to be present at levels greater than normal soil ranges in surface soil and runoff samples throughout all study areas cn the site, as well as in subsurface soils (discussed in Section 4.4). Based on these sample results, the background concentration of antimony at the Fisher-Calo site is in the range of 5 to 10 mg/kg, considerably higher than normal ranges for soils in the easter United States (Table 4-6). The high levels of antimony at the site may be accounted for by past uses of antimony in

TABLE 4-6

INORGANIC MAXIMUM BACKGROUND CONCENTRATIONS (mg/kg)

Compound	RO5	SS-104	"Normal" Range of 95% of samples in the Eastern United States[a]
Aluminum	2520	4360	4000 - 272,000
Antimony	5.0	9.1	0.09 - 2.95
Arsenic	2.35	-	0.73 - 31.5
Barium	35	52	53 - 1600
Baryllium	1.1	-	0.09 - 3.5
Cadmium	3.3	0.6	NA
Calcium	41700	548	358 - 32,200
Chromium	6.4	6.3	4.9 - 223
Cobalt	3.3	2.4	0.9 - 39
Copper	11.0	4.0	1.7 - 100
Iron	5860	5670	1700 - 115,000
Lead	44	23	3.7 - 53
Magnesium	20600	742	170 - 26,000
Manganese	391	103	18 - 3800
Mercury	-	-	0.01 - 0.51
Nickel	9.0	9.1	1.6 - 77
Potassium	240	310	6800 - 21,000
Selenium	0.6	-	0.05 - 1.8
Silver	1.3	-	NA
Sodium	53	30	120 - 52,000
Thallium	0.8	-	NA
Tin	-	-	0.1 - 6.8
Vanadium	8.1	6.9	6.8 - 270
Zinc	747	46.0	9.0 - 180
Cyanide	2.7	-	NA

a = Source: Shacklette and Boengen, 1984
nd = Analyzed for but not detected
NA = Data not available
- = Not analyzed for

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TABLE 4-6A

INORGANIC CONTAMINANTS IN SURFACE SOILS AT FISHER-CALO
COMPARED TO THOSE IN SURFACE SOILS IN THE EASTERN UNITED STATES
Summary of Surface Soil Samples

		Eastern U.S. Surface Soils		Fisher-Calo Samples Above Eastern U.S. Background Range			
Element	*CAS*	*Average*	*Range*	*Hits / Samples*	*Max*	*Average*	*St. Dev.*
AREA A							
Antimony	7440-36-0	0.76	0.09 - 2.95	21 / 52	72.0	12.5	13.8
Beryllium	7440-41-7	0.85	0.09 - 4	1 / 52	7.3	7.3	
Cadmium	7440-43-9	◊	◊	19 / 52	5.6	1.7	1.2
Calcium	7440-70-2	6,300	358 - 32,200	7 / 52	191,000.0	96,214.2	59,184.1
Copper	7440-50-8	22	1.7 - 100	1 / 52	274.0	274.0	0.0
Cyanide	74-90-8	◊	◊	19 / 52	3,295.0	190.0	752.5
Lead	7439-92-1	17	3.7 - 53	6 / 52	1,070.0	280.0	391.1
Magnesium	7439-95-4	4,600	170 - 26,000	2 / 52	90,600.0	69,500.0	29,834.9
Manganese	7439-96-5	640	18 - 3,800	1 / 52	4,300.0	4,300.0	
Mercury	7439-97-6	0.12	0.01 - 0.51	3 / 52	1.2	0.8	0.3
Nickel	7440-02-0	18	1.6 - 77	1 / 52	174.0	174.0	
Thallium	7440-28-0	◊	◊	4 / 52	0.8	0.6	0.1
AREA B							
Antimony	7440-36-0	0.76	0.09 - 2.95	5 / 34	98.0	26.0	40.0
Cadmium	7440-43-9	◊	◊	1 / 34	14.6	14.6	
Calcium	7440-70-2	6,300	358 - 32,200	1 / 34	37,900.0	37,900.0	
Chromium	7440-47-3	52	4.9 - 223	1 / 34	556.0	556.0	
Copper	7440-50-8	22	1.7 - 100	1 / 34	3,330.0	3,330.0	
Cyanide	74-90-8	◊	◊	2 / 34	94.0	47.0	66.0
Lead	7439-92-1	17	3.7 - 53	6 / 34	116.0	70.0	23.0
Potassium	7440-09-7	12,000	6,800 - 21,000	1 / 34	25,400.0	25,400.0	
Silver	7440-22-4	◊	◊	1 / 34	5.1	5.1	
AREA C							
Antimony	7440-36-0	0.76	0.09 - 2.95	9 / 32	101.0	22.4	31.5
Cadmium	7440-43-9	◊	◊	10 / 32	104.0	31.6	37.3
Calcium	7440-70-2	6,300	358 - 32,200	6 / 32	145,000.0	69,816.6	38,050.4
Chromium	7440-47-3	52	4.9 - 223.00	6 / 32	12,000.0	4,168.6	5,451.8
Cobalt	7440-48-4	9.2	0.9 - 39	1 / 32	93.9	93.9	
Copper	7440-50-8	22	1.7 - 100	7 / 32	5,690.0	1,333.4	1,938.4
Cyanide	74-90-8	◊	◊	15 / 32	89.8	23.3	39.2
Iron	7439-89-6	25,000	1700 - 115,000	2 / 32	185,000.0	161,500.0	33,234.0
Lead	7439-92-1	17	3.7 - 53.00	9 / 32	4,770.0	1,187.1	1,452.2
Magnesium	7439-95-4	4,600	170 - 26,000	2 / 32	82,800.0	57,050.0	36,415.9
Nickel	7440-02-0	18	1.6 - 77	7 / 32	482.0	301.2	150.7
Silver	7440-22-4	◊	◊	5 / 32	4.4	3.3	0.7
Thallium	7440-28-0	◊	◊	1 / 32	0.4	0.4	
Zinc	7440-66-6	52	9 - 180	8 / 32	3,550.0	1,825.5	1,924.6
AREA D							
Antimony	7440-36-0	0.76	0.09 - 2.95	1 / 9	10.0	10.0	
Cadmium	7440-43-9	◊	◊	1 / 9	1.2	1.2	
Cyanide	74-90-8	◊	◊	1 / 9	0.7	0.7	
AREA E							
Antimony	7440-36-0	0.76	0.09 - 2.95	4 / 7	9.6	8.7	0.7
Cadmium	7440-43-9	◊	◊	4 / 7	6.0	2.3	2.4
Cyanide	74-90-8	◊	◊	3 / 7	1.2	0.9	0.2

◊ No established limit

TABLE 4-6B

INORGANIC CONTAMINANTS IN SURFACE SOILS AT FISHER-CALO COMPARED TO THOSE IN SURFACE SOILS IN THE EASTERN UNITED STATES

Summary of Soil Runoff Samples

		Eastern U.S. Surface Soils		Fisher-Calo Samples Above Eastern U.S. Background Range			
Element	*CAS*	*Average*	*Range*	*Hits / Samples*	*Max*	*Average*	*St. Dev.*
AREA A							
Antimony	7440-36-0	0.76	0.09 - 2.95	4 / 17	13	8.1	3.5
Calcium	7440-70-2	6,300	358 - 32,200	2 / 17	88,700	63,400.0	35,779.6
Cyanide	74-90-8	◊	◊	6 / 17	35	6.8	13.8
Lead	7439-92-1	17	3.7 - 53	2 / 17	59	58.5	0.7
Mercury	7439-97-6	0.12	0.01 - 0.51	1 / 17	0.54	0.5	
Nickel	7440-02-0	18	1.6 - 77	1 / 17	1,970	1,970.0	
Silver	7440-22-4	◊	◊	2 / 17	1.3	1.3	
Thallium	7440-28-0	◊	◊	4 / 17	0.8	0.7	0.05
Zinc	7440-66-6	52	9 - 180	2 / 17	1,260	751.5	719.1
AREA B							
Antimony	7440-36-0	0.76	0.09 - 2.95	22 / 22	7.9	6.6	0.4
Cadmium	7440-43-9	◊	◊	6 / 22	9.7	3.9	3.3
Calcium	7440-70-2	6,300	358 - 32,200	1 / 22	33,900.0	33,900.0	
Cyanide	74-90-8	◊	◊	12 / 22	1.1	0.6	0.1
Lead	7439-92-1	17	3.7 - 53	12 / 22	558.0	239.1	188.7
Selenium	7782-49-2	0.45	0.05 - 1.8	1 / 22	2.1	2.1	
Silver	7440-22-4	◊	◊	3 / 22	1.2	1.0	0.1
Thallium	7440-28-0	◊	◊	7 / 22	0.8	0.5	0.1
Zinc	7440-66-6	52	9 - 180	8 / 22	1,340.0	567.5	466.6
AREA C							
Cadmium	7440-43-9	◊	◊	1 / 9	23.5	23.5	
Calcium	7440-70-2	6,300	358 - 32,200	1 / 9	37,300.0	37,300.0	
Cyanide	74-90-8	◊	◊	1 / 9	2.0	1.3	0.5
Lead	7439-92-1	17	3.7 - 53.00	4 / 9	110.0	110.0	
Silver	7440-22-4	◊	◊	1 / 9	1.4	1.4	
Sodium	7440-23-5	7,800	120 - 52,000	1 / 9	54,300.0	54,300.0	
Thallium	7440-28-0	◊	◊	1 / 9	0.5	0.4	
Zinc	7440-66-6	52	9 - 180	1 / 9	182.0	182.0	
AREA D							
Antimony	7440-36-0	0.76	0.09 - 2.95	2 / 3	6.9	6.8	0.1
Calcium	7440-70-2	6,300	358 - 32,200	1 / 3	55,900.0	55,900.0	
Cadmium	7440-43-9	◊	◊	1 / 3	1.8	1.8	
Cyanide	74-90-8	◊	◊	2 / 3	10.2	5.5	6.6
Silver	7440-22-4	◊	◊	1 / 3	1.3	1.3	
Thallium	7440-28-0	◊	◊	2 / 3	0.8	0.6	0.2
AREA E							
Antimony	7440-36-0	0.76	0.09 - 2.95	1 / 2	9.2	9.2	
Cadmium	7440-43-9	◊	◊	1 / 2	0.9	0.9	
Silver	7440-22-4	◊	◊	1 / 2	1.1	1.1	
Thallium	7440-28-0	◊	◊	1 / 2	0.8	0.8	

◊ Has no established limit

ammunitions manufacture, since two prominent uses for the metal are as hardening alloys for lead and in pyrotechnics.

Area A

Inorganic compounds detected in Area A at higher concentratins that normal eastern U.S. soil ranges include: antimony, beryllium, cadmium, calcium, cyanide, copper, lead, mercury, magnesium, manganese, nickel and thallium. Calcium and magnesium are commonly found in most soils and do not pose a health threat. Thallium was detected in seven samples but had a maximum concentration of 0.81 mg/kg. Mercury was also found in very low concentrations (maximum concentration 2.1 mg/kg) at 5 locations on Area A. Mercury was detected in the surface soil samples SS-81, SS-82, SS-87, SS-88 and SS-91. These five samples were all located at the southern end of the property.

Copper and manganese were found at elevated levels in only one location each. Copper was found at a concentration which was not much higher than normal ranges. Manganese was also not significantly higher than normal ranges. A slightly elevated level of beryllium was detected at only are location. There were no established eastern United States averages for cadmium which was detected at 19 locations with a maximum of only 7.3 mg/kg. All of these inorganic constituents (copper, manganese, beryllium and cadmium) do not pose a source of continuing contamination because they were found at low concentrations and at only a limited number of locations.

Antimony was detected in twenty-two samples, with a maxium concentration of 72 mg/kg found in sample SS-92. Sample SS-92 was the only sample in this area with an antimony concentration above 15 mg/kg. Antimony may be naturally high in this area, and most samples with elevated levels may not be the result of contamination. The fact that the concentration levels of antimony were detected at approximately the same value indicated that most antimony was not from a point source but distributed evenly in the soil from this area. This tends to indicate a natural source of antimony, except in the case of SS-92.

Lead and cyanide concentrations were generally at elevated levels in Area A. Lead was detected in eight samples with a maximum concentration of 1070 mg/kg. These samples were mainly located to the east of the Fisher-Calo Two-Line Facility along the length of the building. Cyanide was detected in twenty-three samples with a maximum concentration of 3,295 mg/kg. In most of Area A, cyanide was found at low concentrations. However, samples which had cyanide concentrations above 50 mg/kg were located just east of the Fisher-Calo Two-Line Facility toward the north side of Study Area A and trend east to the excavated pit.

As discussed in Section 4.4.2, most of the inorganics were found mainly in the top five feet of the unsaturated zone and concentrations declined to lower levels beneath ten feet. Only cyanide, zinc, and antimony were found at elevated levels in soils deeper than 10 feet (as deep as 45 feet). However, most of the high levels of cyanide, zinc, and antimony were found in the upper ten feet of soil. The inorganics are also not found at elevated levels in the groundwater from this area. This may also indicate that the inorganic constituents have not migrated.

4.3.4 SURFACE SOIL AND RUNOFF SOIL RESULT: AREA B

Area B encompasses the New Plant Life Facility on Two-Line Road. A total of twenty-two surface soil samples and nine runoff soil samples were collected in Area B. The samples collected in Area B include SS-09 to SS-67, SS-69 to SS-76, RO-16 to RO-32 and RO-34 to RO-38. Area B contains a solid waste pit, storage tank areas, a spill area, a tanker, empty fiberglass tanks, a drum storage area and soil piles from an excavated ditch. Organic sample results for the surface and runoff soil samples from Area B were summarized in Tables 4-7A and 4-7B. Figure 4.3-8 illustrates the general distribution of total organic (VOC + SVOC) contamination in Area B.

TABLE 4-7A

ORGANIC CONTAMINANT CONCENTRATIONS IN SURFACE SOILS AT FISHER-CALO
Summary of Surface Soil Samples (ppb)

Area B

Volatile Organics	*CAS*	*Hits / Samples*	*Min Max*	*Average*	*St. Dev.*
1,1,1-TRICHLOROETHANE	71-55-6	5 / 34	10 - 41	26.4	12.0
2-BUTANONE	78-93-3	2 / 34	4 - 4	4.0	0.0
4-METHYL-2-PENTANONE	108-10-1	1 / 34	17 - 17	17.0	
ACETONE	67-64-1	7 / 34	22 - 7,600	1,783.1	2,937.2
BENZENE	67-64-1	4 / 34	0.3 - 2	0.8	0.7
CARBON DISULFIDE	75-15-0	6 / 34	1 - 10	5.0	3.2
ETHYLBENZENE	100-41-4	1 / 34	0.9 - 0.9	0.9	0.0
METHYLENE CHLORIDE	75-09-2	13 / 34	6 - 170	113.0	48.8
TETRACHLOROETHENE	127-18-4	2 / 34	2.5 - 24	13.2	15.2
TOLUENE	108-88-3	4 / 34	1 - 22	7.5	9.7
XYLENES	1330-20-7	5 / 34	4 - 9	6.0	2.3
Base-Neutral-Acids					
Acenaphthene	83-32-9	1 / 34	370 - 370	370.0	
Anthracene	120-12-7	1 / 34	640 - 640	640.0	
Benzo(a)anthracene	56-55-3	1 / 34	2,800 - 2,800	2,800.0	
Benzo(a)pyrene	50-32-8	1 / 34	5,500 - 5,500	5,500.0	
Benzo(b)fluoranthene	250-99-2	2 / 34	230 - 5,600	2,915.0	3,797.1
Benzo(g,h,i)perylene	191-24-2	1 / 34	3,900 - 3,900	3,900.0	
Benzo(k)fluoranthene	207-08-9	1 / 34	3,200 - 3,200	3,200.0	
Bis(2-ethylhexyl)phthalate	117-81-7	19 / 34	53 - 260,000	59,046.6	192,762.0
Chrysene	218-01-9	2 / 34	3,000 - 3,000	3,000.0	0.0
Dibenzo(a,h)anthracene	53-70-3	1 / 34	1,400 - 1,400	1,400.0	
Diethylphthalate	84-66-2	7 / 34	240 - 470	310.0	111.9
Dimethyl Phthalate	131-11-3	1 / 34	66 - 66	66.0	
Di-n-butylphthalate	84-74-2	19 / 34	24 - 1,900	304.9	409.7
Di-n-octyl Phthalate	117-84-0	1 / 34	88 - 88	88.0	
Fluoranthene	206-44-0	4 / 34	19 - 3,800	1,034.7	1,844.9
Fluorene	86-73-7	1 / 34	230 - 230	230.0	
Indeno(1,2,3-cd)pyrene	193-39-5	1 / 34	4,200 - 4,200	4,200.0	
Isophorone	78-59-1	14 / 34	45 - 14,000	3,331.0	4,257.0
Phenanthrene	85-01-8	4 / 34	41 - 2,300	660.0	1,095.6
Pyrene	129-00-0	4 / 34	24 - 4,300	1,161.0	2,094.0
Pesticides and PCBs					
AROCLOR-1260	11096-82-5	3 / 34	113 - 17,000	5,744.3	9,747.6

TABLE 4-7B

ORGANIC CONTAMINANT CONCENTRATIONS IN SURFACE SOILS AT FISHER-CALO
Summary of Soil Runoff Samples (ppb)

Area B

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
TOLUENE	108-88-3	2 / 25	3 - 6	4	2
1,1,1-TRICHLOROETHANE	71-55-6	7 / 25	12 - 53	25	16
BENZENE	71-43-2	2 / 25	0.6 - 2.0	1.3	1
CARBON DISULFIDE	75-15-0	2 / 25	1 - 2	2	1
CHLOROBENZENE	108-90-7	1 / 25	21 - 21	21	
ETHYLBENZENE	100-41-4	1 / 25	24 - 24	24	
METHYLENE CHLORIDE	75-09-2	6 / 25	50 - 180	94	51
TETRACHLOROETHENE	127-18-4	1 / 25	5 - 5	5	
XYLENES	1330-20-7	1 / 25	140 - 140	140	
Base-Neutral-Acids					
Phenol	108-95-2	2 / 25	12 - 100	56	62
2-Chlorophenol	95-57-8	1 / 25	160 - 160	160	
1,3-Dichlorobenzene	541-73-1	1 / 25	3,400 - 3,400	3,400	
1,4-Dichlorobenzene	106-46-7	1 / 25	4,300 - 4,300	4,300	
1,2-Dichlorobenzene	95-50-1	1 / 25	15,000 - 15,000	15,000	
Isophorone	78-59-1	13 / 25	83 - 15,000	4,072	4,539
Benzoic Acid	65-85-0	3 / 25	4 - 2,300	770	1,325
4-Chloro-3-methylphenol	59-50-7	1 / 25	170 - 170	170	
2-Methylnaphthalene	91-57-6	1 / 25	2,000 - 2,000	2,000	
Acenaphthylene	208-96-8	1 / 25	85 - 85	85	
4-Nitrophenol	100-02-7	1 / 25	100 - 100	100	
Diethylphthalate	84-66-2	2 / 25	200 - 470	335	191
Phenanthrene	85-01-8	2 / 25	18 - 100	59	58
Dibenzo(a,h) anthracene	53-70-3	1 / 25	300 - 300	300	
Anthracene	120-12-7	1 / 25	77 - 77	77	
Di-n-butylphthalate	84-74-2	15 / 25	25 - 1,300	338	326
Fluoranthene	206-44-0	4 / 25	17 - 1,700	608	788
Pyrene	129-00-0	4 / 25	54 - 1,500	804	598
Benzo(a)anthracene	56-55-3	1 / 25	790 - 790	790	
bis(2-ethylhexyl)phthalate	117-81-7	20 / 25	28 - 55,000	5,286	12,349
Chrysene	218-01-9	2 / 25	16 - 1,200	608	837
Benzo(b)fluoranthene	250-99-2	1 / 25	1,400 - 1,400	1,400	
Benzo(k)fluoranthene	207-08-9	1 / 25	1,400 - 1,400	1,400	
Benzo(a)pyrene	50-32-8	1 / 25	1,300 - 1,300	1,300	
Indeno(1,2,3-cd)pyrene	193-39-5	1 / 25	1,000 - 1,000	1,000	
Pesticides and PCBs					
4,4-DDT	50-29-3	1 / 25	42 - 42	42	
AROCLOR-1260	11096-82-5	15 / 25	41 - 14,000	2,032	3,703

4.3.4.1 Volatiles

In Study Area B, the majority of sample locations were relatively uncontaminated with total VOCs of less than 100 ug/kg. Many locations had no VOC compounds detected. Out of 56 samples, 12 samples had total VOCs above 100 ug/kg. These samples were located mainly around the solid waste pit located in the northeast corner of Area B. Some scattered sample locations with total VOCs detections were located just to the east of the New Plant Life Facility.

Acetone and methylene chloride were detected at the greatest number of locations and at the highest concentration levels. Other VOCs detected in Area B include 1,1,1-tri-chloroethane, chlorobenzene, ethylbenzene, xylenes and toluene. 1,1,1-trichloroethane was only detected in TCLP samples and was probably the result of laboratory contamination. Acetone was found in six samples, with sample SS-48 having the highest concentration of acetone at 7600 ug/kg.

Methylene chloride was detected in nine samples. Sample S-76 had the highest level of methylene chloride at 160 ug/kg. Methylene chloride is a common laboratory contaminant. However, laboratory contamination is unlikely in this case, because the samples with contamined methylene chloride were all located near the same area (the solid waste pit) and were found in samples with other detected VOCs.

VOCs were detected in a number of samples taken from the depression area containing solid waste, located east of th New Plant Life Facility. There were six samples in this area were acetone and methylene chloride with minor amounts of toluene.

Tetrachloroethene was detected in one sample (SS-58) at a concentration of 25 ug/kg. SS-58 is located just east of the New Plant Life Facility.

4.3.4.2 Semivolatiles and Pesticides/PCBs

In study Area B, the majority of surface soil and runoff samples that were contaminated with BNA compounds were located in the southern end of the property and in the depression area (solid waste pit) on the eastern side of the property. The BNA compounds of concern in Area B include: benzoic acid, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, isophorone and PCB-1260.

Isophorone was detected in both the surface soil and runoff samples. In the surface soil samples it was detected 16 times, with concentrations ranging from 45 ug/kg up to 14,000 ug/kg (sample SS-52). Isophorone was detected 18 times in the runoff samples, with the highest concentration found in sample RO-20 at 15,000 ug/kg. Isophorone is used as a solvent for resins, lacquers and pesticides. The highest concentration of isophorone were detected near the solid waste pit and near the soil piles from an excavated ditch on the southeast portion.

Also detected in a number of samples was bis(2-ethylhexyl)phthalate. This compound was detected at concentrations greater than 1,000 ug/kg in 14 surface soil samples and in 10 runoff samples. The highest concentrations were detected in samples S-52 (260,000 ug/kg) and RO-35 (55,000 ug/kg). Sample Ss-52 was located near the soil piles from the excavated ditch and sample RO-35 was from the solid waste pit.

Total PAHs were detected at levels greater than 100 ug/kg in nine samples, five in surface soil samples and four in runoff samples SS-66 at 41,240 ug/kg. PAHs are found in oils and gasoline and may be formed as a result of combustion.

Other compounds were detected only in the runoff samples. RO-34 had concentrations greater than 2,200 ug/kg of 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene and 1,2,4-trichlorobenzene. Benzoic acid was found in sample RO-18 at 2,300 ug/kg and phenol was detected at 100 ug/kg in sample RO-36.

PCB-1260 was detected at 18 soil sample locations in study Area B. The concentrations detected ranged from 113 ug/kg up to 17,000 ug/kg found in sample SS-56. Sample RO-23 had a concentration of 14,000 ug/kg. The hihest concentrations of PCB-1260 were found at the solid waste pit and the excavated ditch. In sample RO-37, 4,4-DDT was found at a concentration of 42 ug/kg. No other pesticide compounds were detected in any of the samples.

4.3.4.3 Inorganics

The results for inorganic compounds are compared to the normal range of soil samples in the eastern United States, as discussed for Area A. The inorganic compounds detected in Area B that were detected above the established criteria include nickel, antimony, zinc, lead, and copper. A summary of inorganic compounds detected in Area B surface and runoff soils was shown in Table 4-6 and 4-6A.

Antimony was detected in 24 samples above normal soil ranges, with sample SS-44 having the highest concentration of 98.4 mg/kg. However, not including sample SS-44, the range of antimony in this area is 6.1 mg/kg to 9.9 mg/kg. This tends to indicate that the levels of antimony detected at Fisher-Calo may be regional background levels and not an indication of contamination, except for some isolated high concentration found in a few samples.

Nickel was detected in two samples. The highest detected concentration of nickel was 1970 mg/kg. Zinc was found in four samples above the established background level. The maximum level of zinc detected was 1340 mg/kg in sample RO-22. Copper was found in two locations with a maximum concentration of 738 mg/kg in sample SS-44. Lead contamination occurred the most frequently. Lead was detected in 18 samples that ranged from 589 mg/kg in sample SS-47 to 58 mg/kg in sample SS-59. The majority of inorganic contamination was found in a relatively small area which was located between the two buildings located south of the New Plant Life Building.

4.3.5 SURFACE SOIL AND RUNOFF SOIL RESULTS: AREA C

Area C encompasses the Cardinal Chemical plant and surrounding areas. Forty-one samples were collected in Area C, including Samples SS-09 to SS-34, SS-68, SS-127 to SS-131 and RO-05 to RO-13. Area C contains areas of stressed vegetation, stained areas, a discharge pond, old tank and drum storage areas, old waste lagoons, old fill areas, and a solid waste pit. Organic analysis results for the surface and runoff soil samples collected in Area C were summarized in Tables 4-8A and 4-8B. Figure 4.3-9 illustrates the general distribution of total organic (VOC + SVOC) contamination in Area C.

4.3.5.1 Volatiles

The majority of sample locations in Area C had total VOCs of less than 100 ug/kg. Out of a total of 41 locations thirteen samples had total VOCs exceeding a concentration of 100 ug/kg. The most contaminated sample was SS-22, located in the vicinity of an old waste lagoon. Sample SS-22 contained vinyl chloride (140 ug/kg), acetone (930 ug/kg), 2-butanane (260 ug/kg), trichloroethene (250 ug/kg), 4-methyl-2-pentanone (330 ug/kg), tetrachloroethene (380 ug/kg), toluene (1,200 ug/kg), ethylbenzene (1,600 ug/kg) and total xylenes (5,900 ug/kg). Acetone was detected with the most frequency. Acetone was detected 9 times and had a maximum concentration of 23,000 ug/kg in Sample SS-09. This sample was located on the north side of Area C, in an area where stained soils and various solid waste piles were present.

Tetrachloroethene was detected at a concentration of 24,000 ug/kg in sample SS-16. This sample was collected in the vicinity of a truck garage, located east of Cardinal Chemical, in an area where various tankers and trailers were previously kept. Tetrachloroethene was detected in a total of 3 samples from Area C. There were 10 different VOCs found in Area C that were detected at concentrations of 100 ug/kg or above. The VOC

TABLE 4-8A

ORGANIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Surface Soil Samples (ppb)

Area C

Volatile Organics	*CAS*	*Hits / Samples*	*Min Max*	*Average*	*St. Dev.*
1,1,1-TRICHLOROETHANE	71-55-6	12 / 32	4 - 63	24.7	16.8
1,2-DICHLOROETHENE	540-59-0	4 / 32	1 - 39	13.0	17.5
2-BUTANONE	78-93-3	2 / 32	5 - 260	132.5	180.3
4-METHYL-2-PENTANONE	108-10-1	10 / 32	9 - 20	48.1	99.2
ACETONE	67-64-1	11 / 32	7 - 23,000	4,375.0	7,764.7
CARBON DISULFIDE	75-15-0	2 / 32	2 - 2	2.0	0.0
CHLOROBENZENE	108-90-7	1 / 32	11 - 11	11.0	
CHLOROFORM	67-66-3	7 / 32	1 - 300	44.5	112.6
ETHYLBENZENE	100-41-4	5 / 32	1 - 1,600	323.0	713.8
METHYLENE CHLORIDE	75-09-2	10 / 32	2 - 160	40.2	51.1
STYRENE	100-42-5	1 / 32	8 - 8	8.0	
TETRACHLOROETHENE	127-18-4	11 / 32	1 - 24,000	2,234.8	7,219.5
TOLUENE	108-88-3	17 / 32	2 - 1,200	84.1	287.9
TRICHLOROETHENE	79-01-6	8 / 32	1 - 640	115.3	28.6
VINYL CHLORIDE	75-01-4	2 / 32	130 - 140	135.0	7.0
XYLENES	1330-20-7	6 / 32	7 - 5,900	1,075.3	2,372.4
Base-Neutral-Acids					
1,2,4-Trichlorobenzene	120-82-1	2 / 32	240 - 4,100	2,170.0	2,729.4
1,4-Dichlorobenzene	106-46-7	2 / 32	210 - 210	210.0	0.0
2,4,6-Trichlorophenol	88-06-2	2 / 32	140 - 140	140.0	0.0
2,4-Dimethylphenol	105-67-9	5 / 32	76 - 2,500	929.2	958.3
2,4-Dinitrophenol	51-28-5	1 / 32	1,200 - 1,200	1,200.0	
2,4-Dinitrotoluene	121-14-2	2 / 32	130 - 1,800	965.0	1,180.8
2-Methylnapthalene	91-57-6	10 / 32	9.7 - 12,000	2,067.3	3,850.0
2-Methylphenol	95-48-7	4 / 32	230 - 2,800	1,090.0	1,158.3
4,6-Dinitro-2-methylphenol	534-52-1	2 / 32	290 - 8,900	4,595.0	6,088.1
2-Nitrophenol	88-75-5	1 / 32	87 - 87	87.0	
3-Nitroaniline	99-09-2	1 / 32	64,000 - 64,000	64,000.0	
4-Chloro-3-methylphenol	59-50-7	5 / 32	35 - 4,200	1,667.2	2,221.9
4-methylphenol	106-44-5	6 / 32	110 - 860	431.6	328.2
4-Nitrophenol	100-02-7	1 / 32	1,300 - 1,300	1,300.0	
Acenaphthene	83-32-9	5 / 32	36 - 9,200	76.2	66.5
Anthracene	120-12-7	4 / 32	4.7 - 2,300	645.6	1,105.2
Benzoic Acid	65-85-0	5 / 32	190 - 2,400	1,146.0	935.0
Benzo(a)anthracene	56-55-3	5 / 32	71 - 230	137.0	57.4
Benzo(a)pyrene	50-32-8	3 / 32	71 - 290	183.6	109.6
Benzo(b)fluoranthene	250-99-2	5 / 32	60 - 480	216.4	154.9
Benzo(g,h,i)perylene	191-24-2	1 / 32	180 - 180	180.0	
Benzo(k)fluoranthene	207-08-9	4 / 32	25 - 340	176.0	115.1
Bis(2-chloroisopropyl)ether	39638-32-9	2 / 32	140 - 660	400.0	367.6
Phenol	108-95-2	6 / 32	550 - 6,500	3,740.0	2,578.8
Benzyl Alcohol	100-51-6	2 / 32	310 - 420	365.0	77.7
Isophorone	78-59-1	17 / 32	43 - 450,000	32,902.0	109,190.3
Napthalene	91-20-3	8 / 32	19 - 18,000	2,771.2	6,183.5
Dimethyl Phthalate	131-11-3	4 / 32	41 - 220	156.2	137.5
Dibenzofuran	132-64-9	1 / 32	7,900 - 7,900	7,900.0	0.0
Diethylphthalate	84-66-2	2 / 32	6 - 21	13.5	10.6

(Continued on Next Page)

TABLE 4-8A (Cont'd)

ORGANIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Surface Soil Samples (ppb)

Area C

Base-Neutral-Acids (Cont'd)

Fluorene	86-73-7	2 / 32	410 - 15,000	7,705.0	10,316.6
N-nitrosodiphenylamine	86-30-6	2 / 32	1,600 - 2,800	2,200.0	848.5
Hexachlorobenzene	118-74-1	3 / 32	24 - 340	183.6	216.4
Phenanthrene	85-01-8	12 / 32	10 - 24,000	3,427.8	9,701.2
Di-n-butylphthalate	84-74-2	9 / 32	42 - 7,200	2,183.0	2,575.1
Fluoranthene	206-44-0	8 / 32	35 - 2,800	1,500.6	2,782.4
Pyrene	129-00-0	12 / 32	23 - 7,000	1,942.5	2,540.4
Butyl Benzyl Phthalate	85-68-7	16 / 32	66 - 17,000	3,975.8	5,932.5
bis(2-ethylhexyl)phthalate	117-81-7	23 / 32	290 - 280,000	16,869.1	45,385.9
Chrysene	218-01-9	6 / 32	55 - 1,500	415.8	547.9
Di-n-octyl Phthalate	117-84-0	5 / 32	120 - 320	206.0	81.7
Indeno(1,2,3-cd)pyrene	193-39-5	2 / 32	140 - 300	220.0	113.1

Pesticides and PCBs

ALDRIN	309-00-2	1 / 32	53 - 53	53.0	
AROCLOR-1254	11097-69-1	1 / 32	540 - 540	540.0	
AROCLOR-1260	11096-82-5	4 / 32	390 - 18,000	5,747.5	8,243.7

TABLE 4-8B

ORGANIC CONTAMINANT CONCENTRATIONS IN SURFACE SOILS AT FISHER-CALO
Summary of Soil Runoff Samples (ppb)

Area C

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	3 / 12	44 - 100	72	28
4-METHYL-2-PENTANONE	108-10-1	1 / 12	16 - 16	16	
TETRACHLOROETHENE	127-18-4	1 / 12	5 - 5	5	
TOLUENE	108-88-3	3 / 12	2 - 11	6	5
XYLENES	1330-20-7	1 / 12	8 - 8	8	
1,1,1-TRICHLOROETHANE	71-55-6	2 / 12	5 - 8	7	2
METHYLENE CHLORIDE	75-09-2	3 / 12	28 - 44	38	9
CHLOROFORM	67-66-3	4 / 12	2 - 380	154	181
2-BUTANONE	78-93-3	1 / 12	18 - 18	18	
BROMODICHLOROMETHANE	124-48-1	2 / 12	2 - 3	3	1
CARBON TETRACHLORIDE	56-23-5	1 / 12	19 - 19	19	
STYRENE	100-42-5	2 / 12	2 - 8	5	4
Base-Neutral-Acids					
Phenol	108-95-2	4 / 12	42 - 150	86	50
Isophorone	78-59-1	3 / 12	91 - 330	230	124
Benzoic Acid	65-85-0	1 / 12	61 - 61	61	
2,4,6-Trichlorophenol	88-06-2	1 / 12	170 - 170	170	
Di-n-butylphthalate	84-74-2	1 / 12	92 - 92	92	
Fluoranthene	206-44-0	5 / 12	39 - 290	132	112
Phenanthrene	85-01-8	3 / 12	23 - 970	344	543
Pyrene	129-00-0	4 / 12	31 - 280	107	117
Butyl Benzyl Phthalate	85-68-7	4 / 12	26 - 110	61	35
Benzo(a)anthracene	56-55-3	3 / 12	31 - 100	53	32
bis(2-ethylhexyl)phthalate	117-81-7	10 / 12	180 - 16,000	3,891	5,406
Chrysene	218-01-9	6 / 12	34 - 290	122	101
Di-n-octyl Phthalate	117-84-0	1 / 12	68 - 68	68	
Benzo(b)fluoranthene	250-99-2	3 / 12	34 - 310	151	143
Benzo(k)fluoranthene	207-08-9	3 / 12	36 - 240	120	107
Benzo(a)pyrene	50-32-8	1 / 12	64 - 64	64	
Benzo(g,h,i)perylene	191-24-2	1 / 12	140 - 140	140	
Pesticides and PCBs					
AROCLOR-1254	11097-69-1	1 / 9	980 - 980	980	
AROCLOR-1260	11096-82-5	6 / 9	110 - 2,600	818	865

compounds include 2-butanone, acetone, chloroform, ethylbenzene, methylene chloride, tetrachloroethene, toluene, trichloroethene, vinyl chloride, and xylenes.

High levels of contamination were found in three areas within study Area C. A number of contaminants were found in the discharge stream which flows into the discharge pond located at the southeast end of Cardinal Chemical. The solid waste pit on the east side of Area C also contained some contamination. However, the most contaminated area, was located just north of the Cardinal Chemical building in the vicinity of old waste lagoons. Four highly contaminated samples were located in this area including the most contaminated sample in Area C, SS-22, described above. The other three samples were SS-15, SS-20 and SS-21.

4.3.5.2 Semivolatiles and Pesticides/PCBs

Semivolatile contamination in Study Area C, was detected throughout the Cardinal Chemical property. The general pattern of semivolatile detections approximated the contamination pattern for VOCs found in this area. The compounds that were detected most frequently in the surface soils in Area C were isophorone, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, and PAHs. Isophorone was detected in 16 surface soil samples with the maximum concentration found in sample SS-23 at 450,000 ug/kg. A concentration of 81,000 ug/kg was detected in sample SS-22 for isophorone. Samples SS-23 and SS-22 were located to the north of the Cardinal Chemical building, in the vicinity of old waste lagoons. Total PAHs were detected in twelve surface soil samples at concentrations greater than 100 ug/kg and up to 71,400 ug/kg.

Bis(2-ethylhexyl)phthalate and butylbenzylphthalate were detected eleven times and seven times, respectively. In sample SS-22, bis(2-ethylhexyl)phthalate was detected at 280,000 ug/kg and in sample SS-25 butylbenzylphthalate was detected at 17,000 ug/kg.

Compounds from the phenolic group were detected in many samples including SS-16, SS-18, SS-22, SS-23, SS-25, SS-26 and SS-29. Chlorinated benzenes were also detected in a few surface soil samples. Hexachlorobenzene was detected in Samples SS-18, SS-22, SS-25 and SS-26. 1,4-dichlorobenzene and 1,2,4-trichlorobenzene were found in samples SS-22 and SS-31. Sample SS-15 had the only detection of dibenzofuran which was detected at a concentration level of 7,900 ug/kg.

Only three semivolatile compounds were detected in the runoff soil samples. Isophorone was found in three samples at concentrations up to 330 ug/kg. Bis(2-ethylhexyl)phthalate was detected in sample RO-5 at 4,000 ug/kg. PAHs were found in four samples in concentrations ranging from 145 ug/kg up to 2,450 ug/kg.

PCB-1254 was detected in only one sample. RO-06 had a concentration of 980 ug/kg of PCB-1254. Sample RO-06 also had PCB-1260 detected at a concentration of 2,200 ug/kg. Sample RO-06 was located just east of the Cardinal Chemical building in the discharge stream that flows into a discharge pond. PCB-1260 was found in eight other samples ranging from 110 ug/kg up to 18,000 ug/kg found in sample SS-23.

Only two pesticide compounds were detected in samples from Study Area C. Aldrin was found in sample SS-31 at a concentration of 5.3 ug/kg and heptachlor epoxide was detected in sample SS-68 at a concentration of 12 ug/kg.

4.3.5.3 Inorganics

Many surface soil samples (including runoff soil samples) contained excessive levels of inorganic constituents in this area (refer to Tables 4-6A and 4-6B). Inorganic constituents found in this area above eastern United States soil averages include antimony, chromium, cyanide, cadmium, lead, nickel, zinc, cobalt, copper and iron. The overall pattern of inorganic contamination was similar to the organic contamination for surface soils in Area C.

The most highly contaminated sample was SS-22. This sample was located north of the Cardinal Chemical building in the vicinity of old waste lagoons. Sample SS-22 contained the following inorganic contaminants: antimony (40.3 mg/kg), cadmium (23 mg/kg), chromium (1,480 mg/kg), cobalt (93 mg/kg), copper (1,090 mg/kg), iron (180,000 mg/kg), nickel (482 mg/kg), zinc (3,550 mg/kg) and cyanide (148 mg/kg). The other samples in this area were also highly contaminated.

Other contaminated samples include SS-24 and SS-25. These samples were located east of Cardinal Chemical, in an area where stressed vegetation and stained soils had been noted. These samples contained antimony (13.2 mg/kg), cadmium (13.2 mg/kg), chromium (622 mg/kg), copper (745 mg/kg) lead (1,790 mg/kg) nickel (418 mg/kg), zinc (900 mg/kg) and cyanide (56.8 mg/kg.)

In sample SS-31, copper (5,690 mg/kg), iron (138,000 mg/kg), and zinc (3,170 mg/kg) were detected at high concentrations. Many other inorganic compounds were detected at levels above typical soil ranges. Sample SS-130 contained antimony at 101 mg/kg, much higher than normal ranges for soils.

4.3.6 SURFACE SOIL AND RUNOFF SOIL RESULTS: AREA D

Area D is located southeast of the intersection of Hupp Road and One-Line Road surrounding the National Packaging plant. The surface and runoff soil samples collected in Area D included SS-01 to SS-08, SS-132, RO-01, RO-02 and RO-04. This area included storage tanks, waste piles, a spill area, and soil piles which had been excavated from along a ditch and a depression area. Analytical results of the surface and runoff soil samples were summarized in Tables 4-9A and 4-9B. Figure 4.3-10 illustrates the general distribution of total organic (VOC + SVOC) contamination in Area D.

4.3.6.1 Volatiles

The VOC contamination found in Area D was not very extensive. Sample SS-04, located south of the National Packaging facility, showed the

TABLE 4-9A

ORGANIC CONTAMINANT CONCENTRATIONS IN SURFACE SOILS AT FISHER-CALO
Summary of Surface Soil Samples (ppb)

Area D

Volatile Organics	*CAS*	*Hits / Samples*	*Min Max*	*Average*	*St. Dev.*
1,1,1-TRICHLOROETHANE	71-55-6	2 / 9	43 - 170	106.5	89.8
1,1-DICHLOROETHANE	75-34-3	1 / 9	6 - 6	6.0	
4-METHYL-2-PENTANONE	108-10-1	2 / 9	24 - 24	24.0	0.0
ACETONE	67-64-1	2 / 9	6 - 30,000	15,003.0	21,208.9
CARBON DISULFIDE	75-15-0	1 / 9	1 - 1	1.0	
METHYLENE CHLORIDE	75-09-2	2 / 9	22 - 24,000	12,011.0	16,955.0
TETRACHLOROETHENE	127-18-4	1 / 9	5 - 5	5.0	
TOLUENE	108-88-3	1 / 9	4 - 4	4.0	
XYLENES	1330-20-7	1 / 9	1 - 1	1.0	
Base-Neutral-Acids					
Benzoic Acid	65-85-0	1 / 9	1,300 - 1,300	1,300.0	
Bis(2-ethylhexyl)phthalate	117-81-7	2 / 9	610 - 1,600	1,105.0	700.0
Di-n-butylphthalate	84-74-2	2 / 9	120 - 430	275.0	219.2
Phenol	108-95-2	2 / 9	5 - 87,000	43,502.5	61,514.7
Pesticides and PCBs					
4,4'-DDD	72-54-8	2 / 9	15 - 85	50.0	49.9
4,4'-DDE	72-55-9	2 / 9	26 - 74	50.0	33.9
4,4'-DDT	50-29-3	1 / 9	73 - 73	73.0	
Delta-BHC	319-86-8	1 / 9	7 - 7	7.0	
Dieldrin	60-57-1	1 / 9	18 - 18	18.0	
Endrin Ketone	53494-70-5	1 / 9	38 - 38	38.0	
Methoxychlor	72-43-5	1 / 9	1,500 - 1,500	1,500.0	

TABLE 4-9B

ORGANIC CONTAMINANT CONCENTRATIONS IN SURFACE SOILS AT FISHER-CALO
Summary of Runoff Soil Samples (ppb)

Area D

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	1 / 4	240 - 240	240	
4-METHYL-2-PENTANONE	108-10-1	1 / 4	24 - 24	24	
TOLUENE	108-88-3	1 / 4	2 - 2	2	
XYLENES	1330-20-7	1 / 4	15 - 15	15	
1,1,1-TRICHLOROETHANE	71-55-6	1 / 4	24 - 24	24	
CARBON DISULFIDE	75-15-0	1 / 4	4 - 4	4	
TETRACHLOROETHENE	127-18-4	1 / 4	2 - 2	2	
Base-Neutral-Acids					
4-NITROPHENOL	100-02-7	1 / 4	3,100 - 3,100	3,100	
BIS (2-ETHYLHEXYL) PHENOL	117-81-7	1 / 4	11,000 - 11,000	11,000	
Pesticides and PCBs					
HEPTACHLOR EPOXIDE	76-44-8	1 / 4	0.3 - 0.3	0.3	
METHOXYCHLOR	72-43-5	1 / 4	3,700 - 3,700	3,700	

presence of 1,1,1-trichloroethane (170 ug/kg), tetrachloroethene (4 ug/kg) and acetone (22 ug/kg) in the TCLP analysis. The RAS analysis of this sample was relatively clean. This sample was collected in the vicinity of a waste pile, with liquid waste containers, a trailer with drums and acid containers, and other types of solid waste.

The most contaminated sample in Area D is SS-03. This sample had total VOCs of 54,000 ug/kg. Acetone (30,000 ug/kg) and methylene chloride (24,000 ug/kg) were the two contaminants found in SS-03. This sample was collected from a soil pile which was the result of soil excavation activities in the area of a spill. The soils had been removed from a depression area located east of the National Packaging building.

4.3.6.2 Semivolatiles and Pesticides/PCBs

In Area D, 6 samples showed the presence of BNA compounds. The major contaminants found in this area were di-n-butylphthalate bis(2-ethylhexyl)phthalate, phenol and 4-nitrophenol.

Samples SS-03, SS-04 and SS-05 were the most contaminated. Sample SS-03 is located in the soil piles east of National Packaging. This sample contained bis(2-ethylhexyl)phthalate (2,130 ug/kg) and benzoic acid (1300 ug/kg). Bis(2-ethylhexyl)phthalate is a common plasticizer and benzoic acid can be a biologic by-product. Samples SS-04 and SS-05 were collected in the vicinity of a solid waste piles located south of National Packaging. These samples contained bis(2-ethylhexyl)phthalate (1,600 ug/kg) and phenol (87,000 ug/kg). Phenol is used as a solvent and laboratory reagent.

A number of pesticides were detected in the soil samples taken from Area D. Sample SS-04 was the most heavily contaminated sample containing 4,4-DDT (73 ug/kg), 4,4-DDE (74 ug/kg), 4,4-DDD (85 ug/kg) and endrin ketone (38 ug/kg). Dieldrin, delta-BHC and 4,4-DDE were detected in sample SS-05 at concentrations less than 30 ug/kg. Sample SS-01 contained methoxychlor at a concentration of 3,700 ug/kg. No PCB compounds were detected in any of the samples collected in Area D.

4.3.6.3 Inorganics

Zinc and antimony were the only inorganic constituents found in Area D at levels above eastern United States soil averages. Zinc was detected in sample SS-04 at a concentration of 261 mg/kg. Sample SS-04 was taken from a soil pile located south of National Packaging. Antimony was detected at 10 mg/kg in sample SS-132 which was located east and north of National Packaging.

4.3.7 SURFACE SOIL AND RUNOFF SOIL RESULTS: AREA E

Area E encompasses the Roll-Coater facility and American Building Components. Area E was located southwest of the intersection of Hupp Road and Two-Line Road. A total of 9 samples were collected in Area E including SS-35 to SS-41, RO-14 and RO-15. This area contains an excavation pit, an old tank pad and berm, a drum storage area and waste treatment ponds. Organic compounds detected in the surface and runoff soil samples were summarized in Tables 4-10A and 4-10B. Figure 4.3-11 illustrates the general distribution of total organic VOC + SVOC) contamination in Area E.

4.3.7.1 Volatiles

Four samples in Area E had VOCs at elevated concentrations above 100 ug/kg total VOCs. These samples were SS-39, SS-40, SS-41 and RO-14.

Sample SS-41 was located just south of the waste treatment ponds. The only contaminant found in SS-41 was acetone at 120,000 ug/kg. Sample SS-39 was collected from a berm surrounding an old tank pad west of the Roll-Coater facility. It contained acetone at 1,100 ug/kg and xylene at 360 ug/kg. Sample RO-14 was located on the far west side of Area E, in the vicinity of a drainage ditch where stressed vegetation had been noted. Sample RO-14 contained acetone at a concentration of 16,000 ug/kg. Sample SS-40 had total VOCs at 195 ug/kg, with xylene the most abundant contaminant at 140 ug/kg.

TABLE 4-10A

ORGANIC CONTAMINANT CONCENTRATIONS IN SURFACE SOILS AT FISHER-CALO
Summary of Surface Soil Samples (ppb)

Area E

Volatile Organics	*CAS*	*Hits / Samples*	*Min Max*	*Average*	*St. Dev.*
1,1,1-TRICHLOROETHANE	71-55-6	1 / 7	60 - 60	60.0	
4-METHYL-2-PENTANONE	108-10-1	1 / 7	22 - 22	22.0	
ACETONE	67-64-1	2 / 7	1,100 - 120,000	60,550.0	84,074.9
CARBON DISULFIDE	75-15-0	1 / 7	1 - 1	1.0	
CHLOROBENZENE	108-90-7	1 / 7	21 - 21	21.0	
ETHYLBENZENE	100-41-4	1 / 7	24 - 24	24.0	
TETRACHLOROETHENE	127-18-4	1 / 7	5 - 5	5.0	
TOLUENE	108-88-3	1 / 7	15 - 15	15.0	
XYLENES	1330-20-7	1 / 7	360 - 360	360.0	
Base-Neutral-Acids					
1,2,4-Trichlorobenzene	120-82-1	1 / 7	2,200 - 2,200	2,200.0	
1,2-dichlorobenzene	95-50-1	1 / 7	15,000 - 15,000	15,000.0	
1,3-dichlorobenzene	541-73-1	1 / 7	3,400 - 3,400	3,400.0	
1,4-dichlorobenzene	106-46-7	1 / 7	4,300 - 4,300	4,300.0	
2-Methylnaphthalene	91-57-6	1 / 7	2,000 - 2,000	2,000.0	
bis(2-ethylhexyl)phthalate	117-81-7	3 / 7	120 - 1,500	4,873.3	7,071.6
Di-n-butylphthalate	84-74-2	1 / 7	1,300 - 1,300	1,300.0	
Isophorone	78-59-1	1 / 7	120 - 120	120.0	
Napthalene	91-20-3	1 / 7	88 - 88	88.0	
Pyrene	129-00-0	1 / 7	1,500 - 1,500	1,500.0	
Pesticides and PCBs					
Aldrin	309-00-2	1 / 7	670 - 670	670.0	
Heptachlor Epoxide	1024-57-3	1 / 7	87 - 87	87.0	

TABLE 4-10B

ORGANIC CONTAMINANT CONCENTRATIONS IN SURFACE SOILS AT FISHER-CALO
Summary of Runoff Soil Samples (ppb)

Area E

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	1 / 2	16,000 - 16,000	16,000	
Base-Neutral-Acids					
ISOPHORONE	78-59-1	2 / 2	340 - 10,000	5,170	6,831
Pesticides and PCBs					
No Detects					

4.3.7.2 Semivolatiles and Pesticides/PCBs

Only two sample locations in Area E showed semivolatile contamination; RO-15 and SS-39. Sample RO-15, located in an excavated pit west of American Building Components, contained di-N-butyl phthalate (3,500 ug/kg) and bis(2-ethylhexyl)phthalate (10,000 ug/kg).

The most contaminated sample in Area E was SS-39. This sample was located just west of Roll-Coater in a berm around an old tank pad. Sample SS-39 contains 1,3-dichlorobenzene (3,400 ug/kg), 1,4-dichlorobenzene (4,300 ug/kg), 1,2-dichlorobenzene (15,000 ug/kg), 1,2,4-trichlorobenzene (2,200 ug/kg) 2-methylnapthalene (2,000 ug/kg), di-n-butylphthalate (1,300 ug/kg) and pyrene (1,500 ug/kg). The di- and tri-chlorobenzenes are used as solvents for a wide range of organic materials and for oxides of nonferrous metals, and in pesticides.

Pesticides were detected in only one sample in Study Area E. Aldrin and heptachlor epoxide were found in Sample SS-37 at concentrations of 670 ug/kg and 87 ug/kg, respectively. No PCB compounds were found in any samples from this area.

4.3.7.3 Inorganics

The only inorganic consitutent in Area E that was found above the eastern United States soil averages was antimony (Refer to Table 4-6A and 4-6B).

The range of antimony found in this area was 7.9 mg/kg to 9.6 As mentioned earlier, at this concentration, antimony was probably not a contaminant but reflects the elevated level of background concentrations in the vicinity.

4.3.8 SURFACE SOIL AND RUNOFF SOIL RESULTS: SUMMARY

- Volatile organic compounds detected at relatively high concentrations in Area A included acetone, methylene chloride, tetrachloroethene, xylenes, 2-butanone, ethylbenzene and toluene.

- The area with the most volatile organic contamination detected in Area A was in the northeast portion of this study area. The maximum total VOC concentration in this area was 81,078 ug/kg.

- Other areas contaminated with VOCs included the area north of the soil piles adjacent to the excavation pit, the old drum storage areas, and in the vicinity of the tank farm.

- The SVOCs that had the highest level of contamination include isophorone, bis(2-ethylhexyl)phthalate, and PAHs, with lesser amounts of phenol, 4-methylphenol and 2,4-dimethylphenol.

- Although BNAs were scattered throughout Area A, the soil piles and the area near the tank farm had the highest levels of contamination.

- PCBs were found in a number of samples in Area A.

- No pesticides were detected in any samples.

- The inorganic constituents antimony, berylium, cadmium, calcium, cyanide, lead, mercury, magnesium, manganese, nickel and thallium were found at elevated concentrations relative to normal soil ranges.

- The inorganic constituents were found at elevated concentrations throughout Area A but were highest toward the southern end of the property.

- High concentrations of cyanide were detected in samples SS-110 (58 mg/kg), SS-116 (3, 285 mg/kg), SS-98 (68 mg/kg) and SS-99 (111 mg/kg).

A summary of the types of contaminants, the number of detections and their ranges are given in Tables 4-5A and 4-5B for Area A. Figure 4.3-7 illustrates the general distribution of the greatest contamination for Area A.

Area B

- 12 samples had total VOC concentrations above 100 ug/kg.

- The VOCs detected in Area B include acetone, methylene chloride, chlorobenzene, ethylbenzene, xylene and toluene.

- The SVOC compounds detected in Area B include benzoic acid, bis (2-ethylhexyl)phthalate, di-n-butylphthalate and isophorone.

- PCB-1260 was detected in 18 soil samples throughout Area B.

- 4,4-DDT was found in Sample RO-37.

- The inorganic compounds detected in Area B normal soil ranges are nickel, antimony, zinc, lead and copper.

- The highest levels of VOC, SVOC and inorganic contamination occur near the solid waste pit, near the storage tanks east of New Plant Life and between the two buildings south of New Plant Life in Area B.

A summary of the types of contaminants, the number of detections and their ranges are given in Table 4-7A and 4-7B for Area B. Figure 4.3-8 illustrates the general distribution of the greatest contamination for Area B.

Area C

- VOC contamination was found in 13 samples at concentrations of more than 100 ug/kg.

- VOCs detected at the highest levels were acetone, 2-butanone, trichloroethene, methylene chloride, tetrachloroethene, toluene, vinyl chloride and xylenes.

- The SVOCs detected most frequently and at the highest concentrations in Area C included isophorone, total PAHs, bis (2-ethylhexyl)phthalate, butylbenzyl phthalate, compounds from the phenolic group and chlorinated benzenes.

- There are three specific areas within Area C that contain the highest concentrations of VOC and SVOC contamination. These areas are the discharge pond and drainage stream southeast of Cardinal Chemical, the solid waste pit on the east side of Area C, and the area just north of the Cardinal Chemical building which showed the highest levels of contamination.

- Inorganic compounds detected in Area C above normal soil ranges include: antimony, chromium, cyanide, cadmium, lead, nickel, zinc, cobalt, copper and iron.

- Sample SS-22 contained the highest leel of inorganic contamination SS-22 was located north of Cardinal Chemical. High concentrations of inorganic compounds were detected throughout this area.

- PCB-1254 was found in only one sample, RO-06 at 980 ug/kg. PCB-1260 was detected in 8 samples including RO-6 at 2,200 ug/kg and in SS-23 at 18,000 ug/kg.

- Two pesticides, aldrin and heptachlor were detected in Area C.

A summary of the types of contaminants, the number of detections and their ranges are presented in Table 4-8A and 4-8B for Area C. Figure 4.3-9 illustrates the general distribution of the highest contamination levels for Area C.

Area D

- The amount of VOC contamination in Area D was not very extensive. VOCs detected in Area D include methylene chloride, acetone, tetrachloroethene, 4-methyl-2-pentane, 1,1-dichloroethane, xylenes and 1,1,1-trichloroethane.

- The areas of highest contamination in Area D were located south of the National Packaging facility and in the soil piles and adjacent spill area east of National Packaging.

- SVOCs were found in 6 samples in Area D. The SVOCs include di-n-butylphthalate, bis(2-ethylhexyl)phthalate, phenol, 4-nitrophenol, and benzoic acid.

- A number of pesticides were found throughout Area D, including 4,4-DDT, 4,4-DDE, 4,4-DDE, endrin ketone, dieldrin, delta-BHC and methoxychlor.

- No PCBs were detected in Area D.

- Zinc and antimony were the only inorganic constituents found at levels greater than normal soil ranges in Area D.

A summary of the types of contaminants, the number of detections and their ranges are presented in Table 4-9A and 4-9B for Area D. Figure 4.3-10 illustrates the general distribution of the greatest contamination for Area D.

Area E

- Samples SS-39, SS-40, SS-41 and RO-14 contained total VOCs at concentrations above 100 ug/kg.

- The VOCs detected in Area E include acetone and xylene. Contamination was detected just south of the waste treatment pond.

- SVOCs were found in two locations west of American Building Components in an excavated pit and just west of Roll-Coater in the berm surrounding an old tank pad.

- The SVOCs found in Area E include 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichlorobenzene, 1,2-4-trichlorobenzene, 2-methylnaphthalene, di-n-butylphthalate and pyrene.

- Pesticides were detected in only one sample and include aldrin and heptachlor.

- No PCBs were detected in Area E.

- No significant inorganic contamination was found in Area E.

A summary of the types of contaminants, the number of detections and their ranges are presented in Table 4-10A and 4-10B for Area E. Figure 4.3-11 illustrates the general distribution of the greatest contamination for Area E.

4.3.9 SURFACE SOIL AND RUNOFF SOIL: RECOMMENDATIONS

Due to the large number, high concentrations and diversity of contaminants, the surface soils at Fisher-Calo should be remediated. Even though contamination in the soils appeared to be confined to the upper 10 feet of the unsaturated zone (Section 4.4), this contamination may be, or may become a continuing source of groundwater contamination. Each study area within the Fisher-Calo site contains a significant amount of contamination. Elevated levels of contamination are found in specific areas within each of the study areas. These areas should be considered for soil remediation.

1st sentence should be stated in FS

4.4 SUBSURFACE SOIL SAMPLE RESULTS

Subsurface soil samples were collected from both soil borings and from monitoring well borings. Soil borings comprised shallow (total depth generally 4.5 feet) and deep (generally 20 feet) borings, which were sampled every 1.5 to 2.5 feet. Monitoring well borings were generally advanced to the bottom of the upper sand unit (approximately 75 feet); they were sampled at 0.5 and 15 feet, and generally every 15 feet thereafter. The analytical results from soil borings and monitoring well borings are discussed (by area) in the sections that follow. (Refer to Figures 3.3-6 through 3.3-13 for the locations of the subsurface soil samples.) A discussion of the sample depth intervals and sampling protocol used during subsurface soil sample collection is presented in the Hydrogeologic Technical Memorandum, included in Volume III, Appendix A.1.

4.4.1 STANDARDS AND CRITERIA

There are very few regulatory standards that apply to soils; most apply to water or air. The only standard that applies to soils is the U.S. EPA cleanup criteria for PCBs of 50 parts per million (ppm). However, other constituents in soils are of concern because of their potential for migration to other media, such as groundwater or air.

In assessing the results of subsurface soil sampling, the general guideline for organic constituents is that most priority pollutant organics are not present naturally in soils. The main exceptions to this pattern are benzoic acid and the class of compounds known as polycyclic aromatic hydrocarbons (PAHs). Benzoic acid is present in some soils due to its occurrence in animal excrement or plant decay products. PAHs include the following compounds: naphthalene, anthracene, phenanthrene, fluorene, fluoranthene, pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, pyrene, benzo(g,h,i)perylene. These compounds are present in coal tars, which are found in natural shale and coal deposits.

Other sources of PAHs are the disposal of waste oils or creosote, and the combustion of wood or oil. PAHs that originate from combustion are airborne particulates that can travel great distances and eventually settle on the earth's surface. Thus PAHs may be derived from specific site disposal activities such as the dumping of waste oil, or they may result from other causes, such as the existence of coaly deposits in subsurface soils, or the settling of combustion products on surface soils.

To assess the inorganic results of subsurface soil sampling, samples from the Fisher-Calo site were compared to the results of a comprehensive survey of surface soils throughout the United States, conducted by Shacklette and Boerngen (1984). For comparative purposes, their results for eastern U.S. sampling were used to assess the data for Fisher-Calo.

comment - not addressed - should compare to background subsurface samples

4.4.2 GENERAL DISCUSSION OF SUBSURFACE SOIL RESULTS

Before discussing the specific results found in the subsurface soil samples collected from each study area, a number of common trends should be noted.

Most PAHs were detected only in shallow soil samples, generally at depths less than 5 feet. This corresponds to a depth of 10 to 20 feet above the water table. The two PAHs found from deeper samples are naphthalene and methylnaphthalene, which were present at depths up to 20 feet (but at lower

concentrations than near the surface). This pattern is to be expected, because these two compounds have solubilities considerably higher than the other PAHs (the solubility of naphthalene is 32 ppm, while the solubility of other PAHs is less than 4 ppm; U.S. EPA, 1982). Most PAHs, then, are fairly immobile in soil, but naphthalene and methylnaphthalene would be expected to move farther downward beneath the surface.

Semi-volatile organic compounds (SVOCs) other than PAHs were generally limited to the upper 10 to 12 feet of soil, with minor occurrences from as deep as 30 feet; detections below 30 feet were rare. This pattern is similar to that for PAHs, but these compounds are present in soils at somewhat greater depths than PAHs. The shallow depth occurrence of the SVOCs is due to the fact that most SVOCs have low solubility, are easily adsorbed by organic matter in surface soils, and many of the compounds are solids.

Volatile organic compounds (VOCs) have the most widespread occurrence in terms of both area and depth. This would be expected, considering their higher solubilities and volatilities, and the fact that they are mainly liquids and gases. VOCs are present in soils throughout the depth extent of the shallow aquifer (to approximately 75 feet), but are mainly limited to the middle and upper portions of the shallow aquifer. The highest concentration of VOCs are generally found in the unsaturated zone, at depths of less than 12 feet. This pattern might also be expected, considering the relative amounts of water that have likely flushed through the unsaturated zone and the shallow aquifer, respectively, since disposal of contaminants. The results of calculations which take into account the solubility of the compounds detected, and the impact from surface water infiltration and percolation indicate that much more water has likely flowed through the saturated zone per unit volume than has infiltrated down through the unsaturated zone; this would result in more removal of contaminants from the aquifer than from the unsaturated zone. Alternatively, high amounts of VOCs in the unsaturated zone may reflect small or sporadic disposal, so that VOCs may never have reached the saturated zone in high concentrations.

The phthalates were the most predominant contaminants found in the subsurface soil samples. In fact, several entire borings (MW-59, 62 and 65) contained no other constituents. Considering these patterns and the fact that phthalates are common laboratory and sampling method contaminants, many of these occurrences can be discounted. However, almost all of the site study areas have recently had or still do have waste piles which contain varying quantities of acid containers. Most of these containers are made from plasticized rubber materials. So that phthalate results were considered legitimate "hits" (instances of contamination) when reported concentrations were high and other contaminants were detected in the sample.

Similar to the occurrence of PAHs and other SVOCs, metals were consistently present at their highest levels in shallow subsurface soils. In the soil boring samples, they were at their highest in the A-, B-, and C-depth samples (collected at 0-1.5, 1.5-3, and 3-4.5 feet, respectively). Most inorganic constituents decline to low, steady levels beneath a depth of about 10 feet in the subsurface soils. The exceptions are cyanide, zinc, and antimony. While these constituents are generally present at their highest levels in samples above 10 feet, they are also present at anomalous levels in some soils as deep as 45 feet. These constituents are somewhat more soluble than most other inorganics, accounting for their greater depth distribution throughout the aquifer. It should be noted that inorganic samples were not collected below the water table during Phase I of the RI, because it was felt that the presence of inorganic constituents would be detected in groundwater analysis. However, this does not affect the data interpretation to a large extent, since Phase II subsurface soil sampling showed that metals were rarely detected at elevated concentrations in the soils below the water table.

At most locations a portion of the top three sampling intervals were composited into one sample and submitted for leachability analysis for metals. In this analysis, the sample was mixed with distilled water for several days, and the resulting ("leached") solution was analyzed. This

method was chosen in order to simulate the leaching effect of rainwater percolating through the shallow soils. In contrast, the total metals analysis indicates the total quantity of a metal present in a sample, whether or not it is in a leachable form. Thus, the results of these two analytical methods are not expected to provide quantitatively similar results.

Because the leachability analysis provides results for a liquid sample, which is intended to indicate the effects of infiltration, these results are most appropriately compared to groundwater standards. Instances in which leachability results exceed applicable groundwater standards are discussed in the sections that follow. In general, however, leachability samples contained mainly alkalies (sodium, potassium) and alkaline earth elements (calcium, magnesium, barium), with lesser amounts of heavy metals such as iron, copper and zinc; other constituents were sporadically detected. This is to be expected, owing to the relative solubilities of the inorganic constituents and their abundance in soil. High leachability results for heavy metals generally correspond to high levels of total metals. The exception to this trend is mercury, which was detected in some leachability samples but not in corresponding total metals samples. Because mercury is a liquid in its native state, it might be expected to appear in the leachability extract. Its occurrence in the leachability sample but not in the total metals sample could also result from the much lower detection limits for the leachability sample (ppb range, while the total metals soil samples had concentrations reported in the ppm range). The leachability sample collection and analytical methods appear to be appropriate in assessing the leaching effect of infiltrating precipitation. However, this is based only on a qualitative comparison of leachability results with those of total inorganics.

In Phase II subsurface soil sampling, samples were collected and analyzed for organics by the TCLP (Toxic Compound Leaching Procedure) method. This

analysis is designed to indicate whether organic contaminants in the unsaturated zone are susceptible to leaching. This method is analogous to the leachability test for inorganics.

Due to differing analytical methods and slightly different detection limits, results from TCLP can not be quantitatively compared to those for routine (RAS) organics. However, qualitative comparisons can be made. Where RAS analyses gave high organics results (as in borings SB-8, 23, 33 and 36), many of the same compounds were also detected in TCLP samples. Most TCLP detections were considerably lower than those of RAS samples, reflecting the low solubility of most organics (and thus low susceptibility to leaching).

In many borings, only acetone and 4-methyl-2-pentanone (MIBK) were detected in the TCLP sample; the RAS results for some of these samples showed many low-level detections that did not appear in the TCLP results. The fact that many compounds were detected in the RAS samples but not the TCLP samples may reflect the low solubility of most of these constituents. The presence of acetone and MIBK in the TCLP samples, but not in RAS samples, may reflect laboratory contamination. Alternatively, it may derive from a combination of high solubility (acetone and MIBK are miscible with water) and lower detection limits for the TCLP analysis. Acetone and MIBK may indeed be present in the soil samples, but at concentrations too low to be detected in the RAS samples. However, their high solubility would enable them to be easily leached, so that they could appear in the TCLP sample.

Soil samples were also collected and submitted for Special Analytical Services (SAS) analysis for semi-volatiles (BNAs or SVOCs). The purpose of this analysis was to eliminate interferences from unknown hydrocarbons that caused increased detection limits for Phase I subsurface soil samples. In an attempt to offset this interference, the Phase II SAS BNA samples were treated with a solvent to clean the hydrocarbons from the sample, and the remaining portion of the sample was analyzed for BNAs by Routine Analytical Services (RAS) methods. The intended effect of cleaning the

hydrocarbons from the sample was to avoid the need for diluting the sample and, in turn, avoid increasing the detection limits for the BNAs. Unfortunately, the SAS BNA sample results still came out with high detection limits, approximately twice that for typical RAS samples. There was very poor correlation between what was found in the BNA fraction of the RAS and the SAS samples. Commonly, compounds were found in the RAS sample but not the SAS sample. The poor comparison could derive from the differing detection limits for the two methods, or from the loss of some BNA constituents in the process of cleaning the hydrocarbons from the SAS sample.

4.4.3 QA/QC RESULTS

For subsurface soil samples, quality control was assessed through duplicate sampling. Approximately one duplicate sample was collected for every 10 subsurface soil samples collected in both Phase I and Phase II. Due to the heterogeneous nature of soil and the difficulty of collecting identical material for samples and duplicates, the results for soil investigative samples and field duplicates were not expected to be as closely comparable as those for water samples. Considering these limitations, quality control results were fairly good for both Phase I and Phase II.

Results for samples and duplicates were most similar for inorganics analyses. Relative percent deviation (RPD) was less than 30% for most metals (RAS and leachability) in samples from most borings; however, RPD was commonly near 50% in samples from SB-9 and MW-4. Quantitatively, organic constituents compared poorly between sample and duplicate. RPD was commonly greater than 50% for VOCs, SVOCs, pesticides and PCBs. The fact that organics results were less reproducible than inorganics may be due to the fact that inorganics are present as natural soil constituents, while most organics are not. As noted in section 4.4.2, inorganic concentrations are fairly uniform below about 15 feet in suspected disposal areas. The more homogeneous nature of soils with respect to inorganics would account for lower RPDs between samples and duplicates. Significantly, the instances of excessive deviation with respect to metals occur in samples

with high metals concentrations. These occurrences are likely due to the introduction of metals to the soil, resulting in heterogeneous soils and, in turn, poor comparison between sample and duplicate. Likewise, in any sample containing organics, the soil would be expected to be heterogeneous, and samples and duplicates would not compare well quantitatively.

Considering the heterogeneous nature of soil materials, qualitative comparisons of investigative samples and field duplicates are most appropriate in assessing quality control. By qualitative standards, the number of subsurface soil samples from the Fisher-Calo site provided adequate quality control.

4.4.4 SUBSURFACE SOIL RESULTS: BACKGROUND AND UPGRADIENT LOCATIONS

Subsurface soil sample results were obtained from offsite background locations (SB-01 and SL-31) and from onsite areas located upgradient from expected areas of contamination (SB-36 and SL-6B). These locations were sampled in an effort to obtain data that would be representative of subsurface soils from "clean" areas in the vicinity of the site.

Results from the offsite background location SB-01 showed low levels of the pesticides 4,4-DDT and 4,4-DDE at 14 and 18 ppb, respectively, in soils near the surface (0-3' depth intervals). Samples from SL-31 showed elevated concentations of methylenechloride (at 65 ppb) and acetone (at 240 ppb) at the 30-32' depth interval. The presence of elevated VOC concentrations at depths in the saturated zone may indicate the migration of contaminants resulting from the past operations of industries formerly located in an area upgradient from SL-31.

Subsurface soil samples collected at the upgradient onsite locations SB-36 and SL-6B showed elevated concentrations of various VOC and SVOC contaminants. Most of the contamination detected was found at location SB-36. Chlorinated organic solvents (methylene chloride, TCE, PCE, 1,2-DCE and 1,1,1-TCA) were found at location SB-36 in a total concentration of 1,004

ppb; aromatic SVOC's (phenols, isophorone) were detected at a total concentration of 480 ppb; and PAHs at 293 ppb. PCB-1260 at (480 ppb) was also found at location SB-36. These elevated levels of contamination were found in the shallow sample depth intervals (0-3 feet).

Contaminants detected at SL-68 include methylene chloride at 140 ppb, acetone at 3,000 ppb, n-nitrosodiphenylamine at 230 ppb, and phthalates at 4,100 ppb. The acetone and phthalates were found in the sample depth interval at approximately 65'. Methylene chloride and n-nitrosodiphenylamine were found in samples taken from the 0-5' depth intervals.

It was previously stated that locations SB-36 and SL-68 had been selected in an onsite area expected to be upgradient from a suspected contamination area. However, the number and concentration levels of compounds detected at these locations indicated that past drum storage and waste disposal activities in this area may have been more extensive than previously suspected.

4.4.5 SUBSURFACE SOIL RESULTS: STUDY AREA A

Study Area A encompasses the Fisher-Calo facility on Two-Line Road and adjacent areas. The soil borings and monitoring wells installed in Area A were SB-20, 22, 23, 24, 25, 27, 28, 29, 30, and MW-1 and MW-4.

4.4.5.1 Volatiles

Subsurface soil sampling in Study Area A shows that a similar suite of volatiles occurs in most borings. These constituents can conveniently be divided into three major classes: 1) Chlorinated organic solvents, including tetrachloroethene (PCE), 1,1,1-trichloroethane (1,1,1-TCA), methylene chloride, trichloroethene (TCE), cis-1,3-dichloropropene, and trans-1,2dichloroethene (trans-1,2-DCE); 2) non-chlorinated solvents, including toluene, ethylbenzene and xylenes; and 3) ketones (which are also non-chlorinated solvents), including acetone, 4-methyl-2-pentanone (or

methyl isobutyl ketone, MIBK), and 2-butanone (or methyl ethyl ketone, MEK) These contaminants are the main VOCs found at other locations throughout the project study area.

The chlorinated organic solvents are used as degreasers for metal tools and parts and for dry-cleaning applications. The toluene-ethylbenzene-xylene group is found in gasoline in high concentrations, but in such cases is also found with benzene. The occurrence of these chemicals without benzene at Fisher-Calo likely indicates their derivation from solvents (common uses are in paints, paint thinners and non-chorinated degreasing solvents) rather than gasoline. The ketones are used as solvents and as ingredients in paints and coatings.

Organics results for all subsurface soils collected in Area A are summarized in Table 4-11, 4-11A and 4-11B. As with all subsequent tables in this section, this table lists the VOCs (and SVOCs, discussed in section 4.4.4.2) according to the groups mentioned above. The peak levels attained by each group are listed for each boring or well, along with the depth of the sample and the specific compounds present (from highest to lowest abundance). Figure 4.4-1, found in Volume II of this report, summarizes the subsurface soil sampling results for VOCs only. For each boring, the sample with the highest concentration of total VOCs is symbolized. Comprehensive "hits" tables, found in the appendices contained in Volume III of this report, list sample results for all media that were detected at any concentration.

All the volatile organic constituents (VOCs) listed above were present at high concentrations in the top 4.5 feet at SB-23, which was located in the soil piles east of the excavated pit. The soil piles and the excavated pit were the result of excavation activities in the vicinity of a past waste disposal area, identified as a large magnetic anomaly area in the FIT report (1982). Total VOCs in the samples taken from this location were greater than 50,000 ppb. Concentrations of VOCs in SB-23 decrease with depth, but were still in the range of 100 ppb in the deepest samples

Table 4-11
Organic Compounds Detected in Subsurface Soils

Area A (1,3,4)

	SL-4 (from MW-4)		SB-20	
Compound Group	***Compounds Present***	***Peak (2) Concentration ppb***	***Compounds Present***	***Peak (2) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	1,1-DCA, MeCl, 1,1,1-TCA,TCE	13,460 @ 45 ft., 13,100 @ 30 ft.	1,1,1-TCA, TCE	17 @ 18.5 ft.
Non-chlorinated organic solvents	none	n/a	none	n/a
Ketones	MEK, MIBK	33,400 @ 45 ft. 22,600 @ 30 ft.	none	n/a
SEMI-VOLATILES				
Aromatics	isophorone	310 @ 30 ft.	none	n/a
PAHs	none	n/a	benzo(a)pyrene, benzo(g,h,i)perylene	136 @ 0.0 ft.
Phthalates	B2EP	1,200 @ 90 ft.	di-n-butyl phthal.	93 @ 4.5 ft
PESTICIDES/PCBs				
All compounds	none	n/a	none	n/a

	SB-23		SB-24	
Compound Group	***Compounds Present***	***Peak (2) Concentration ppb***	***Compounds Present***	***Peak (2) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	MeCl, trans-1,2-DCE 111-TCA,TCE PCE, cis-12DCP	106,000 @ 0.0 ft.	1,1,1-TCA	20 @ 12 ft.
Non-chlorinated organic solvents	toluene, xylenes ethylbenzene	168,100 @ 0.0 ft.	none	n/a
Ketones	acetone, MEK, MIBK	37,000 @ 0.0 ft.	acetone	35 @ 5.5 ft.
SEMI-VOLATILES				
Aromatics	isophorone	12,000 @ 0.0 ft.	none	n/a
PAHs	naphthalene, 2-methylnaphthalene	77,000 @ 0.0 ft.	none	n/a
Phthalates	BBP, di-n-butylph.	12,900 @ 0.0 ft.	B2EP	2,700 @ 9.0 ft.
PESTICIDES/PCBs				
All compounds	none	n/a	none	n/a

1-Results for RAS (Routine Analytical Services) samples only are summarized here
2-Peak Concentrations indicate the sum of all compounds listed in the groups for the depth shown
3-MeCl=methylene chloride; 1,2-DCP=1,2-dichloropropene; B2EP=bis(2-ethylhexyl)phthalate; BBP=butylbenzylphthalate; 1,1-DCA=1,1-dichloroethane; 1,1,1-TCA=1,1,1-trichloroethane; MEK=methylethyl ketone; MIBK=4-methyl-2-pentanone; TCE=trichloroethene; trans-1,2-DCE=trans-1,2-dichloroethene; PCE-tetrachloroethene; cis-12DCP=cis-1,2-dichloropropene
4-No organic hits were detected in SL-1, SB-27, or SB-28

Table 4-11 (continued)
Organic Compounds Detected in Subsurface Soils

Area A (1,3,4)

	SB-25		SB-29	
Compound Group	***Compounds Present***	***Peak (2) Concentration ppb***	***Compounds Present***	***Peak (2) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	MeCl, 1,1,1-TCA, TCE, PCE	145 @ 18.5 ft.	none	n/a
Non-chlorinated organic solvents	none	n/a	none	n/a
Ketones	acetone	20 @ 1.5 ft.	acetone	26 @ 9.5 ft.
SEMI-VOLATILES				
Aromatics	none	n/a	phenol	80 @ 6.0 ft.
PAHs	none	n/a	none	n/a
Phthalates	di-n-ocytl phthalate	150 @ 5 ft.	none	n/a
PESTICIDES/PCBs				
All compounds	Beta-BHC	130 @ 18.5 ft.	Beta-BHC	60 @ 17 ft.

	SB-22		SB-30	
Compound Group	***Compounds Present***	***Peak (2) Concentration ppb***	***Compounds Present***	***Peak (2) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	none	n/a	none	n/a
Non-chlorinated organic solvents	none	n/a	none	n/a
Ketones	none	n/a	none	n/a
SEMI-VOLATILES				
Aromatics	none	n/a	none	n/a
PAHs	none	n/a	acenapthene, fluorene, (5)	6,327 @ 0.0 ft.
Phthalates	B2EP	39 @ 0.0 ft.	B2EP, di-n-butylphthalate di-n-octylphthalate	617 @ 0.0 ft.
PESTICIDES/PCBs				
All compounds	none	n/a	none	n/a

1-Results for RAS (Routine Analytical Services) samples only are summarized here
2-Peak Concentrations indicate the sum of all compounds listed in the groups for the depth shown
3-MeCl=methylene chloride; B2EP=bis(2-ethylhexyl)phthalate;1,1,1-TCA=1,1,1-trichloroethane; TCE=trichloroethene; PCE=tetrachloroethene
4-No organic hits were detected in SL-1, SB-27, or SB-28
5-PAHs also present in SB-30: 2-methylnaphthalene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene

TABLE 4-11A

ORGANIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Monitoring Well Boring Samples (ppb)

Area A

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	1 / 17	7 - 7	7	
TRICHLOROETHENE	79-01-6	3 / 17	3 - 1,300	721	660
4-METHYL-2-PENTANONE	108-10-1	6 / 17	18 - 30,000	12,846	14,525
TETRACHLOROETHENE	127-18-4	2 / 17	1 - 2	2	1
TOLUENE	108-88-3	1 / 17	2 - 2	2	
1,1-DICHLOROETHANE	75-34-3	4 / 17	4 - 9,300	4,901	4,989
1,1,1-TRICHLOROETHANE	71-55-6	3 / 17	5 - 1,800	968	905
METHYLENE CHLORIDE	75-09-2	3 / 17	1,400 - 1,700	1,600	173
2-BUTANONE	78-93-3	2 / 17	3,400 - 3,600	3,500	141
Base-Neutral-Acids					
Isophorone	78-59-1	2 / 17	210 - 310	260	71
Butyl Benzyl Phthalate	85-68-7	2 / 17	3 - 3	3	0
bis(2-ethylhexyl)phthalate	117-81-7	4 / 17	3 - 1,200	601	588
Pesticides and PCBs					
No Detects					

TABLE 4-11B

ORGANIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Soil Boring Samples (ppb)

Area A

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	21 / 71	1 - 23,000	2,033	5,499
TRICHLOROETHENE	79-01-6	14 / 71	2 - 11,000	1,022	2,940
4-METHYL-2-PENTANONE	108-10-1	4 / 71	8 - 530	140	260
TETRACHLOROETHENE	127-18-4	16 / 71	3 - 43,000	3,713	10,779
TOLUENE	108-88-3	22 / 71	1 - 89,000	4,610	18,936
XYLENES	1330-20-7	8 / 71	57 - 72,000	12,191	24,831
1,1-DICHLOROETHANE	75-34-3	1 / 71	3 - 3	3	
TRANS-1,2-DICHLOROETHENE	156-60-5	4 / 71	1 - 590	150	294
1,1,1-TRICHLOROETHANE	71-55-6	19 / 71	1 - 41,000	2,310	9,380
METHYLENE CHLORIDE	75-09-2	13 / 71	13 - 11,000	1,188	3,028
1,2-DICHLOROETHENE	540-59-0	1 / 71	6 - 6	6	
CHLOROFORM	67-66-3	7 / 71	1 - 2	2	1
2-BUTANONE	78-93-3	6 / 71	2 - 14,000	4,801	5,791
1,1,2-TRICHLOROETHANE	79-00-5	2 / 71	2 - 2	2	0
CIS-1,3-DICHLOROPROPENE	10061-01-5	1 / 71	1,400 - 1,400	1,400	
ETHYLBENZENE	100-41-4	4 / 71	8 - 7,100	2,552	3,131
Base-Neutral-Acids					
Phenol	108-95-2	1 / 71	80 - 80	80	
1,2-Dichlorobenzene	95-50-1	1 / 71	160 - 160	160	
N-Nitroso-Dipropylamine	621-64-7	1 / 71	730 - 730	730	
Isophorone	78-59-1	9 / 71	120 - 140,000	17,658	46,038
Benzoic Acid	65-85-0	1 / 71	250 - 250	250	
Napthalene	91-20-3	6 / 71	81 - 48,000	11,644	18,953
4-Chloro-3-methylphenol	59-50-7	1 / 71	290 - 290	290	
2-Methylnaphthalene	91-57-6	6 / 71	52 - 29,000	6,514	11,604
Dimethyl Phthalate	131-11-3	1 / 71	1,400 - 1,400	1,400	
Acenaphthylene	208-96-8	1 / 71	40 - 40	40	
Acenaphthene	83-32-9	2 / 71	60 - 81	71	15
Dibenzofuran	132-64-9	2 / 71	260 - 730	495	332
2,6-Dinitrotoluene	606-20-2	1 / 71	1,400 - 1,400	1,400	
Fluorene	86-73-7	3 / 71	87 - 370	184	161
Phenanthrene	85-01-8	3 / 71	220 - 570	437	189
Anthracene	120-12-7	1 / 71	220 - 220	220	
Di-n-butylphthalate	84-74-2	9 / 71	13 - 3,900	652	1,274
Fluoranthene	206-44-0	1 / 71	430 - 430	430	
Pyrene	129-00-0	1 / 71	2,500 - 2,500	2,500	
Butyl Benzyl Phthalate	85-68-7	4 / 71	100 - 9,000	3,023	4,092
Benzo(a)anthracene	56-55-3	1 / 71	430 - 430	430	
bis(2-ethylhexyl)phthalate	117-81-7	18 / 71	39 - 8,900	1,180	2,136
Chrysene	218-01-9	2 / 71	150 - 880	515	516
Di-n-octyl Phthalate	117-84-0	6 / 71	74 - 230	131	56
Benzo(a)pyrene	50-32-8	4 / 71	55 - 520	296	224
Benzo(g,h,i)perylene	191-24-2	3 / 71	81 - 540	307	230
Pesticides and PCBs					
beta-BHC	319-85-7	6 / 71	28 - 130	78	35

(total depth was 20 feet). The only other boring or well with extremely high VOC concentrations was MW-4, located near the excavation pits and near SB-23. Unlike SB-23, however, the contamination in soils from MW-4 was present at depth (in the 30- and 45-foot samples), and no toluene, xylenes, ethylbenzene, acetone or PCE were detected. Rather, MW-4 contained high levels of MIBK (up to 30,000 ppb), 1,1-DCA (9300 ppb), MEK (3600 ppb), 1,1,1-TCA (1800 ppb), methylene chloride, and TCE.

All other soil borings and well borings in Area A contained much lower concentrations of VOCs (total VOCs were less than 100 ppb, with one exception) than SB-23 and MW-4. In three soil borings (SB-20, 24, and 25), chlorinated solvents were present only in samples from near the bottom of the boring (below 15 feet). This pattern suggests that, rather than originating from infiltration through the unsaturated zone at the boring, these contaminants may have originated at an upgradient source. The depth to water in the area is 17 to 19 feet, further suggesting the potential for contaminant migration from upgradient sources.

The two distinct patterns of contamination exhibited in Study Area A were repeated throughout the project study area. The first pattern, represented by SB-23, was that high VOC concentrations were present in the unsaturated zone; these concentrations generally decrease to low levels at the water table and below. The second pattern of VOC distribution was illustrated in Area A by MW-4, SB-20, 24, and 25. At these locations, the unsaturated zone soils were clean, but generally low to moderate levels of VOC contamination were present in the shallow and middle portions of the shallow aquifer.

The second pattern was more commonly observed throughout the project study area, and suggests the occurrence of contaminant transport in groundwater from upgradient areas. A source from unsaturated soil in the immediate area of such borings is unlikely, because the sample analysis showed little or no contamination present in these soils. The first pattern outlined

above was an example of an contaminant source that could be responsible for soil contamination in the saturated zone, which was represented by the second pattern. As discussed in Section 4.4.2, high contaminant levels were expected to persist much longer in unsaturated soils than in the saturated zone, due to the relative amounts of water flowing through these volumes.

4.4.5.2 Semivolatiles

The semivolatile organic constituents (SVOCs) that were detected in subsurface soils from Areas A through F can be divided into three groups of similar compounds: 1) aromatics, including di- and trichlorobenzenes, hexachlorobenzene, dinitrotoluenes, phenol, methylphenols, nitrophenols, pentachlorophenol, dibenzofuran, and isophorone; 2) polycyclic aromatic hydrocarbons (PAHs), listed in Section 4.4.1 and in Tables 4-10 and 4-12 through 4-17; 3) phthalates, including bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, di-n-octyl phthalate, butyl benzyl phthalate, and diethyl phthalate.

The aromatic SVOCs present at the site may derive from a number of uses, such as solvents, intermediates in the manufacture of dyes and resins, degreasers, metal polishes, insecticides, pesticides, and fungicides. The PAHs, compounds found in coal tars and heavy oils, may be present because of disposal of waste oils. Phthalates are mainly plasticizers that may be used in a wide variety of applications, and may be present at the site as a result of widespread disposal of plasticized rubber acid containers.

As noted in Section 4.4.2, SVOCs were generally limited to the upper 10 to 12 feet of the subsurface. This tendency holds true in Area A, where the only SVOCs detected below 12 feet were phthalates and, in one instance, isophorone. High concentrations of SVOCs other than phthalates were found only in the top 3 feet of soil.

Table 4-11 shows that the highest concentrations of SVOCs were found in SB-23. The 0 to 1.5-foot sample from SB-23 contained 48,000 ppb of naphthalene, 29,000 ppb of 2-methylnaphthalene, 12,000 ppb of isophorone, and 9,000 ppb of butyl benzyl phthalate (BBP) in the RAS analysis. High concentrations of other aromatics, PAHs and phthalates were detected in the SAS BNA analysis. The 1.5 to 3-foot sample contained lower, but still elevated, levels of contaminants; only minor concentrations of isophorone, naphthalene, and 2-methylnaphthalene were found below 3 feet.

SB-20 contained low levels of PAHs in the uppermost RAS sample (0-1.5 feet), while the SAS BNA sample from the same interval contained 730 ppb of dibenzofuran, as well as higher concentrations of PAHs. SB-22 contained extremely high levels of isophorone (140,000 ppb) in the uppermost SAS sample; however, none was detected in the RAS sample, so the detection is questionable. SB-29 contained low levels of isophorone (150 ppb) and phenol (80 ppb) in single samples, as well as sporadic occurrences of phthalates. The top sample (0-1.5 feet) from SB-30 contained 2500 ppb of pyrene, as well as many other PAHs in the RAS sample. However, in the SAS sample only one of these PAHs was reported at higher than the detection limits. In MW4, isophorone was detected at 310 ppb at a depth of 30 feet.

In the remaining borings, phthalates were the only compounds detected. They were present at high levels only in SB-24, but both instances were marked by lab blank contamination.

4.4.5.3 Pesticides and PCBs

The only occurrences of pesticides or PCBs in subsurface soils in Area A were in SB-25 and SB-29. Beta-benzene hexachloride was detected in SB-25 at levels ranging from 71 to 130 ppb in samples between 12 and 20 feet. SB-29 also contained Beta-BHC, but only in the 12- and 16-foot samples and at lower concentrations.

4.4.5.4 Inorganics

As discussed in Section 4.4.2, inorganic constituents in the subsurface soil samples were considered to be present at excessive levels if they exceed typical ranges for soils in the eastern United States. Fisher-Calo samples that exceed these ranges were listed in Tables 4-12, 4-12A and 4-12B. Common constituents such as calcium and magnesium are not listed in this table because of their low toxicity. Average soil concentrations were not available for cyanide and cadmium; sample results for these constituents were listed in Tables 4-12 where they exceed 1 ppm and 5 ppm, respectively.

As noted in Section 4.4.2, inorganics were rarely present at high levels below 10 feet; in Study Area A the highest concentrations were found in the top 3 to 5 feet. The areal distribution of inorganic contamination generally follows that of the organics: the borings and wells displaying inorganic contamination were SB-22, 23, 20, MW-4 and SB-30. High levels of cyanide were present in both SB-22 and 23 (up to 44 and 21.3 ppm, respectively). SB-23 and MW-4 contained antimony at about 3 times typical ranges. Nickel, cadmium, and zinc were also present at elevated levels in several borings.

4.4.6 SUBSURFACE SOIL RESULTS: STUDY AREA B

Study Area B encompasses the New Plant Life facility off Two-Line Road in the southeast portion of the project study area. The soil borings and monitoring wells which were sampled for subsurface soils were SB-31, 33, and 34, and MW-30, 56, and 59.

4.4.6.1 Volatiles

Organic results for subsurface soils in Study Area B were summarized in Tables 4-13, 4-13A and 4-13B and in Figure 4.4-2 (Vol. II). SB-33 was the only boring or well in Area B that contained high levels of VOCs. VOCs were detected in samples at all depths of SB-33, and total VOCs exceeded

Table 4-12
Inorganics of Concern in Subsurface Soils at Fisher-Calo Site (1)

	Eastern U.S. Surface Soils (2)		Area A Samples Above Eastern U.S. Range	
Compound Group	*Average Concentration*	*Range of 95% of Samples*	*Concentration*	*Location and Depth in Feet (5,6)*
Anitmony	0.76	0.09-2.95	8.8; 7.6	MW-4 @ 0; SB-23 @ 9.5
Cadmium (3)	-	-	none	-
Chromium	52	4.9-223	none	-
Cobalt	9.2	0.9-39	none	-
Copper	22	1.7-100	none	-
Cyanide (4)	-	-	1.3 to 44	SB-21, SB-23 @ 0-4.5 SB-20 @ 1.5; SB-30 @ 0
Lead	17	3.7-53	none	-
Mercury	0.12	0.01-0.51	none	-
Nickel	18	1.68-77	119; 96.8	SB-23, SB-20 (leach)
Zinc	52	9-180	198 to 235	MW-4 @ 34 SB-23 @ 14.5, 3 and 12

	Area B Samples Above Eastern U.S. Range		Area C Samples Above Eastern U.S. Range	
Compound Group	*Concentration*	*Location and Depth in Feet (5,6)*	*Concentration*	*Location and Depth in Feet (5,6)*
Anitmony	none	-	6.6 to 10.4	SB-16 @ 1.5; SB-4 @ 3, 12
Cadmium (3)	none	-	7.4	SB-5 (leach)
Chromium	none	-	241 to 626	SB-9 @ 1.5-4.5
Cobalt	none	-	115 to 820	SB-16 @ 1.5; SB-5 (leach)
Copper	729	MW-31 (leach)	691	SB-5 (leach)
Cyanide (4)	4.9	MW-34 @ 0	1.2 to 61.7	SB-7 @ 0-4.5; SB-5 @ 0-8.5 SB-11 @ 1.5; SB-14 @ 3
Lead	63.7	MW-59 @ 5	66.8 to 690	SB-5 @ 0-4.5; SB-7 @ 1.5 SB-9 @ 1.5
Mercury	none	-	none	-
Nickel	95.2	MW-31 (leach)	78.3 to 1,570	SB-7 @ 0-4.5, leach; SB-5 @ 0, leach; SB-9 @ 1.5
Zinc	503	MW-33 @ 5	574 to 1,880	SB-8 @ 1.5; SB-5 @ leach, 0

1-Concentrations in ppm (parts per million), except for leachability samples, for which concentrations are in ppb (parts per billion)
2-Source: Shacklette, H.T., and J.G. Boerngen, 1984, "Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States": U.S. Geological Survey Prof. Paper 1270, Wash., D.C.
3-Eastern U.S. data for cadmium not available; Fisher-Calo results are listed where they exceed 5 ppm
4-Eastern U.S. data for cyanide not available; Fisher-Calo results are listed where they exceed 5 ppm
5-Samples locations are listed from highest to lowest concentrations
6-"leach" refers to the leachability sample, a composite of the top 3 sample intervals (0 to 4.5 ft. in SBs, 0 to 15 ft. in MWs)

Table 4-12 (continued)
Inorganics of Concern in Subsurface Soils at Fisher-Calo Site (1)

	Eastern U.S. Surface Soils (2) Samples Above Eastern U.S. Range		Area D Samples Above Eastern U.S. Range	
Compound Group	*Average Concentration*	*Range of 95% of Samples*	*Concentration*	*Location and Depth in Feet (5,6)*
Anitmony	0.76	0.09-2.95	7.2-7.4	SB-2 @1.5, 0
Cadmium (3)	-	-	none	-
Chromium	52	4.9-223	none	-
Cobalt	9.2	0.9-39	none	-
Copper	22	1.7-100	none	-
Cyanide (4)	-	-	none	-
Lead	17	3.7-53	none	-
Mercury	0.12	0.01-0.51	14	MW-34 (leach)
Nickel	18	1.68-77	none	-
Zinc	52	9-180	none	-

	Area E Samples Above Eastern U.S. Range		Area F Samples Above Eastern U.S. Range	
Compound Group	*Concentration*	*Location and Depth in Feet (5,6)*	*Concentration*	*Location and Depth in Feet (5,6)*
Anitmony	9.3	MW-42 @ 5	none	-
Cadmium (3)	none	-	none	-
Chromium	none	-	none	-
Cobalt	none	-	none	-
Copper	none	-	none	-
Cyanide (4)	none	-	none	-
Lead	none	-	none	-
Mercury	72-248	MW-48, MW-45 (leach)	none	-
Nickel	none	-	none	-
Zinc	281-1,190	SB-18 @ 0-4.5; SB-21 @ 9.5 MW-48 (leach)	none	-

1-Concentrations in ppm (parts per million), except for leachability samples, for which concentrations are in ppb (parts per billion)
2-Source: Shacklette, H.T., and J.G. Boerngen, 1984, "Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States": U.S. Geological Survey Prof. Paper 1270, Wash., D.C.
3-Eastern U.S. data for cadmium not available; Fisher-Calo results are listed where they exceed 5 ppm
4-Eastern U.S. data for cyanide not available; Fisher-Calo results are listed where they exceed 5 ppm
5-Samples locations are listed from highest to lowest concentrations
6-"leach" refers to the leachability sample, a composite of the top 3 sample intervals (0 to 4.5 ft. in SBs, 0 to 15 ft. in MWs)

TABLE 4-12A

INORGANIC CONTAMINANTS IN SUBSURFACE SOILS AT FISHER-CALO COMPARED TO THOSE IN SURFACE SOILS IN THE EASTERN UNITED STATES

Summary of Monitoring Well Boring Samples (ppm)

		Eastern U.S. Surface Soils		Fisher-Calo Samples Above Eastern U.S. Background Range			
Element	*CAS*	*Average*	*Range*	*Hits / Samples*	*Max*	*Average*	*St. Dev.*
AREA A							
none				0 / 17			
AREA B							
Cadmium	7440-43-9	◊	◊	2 / 29	1.5	1.4	0.1
Calcium	7440-70-2	6,300	358 - 32,200	5 / 29	49,400	43,080	6,463
Cyanide	74-90-8	◊	◊	1 / 29	0.7	0.7	
Lead	7439-92-1	17	3.7 - 53	1 / 29	64	64	
Silver	7440-22-4	◊	◊	3 / 29	1.8	1.2	0.5
AREA C							
Antimony	7440-36-0	0.76	0.09 - 2.95	1 / 94	13.80	13.80	
Arsenic	7440-38-2	7.4	0.73 - 31.5	1 / 94	31.7	31.7	
Cadmium	7440-43-9	◊	◊	5 / 94	4.0	2.1	1.1
Calcium	7440-70-2	6,300	358 - 32,200	11 / 94	76,000	44,682	15,483
Cyanide	74-90-8	◊	◊	3 / 94	0.8	0.7	0.1
Magnesium	7439-95-4	4,600	170 - 26,000	1 / 94	33,700	33,700	
Mercury	7439-97-6	0.12	0.01 - 0.51	3 / 94	248.00	203.00	63.79
Selenium	7782-49-2	0.45	0.05 - 1.8	1 / 94	7.50	7.50	
Silver	7440-22-4	◊	◊	7 / 94	1.1	1.0	0.1
Zinc	7440-66-6	52	9 - 180	4 / 94	447	330	93
AREA D							
Cadmium	7440-43-9	◊	◊	2 / 21	5.2	3.0	3.2
Calcium	7440-70-2	6,300	358 - 32,200	1 / 21	37,000	37,000	
Copper	7440-50-8	22	1.7 - 100	1 / 21	16,900	16,900	
Lead	7439-92-1	17	3.7 - 53	1 / 21	720	720	
Mercury	7439-97-6	0.12	0.01 - 0.51	1 / 21	14.00	14.00	
Nickel	7440-02-0	18	1.6 - 77	1 / 21	1,170	1,170	
Zinc	7440-66-6	52	9 - 180	1 / 21	660	660	
AREA E							
Antimony	7440-36-0	0.76	0.09 - 2.95	2 / 18	9.30	8.15	1.63
Cadmium	7440-43-9	◊	◊	1 / 18	1.6	1.6	
Calcium	7440-70-2	6,300	358 - 32,200	3 / 18	42,600	40,467	1,890
Mercury	7439-97-6	0.12	0.01 - 0.51	1 / 18	72.00	72.00	
Silver	7440-22-4	◊	◊	1 / 18	1.1	1.1	
AREA F							
Calcium	7440-70-2	6,300	358 - 32,200	8 / 18	66,200	44,488	10,408
Magnesium	7439-95-4	4,600	170 - 26,000	1 / 18	28,900	28,900	
Thallium	7440-28-0	◊	◊	2 / 18	0.6	0.6	0.0

◊ Has no established limit

TABLE 4-12B

INORGANIC CONTAMINANTS IN SUBSURFACE SOILS AT FISHER-CALO COMPARED TO THOSE IN SURFACE SOILS IN THE EASTERN UNITED STATES

Summary of Soil Boring Samples (ppm)

		Eastern U.S. Surface Soils		Fisher-Calo Samples Above Eastern U.S. Background Range			
ELEMENT	*CAS*	*Average*	*Range*	*Hits / Samples*	*Max*	*Average*	*St. Dev.*
AREA A							
Antimony	7440-36-0	0.76	0.09 - 2.95	2 / 71	7.60	7.05	0.78
Cadmium	7440-43-9	◊	◊	7 / 71	18.7	5.3	6.5
Calcium	7440-70-2	6,300	358 - 32,200	1 / 71	105,000	105,000	
Cyanide	74-90-8	◊	◊	7 / 71	21.3	6.6	7.3
Magnesium	7439-95-4	4,600	170 - 26,000	1 / 71	46,100	46,100	
Manganese	7439-96-5	640	18 - 3,800	1 / 71	4,390	4,390	
Nickel	7440-02-0	18	1.6 - 77	2 / 71	119	108	16
Silver	7440-22-4	◊	◊	19 / 71	1.7	1.2	0.2
Zinc	7440-66-6	52	9 - 180	5 / 71	229	202	16
AREA B							
Cadmium	7440-43-9	◊	◊	1 / 26	2.6	2.6	
Copper	7440-50-8	22	1.7 - 100	1 / 26	729	729	
Cyanide	74-90-8	◊	◊	2 / 26	4.9	2.7	3.1
Nickel	7440-02-0	18	1.6 - 77	1 / 26	95	95	
AREA C							
Antimony	7440-36-0	0.76	0.09 - 2.95	4 / 106	10.40	7.80	1.78
Cadmium	7440-43-9	◊	◊	14 / 106	4.1	1.9	1.2
Calcium	7440-70-2	6,300	358 - 32,200	4 / 106	133,000	79,575	43,382
Chromium	7440-47-3	52	4.9 - 223	2 / 106	626	434	272
Cobalt	7440-48-4	9.2	0.9 - 39	1 / 106	820.0	820.0	
Copper	7440-50-8	22	1.7 - 100	4 / 106	822	590	218
Cyanide	74-90-8	◊	◊	11 / 106	61.7	12.9	20.5
Lead	7439-92-1	17	3.7 - 53	2 / 106	83	75	11
Nickel	7440-02-0	18	1.6 - 77	5 / 106	1,570	447	631
Selenium	7782-49-2	0.45	0.05 - 1.8	2 / 106	7.20	5.25	2.76
Silver	7440-22-4	◊	◊	18 / 106	22.0	2.7	5.1
Sodium	7440-23-5	7,800	120 - 52,000	2 / 106	248,000	167,500	113,844
Thallium	7440-28-0	◊	◊	2 / 106	2.1	1.3	1.1
Zinc	7440-66-6	52	9 - 180	2 / 106	1,880	1,038	1,191
AREA D							
Antimony	7440-36-0	0.76	0.09 - 2.95	2 / 25	7.40	7.30	0.14
Calcium	7440-70-2	6,300	358 - 32,200	1 / 25	44,000	44,000	
Cyanide	74-90-8	◊	◊	1 / 25	0.6	0.6	
Mercury	7439-97-6	0.12	0.01 - 0.51	1 / 25	0.80	0.80	
Silver	7440-22-4	◊	◊	7 / 25	1.3	1.1	0.1
Thallium	7440-28-0	◊	◊	1 / 25	0.5	0.5	
AREA E							
Thallium	7440-28-0	◊	◊	1 / 15	4.5	4.5	
Zinc	7440-66-6	52	9 - 180	3 / 15	1,190	697	459
AREA F							
Cadmium	7440-43-9	◊	◊	2 / 4	3.2	2.6	0.9
Calcium	7440-70-2	6,300	358 - 32,200	1 / 4	38,700	38,700	
Cyanide	74-90-8	◊	◊	1 / 4	0.8	0.8	

◊ Has no established limit

Table 4-13
Organic Compounds Detected in Subsurface Soils

Area B (1,2,4)

	SL-30 (MW-30)		SL-59 (MW-59)	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	none	n/a	chlorobenzene	6 @ 45 ft.
Non-chlorinated organic solvents	none	n/a	none	n/a
Ketones	none	n/a	none	n/a
SEMI-VOLATILES				
Aromatics	none	n/a	none	n/a
PAHs	none	n/a	none	n/a
Phthalates	di-n-octyl phthalate	410 @ 86 ft.	B2EP	210 @ 0.0 ft.
PESTICIDES/PCBs				
All compounds	none	n/a	none	n/a

	SB-31		SB-33	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	MeCl, TCE, PCE	100 @ 7 ft.	MeCl, PCE, TCE, 1,1,1-TCA	50,000 @ 5.5 ft.
Non-chlorinated organic solvents	toluene, xylenes, ethylbenzene	75 @ 7 ft.	toluene, xylenes, ethylbenzene	141,000 @ 5.5 ft.
Ketones	acetone	10 @ 7 ft.	acetone	130 @18.5 ft.
SEMI-VOLATILES				
Aromatics	none	n/a	none	n/a
PAHs	none	n/a	naphthalene, 2-methylnaphthalene	2,010 @ 5.5 ft.
Phthalates	none	n/a	B2EP, di-n-butylphthalate	660 @ 7 ft.
PESTICIDES/PCBs				
All compounds	none	n/a	none	n/a

1-No organic contaminants were detected at SL-56
2-Results for RAS (Routine Analytical Services) samples only are summarized here
3-Peak Concentrations indicate the sum of all compounds listed in the groups for the depth shown
4-B2EP=bis(2-ethyhexyl)phthalate; MeCl=methylene chloride; TCE=trichloroethene; PCE=tetrachloroethene; 1,1,1-TCA=1,1,1-trichloroethane

Table 4-13 (continued)
Organic Compounds Detected in Subsurface Soils

Area B (1,2)

	SB-34	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES		
Chlorinated organic solvents	none	n/a
Non-chlorinated organic solvents	toluene	6 @ 0.0 ft.
Ketones	none	n/a
SEMI-VOLATILES		
Aromatics	none	n/a
PAHs	none	n/a
Phthalates	none	n/a
PESTICIDES/PCBs		
All compounds	none	n/a

1-No organic contaminants were detected at SL-56
2-Results for RAS (Routine Analytical Services) samples only are summarized here
3-Peak Concentrations indicate the sum of all compounds listed in the groups for the depth shown

TABLE 4-13A

ORGANIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Monitoring Well Boring Samples

Area B

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
TOLUENE	108-88-3	3 / 19	1.2 - 2.1	1.6	0.5
1,1,1-TRICHLOROETHANE	71-55-6	1 / 19	1 - 1	1	
CHLOROFORM	67-66-3	1 / 19	2.5 - 2.5	2.5	
CHLOROBENZENE	108-90-7	1 / 19	6 - 6	6	
Base-Neutral-Acids					
Diethylphthalate	84-66-2	1 / 19	150 - 150	150	
Di-n-butylphthalate	84-74-2	1 / 19	80 - 80	80	
bis(2-ethylhexyl)phthalate	117-81-7	3 / 19	41 - 410	660	185
Benzo(a)pyrene	50-32-8	4 / 19	55 - 520	296	224
Benzo(g,h,i)perylene	191-24-2	3 / 19	81 - 540	307	230
Pesticides and PCBs					
No Detects					

TABLE 4-13B

ORGANIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Soil Boring Samples (ppb)

Area B

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	2 / 26	10 - 130	70	85
TRICHLOROETHENE	79-01-6	5 / 26	3 - 20	10	7
4-METHYL-2-PENTANONE	108-10-1	2 / 26	32 - 33	33	1
TETRACHLOROETHENE	127-18-4	15 / 26	4 - 25,000	3,928	7,667
TOLUENE	108-88-3	11 / 26	2 - 16,000	3,178	6,041
XYLENES	1330-20-7	14 / 26	7 - 110,000	16,701	35,772
1,1,1-TRICHLOROETHANE	71-55-6	4 / 26	4 - 13	9	4
METHYLENE CHLORIDE	75-09-2	6 / 26	79 - 25,000	8,310	12,545
CHLOROFORM	67-66-3	2 / 26	3 - 3	3	0
ETHYLBENZENE	100-41-4	7 / 26	3 - 17,000	4,180	6,942
Base-Neutral-Acids					
Isophorone	78-59-1	1 / 26	12,000 - 12,000	12,000	
Napthalene	91-20-3	8 / 26	12 - 810	301	290
2-Methylnaphthalene	91-57-6	9 / 26	14 - 1,200	449	367
Di-n-butylphthalate	84-74-2	1 / 26	180 - 180	180	
bis(2-ethylhexyl)phthalate	117-81-7	4 / 26	170 - 660	330	225
Pesticides and PCBs					
No Detects					

10,000 ppb in samples collected between 3 and 11 feet. The VOC contaminants detected in SB-33 comprise a suite distinct from that found in Areas A and C. The highest VOC concentrations were found in the 5.5 to 7-foot sample interval where 110,000 ppb of total xylenes, 25,000 ppb each of PCE and methylene chloride, 17,000 ppb of ethylbenzene, and 14,000 ppb of toluene were detected.

SB-31 contained between 13 and 175 ppb total VOCs between 5.5 and 16 feet; the specific chemicals detected were virtually identical to the suite of SB-33. Other borings contained less than 10 ppb of VOCs.

SB-33 was located adjacent to a spill area and near storage tanks east of the New Plant Life building. The contaminated soil in the spill area at SB-33 may not be a continuing source for groundwater contamination, since no VOCs were detected in the deep portions of SB-34 (approximately downgradient from SB-33; Figure 4.4-2, Vol. II).

4.4.6.2 Semivolatiles

Semivolatiles (SVOC) contamination in Study Area B mirrors the occurrence of VOC contamination in that persistent concentrations were found only in SB-33 (Table 4-12). The PAHs naphthalene and 2-methylnaphthalene were detected at levels between 315 and 2,010 ppb in samples collected at depths between 0 and 11 feet. Bis(2-ethylhexyl)phthalate was present in some of these samples at up to 660 ppb.

The only other SVOC occurrence in subsurface soils in Area B was in the top (0-1.5 feet) sample of SB-31, which contained 12,000 ppb of isophorone in the SAS sample. Similar to the reported detection in Area A, this value may be questionable because the RAS sample contained no detectable isophorone. Also, no other contaminants were found in this or nearby samples.

4.4.6.3 Pesticides and PCBs

No pesticides or PCBs were detected in subsurface soils from Study Area B.

4.4.6.4 Inorganics

The occurrence of excessive levels of metals in subsurface soils was more widespread in Study Area B than was the occurrence of organics. SB-31, 33, and 34 and MW-59 contained high levels of one or two inorganics (Tables 4-12). However, each constituent was present in only one sample at elevated levels, and these were all above a depth of 4.5 feet.

4.4.7 SUBSURFACE SOIL RESULTS: STUDY AREA C

Study Area C encompasses the area surrounding the Cardinal Chemical facility in the southwestern part of the project study area. The soil borings and the monitoring wells that were sampled for subsurface soils are SB-4 through 17 and MW-10, 15, 18, 21, 29 and 37.

4.4.7.1 Volatiles

The results of organic analysis of subsurface samples in Area C were summarized in Table 4-14, 4-14A and 4-14B and in Figure 4.4-3 (Vol. II). Three basic patterns were exhibited by the subsurface samples of borings and wells in Area C: 1) locations containing moderate to high levels of VOCs in the unsaturated zone, represented by SB-8, 9, 11 and 14; 2) locations containing low to high levels of VOCs in the shallow to middle portions of the shallow aquifer, represented by SB-5, 6, 12 and 13, and MW-10, 29 and 37; and 3) locations with no appreciable concentrations of VOCs, represented by SB-4, 7, 10, 15, 16 and 17 and MW-15 and 21.

By far the highest concentrations of VOCs in Area C occurred in SB-8, which contained greater than 10,000 ppb of total VOCs in all RAS samples collected between 3 and 11 feet. The compounds present at high levels in SB-8 were total xylenes (up to 410,000 ppb), toluene (90,000 ppb), PCE

Table 4-14
Organic Compounds Detected in Subsurface Soils

Area C (1,2,4)

	SL-10 (MW-10)		SL-15 (MW-15)	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	1,1-DCA, 1,1,1-TCA TCE, PCE, trans-1,2-DCE	592 @ 35 ft.	MeCl	11 @ 30 ft.
Non-chlorinated organic solvents	toluene xylenes	6 @ 35 ft.	none	n/a
Ketones	acetone, MEK	8,700 @ 45 ft.	none	n/a
SEMI-VOLATILES				
Aromatics	none	n/a	none	n/a
PAHs	none	n/a	none	n/a
Phthalates	none	n/a	none	n/a
PESTICIDES/PCBs				
All compounds	none	n/a	none	

	SL-21 (MW-21)		SL-29 (MW-29)	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	chloroethane	8 @ 60 ft.	none	n/a
Non-chlorinated organic solvents	none	n/a	none	n/a
Ketones	none	n/a	acetone	240 @ 73 ft.
SEMI-VOLATILES				
Aromatics	benzoic acid, penta-chlorophenol, 4-nitrophenol, n-nitrosodiphenylamine	1,729 @ 140 ft.	none	n/a
PAHs	phenanthrene, anthracene, fluor-anthene, pyrene (5)	1,320 @ 140 ft.	none	n/a
Phthalates	diethyl phthalate, di-n-butyl phthalate, BBP, di-n-octyl phthalate	668 @ 140 ft.	none	n/a
PESTICIDES/PCBs				
All compounds	none	n/a	none	n/a

1-No organic compounds detected in SI-18, SB-10, and SB-16
2-Results for RAS (Routine Analytical Services) samples only are summarized here
3-Peak Concentrations indicate the sum of all compounds listed in the groups for the depth shown
4-B2EP=bis(2-ethyhexyl)phthalate; 1,1-DCA=1,1-dichloroethane; 1,1,1-TCA=1,1,1-trichloroethane; TCE=trichloroethene; PCE=tetrachloroethene; trans-1,2-DCE=trans-1,2-dichloroethene;
5- Other PAHs detected in SL-21:benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthrancene, benzo(g,h,i)perylene

Table 4-14 (continued)
Organic Compounds Detected in Subsurface Soils

Area C (1,2,4)

	SL-37 (MW-37)		SB-4	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	none	n/a	MeCl	32 @ 5.5 ft.
Non-chlorinated organic solvents	xylenes, toluene, ethylbenzene	100 @ 30 ft	none	n/a
Ketones	acetone, MIBK	1,200 @ 30 ft.	acetone	92 @ 18.5 ft.
SEMI-VOLATILES				
Aromatics	none	n/a	none	n/a
PAHs	none	n/a	none	n/a
Phthalates	none	n/a	none	n/a
PESTICIDES/PCBs				
All compounds	none	n/a	none	n/a

	SB-5		SB-6	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	PCE, TCE, chloroform, 1,1,1-TCA	30 @ 20 ft.	TCE, PCE, trans-1,2-DCE, 1,1,1-TCA	145 @ 18.5 ft.
Non-chlorinated organic solvents	none	n/a	none	n/a
Ketones	none	n/a	acetone	110 @ 7 ft.
SEMI-VOLATILES				
Aromatics	isophrone, phenol	219 @ 1.5 ft.	none	n/a
PAHs	none	n/a	none	n/a
Phthalates	BBP, B2EP	1,210 @ 1.5 ft.	none	n/a
PESTICIDES/PCBs				
All compounds	none	n/a	none	n/a

1-No organic compounds detected in SI-18, SB-10, and SB-16
2-Results for RAS (Routine Analytical Services) samples only are summarized here
3-Peak Concentrations indicate the sum of all compounds listed in the groups for the depth shown
3-MeCl=methylene chloride; B2EP=bis(2-ethylhexyl)phthalate;
BBP=butylbenzylphthalate; 1,1,1-TCA=1,1,1-trichloroethane;
MIBK=4-methyl-2-pentanone; TCE=trichloroethene;
1,2-DCE=1,2-dichloroethene; PCE-tetrachloroethene;

Table 4-14 (continued)
Organic Compounds Detected in Subsurface Soils

Area C (1,2,4)

	SB-7		SB-8	
Compound Group	*Compounds Present*	*Peak (3) Concentration ppb*	*Compounds Present*	*Peak (3) Concentration ppb*
VOLATILES				
Chlorinated organic solvents	none	n/a	PCE, MeCl, TCE, 111-TCA, 1122-PCA	149,000 @ 5.5 ft.
Non-chlorinated organic solvents	toluene	5 @ 0.0	xylenes, toluene, ethylbenzene	573,000 @ 5.5 ft.
Ketones	none	n/a	acetone, MIBK, MEK	28,000 @ 5.5 ft.
SEMI-VOLATILES				
Aromatics	dichlorobenzidine	1,100 @ 3 ft.	isophorone, hexachlorobenzene	260 @ 3 ft.
PAHs	none	n/a	naphthalene, 2-methylnaphthalene	1,900 @ 5.5 ft.
Phthalates	none	n/a	BBP, B2EP, di-n-butylphthalate	8,000 @ 5.5 ft.
PESTICIDES/PCBs				
All compounds	none	n/a	none	n/a

	SB-9		SB-11	
Compound Group	*Compounds Present*	*Peak (3) Concentration ppb*	*Compounds Present*	*Peak (3) Concentration ppb*
VOLATILES				
Chlorinated organic solvents	TCE, 1,1,1-TCA	89 @ 1.5 ft.	none	n/a
Non-chlorinated organic solvents	none	n/a	toluene	15 @ 0.0 ft.
Ketones	none	n/a	2-hexanone	16 @ 0.0 ft.
SEMI-VOLATILES				
Aromatics	none	n/a	none	n/a
PAHs	none	n/a	none	n/a
Phthalates	B2EP, di-n-butyl phthalate	2,090 @ 3 ft.	none	n/a
PESTICIDES/PCBs				
All compounds	PCB-1260	3,400 @ 3 ft.	PCB-1260	63 @ 1.5 ft.

1-No organic compounds detected in SI-18, SB-10, and SB-16
2-Results for RAS (Routine Analytical Services) samples only are summarized here
3-Peak Concentrations indicate the sum of all compounds listed in the groups for the depth shown
4-MeCl=methylene chloride; B2EP=bis(2-ethylhexyl)phthalate;
BBP=butylbenzylphthalate; 1,1,1-TCA=1,1,1-trichloroethane;
MEK=methylethyl ketone; MIBK=4-methyl-2-pentanone; TCE=trichloroethene;
PCE-tetrachloroethene; 1122-PCA=1,1,2,2--tetrachloroethane

Table 4-14 (continued)
Organic Compounds Detected in Subsurface Soils

Area C (1,2,4)

	SB-12		SB-13	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	1,1-DCA, PCE, trans-1,2-DCE, 1,1,1-TCA	15 @ 18.5 ft.	PCE	7 @ 18.5 ft.
Non-chlorinated organic solvents	xylenes	8 @ 18.5 ft.	none	n/a
Ketones	acetone	77 @ 3 ft.	none	n/a
SEMI-VOLATILES				
Aromatics	none	n/a	none	n/a
PAHs	none	n/a	none	n/a
Phthalates	none	n/a	none	n/a
PESTICIDES/PCBs				
All compounds	none	n/a	none	n/a

	SB-14		SB-15	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	none	n/a	MeCl	69 @ 17 ft.
Non-chlorinated organic solvents	toluene	12 @ 3 ft.	none	n/a
Ketones	2-hexanone	160 @ 0.0 ft.	none	n/a
SEMI-VOLATILES				
Aromatics	none	n/a	none	n/a
PAHs	phenanthrene, pyrene, chrysene, benzo(a)pyrene	860 @ 1.5 ft.	none	n/a
Phthalates	B2EP, BBP	220 @ 1.5 ft.	none	n/a
PESTICIDES/PCBs				
All compounds	PCB-1260	86 @ 0.0 ft.	none	n/a

1-No organic compounds detected in SI-18, SB-10, and SB-16
2-Results for RAS (Routine Analytical Services) samples only are summarized here
3-Peak Concentrations indicate the sum of all compounds listed in the groups for the depth shown
3-MeCl=methylene chloride; B2EP=bis(2-ethylhexyl)phthalate;
BBP=butylbenzylphthalate; 1,1-DCA=1,1-dichloroethane; 1,1,1-TCA=1,1,1-trichloroethane;
trans-1,2-DCE=trans-1,2-dichloroethene; PCE-tetrachloroethene;

Table 4.4-14 (continued)
Organic Compounds Detected in Subsurface Soils

Area C (1,2)

	SB-17	
Compound Group	*Compounds Present*	*Peak (3) Concentration ppb*
VOLATILES		
Chlorinated organic solvents	none	n/a
Non-chlorinated organic solvents	none	n/a
Ketones	none	n/a
SEMI-VOLATILES		
Aromatics	none	n/a
PAHs	none	n/a
Phthalates	none	n/a
PESTICIDES/PCBs		
All compounds	4,4-DDT, dieldrin, endrin, aldrin, heptachlor	26.1 @ 1.5 ft.

1-No organic compounds detected in SI-18, SB-10, and SB-16
2-Results for RAS (Routine Analytical Services) samples only are summarized here
3-Peak Concentrations indicate the sum of all compounds listed in the groups for the depth shown

TABLE 4-14A

ORGANIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Monitoring Well Boring Samples (ppb)

Area C

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	36 / 94	5 - 3,800	379	684
TRICHLOROETHENE	79-01-6	2 / 94	54 - 59	57	4
4-METHYL-2-PENTANONE	108-10-1	3 / 94	2 - 5	4	2
TETRACHLOROETHENE	127-18-4	7 / 94	1 - 27	10	9
TOLUENE	108-88-3	17 / 94	1 - 25	4	6
XYLENES	1330-20-7	16 / 94	2 - 66	16	21
1,1-DICHLOROETHANE	75-34-3	4 / 94	10 - 130	54	52
TRANS-1,2-DICHLOROETHENE	156-60-5	4 / 94	30 - 390	203	148
1,1,1-TRICHLOROETHANE	71-55-6	12 / 94	2 - 270	61	104
METHYLENE CHLORIDE	75-09-2	12 / 94	5 - 500	57	140
2-HEXANONE	591-78-6	1 / 94	10 - 10	10	
CHLOROETHANE	75-00-3	1 / 94	8 - 8	8	
1,1-DICHLOROETHENE	75-35-4	1 / 94	1 - 1	1	
CHLOROFORM	67-66-3	3 / 94	2 - 3	2	1
2-BUTANONE	78-93-3	3 / 94	8 - 4,900	1,639	2,824
2-CHLOROETHYLVINYLETHER	110-75-8	1 / 94	6 - 6	6	
CHLOROBENZENE	108-90-7	3 / 94	11 - 16	13	3
ETHYLBENZENE	100-41-4	17 / 94	1 - 34	10	12
Base-Neutral-Acids					
2-Chlorophenol	95-57-8	1 / 94	120 - 120	120	
1,4-Dichlorobenzene	106-46-7	1 / 94	74 - 74	74	
Isophorone	78-59-1	1 / 94	68 - 68	68	
Benzoic Acid	65-85-0	2 / 94	410 - 940	675	375
1,2,4-Trichlorobenzene	120-82-1	1 / 94	84 - 84	84	
2-Methylnaphthalene	91-57-6	1 / 94	4 - 4	4	
4-Nitrophenol	100-02-7	2 / 94	370 - 480	425	78
Diethylphthalate	84-66-2	7 / 94	44 - 7,700	1,167	2,881
N-nitrosodiphenylamine	86-30-6	1 / 94	89 - 89	89	
Pentachlorophenol	87-86-5	9 / 94	9 - 19,000	4,128	7,624
Phenanthrene	85-01-8	3 / 94	11 - 280	119	142
Anthracene	120-12-7	2 / 94	58 - 72	65	10
Di-n-butylphthalate	84-74-2	1 / 94	430 - 430	430	
Fluoranthene	206-44-0	2 / 94	66 - 180	123	81
Pyrene	129-00-0	3 / 94	110 - 220	150	61
Butyl Benzyl Phthalate	85-68-7	8 / 94	43 - 320	111	90
bis(2-ethylhexyl)phthalate	117-81-7	13 / 94	5 - 21,000	3,557	7,190
Di-n-octyl Phthalate	117-84-0	1 / 94	99 - 99	99	
Benzo(k)fluoranthene	207-08-9	3 / 94	40 - 260	163	112
Benzo(a)pyrene	50-32-8	2 / 94	140 - 140	140	0
Indeno(1,2,3-cd)pyrene	193-39-5	2 / 94	140 - 180	160	28
Dibenz(a,h)anthracene	53-70-3	1 / 94	130 - 130	130	
Benzo(g,h,i)perylene	191-24-2	2 / 94	170 - 190	180	14
Pesticides and PCBs					
beta-BHC	319-85-7	4 / 94	86 - 130	114	17

TABLE 4-14B

ORGAINIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Soil Boring Samples (PPB)

Area C

Volatile Organics	*CAS*	*Hits / Samples*	*Min Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	13 / 106	19 - 28,000	2,273	7,732
TRICHLOROETHENE	79-01-6	21 / 106	1 - 16,000	1,651	4,053
4-METHYL-2-PENTANONE	108-10-1	7 / 106	8 - 100	25	34
TETRACHLOROETHENE	127-18-4	27 / 106	1 - 85,000	6,346	18,343
TOLUENE	108-88-3	22 / 106	1 - 90,000	8,630	21,110
XYLENES	1330-20-7	13 / 106	1 - 410,000	61,933	117,371
1,1-DICHLOROETHANE	75-34-3	1 / 106	8 - 8	8	
TRANS-1,2-DICHLOROETHENE	156-60-5	3 / 106	1 - 25	10	13
1,1,1-TRICHLOROETHANE	71-55-6	15 / 106	1 - 14,000	2,318	4,436
STYRENE	100-42-5	2 / 106	2 - 2	2	0
METHYLENE CHLORIDE	75-09-2	9 / 106	2 - 34,000	7,238	12,794
2-HEXANONE	591-78-6	3 / 106	16 - 160	89	72
1,2-DICHLOROETHENE	540-59-0	1 / 106	5 - 5	5	
CHLOROFORM	67-66-3	10 / 106	1 - 3	2	1
2-BUTANONE	78-93-3	7 / 106	0 - 89	13	34
1,1,2,2-TETRACHLOROETHANE	79-34-5	1 / 106	600 - 600	600	
ETHYLBENZENE	100-41-4	8 / 106	6 - 73,000	15,395	25,358
Base-Neutral-Acids					
Phenol	108-95-2	3 / 106	69 - 180	112	59
2-Methylphenol	95-48-7	1 / 106	97 - 97	97	
Isophorone	78-59-1	7 / 106	64 - 250	143	74
2,4-Dimethylphenol	105-67-9	1 / 106	57 - 57	57	
Napthalene	91-20-3	6 / 106	84 - 1,900	744	712
2-Methylnaphthalene	91-57-6	1 / 106	170 - 170	170	
2,4-Dinitrophenol	51-28-5	1 / 106	210 - 210	210	
Diethylphthalate	84-66-2	1 / 106	170 - 170	170	
Fluorene	86-73-7	1 / 106	130 - 130	130	
4,6-Dinitro-2-methylphenol	534-52-1	2 / 106	150 - 1,100	625	672
Hexachlorobenzene	118-74-1	3 / 106	160 - 260	223	55
Phenanthrene	85-01-8	2 / 106	310 - 440	375	92
Di-n-butylphthalate	84-74-2	5 / 106	150 - 1,500	578	560
Pyrene	129-00-0	2 / 106	140 - 300	220	113
Butyl Benzyl Phthalate	85-68-7	15 / 106	100 - 4,600	836	1,310
3,3'-Dichlorobenzidene	91-94-1	1 / 106	1,100 - 1,100	1,100	
bis(2-ethylhexyl)phthalate	117-81-7	27 / 106	1 - 3,400	681	887
Chrysene	218-01-9	1 / 106	130 - 130	130	
Di-n-octyl Phthalate	117-84-0	2 / 106	73 - 90	82	12
Benzo(a)pyrene	50-32-8	1 / 106	120 - 120	120	
Pesticides and PCBs					
Heptachlor	76-44-8	1 / 106	3 - 3	3	
Aldrin	309-00-2	1 / 106	5 - 5	5	
Dieldrin	60-57-1	1 / 106	6 - 6	6	
Endrin	72-20-8	1 / 106	6 - 6	6	
4,4'-DDT	50-29-3	1 / 106	7 - 7	7	
AROCLOR-1260	11096-82-5	5 / 106	63 - 3,400	890	1,423

(85,000 ppb), ethylbenzene (73,000 ppb), methylene chloride (34,000 ppb), acetone (28,000 ppb), TCE (16,000 ppb), and 1,1,1-TCA (14,000 ppb). Similar contaminants were detected to the bottom of the boring, but at 720 ppb and less. The suite of VOCs found in SB-8 was nearly identical to that detected in SB-23 in Area A, and concentrations are at roughly similar levels.

Considering the other locations in the first group noted above, the only VOC above detection limits in SB-9 was TCE at 85 ppb in the 1.5- to 3-foot sample. In SB-11 and SB-14, 2-hexanone and toluene were detected at levels between 7 and 160 ppb in samples from above 4.5 feet.

The second group of samples noted above contained VOCs only in samples below 17 feet (15 feet in MW-37). These samples are located in the saturated zone or the capillary zone just above saturation, because the depth to saturation in the vicinity ranges from 17 to 22 feet. The low levels of contaminants found at these locations was thus likely to be derived from contaminated soils in upgradient locations. In SB-5, 6, 12 and 13, as well as MW-10, the VOCs present were primarily chlorinated organics (PCE, TCE, 1,1,1-TCA, trans-1,2-DCE, and 1,1-DCA), and concentrations range from 5 to 400 ppb. High levels of acetone and MEK (2-butanone) were detected at 45 feet in MW-10, but low levels of lab blank contamination were also noted in this sample. Though VOC contamination was noted throughout the shallow aquifer at MW-10, the highest concentrations were found in samples from the middle to upper part of the aquifer. As noted in Section 4.4.11, this pattern was consistent with the distribution of groundwater contamination.

In MW-37, acetone was detected in all samples at concentrations ranging from 5 to 1,200 ppb, with the highest levels appearing in the 30-foot sample. The 30-foot sample also contained xylenes (66 ppb), ethylbenzene (34 ppb), toluene (8 ppb), and MIBK (5 ppb).

The only contaminant detected in the subsurface at MW-29 was acetone (240 ppb) at a depth of 73 feet. This result could be due to lab contamination. MW-29 and 37 differ from the other locations in Area C in that chlorinated organics were not detected there.

The third group of locations mentioned above contained only the suspected lab contaminants methylene chloride or acetone, or other constituents at less than 10 ppb.

4.4.7.2 Semivolatiles

The results of semivolatiles (SVOC) analysis of subsurface samples from Study Area C were summarized in Table 4-14. Similar to the situation for VOCs, the highest levels of SVOCs in Area C were reported for samples from SB-8. The highest concentrations were from the 5.5 to 7-foot sample, where butyl benzyl phthalate (4,600 ppb), bis(2-ethylhexyl)phthalate (3,400 ppb), naphthalene (1,900 ppb), hexachlorobenzene (250 ppb) and 2-methylnaphthalene (170 ppb) were reported. Isophorone was also present in some samples at up to 250 ppb.

Unlike the VOC results, SB-7 and 10 and MW-21 contained SVOC contamination. SB-7 had phenol, methylphenols and nitrophenols at a total concentrations as high as 1,644 ppb, but only in the SAS samples from above 4.5 feet. 3,3-dichlorobenzidine was reported from the 3 to 4.5-foot sample at 1100 ppb. In SB-10, PAHs were detected only in the top sample.

In contrast to the vertical distribution of contaminants at most locations throughout the site, the contaminants in MW-21 were found only in the deep portion of the hole (80 to 142 feet). The compounds detected are PAHs, isophorone, benzoic acid, 4-nitrophenol, pentachlorophenol, n-nitrosodiphenylamine, and several phthalates. The occurrence of these constituents at great depths but not shallow in MW-21 is difficult to explain. However, many of the compounds occur naturally in shales and other similar sediments (PAHs and benzoic acid), and might be expected to be present in the dark clayey tills constituting some of the lower samples. One of the anomalous

samples was a sand, but it contained small black grains that looked like coal. The other compounds reported from MW-21 were not expected to occur, but all were flagged by the lab as being estimated quantities; their detection may possibly be due to interference from the PAHs.

A natural origin from coal tars appears likely for at least some of the SVOCs detected in MW-21 because: 1) this was the lone occurrence for these PAHs below 10 feet in the subsurface, and 2) they were not associated with VOC contamination; in all other instances of subsurface SVOC contamination, VOC contamination was significant.

Isophorone and phenol were present in samples collected between 0 and 8.5 feet in SB-5, at concentrations ranging up to 150 ppb. Phthalates were reported at up to 690 ppb. In the other borings and wells in Area C (SB-4, 6, 9, and 12, and MW-10, 15, 29, and 37), sporadic occurrences of phthalates were reported. However, the low and irregular occurrences of phthalates suggests that they were present as a result of lab or sampling contamination.

4.4.7.3 Pesticides and PCBs

The only pesticides or PCBs reported for Area C were at SB-9, 11, and 14, where PCB-1260 (Aroclor-1260) was detected at between 63 and 3400 ppb in samples above 4.5 feet.

4.4.7.4 *Inorganics*

Many subsurface samples from Area C contained elevated levels of inorganic constituents. However, a different set of borings and wells had inorganic contamination than those that had organic contamination. The highest reported inorganic concentrations were for samples from SB-5, 7, 9, and 16. Cyanide was present at concentrations of 1.2 to 61.7 ppm in four borings. Excessive levels of nickel, zinc, lead, copper, cobalt, cadmium, mercury, and antimony were also found in Area C (Tables 4-12). Many of these were detected in leachability samples as well as RAS samples, indicating that

the metals were in a form with a potential of migrating. However, the constituents apparently have not migrated far because nearly all the instances of excessive inorganics were from above 4.5 feet (the remaining three occurrences were from depths of 4.5 to 13.5 feet, still above the groundwater).

4.4.8 SUBSURFACE SOIL RESULTS: STUDY AREA D

Study Area D encompasses the area surrounding the National Packaging facility in the northwest portion of the project study area. The soil borings and the monitoring wells sampled for subsurface soils in Area D were SB-2, 3 and 26 and MW-33 and 34.

4.4.8.1 Volatiles

The results of organic analysis of subsurface soils in Study Area D were summarized in Tables 4-15, 4-15A and 4-15B and in Figure 4.4-4 (Vol. II). The only borings or wells in Area D that contained elevated levels of VOC contamination were SB-26 and MW-34. Both locations have characteristics similar to borings or wells in other areas.

In SB-26, 2-hexanone (220 ppb) and toluene (9 ppb) were detected in the uppermost (0 to 1.5-foot) sample; however, VOC contamination was not detected in deeper samples. The highest levels of VOCs in Area D soils were detected in MW-34, where samples from 15 and 30 feet contained up to 150 ppb of 1,1,1-TCA, 56 ppb of total xylenes and 26 ppb of ethylbenzene. These samples represent the upper part of the shallow aquifer because the depth to saturation at MW-34 was approximately 14 feet. Low levels of 1,1,1-TCA and toluene (12 and 7 ppb, respectively) were reported for the 70-foot sample. Moderate to high (67 to 720 ppb) levels of acetone or methylene chloride were detected in most samples below 15 feet. However, these particular results may be questionable, because the values were flagged as having contamination in the lab blanks. Thus, the contaminated soils were probably limited to the upper part of the aquifer. In other soil boring and well boring samples collected from Study Area D, the only

Table 4-15
Organic Compounds Detected in Subsurface Soils

Area D (1,2,4)

	SL-34 (MW-34)		SB-2	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	MeCl, 1,1,1-TCA, 1,1-DCE	212 @ 70 ft.	none	n/a
Non-chlorinated organic solvents	xylenes, toluene, ethylbenzene	86 @ 30 ft.	none	n/a
Ketones	acetone, MIBK	720 @ 70 ft.	none	n/a
SEMI-VOLATILES				
Aromatics	pentachlorophenol	620 @ 0.0 ft.	none	n/a
PAHs	pyrene	24 @ 0.0 ft.	none	n/a
Phthalates	B2EP, di-n-butyl phthalate	8,800 @ 5 ft.	B2EP	61 @ 3 ft.
PESTICIDES/PCBs				
All compounds	none	n/a	beta-BHC	19 @ 0.0 ft.

	SB-3		SB-26	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	MeCl	11 @ 5.5 ft.	none	n/a
Non-chlorinated organic solvents	none	n/a	toluene	9 @ 0.0 ft.
Ketones	none	n/a	2-hexanone	220 @ 0.0 ft.
SEMI-VOLATILES				
Aromatics	none	n/a	none	n/a
PAHs	none	n/a	none	n/a
Phthalates	diethyl phthalate, B2EP, di-n-butyl phthalate	660 @ 8 ft.	none	n/a
PESTICIDES/PCBs				
All compounds	beta-BHC	2.9 @ 17 ft.	methoxychlor	1,100 @ 0.0 ft.

1-No organic compounds were detected in MW-33 (SL-33)
2-Results for RAS (Routine Analytical Services) samples only are summarized here
3-Peak Concentrations indicate the sum of all compounds listed in the groups for the depth shown
4-MeCl=methylene chloride; B2EP=bis(2-ethylhexyl)phthalate;
1,1,1-TCA=1,1,1-trichloroethane; 1,1-DCE=1,1-dichloroethene
MIBK=4-methyl-2-pentanone;

TABLE 4-15A

ORGANIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Monitoring Well Boring Samples (ppb)

Area D

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	9 / 21	67 - 720	433	254
4-METHYL-2-PENTANONE	108-10-1	1 / 21	6 - 6	6	
TOLUENE	108-88-3	11 / 21	1 - 7	3	2
XYLENES	1330-20-7	7 / 21	2 - 56	21	25
1,1,1-TRICHLOROETHANE	71-55-6	9 / 21	3 - 150	21	48
METHYLENE CHLORIDE	75-09-2	3 / 21	65 - 200	155	78
CARBON DISULFIDE	75-15-0	4 / 21	2 - 3	3	1
1,1-DICHLOROETHENE	75-35-4	1 / 21	6 - 6	6	
CHLOROFORM	67-66-3	5 / 21	1 - 2	2	1
ETHYLBENZENE	100-41-4	7 / 21	1 - 26	10	12
Base-Neutral-Acids					
Phenol	108-95-2	2 / 21	43 - 60	52	12
1,2-Dichlorobenzene	95-50-1	2 / 21	7 - 8	8	1
Pentachlorophenol	87-86-5	1 / 21	620 - 620	620	
Di-n-butylphthalate	84-74-2	3 / 21	81 - 140	110	30
Pyrene	129-00-0	1 / 21	24 - 24	24	
bis(2-ethylhexyl)phthalate	117-81-7	2 / 21	780 - 8,800	4,790	5,671
Pesticides and PCBs					
Endosulfan I	959-98-8	1 / 21	0.1 - 0.1	0.1	
4,4'-DDE	72-55-9	1 / 21	21 - 21	21	

TABLE 4-15B

ORGANIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Soil Boring Samples (ppb)

Area D

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	2 / 25	20 - 61	41	29
4-METHYL-2-PENTANONE	108-10-1	2 / 25	10 - 26	18	11
TOLUENE	108-88-3	1 / 25	9 - 9	9	
METHYLENE CHLORIDE	75-09-2	12 / 25	1 - 11	6	3
2-HEXANONE	591-78-6	1 / 25	220 - 220	220	
Base-Neutral-Acid					
Diethylphthalate	84-66-2	1 / 25	550 - 550	550	
Di-n-butylphthalate	84-74-2	3 / 25	39 - 150	77	63
bis(2-ethylhexyl)phthalate	117-81-7	9 / 25	42 - 4,900	612	1,608
Di-n-octyl Phthalate	117-84-0	1 / 25	95 - 95	95	
Pesticides and PCBs					
beta-BHC	319-85-7	8 / 25	0.8 - 19	6	6
Methoxychlor	72-43-5	3 / 25	15 - 1,100	468	564

inorganic contamination in the vertical plain was limited to the unsaturated zone.

4.4.9 SUBSURFACE SOIL RESULTS: STUDY AREA E

Study Area E encompasses the area around the Roll Coater facility in the north-central part of the project study area. The soil borings and the monitoring wells sampled for subsurface soils were SB-18 and 21 and MW-7, 42, 45, 48, and 62.

4.4.9.1 Volatiles

The VOC results of subsurface sampling from Study Area E were summarized in Table 4-16, 4-16A and 4-16B and in Figure 4.4-5 (Vol. II). Overall, very little VOC contamination was detected in Area E. Acetone and methylene chloride were the only compounds detected in many samples. However, as in other areas, their presence in these samples was suspected to be due to lab contamination, because 1) they were not found with other common soil VOC contaminants; and 2) they were present at generally similar levels throughout the vertical extent of the soil boring (in both unsaturated and saturated zones), behavior that was not typical for the soil VOC contaminants at the site.

Beyond the occurrences noted above, the only occurrences of other VOCs in Area E subsurface soils appeared in MW-7, 42, and 48. The highest concentrations were detected in MW-48 at a depth of 30 feet, where ethylbenzene, toluene, xylenes, chlorobenzene and PCE were detected at levels ranging from 5 to 33 ppb. Low concentrations of toluene (15 and 6 ppb) were detected in MW-42 at 30 and 45 feet, while MW-7 had a single report of 2-chloroethylvinylether (6 ppb) at 30 feet. All the detections were from the shallow part of the shallow aquifer.

Table 4-16
Organic Compounds Detected in Subsurface Soils

Area E (1,2,4)

	SL-7 (MW-7)		SL-42 (MW-42)	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	2-chloroethylvinyl-ether	6 @ 28.5 ft.	none	n/a
Non-chlorinated organic solvents	none	n/a	toluene	15 @ 30 ft.
Ketones	acetone	84 @ 43.5 ft.	acetone	330 @ 70 ft.
SEMI-VOLATILES				
Aromatics	pentachlorophenol	180 @ 43.5 ft.	none	n/a
PAHs	none	n/a	none	n/a
Phthalates	B2EP, BBP, diethyl phthalate	3,960 @ 88.5 ft.	B2EP	11,000 @ 30 ft.
PESTICIDES/PCBs				
All compounds	none	n/a	none	n/a

	SL-48 (MW-48)		SL-62 (MW-62)	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	MeCl, PCE, chloroform, chloro-benzene, 111-TCA	51 @ 47 ft.	none	n/a
Non-chlorinated organic solvents	xylenes, toluene, ethylbenzene	56 @ 47 ft.	none	n/a
Ketones	acetone	450 @ 47 ft.	acetone	330 @ 15 ft.
SEMI-VOLATILES				
Aromatics	pentachlorophenol, 2-chlorophenol, 1,2,4-trichlorobenzene, 1,4-dichlorobenzene	19,000 @ 7 ft.	none	n/a
PAHs	phenanthrene, pyrene, 2-methyl-naphthalene	110 @ 17 ft.	none	n/a
Phthalates	B2EP, BBP	21,000 @ 7 ft.	B2EP	230 @ 30 ft.
PESTICIDES/PCBs				
All compounds	none	n/a	none	n/a

1-No organic compounds were detected in MW-45 (SL-45)
2-Results for RAS (Routine Analytical Services) samples only are summarized here
3-Peak Concentrations indicate the sum of all compounds listed in the groups for the depth shown
4-MeCl=methylene chloride; B2EP=bis(2-ethylhexyl)phthalate;
BBP=butylbenzylphthalate; 111-TCA=1,1,1-trichloroethane;
PCE-tetrachloroethene;

TABLE 4-16A

ORGANIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Monitoring Well Boring Samples (ppb)

Area E

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	9 / 18	18 - 920	171	298
TRICHLOROETHENE	79-01-6	1 / 18	1 - 1	1	
4-METHYL-2-PENTANONE	108-10-1	1 / 18	10 - 10	10	
TOLUENE	108-88-3	2 / 18	6 - 15	11	6
CARBON DISULFIDE	75-15-0	1 / 18	2 - 2	2	
Base-Neutral-Acids					
bis(2-ethylhexyl)phthalate	117-81-7	2 / 18	18 - 11,000	7,100	5,515
Pesticides and PCBs					
No Detects					

TABLE 4-16B

ORGANIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Soil Boring Samples (ppb)

Area E

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
4-METHYL-2-PENTANONE	108-10-1	2 / 15	36 - 38	37	1
TOLUENE	108-88-3	1 / 15	3 - 3	3	
METHYLENE CHLORIDE	75-09-2	2 / 15	1 - 5	3	3
CHLOROFORM	67-66-3	2 / 15	2 - 3	3	1
Base-Neutral-Analysis					
Isophorone	78-59-1	1 / 15	330 - 330	330	
Butyl Benzyl Phthalate	85-68-7	2 / 15	3 - 480	242	337
bis(2-ethylhexyl)phthalate	117-81-7	2 / 15	120 - 130	125	7
Pesticides and PCBs					
AROCLOR-1260	11096-82-5	10 / 15	29 - 360	133	103

4.4.9.2 Semivolatiles

As with VOCs in Study Area E, the highest concentrations of SVOCs were reported for subsurface samples from MW-48; lower levels were found in MW-7 and SB-18.

High levels of pentachlorophenol (16,000 ppb) and bis(2-ethylhexyl)-phthalate (21,000 ppb) were detected in the 5-foot sample (unsaturated zone) from MW-48. The 15-foot sample (top of saturated zone) contained between 74 and 270 ppb of pentachlorophenol, 2-chlorophenol, pyrene, 1,2,4-trichlorobenzene, and 1,4-dichlorobenzene. Peak levels of pentachlorophenol (1000 ppb) were detected in the 45-foot sample, but other constituents were nearly undetectable here and deeper in the aquifer.

Pentachlorophenol was also detected (180 ppb) at the 30-foot depth in MW-7, while isophorone was detected at 330 ppb in the 5-foot sample from SB-18. Phthalates were found in some other samples, but their patterns suggest that they may have appeared due to lab contamination.

4.4.9.3 Pesticides and PCBs

PCB-1260 (Aroclor-1260) was reported for most subsurface samples from SB-18 and 21, at concentrations ranging from 30 to 360 ppb. No pesticides or PCBs were detected in the soil borings.

4.4.9.4 Inorganics

Zinc, mercury, or antimony were detected at excessive levels in SB-18 and 21, and MW-42, 45, and 48. With the exception of zinc in the 9.5- to 11-foot sample at SB-21, all these occurrences were in samples above 4.5 feet. Leachability results suggest that zinc (MW-48) and mercury (MW-45 and 48) are somewhat mobile. As in other areas, however, only the near-surface soils appeared to be affected by inorganic contamination.

4.4.10 SUBSURFACE SOIL RESULTS: STUDY AREA F

Study Area F encompasses the Space Leasing facility at the far northeast corner of the project study area. The soil borings and the monitoring well borings that were sampled for subsurface soils in Area F were SB-36, MW-65 and 68.

4.4.10.1 Volatiles

The organic results of soil sampling in Study Area F were summarized in Table 4-17, 4-17A and 4-17B and in Figure 4.4-6 (Vol. II). The highest levels of VOCs were found in SB-36. The boring was extended to only 4.5 feet, but moderate levels (up to 870 ppb) of PCE were detected in all samples, along with lower concentrations of the chlorinated organics TCE (94 ppb), 1,1,1-TCA, 1,2-DCE, and methylene chloride.

The only VOCs reported above the detection limit in MW-65 and 68 were acetone and methylene chloride. Their patterns of roughly similar levels throughout the intervals sampled, along with the lack of other contaminants, suggest that these constituents were, again, present due to lab contamination.

4.4.10.2 Semivolatiles

A fairly typical suite of SVOCs was reported from samples from SB-36, including benzoic acid (to 690 ppb), phenol (460 ppb), isophorone (380 ppb), benzyl alcohol (100 ppb), several PAHs, and several phthalates. As with the VOCs, the highest concentrations were found in the 1.5- to 3-foot sample.

The only SVOC detected in MW-65 or 68 (other than phthalates) was N-nitrosodiphenylamine (230 ppb), in the 5-foot sample from MW-68.

Table 4-17
Organic Compounds Detected in Subsurface Soils

Area F (1,2,4)

	SL-65 (MW-65)		SL-68 (MW-68)	
Compound Group	***Compounds Present***	***Peak (2) Concentration ppb***	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES				
Chlorinated organic solvents	MeCl	64 @ 30 ft.	MeCl	140 @ 0.0 ft.
Non-chlorinated organic solvents	none	n/a	none	n/a
Ketones	acetone	790 @ 30 ft.	acetone	3,000 @ 65 ft.
SEMI-VOLATILES				
Aromatics	none	n/a	n-nitrosodi-phenylamine	230 @ 5 ft.
PAHs	none	n/a	none	n/a
Phthalates	B2EP	770 @ 45 ft.	B2EP	4,100 @ 60 ft.
PESTICIDES/PCBs				
All compounds	none	n/a	none	n/a

	SB-36	
Compound Group	***Compounds Present***	***Peak (3) Concentration ppb***
VOLATILES		
Chlorinated organic solvents	PCE, TCE, MeCl, 1,2-DCE, 111-TCA	1,004 @ 1.5 ft
Non-chlorinated organic solvents	none	n/a
Ketones	none	n/a
SEMI-VOLATILES		
Aromatics	benzoic acid, phenol, isophorone, benzyl alcohol, 4-methylphenol	1,560 @ 1.5 ft.
PAHs	naphthalene, 2-methylnaphthalene phenanthrene, chrysene, pyrene, fluoranthene, anthracene	293 @ 1.5 ft.
Phthalates	B2EP, BBP	3,582 @ 1.5 ft.
PESTICIDES/PCBs		
All compounds	PCB-1260	480 @ 3 ft.

1-No organic compounds were detected in MW-33 (SL-33)
2-Results for RAS (Routine Analytical Services) samples only are summarized here
3-Peak Concentrations indicate the sum of all compounds listed in the groups for the depth shown
4-MeCl=methylene chloride; B2EP=bis(2-ethylhexyl)phthalate; PCE=tetrachloroethene; BBP=butylbenzylphthalate; 111-TCA=1,1,1-trichloroethane; TCE=trichloroethene; 1,2-DCE=1,2-dichloroethene

TABLE 4-17A

ORGANIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Monitoring Well Boring Samples (ppb)

Area F

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
ACETONE	67-64-1	13 / 18	16 - 3,000	807	940
TOLUENE	108-88-3	1 / 18	4 - 4	4	
1,1,1-TRICHLOROETHANE	71-55-6	1 / 18	4 - 4	4	
METHYLENE CHLORIDE	75-09-2	17 / 18	6 - 140	47	37
1,1-DICHLOROETHENE	75-35-4	1 / 18	3 - 3	3	
Base-Neutral-Acids					
N-nitrosodiphenylamine	86-30-6	1 / 18	230 230	230	
bis(2-ethylhexyl)phthalate	117-81-7	7 / 18	3 - 4,100	833	1,469
Pesticides and PCBs					
No Detects					

TABLE 4-17B

ORGANIC CONTAMINANT CONCENTRATIONS IN SUBSURFACE SOILS AT FISHER-CALO
Summary of Soil Boring Samples (PPB)

Area F

Volatile Organics	*CAS*	*Hits / Samples*	*Min - Max*	*Average*	*St. Dev.*
TRICHLOROETHENE	79-01-6	5 / 5	6 - 94	31	36
4-METHYL-2-PENTANONE	108-10-1	1 / 5	33 - 33	33	
TETRACHLOROETHENE	127-18-4	5 / 5	25 - 870	313	349
1,1,1-TRICHLOROETHANE	71-55-6	4 / 5	1 - 13	7	6
METHYLENE CHLORIDE	75-09-2	4 / 5	5 - 13	8	3
1,2-DICHLOROETHENE	540-59-0	4 / 5	2 - 14	6	5
CHLOROFORM	67-66-3	1 / 5	3 - 3	3	
Base-Neutral-Acid					
Phenol	108-95-2	3 / 5	440 - 460	453	12
Benzyl Alcohol	100-51-6	3 / 5	68 - 100	89	18
4-Methylphenol	106-44-5	1 / 5	39 - 39	39	
Isophorone	78-59-1	2 / 5	120 - 380	250	184
Benzoic Acid	65-85-0	4 / 5	220 - 850	595	268
Napthalene	91-20-3	1 / 5	80 - 80	80	
2-Methylnaphthalene	91-57-6	1 / 5	51 - 51	51	
Phenanthrene	85-01-8	1 / 5	46 - 46	46	
Anthracene	120-12-7	2 / 5	46 - 56	51	7
Di-n-butylphthalate	84-74-2	2 / 5	54 - 82	68	20
Fluoranthene	206-44-0	1 / 5	36 - 36	36	
Pyrene	129-00-0	2 / 5	36 - 43	40	5
Butyl Benzyl Phthalate	85-68-7	2 / 5	97 - 1,400	749	921
bis(2-ethylhexyl)phthalate	117-81-7	1 / 5	2,100 - 2,100	2,100	
Chrysene	218-01-9	1 / 5	44 - 44	44	
Pesticides and PCBs					
AROCLOR-1260	11096-82-5	1 / 5	480 - 480	480	

4.4.10.3 Pesticides and PCBs

PCB-1260 was the only pesticide or PCB detected in the subsurface of Area F. It was present at 480 ppb in the 3- to 4.5-foot sample from SB-36.

4.4.10.4 Inorganics

No inorganic constituents were detected at excessive levels in subsurface soils in Study Area F.

4.4.11 SOIL GAS SURVEY

A Soil Gas Survey was conducted at the Fisher-Calo site as a field screening activity in order to identify and characterize the extent of contamination in suspected areas of waste disposal and in areas of buried tanks or drums. Five study areas were investigated, including three on-site areas (A-1, A-2, and C-1) and two off-site areas (F-1 and Background Locations in White Oak Park). The study areas and sample locations are shown in Figures 4.4-7 through 4.4-11, contained in Vol. II, Appendix A.

Upon the completion of soil gas sampling and analysis at Fisher-Calo, Camp Dresser & McKee Inc. (CDM) received the "Report for Soil Gas Sample Results" dated December 12, 1988 from ATEC Associates, Inc. (subcontracted by CDM to perform the Soil Gas Survey). This report was reviewed by a CDM soil gas specialist.

After a thorough check of ATEC's report, the following types of errors and/or discrepancies were noticed:

- Transcription errors from the raw data to Table 4-18;
- Failure to attach appropriate data qualifiers to the data results;

- Several reported concentrations differed significantly from their true values due to errors in the initial calculations prepared by ATEC. Calculations to determine the corrected concentrations were prepared during CDM's review of the soil gas data.

The corrected concentration values were used in CDM's assessment of the soil gas analytical results. Calculations to determine the concentration values made use of the initial daily standard and peak area (vs) in order to quantitate the concentrations of tetrachloroethylene (TCE), toluene and unknown compounds in soil gas samples. The integrator in the photovac gas chromatograph used by ATEC failed to store appropriate standard's data and hence generated erroneous results. Therefore, use of the integrator was discounted for the quantitation of final results.

Several errors in transcription and quantitation were noticed in ATEC's report. For example, sample no. SG-2SC reported the presence of 712 ppb of toluene in Table 4-18. However, calculations in their report indicated that toluene as not detected (N.D.). Sample no. SG-1SB was reported with 999 ppb of TCE in Table 4-18 but the corrected value of TCE was quantitated at 1 ppb from its respective chromatograph.

Wherever necessary, the CDM specialist qualified the necessary data with "J" thereby estimating presence of that particular compound below the instrument detection limit. Instead of correcting ATEC's report, it was determined to be more efficient and feasible to utilize the data tabulated by CDM. In terms of improvement, all undetected compounds can be reported with their detection limits. All soil gas analyses performed before November 9, 1988 had a detection limit of 5 ppb and all analyses performed after that date had a detection limit of 0.5 ppm (approximately). The results of the soil gas field screening survey are discussed below.

4.4.11.1 Soil Gas Study Area A-1

Study Area A-1 is located north of the tank farm at the Fisher-Calo Two-Line Road facility. Samples were taken from an area approximately 25

TABLE 4-18

SOIL GAS RESULTS

FISHER-CALO TANK FARM (AREA A-1)

SAMPLE ID	DATE ANALYZED	SAMPLE DEPTH FT	CONCENTRATION IN PPM			
			TCE	TOLUENE	UNKNOWN A	UNKNOWN B
SG-F01A	11/11/88	2.5	ND	193	13J	ND
SG-F01B	11/11/88	5.0	ND	170	62.6	76.6
SG-F01C	11/11/88	7.5	ND	308	63.3	14J
SG-F01D	11/11/88	10.0	ND	21.6	5.2J	4.2J
SG-F02A	11/14/88	2.5	ND	540	102	103
SG-F02B	11/14/88	5.0	ND	1842	234	234
SG-F02C	11/14/88	7.5	ND	1397	129J	ND
SG-F02D	11/14/88	10.0	ND	62.2	12.6	12.6
SG-F03A	11/14/88	2.5	ND	1238	153	143
SG-F03B	11/14/88	5.0	ND	17.2	ND	ND
SG-F03C	11/14/88	7.5	ND	140	ND	ND
SG-F03D	11/14/88	10.0	ND	1270	193	183
SG-F04A	11/14/88	2.5	ND	151	66.4	34.3
SG-F04B	11/14/88	5.0	ND	214	132	72.2
SG-F04C	11/14/88	7.5	ND	54.9	112	52.9
SG-F04D	11/14/88	10.0	ND	45.4	69.7	29.3
SG-F05A	11/15/88	2.5	ND	45.5	64.8	60.3
SG-F05B	11/15/88	5.0	ND	63.0	73.7	73.7
SG-F05C	11/15/88	7.5	ND	41J	33J	20J
SG-F05D	11/15/88	10.0	ND	158	103	93.9

* - Unknown A and B are the two highest concentration unknown compounds detected
J - Estimated value

All samples have a detection limit of 1 ppm.

TABLE 4-18 (Cont.)

SOIL GAS RESULTS

FISHER-CALO TANK FARM (AREA A-1)

SAMPLE ID	DATE ANALYZED	SAMPLE DEPTH FT	CONCENTRATION IN PPM			
			TCE	TOLUENE	UNKNOWN A	UNKNOWN B
SG-F06A	11/15/88	2.5	ND	38.5	5.0	ND
SG-F06B	11/15/88	5.0	12.9	36.8	49.2	38.0
SG-F06C	11/15/88	7.5	ND	34.1	36.6	49.2
SG-F06D	11/15/88	10.0	ND	137	89.4	103
SG-F07A	11/15/88	2.5	ND	19.9	11.4	ND
SG-F07B	11/15/88	5.0	ND	5.25	3.9	ND
SG-F07C	11/15/88	7.5	0.27J	1.03	9.8	2.0
SG-F07D	11/15/88	10.0	ND	ND	1.6	ND
SG-F08A	11/15/88	2.5	ND	2.1	1.95	1.06
SG-F08B	11/15/88	5.0	ND	ND	1.12	0.4J
SG-F08C	11/15/88	7.5	ND	ND	1.8	0.4J
SG-F08D	11/15/88	10.0	ND	1.08	9.16	1.17
SG-F09A	11/15/88	2.5	ND	3.33	2.68	0.4J
SG-F09B	11/15/88	5.0	ND	394	104	9J
SG-F09C	11/15/88	7.5	ND	780	302	64.5
SG-F09D	11/15/88	10.0	ND	630	268	53J
SG-F10A	11/16/88	2.5	ND	ND	ND	ND
SG-F10B	11/16/88	5.0	ND	28.6	99.0	66.8
SG-F10C	11/16/88	7.5	ND	13.5	34.5	23.0
SG-F10D	11/16/88	10.0	ND	3J	4J	4J

* - Unknown A and B are the two highest concentration unknown compounds detected.

J - Estimated Value

All samples have a detection limit of 1 ppm.

feet wide by 30 feet long, in the vicinity of three buried railroad tank cars. Samples were collected at ten locations along the perimeter of the tank cars at four depths (2.5, 5, 7.5, and 10 feet). Sample locations and the levels of contamination detected at each were shown in Figure 4.4-8 (Vol. II).

Toluene was detected at all sample locations at varying depths ranging from 2.5 to 10 feet. Trichloroethylene was detected at only two locations (SG-F06 at 5 feet and SG-F07 at 7.5 feet). However, the concentration detected at the latter location was below the detection limit and was therefore only an estimated value. Based upon the data collected (see Table 4-18) it appears that the railroad tank cars have leaked and caused toluene contamination in the vicinity of the disposal area. The highest levels of toluene were detected at two locations in the southwest corner (SG-F02 and SG-F03) and at two locations in the southeast corner (SG-F09 and SG-F10) of the study area. In addition to toluene, several unknown compounds were detected at all locations. The actual compounds present at these locations were not determined, however, the concentrations of each unknown compound detected were shown in Table 4-18.

4.4.11.2 Soil Gas Study Area A-2

Samples collected from Study Area A-2 were collected in the vicinity of four exposed tanks located at the southern end of the Fisher-Calo facility. Five sample locations were placed in the vicinity of the tanks (SG-02 through SG-06) and one location was placed south of the access road and west of the railroad tracks as a downgradient location (SG-01). Sample locations and the levels of contamination detected at each were shown in Figure 4.4-9 (Vol. II).

Based upon the data obtained (See Table 4-19), low level toluene contamination (6.6 to 14.0 ppb) was detected at depths ranging from 5 to 10 feet at the two locations west of the tank farm (SG-02 and SG-03) and at the downgradient location (SG-01). The most heavily contaminated sample

TABLE 4-19

SOIL GAS RESULTS

FISHER-CALO EXPOSED TANK LOCATIONS
(SOUTH FISHER)
AREA A-2

SAMPLE ID	DATE ANALYZED	SAMPLE DEPTH FT	CONCENTRATION IN PPM			
			TCE	TOLUENE	UNKNOWN A	UNKNOWN B
SG-01A	10/10/88	2	ND	1.7J	ND	ND
SG-01B	10/10/88	10	ND	10.0	55.2	32.0
SG-01B(DUP)	10/10/88	10	ND	2.0J	65.3	27.6
SG-02A	10/10/88	10	ND	13.3	22.1	14.3
SG-02B	10/10/88	10	ND	9.0	19.3	6.4
SG-03A	10/10/88	5	ND	14.0	ND	ND
SG-03B	10/10/88	10	ND	6.6	7.4	2.1J
SG-04A	10/7/88	5	ND	31.2	11.4	ND
SG-04B	10/7/88	7	79.4	15.4	37.3	11.8
SG-04(DUP)	10/7/88	7	79.4	13.1	37.0	12.7
SG-04C	10/7/88	10	203	30.4	1324	150
SG-05A	11/16/88	5	ND	ND	ND	ND
SG-05B	11/16/88	7	ND	ND	ND	ND
SG-05C	11/16/88	10	ND	ND	ND	ND
SG-06A	10/7/88	5	ND	ND	26.8	ND
SG-06B	10/7/88	7	ND	ND	15.5	ND
SG-06C	10/7/88	10	ND	ND	12.0	ND

* - Unknowns A and B are the two highest concentrations of the unknown compounds detected.

J - Value is below the detection limit and therefore estimated.

All samples analyzed 10/7 through 10/10/88 have a detection limit of 5 ppb.
All samples analyzed on 11/16/88 have a detection limit of 1 ppm.

was located in the low area east of the tanks (SG-04) and contained both toluene and trichloroethylene. This location was the only location that exhibited TCE contamination. In addition to the above, several unknown contaminants were detected at all locations except SG-05. The concentrations of the unknown compounds detected were shown in Table 4-19.

4.4.11.3 Soil Gas Study Area C-1

Study Area C-1 was located south and east of Cardinal Chemical in an area of known past drum storage and waste disposal activities. Ten sample locations were selected and sampled at three depths: 1 foot, 2 feet, and 3 feet. Sample locations and the levels of contamination detected at each were shown in Figure 4.4-10 (Vol. II).

Locations SG-CC9 and SG-CC10 were the only two locations that showed contamination at levels greater than the detection limit. Trichloroethylene was detected at both locations at depths ranging from 1 to 3 feet, with the highest concentrations detected at the 2 and 3 feet depths at location SG-CC09. Toluene was not detected in concentrations greater than the detection limit at any locations. Low level contamination by unknown compounds was also detected in the 2 and 3 foot sample depths at locations SG-CC09 and SG-CC10. The concentrations of contaminants detected were shown in Table 4-20.

4.4.11.4 Soil Gas Study Area F-1

Study Area F-1 was located at the northeastern corner of the Space Leasing Facility in a suspected area of past drum storage and waste disposal activities. A background sample was collected at location SG-1S. Locations SG-2S and SG3S were placed upgradient and downgradient respectively of the suspected waste disposal area. Sample locations and the levels of contamination detected at each were shown in Figure 4.4-11 (Vol. II).

TABLE 4-20

CARDINAL CHEMICAL LOCATIONS
AREA C-1

SAMPLE ID	DATE ANALYZED	SAMPLE DEPTH(FT)	CONCENTRATION IN PPM			
			TCE	TOLUENE	UNKNOWN A*	UNKNOWN B*
SG-CC01A	10/18/88	1	ND	ND	ND	ND
SG-CC01B	10/18/88	2	ND	ND	ND	ND
SG-CC01C	10/18/88	3	ND	ND	ND	ND
SG-CC01N	11/11/88	1	ND	ND	ND	ND
SG-CC01S	11/11/88	1	ND	ND	ND	ND
SG-CC01E	11/11/88	1	ND	ND	ND	ND
SG-CC01W	11/11/88	1	ND	ND	ND	ND
SG-CC02A	10/18/88	1	ND	ND	ND	ND
SG-CC02B	10/18/88	2	ND	ND	ND	ND
SG-CC02C	10/18/88	3	ND	ND	ND	ND
SG-CC02N	11/11/88	2	ND	ND	ND	ND
SG-CC02S	11/11/88	2	ND	ND	ND	ND
SG-CC02E	11/11/88	2	ND	ND	ND	ND
SG-CC02W	11/11/88	2	ND	ND	ND	ND
SG-CC03A	11/9/88	1	ND	ND	ND	ND
SG-CC03B	11/9/88	2	ND	ND	ND	ND
SG-CC03A	11/9/88	1	ND	ND	ND	ND
SG-CC03B	11/9/88	2	ND	ND	ND	ND
SG-CC03C	11/9/88	3	ND	ND	ND	ND
SG-CC03N	11/10/88	1.5	ND	ND	ND	ND
SG-CC03S	11/10/88	1.5	ND	ND	ND	ND
SG-CC03E	11/10/88	1.5	ND	ND	ND	ND

* - Unknowns A and B are the two highest concentrations of the unknown compounds detected.

J - Value is below detection limit and therefore estimated.

All samples analyzed on 10/18/88 have a detection limit of 5 ppb. All samples analyzed 11/9 through 11/1/88 have a detection limit of 1 ppm.

TABLE 4-20 (Cont.)

CARDINAL CHEMICAL LOCATIONS
AREA C-1

SAMPLE ID	DATE ANALYZED	SAMPLE DEPTH FT	CONCENTRATION IN PPM			
			TCE	TOLUENE	UNKNOWN A*	UNKNOWN B*
SG-CC03W	11/10/88	1.5	ND	ND	ND	ND
SG-CC04A	11/9/88	1	ND	ND	ND	ND
SG-CC04B	11/9/88	2	ND	ND	ND	ND
SG-CC04C	11/9/88	3	ND	ND	ND	ND
SG-CC04N	11/10/88	1.5	ND	ND	ND	ND
SG-CC04S	11/10/88	1.5	ND	ND	ND	ND
SG-CC04E	11/10/88	1.5	ND	ND	ND	ND
SG-CC04W	11/10/88	1.5	ND	ND	ND	ND
SG-CC05A	11/9/88	1	ND	ND	ND	ND
SG-CC05B	11/9/88	2	ND	ND	ND	ND
SG-CC05C	11/9/88	3	ND	ND	ND	ND
SG-CC05N	11/10/88	2	ND	ND	ND	ND
SG-CC05S	11/10/88	2	ND	ND	ND	ND
SG-CC05E	11/10/88	2	ND	ND	ND	ND
SG-CC05W	11/10/88	2	ND	ND	ND	ND
SG-CC06A	11/9/88	1	ND	ND	ND	ND
SG-CC06B	11/9/88	2	ND	ND	ND	ND
SG-CC06C	11/9/88	3	ND	ND	ND	ND

* - Unknown A and B are the two highest concentrations of the unknow compounds detected.

J - Value is below detection limit and therefore estimated.

All samples analyzed on 10/18/88 have a detection limit of ppb. All samples analyzed 11/9 through 11/11/88 have a detection limit of 1 ppm.

TABLE 4-20 (Cont.)

CARDINAL CHEMICAL LOCATIONS
AREA C-1

SAMPLE ID	DATE ANALYZED	SAMPLE DEPTH FT	CONCENTRATION IN PPM			
			TCE	TOLUENE	UNKNOWN A	UNKNOWN B
SG-CC06N	11/10/88	1.5	ND	ND	ND	ND
SG-CC06S	11/10/88	1.5	ND	ND	ND	ND
SG-CC06E	11/10/88	1.5	ND	ND	ND	ND
SG-CC06W	11/10/88	1.5	ND	ND	ND	ND
SG-CC07A	11/10/88	1	ND	ND	ND	ND
SG-CC07B	11/10/88	2	ND	ND	ND	ND
SG-CC07C	11/10/88	3	ND	ND	ND	ND
SG-CC07S	11/11/88	1.5	ND	ND	ND	ND
SG-CC07E	11/11/88	1.5	ND	ND	ND	ND
SG-CC07W	11/11/88	1.5	ND	ND	ND	ND
SG-CC08A	11/10/88	1	ND	ND	ND	ND
SG-CC08B	11/10/88	2	ND	ND	ND	ND
SG-CC08C	11/10/88	3	ND	ND	ND	ND
SG-CC08N	11/10/88	1	ND	ND	ND	ND
SG-CC08S	11/11/88	1	0.17J	0.27J	0.1J	ND
SG-CC08E	11/11/88	1	ND	ND	ND	ND
SG-CC08W	11/11/88	1	0.54J	0.81J	0.5J	ND

* - Unknown A and B are the two highest concentrations of the unknown compounds detected.

J - Value is below detection limit and therefore estimated.

All samples analyzed on 10/18/88 have a detection limit of 5 ppb. All samples analyzed 11/9 through 11/11/88 have a detection limit of 1 ppm.

TABLE 4-20 (Cont.)

CARDINAL CHEMICAL LOCATIONS
AREA C-1

SAMPLE ID	DATE ANALYZED	SAMPLE DEPTH FT	CONCENTRATION IN PPM			
			TCE	TOLUENE	UNKNOWN A	UNKNOWN B
SG-CC09A	11/10/88	1	0.86	ND	0.58J	ND
SG-CC09B	11/10/88	2	33.1	ND	22.0	3.2J
SG-CC09C	11/10/88	3	30.2	ND	17.9	2.3J
SG-CC10A	11/10/88	1	ND	ND	ND	ND
SG-CC10B	11/10/88	2	0.86	ND	2.91	0.2J
SG-CC10C	11/10/88	3	1.05	ND	3.36	0.2J

* - Unknown A and B are the two highest concentrations of the unknown compounds detected.

J - Value is below detection limit and therefore estimated.

All samples analyzed on 10/18/88 have a detection limit of 5 ppb. All samples analyzed 11/9 through 11/11/88 have a detection limit of ppm.

The highest levels of TCE contamination were detected at location SG-2S at depths ranging from 2 to 10 feet, with the highest readings at 7 and 10 feet. TCE was also detected at location SG-1S with the highest concentration at the 1 foot depth. No contamination was detected at location SG-3S.

The highest level of toluene contamination was also detected at location SG-2S, with the highest reading at 10 feet. Additionally, toluene was detected at location SG-1S with the highest concentration at the 1 foot depth. No toluene contamination was detected at location SG-3S.

The highest concentration of unknown compounds was also detected at location SG-2S, indicating additional contamination at this location. Unknown compounds were also detected at location SG-1S at the 1 foot depth. No other unknown compounds were detected at concentrations greater than the detection limit. Data collected for locations SG-1S through SG-3S was summarized in Table 4-21.

Based upon the data generated, it was evident that contamination was present in an area north/northeast of the past drum storage/waste disposal area originally suspected. Apparently, waste disposal activities may have also occurred in the location of SG-1S. Since location SG-2S is located in a low area or depression, it is likely that contamination may have collected in this area.

4.4.11.5 Soil Gas Background Study Area

A background soil gas location was selected in White Oak Park, shown in Figure 4.4-7 (Vol. II). Samples were taken from depth intervals of 1, 3, 5 and 10 feet. TCE was detected at 225 ppb at 3 feet and toluene was detected at concentrations above the detection limit at depths of 3 and 10 feet, with the highest concentration (216 ppb) also being at 3 feet. Unknown compounds were also detected in the sample taken from the 3 foot interval. The data for the background location is summarized in Table 4-22.

TABLE 4-21

SPACE LEASING LOCATIONS
AREA F-1

SAMPLE ID	DATE ANALYZED	SAMPLE DEPTH FT	CONCENTRATION IN PPB			
			TCE	TOLUENE	UNKNOWN A	UNKNOWN B
SG-1SA	10/6/88	1	840	1,180	658	250
SG-1SB	10/6/88	3	1.60	21.2	ND	ND
SG-1SC	10/6/88	5	ND	7J	ND	ND
SG-1SD	10/6/88	10	ND	11	ND	ND
SG-2SA	10/6/88	2	480	721	777	366
SG-2SB	10/6/88	5	82.3	1.58J	2,971	238
SG-2SC	10/6/88	7	3,108	ND	15,000	7,770
SG-2SD	10/6/88	10	3,657	2,443	137,000	8,685
SG-3SA	10/6/88	2	ND	ND	32J	ND
SG-3SB	10/6/88	5	ND	ND	40J	ND
SG-3SC	10/6/88	10	ND	ND	82J	ND

* - Unknown A and B are the two highest concentrations of the unknown compounds detected.

J - Value is below detection limit and therefore estimated.

All samples have a detection limit of 5 ppb.

TABLE 4-22

WHITE OAK PARK LOCATIONS
BACKGROUND AREA

SAMPLE ID	DATE ANALYZED	SAMPLE DEPTH FT	CONCENTRATION IN PPB			
			TCE	TOLUENE	UNKNOWN A	UNKNOWN B
SG-40A	10/7/88	1	ND	ND	ND	
SG-40B	10/7/88	3	225	216	194	5.87
SG-40C	10/7/88	5	ND	2.40J	7.01	ND
SG-40D	10/7/88	10	ND	38.6	ND	ND
SG-FB-01			ND	ND	ND	ND

* - Unknown A and B are the two highest concentrations of the unknown compounds detected.

J - Value is below detection limit and therefore estimated.

All samples have a detection limit of 5 ppb.

Based upon the data collected, it appears that low level contamination was present in White Oak Park. To date, the source of this contamination has not been identified.

4.4.11.6 Soil Gas Results: Comparison With Subsurface Soils

The results of the soil gas survey were broadly consistent with subsurface soil sampling results. Soils in the unsaturated zone cannot be correlated across more than a few feet with regard to organic constituents, because the movement of fluids in the unsaturated zone is vertically downward. However, a few broad generalizations can be made in comparing the results of soil gas to that of subsurface soil. In soil gas area A-1, locally high values of toluene were reported, but only traces of TCE were found in a few samples. Subsurface soils near soil gas area A-1 contained locally high levels of both toluene and TCE.

In soil gas area A-2, low levels of TCE and toluene were only locally detected, while subsurface soils had no detectable contaminants. TCE, but not toluene was found in Soil Gas Area C-1, and yet, subsurface samples nearby contained both TCE and toluene. Soil gas area F-1 contained a location with high concentrations of both TCE and toluene; the soil boring nearest this location contained elevated levels of TCE, but no detectable levels of toluene.

4.4.12 SUBSURFACE SOIL RESULTS: SUMMARY AND RECOMMENDATIONS

Subsurface soil sampling at the Fisher-Calo site showed that semi-volatile contamination and excessive levels of inorganics were generally limited to the shallow parts of the unsaturated zone (above 10 to 12 feet in depth). Pesticides and PCBs penetrated to greater depths, and may locally affect groundwater. Based on subsurface soil sampling results, the primary threat to groundwater was through VOC contamination. Two distinct patterns of VOC distribution were seen in the subsurface: 1) high concentrations of VOCS in

the unsaturated zone, and low to moderate concentrations in the saturated zone; and 2) no VOCs in the unsaturated zone, and low to moderate concentrations in the shallow to middle depths of the saturated zone. Locations exhibiting the first patterns may be situated near a contaminant source in the unsaturated zone; locations displaying the second pattern reflect the existence of an upgradient contaminant source. Results from each subsurface sample location were composited to indicate the extent of contamination found in the unsaturated soils, shown in Figure 4.4-12 (Vol. II).

Three major classes of VOCs were detected in the subsurface soil samples: 1) chlorinated organic solvents; 2) non-chlorinated organic solvents, including xylenes, toluene and ethylbenzene; and 3) ketones, comprising acetone, MEK (2-butanone), and MIBK (4-methyl-1-2-pentanone). Except for the fact that VOC contamination was mainly limited to the shallow depths in the upper aquifer, the non-chlorinated solvents appear to be highly attenuated with depth, and were present at very low levels throughout the aquifer. This may relate to the low density of these compounds and high susceptibility to volatilization from the soil before they migrate down in to the aquifer.

High contaminant levels are likely to remain in the unsaturated zone for much longer than in the groundwater, due to the relative amounts of water that flow through the unsaturated and saturated zones. Thus, to eliminate a source of ongoing VOC contamination to groundwater, the locations showing very high VOC concentrations in the unsaturated zone should be remediated. The only locations with this patterns of contamination are SB-8, 23, 33 and to a lesser extent, SB-36 (located in Study Areas C, A, B and F, respectively). In addition, Soil Gas Area A-1 contains several locations (SS-F01, 2, 3 and 9) which exhibited highly contaminated soils which should be remediated. SB-8, 23 and 33 contained very high levels of toluene, xylenes and ethylbenzene (more than 100,000 ppb total), as well as chlorinated organics (more than 50,000 ppb total). SB-36 contained only lower levels of chlorinated organics (1,000 ppb total). Soil Gas Area A-1

contained soils with very high levels of toluene (commonly 500 to 1,000 ppm), and other related constituents were likely present as well (however, only toluene and TCE were analyzed for). These constituents might all be expected to be present in the subsurface, considering the past disposal practices at the site. All other locations sampled for subsurface soils contained low or sporadic levels of VOCs, and do not require remediation.

4.5 GROUNDWATER SAMPLES

Two rounds of groundwater samples were collected from the fisher Calo site in 1988. Round I samples were collected between August 8 through 24 and Round II samples were collected between November 7 through 22. The sampling was performed by ATEC Associates, Inc. with supervision by the CDM REM II Team. A total of 81 groundwater samples (including field blanks and duplicates) were collected during Round I from 68 monitoring wells and 2 production wells. Round II included resampling of these same wells plus one additional production well.

The locations of the monitoring and production wells are shown in Figure 4.5-1, attached in Volume II, Appendix A. All samples were analyzed for full CLP organics, inorganics, and cyanide, with filtered and unfiltered samples collected for inorganic analysis. The groundwater samples were also analyzed for total dissolved and total suspended solids, nitrate/nitrite, ammonia, chloride, and sulfate. Field blanks and duplicate samples were collected in accordance with the protocol described in the site Sampling and Analysis Plan (SAP).

4.5.1 STANDARDS AND CRITERIA

To date, Indiana has not established state groundwater quality standards. Thus, sample results were compared to the federal primary and secondary maximum contaminant levels (MCL) promulgated under the Safe Drinking Water Act. Primary MCLs are enforceable standards while secondary MCLs are non-enforceable standards. Filtered and unfiltered inorganic results were also

compared to background location sample results. The primary and secondary MCLs and the background concentrations detected are shown in Table 4-23. As can be seen from the table, MCLs have not been promulgated for most of the CLP parameters.

4.5.2 DATA PROBLEMS AND QA/QC RESULTS

The results of the field blanks and duplicate samples (sample pairs) were used to evaluate the quality of the sampling procedures as well as the CLP laboratory methods and procedures. Volatile organics, BNAs, and pesticides/PCBs were not detected in any of the Round I field blanks.

Aluminum, barium, copper, and lead were detected in some of the field blank samples at concentrations slightly above the CLP detection limits.

Methylene chloride, acetone, and chloroform were found in the Round II field blanks at concentrations up to 26, 15, and 180 ug/l, respectively. Several inorganics were detected in the field blank samples in Round II. These inorganics included barium (25 ug/l), calcium (68,200 ug/l), lead (11.5 ug/l), magnesium (24,500 ug/l), manganese (328 ug/l), and zinc (18 ug/l).

Round I investigative and field samples indicated good qualitative and quantitative comparison for most sample pairs. However, the unfiltered sample duplicate from MW-58 had almost twice the concentrations of aluminum, chormium, and nickel than the investigative sample indicating poor quantitative comparability for the inorganic results from these samples. Concentrations for all detected compounds in the sample duplicate for MW-71 were higher than the investigative sample results.

Except for the duplicate samples from MW-12, MW-13, MW-24, and MW-62, all other Round II duplicates had good qualitative and quantitative comparison to the investigative samples. The differences in the results were as follows:

TABLE 4-23

Volatile Organic Compounds	Federal Primary Drinking Water Standards MCL(ug/l)	Federal Secondary Drinking Water Standards SMCL(ug/l)	Maximum Background Concentration Round I Wells 1,2,3	Round I Wells 68,69	Round II Wells 1,2,3	Round II Wells 68,69
Acetone	-	-	nd	nd	nd	nd
Benzene	5	-	nd	nd	nd	nd
2-Butanone	-	-	nd	nd	nd	nd
Carbon disulfide	-	-	nd	nd	nd	nd
Carbon tetrachloride	5	-	nd	nd	nd	nd
Chlorobenzene	-	-	1	nd	nd	nd
Chloroethane	-	-	nd	nd	nd	nd
Chloroform	100[a]	-	nd	nd	nd	nd
Chloromethane	-	-	nd	nd	nd	nd
1,2-Dichlorobenzene	750	-	nd	nd	nd	nd
1,4-Dichlorobenzene	750	-	nd	nd	nd	nd
1,2-Dichloroethane	5	-	nd	nd	nd	nd
1,1-Dichloroethene	7	-	2	nd	nd	nd
1,1-Dichloropropane	-	-	nd	nd	nd	nd
Ethylbenzene	-	-	nd	nd	nd	nd
Methylene chloride	-	-	nd	nd	24	nd
4-Methyl-2-pentanone	-	-	nd	nd	nd	nd
Styrene	-	-	nd	nd	nd	nd
1,1,2,2,-Tetrachloroethane	-	-	nd	nd	nd	nd
Tetrachloroethene	5	-	nd	nd	nd	nd
Toluene	-	-	2	nd	nd	nd
1,1,1-Trichloroethane	200	-	nd	nd	nd	nd
Trichloroethene	5	-	1	nd	nd	nd
Xylenes, total	-	-	nd	nd	nd	nd

ND = Parameter was analyzed for but was not detected.

- = Indicates that an MCL has not been set under the National Primary and Secondary Drinking Water Standards.

[a] = Based on the MCL for trihalomethanes.

TABLE 4-23 (Continued)

Semivolatile (BNA) Compounds	Federal Primary Drinking Water Standards MCL(ug/l)	Federal Secondary Drinking Water Standards SMCL(ug/l)	Maximum Background Concentration Round I Wells 1,2,3	Round I Wells 68,69	Round II Wells 1,2,3	Round II Wells 68,69
Acenaphthene	-	-	nd	nd	nd	nd
Anthracene	-	-	nd	nd	nd	nd
Benzoic acid	-	-	nd	nd	nd	nd
Benzo(a)anthracene	-	-	nd	nd	nd	nd
Benzo(b)fluoranthene	-	-	nd	nd	nd	nd
Benzo(k)fluoranthene	-	-	nd	nd	nd	nd
Benzo(g.h.i)perylene	-	-	nd	nd	nd	nd
Benzo(a)pyrene	-	-	nd	nd	nd	nd
Benzyl alcohol	-	-	nd	nd	nd	nd
bis(s-Chloroethyl)ether	-	-	nd	nd	nd	nd
bis(2-Isopropyl)ether	-	-	nd	nd	nd	nd
Butylbenyl phthalate	-	-	nd	nd	nd	nd
2-Chlorophenol	-	-	nd	nd	nd	nd
Chrysene	-	-	nd	nd	nd	nd
Dibenzo(a,h)anthracene	-	-	nd	nd	nd	nd
Dibenzofuran	-	-	nd	nd	nd	nd
Di-n-butylphthalate	-	-	nd	nd	nd	nd
Diethylphthalate	-	-	nd	nd	nd	nd
Di-n-octylphthalate	-	-	nd	nd	nd	nd
2,4-Dimethylphenol	-	-	nd	nd	nd	nd
bis(2-Ethylhexyl)phthalate	-	-	nd	nd	nd	nd
Fluoranthen	-	-	nd	nd	nd	nd
Fluorene	-	-	nd	nd	nd	nd
Indeno(1.2.3-cd)pyrene	-	-	nd	nd	nd	nd
Isophorone	-	-	nd	nd	nd	nd
2-Methylnapthalene	-	-	nd	nd	nd	nd
2-Methyphenol	-	-	nd	nd	nd	nd
4-Methylphenol	-	-	nd	nd	nd	nd
Naphthalene	-	-	nd	nd	nd	nd
4-Nitrophenol	-	-	nd	nd	nd	nd
N-nitrosodiphenylamine	-	-	nd	nd	nd	nd
Pentachlorophenol	-	-	nd	nd	nd	nd
Phenanthracene	-	-	nd	nd	nd	nd
Phenol	-	-	nd	nd	nd	nd
Pyrene	-	-	nd	nd	nd	nd
2,4,5-Trichlorophenol	-	-	nd	nd	nd	nd

ND = Parameter was analyzed for but was not detected.

- = Indicates that an MCL has not been set under the National Primary and Secondary Drinking Water Standards.

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TABLE 4-23 (Continued)

Pesticides and PCBs	Federal Primary Drinking Water Standards MCL(ug/l)	Federal Secondary Drinking Water Standards SMCL(ug/l)	Maximum Background Concentration Round I Wells 1,2,3	Round I Wells 68,69	Round II Wells 1,2,3	Round II Wells 68,69
DDD	-	-	nd	nd	nd	nd
DDE	-	-	nd	nd	nd	nd
DDT	-	-	nd	nd	nd	nd
Aldrin	-	-	nd	nd	nd	nd
Endosulfan I	-	-	nd	nd	nd	nd
Endrin	0.2	-	nd	nd	nd	nd
Heptachlor	-	-	nd	nd	nd	nd
Heptachlor-Epoxide	-	-	nd	nd	nd	nd
PCBs	-	-	nd	nd	nd	nd

ND = Parameter was analyzed for but was not detected.

- = Indicates that an MCL has not been set under the National Primary and Secondary Drinking Water Standards.

TABLE 4-23 (Continued)

Inorganics	Federal Primary Drinking Water Standards MCL(ug/l)	Federal Secondary Drinking Water Standards SMCL(ug/l)	Maximum Background Concentrations (Filtered Samples) Round I Wells 1,2,3	Round I Wells 68,69	Round II Wells 1,2,3	Round II Wells 68,69
Aluminum	-	-	nd	52.4	nd	nd
Antimony	-	-	nd	43.7	nd	nd
Arsenic	50	-	1.8	2.1	nd	nd
Barium	1,000	-	32.6	30.1	37.2	67.5
Beryllium	-	-	nd	nd	nd	nd
Cadmium	10	-	nd	nd	3.5	nd
Calcium	-	-	76,100	66,300	77,200	65,400
Chromium[d]	50	-	nd	nd	nd	nd
Cobalt	-	-	nd	nd	nd	nd
Copper	-	1,000	5.3	5.1	5.0	nd
Iron	-	300	674	35.3	856	1,470
Lead	50	-	nd	nd	2.1	6.1
Magnesium	-	-	25,200	16,100	26,800	16,800
Manganese	-	50	171	147	827	135
Mercury	2	-	nd	nd	nd	nd
Nickel	-	-	nd	nd	nd	nd
Potassium	-	-	3,160	2,330	2,970	1,400
Selenium	10	-	nd	nd	nd	nd
Silver	50	-	nd	nd	nd	nd
Sodium	-	-	8,500	23,300	7,070	13,300
Tin	-	-	nd	nd	nd	nd
Vanadium	-	-	nd	nd	nd	nd
Zinc	-	5,000	11.6	22.0	25.0	6.2

ND = Parameter was analyzed for but was not detected.

- = Indicates that an MCL has not been set under the National Primary and Secondary Drinking Water Standards.

TABLE 4-23 (Continued)

Conventional Parameters	Federal Primary Drinking Water Standards MCL(ug/l)	Federal Secondary Drinking Water Standards SMCL(ug/l)	Maximum Background Concentrations Round I Wells 1,2,3	Round I Wells 68,69	Round II Wells 1,2,3	Round II Wells 68,69
Cyanide	-	200	nd	nd	nd	nd
Total organic carbon	-	-	-	-	-	-
Alkalinity (as $CaCO_3$)	-	-	-	-	-	-
BOD_5	-	-	-	-	-	-
COD	-	-	-	-	-	-
Hardness	-	-	-	-	-	-
Ammonia-N	-	-	.16	.38		
TKN	-	-	-	-	-	-
TSS	-	-	7	50.0	-	-
TDS	-	500,000	7	312.0		
Nitrate -N	10,000	-	-	-	-	-
Chloride	-	250,000	10.9	7.0		
Phosphate	-	-	-	-	-	-
pH	-	6.5-8.5	-	-	-	-
Sulfate	-	250,000	90.0	43.0		

ND = Parameter was analyzed for but was not detected.

- = Indicates that an MCL has not been set under the National Primary and Secondary Drinking Water Standards or that this compound was not part of the SAS request for analysis.

- For the sample pairs from MW-12, methylene chloride was detected at 1,806 ug/l in the sample and at 830 ug/l in the duplicate. However, all other compounds were both qualitatively and quantitatively comparable.

- In MW-62, DCA was detected in the sample and not in the duplicate. The difference in the results could be due to volatilization of the compound either in the laboratory or in the field, false positive/false negative detection by the laboratory, or the fact that the detected value in the sample was close to the CLP detection limit.

- The duplicate sample from MW-13 had higher concentrations of arsenic, magnesium, manganese, potassium and sodium than the sample. However, comparability of the unfiltered sample concentration results from MW-13 were good.

- In sample MW-24, the investigative sample results for aluminum were twice that found in the duplicate sample. Again, all other results were comparable.

One other problem noted during data analysis is the possible mis-labeling of samples from MW-35 and MW-36. In Round I, TCA, DCA and TCE were detected in MW35, with no VOCs detected in MW-36. In Round II, the same three compounds were detected in MW-36, with no VOCs detected in MW-35.

4.5.3 ANALYTICAL RESULTS

Monitoring Well Samples

Background

The concentration levels of the contaminants of concern detected in the Round I and Round II groundwater samples are shown in Figures 4.5-2 through 4.5-4 enclosed in Volume II, Appendix A. The following sections describe

- For the sample pairs from MW-12, methylene chloride was detected at 1,806 ug/l in the sample and at 830 ug/l in the duplicate. However, all other compounds were both qualitatively and quantitatively comparable.

- In MW-62, DCA was detected in the sample and not in the duplicate. The difference in the results could be due to volatilization of the compound either in the laboratory or in the field, false positive/false negative detection by the laboratory, or the fact that the detected value in the sample was close to the CLP detection limit.

- The duplicate sample from MW-13 had higher concentrations of arsenic, magnesium, manganese, potassium and sodium than the sample. However, comparability of the unfiltered sample concentration results from MW-13 were good.

- In sample MW-24, the investigative sample results for aluminum were twice that found in the duplicate sample. Again, all other results were comparable.

One other problem noted during data analysis is the possible mis-labeling of samples from MW-35 and MW-36. In Round I, TCA, DCA and TCE were detected in MW35, with no VOCs detected in MW-36. In Round II, the same three compounds were detected in MW-36, with no VOCs detected in MW-35.

4.5.3 ANALYTICAL RESULTS

Monitoring Well Samples

Background

The concentration levels of the contaminants of concern detected in the Round I and Round II groundwater samples are shown in Figures 4.5-2 through 4.5-4 enclosed in Volume II, Appendix A. The following sections describe

the analytical results for the groundwater samples collected during both Round I and II of sampling.

Three well nests were identified as upgradient or background wells, two with three wells each and one with two wells. These background well locations were MW-1/MW-2/MW-3, MW-31/MW-32, and MW-68/MW-69. Well nest MW-68/MW-69 was used as background for the samples collected from the Space Leasing property. The remaining wells on th Fisher Calo site were compared to the well nest MW-1/MW-2/MW-3 as the upgradient (background) location. Well nest MW-31/MW-32 was not used to represent background primarily because of its location in reference to the site. These wells were situated between Travis Ditch and Kingsbury Creek, about 2,500 feet west of the site.

Volatiles

Round I. A total of 14 VOCs were detected in the Round I groundwater samples in 15 of the 68 monitoring wells. DCA, DCE, TCA, and TCE were detected most frequently and at higher concentrations than the other VOCs. This is consistent with the previous data generated for this site. Except for benzene (which was detected three times), the remaining VOCs were detected only once. VOCs were mainly detected in the shallow wells. When detected in the mid-level wells, VOCs were detected at concentrations less than those found in the shallow wells, except at MW-60 and MW-35. At these locations, VOCs were not detected in the shallow wells, but were detected in the Mid-level wells. VOCs were not detected in the deeper wells, except at MW-10. VOC concentrations in MW-10 were less than those found in the shallow and mid-level wells at this location.

VOCs were detected in the shallow and mid-level wells (MW-6 and MW-5) in the well nest east of the Fisher Calo Plant (Two-Line Road) and south of waste disposal area, identified as the excavation/soils pile (or "magnetic anomaly area" by FIT, 1982). VOCs were not detected in the deeper well MW-4. More VOCs were detected in the shallow well MW-6 than in mid-level

well MW-5. VOCs detected in MW-6 included DCA, DCE, TCA, TCE, 4-methyl-2-pentanone, and methylene chloride. TCA and PCE were detected in MW-5 at lower concentrations than in MW-6 (1,100 and 53 ug/l in MW-6 to 16 and 5 ug/l in MW-5). 2-Hexanone, which was not detected in MW-6, was detected in MW-5. Based on the water level contours (reproduced in Figure 3.4-8 thru 3.4-10), groundwater flow from this well nest is to the south-southwest.

MW-51 and the well nest MW-29/MW-53/MW-54 are located hydraulically downgradient of well nest MW-4/MW-5/MW-6. VOCs were not detected in any of these wells. This indicates that these wells may be outside of or beyond the influence of the plume. Groundwater flow from the shallow well, MW-6, would reach Travis Ditch below the confluence of Kingsbury Creek and Travis Ditch.

TCA was detected at a concentration of 33 ug/l in shallow well, MW-50. VOCs were not detected in MW-48 or MW-49, the deep and medium level wells in this well nest. This well nest is located west of the Fisher Calo Plant, across Two-Line Road, and to the southwest of the bunker. Based on the groundwater level contours, MW-50 does not appear to be directly downgradient from the well nest MW-4, 5, and 6 (located north-northwest of MW-50). This indicates the presence of another source for the TCA contamination found in MW-50. Water level contours do suggest that well nest MW-21, 22, and 23 (loated south and west of Cardinal Chemical) is hydraulically downgradient to MW-50 and contaminants from this well may impact these wells.

Two single wells and two well nests of three wells each (MW-26, MW-27 and MW-10, 11, 12 and MW-21, 22, 23) were located to the west-southwest of the Fisher Calo One-Line Road facility (the facility is now operated by Cardinal Chemical Company). VOCs were detected in all these wells, except

deep well MW-21. VOCs were probably not detected in MW-21 for two reasons: the plume has not yet infiltrated to that depth (the well is screened from 111 to 121 feet below land surface); and (2) a 20 foot thick layer of silty sand, at a depth of approximately 75 feet below land surface, may be acting as a semi-confining layer thereby retarding the vertical migration of this plume.

The depth at which VOC contamination was detected in these wells ranged from 27 to 77 feet below land surface. More VOCs at higher concentrations were found in the shallower wells, which have a screened interval in the upper portion of the aquifer, approximately 5 to 40 feet below the surface of the water table. Table 4-24 presents the VOCs detected in the shallow wells, located west-southwest of the One-Line facility.

Although DCA and DCE were detected in all shallow wells except MW-27, data interpretation of the monitoring well data and water level contours indicates that there is more than one source of contamination in this area. VOC contamination detected in MW-26 and MW-21 may be from the drum storage and waste disposal area that burned in 1978, or from other operations in the area directly to the north of Cardinal Chemical (e.g., lagoons and storage tanks). VOC contamination detected in MW-27 may be from operations in the northern part of the Cardinal Chemical area (e.g., lagoons, processing tanks, and drums), while contamination in MW-23 may be from the southern part of the Cardinal Chemical area (e.g., drum storage areas and lagoons).

The same VOCs were not detected in MW-50, a well that appeared to be within the expected groundwater flow path with the well nest at MW-23. TCA was detected in MW-50, but not in MW-23. The VOCs detected in MW-23, DCA and DCE were not detected in MW-50. This may indicate that the plume from the MW-50 area has not migrated that far southwest, that VOCs from another upgradient source area presently being released, or that a different contaminant source, closer to MW-23, is present.

TABLE 4-24

ROUND I VOCs DETECTED IN SHALLOW WELLS
WEST OF ONE-LINE ROAD (ug/l)

VOC	MW-26	MW-12	MW-27	MW-23
DCA	190	580	-	210
DCE	220	3,400	-	140
TCA	-	2,600	2,200	-
TCE	-	190	80	-
Acetone	-	400	-	-

- = Not detected

Water level contour data indicates that well nest MW-13 and 14 is downgradient from wells MW-50 and the wells located south and west of Cardinal Chemical (MW-26, MW-27, MW-21, 22, 23 and MW-10, 11, 12). Groundwater flow from these wells would reach Travis Ditch below the confluence of Kingsbury Creek and Travis Ditch. However, VOCs were not detected in the downgradient well nest (MW-13 and -14) located approximately 1,000 feet west and downgradient of the stream confluence.

Benzene was detected in the shallow and intermediate depth wells MW-16 and MW-17 at concentrations of 5 and 10 ug/l, respectively. MW-60 was the only other well in which benzene was detected (28 ug/l). Although the detection of benzene could indicate the presence of additional sources, it was felt that these detections were false positive detections (the detection of a compound not present in the sample) reported by the CLP laboratory that performed the analyses. This interpretation was based in part on the location of the wells and in part on a comparison of the results from the Round I and Round II groundwater analyses.

MW60, the intermediate depth well in a well nest located east of New Plant Life, and northeast (upgradient) from a ravine which was used for waste disposal, and MW-16/MW-17 are located in the field east of Cardinal Chemical and north (upgradient) of the solid waste disposal ravine. These upgradient areas were expected to be relatively free of VOC contamination; a comparison of Round I and Round II groundwater analyses indicated that no VOCs, including benzene, were detected in these three wells (MW-60, MW-16, MW-17) in Round II. In addition, benzene was not detected in any other monitoring well in both Round I and Round II. Therefore, the presence of benzene in these three wells during Round I sampling was interpreted to be due to laboratory contamination rather than to additional contaminant sources.

DCA (48 ug/l), TCA (1,900 ug/l), and PCE (1,000 ug/l) were detected in MW-35, the intermediate depth well in a well nest located southwest of National packaging. Other wells in the area of MW-35 had no VOCs detected.

VOCs were not detected in the well nests along the Roll Coater facility (MW-2 through 47, and 62 through 64).

The only other well in which VOCs were detected was MW-55, located at the southern end of the site, to the south of New Plant Life. At this location, carbon tetrachloride, the only detection of this compound, was found at a concentration of 15 ug/l. Because this VOC was not found in any other samples or in the Round II sample from this well, the detection of this compound may be due to a false positive reported by the CLP laboratory performing the analyses.

Round II. Table 4-25 presents a comparison of the Round I and II VOC results. A comparison of the Round I and Round II groundwater sample results shows a close correlation in the VOC data obtained during both rounds of sampling. The majority of the wells where VOCs were observed in Round I also had detections of the same compounds in Round II. All seven wells in the southwestern section of the site were contaminated by the same VOCs at similar concentrations. The concentrations of DCA and DCE in MW-10 and MW-11 were slightly lower in the Round II samples. MW-23 and MW-26 had approximately the same concentrations in both rounds. For MW-12 and MW-22, the VOCs were found in higher concentrations in Round I, than in the Round II samples. MW-27 had a lower concentration of TCA and a higher concentration of TCE in the Round II sample.

Comparison of Standards. The detection of benzene in Round I and chloroform in Round II was thought to be attributable to laboratory contamination or false positive detections, and these data will not be compared. Therefore, the only MCL regulated VOCs detected were TCA and TCE, with MCls of 200 and 5 ug/l, respectively.

TCA was detected in MW-5, MW-6, MW-12, MW-27, and MW-35/MW-36. Except for MW-5, TCA was detected above the MCL in these wells. TCA concentrations above the MCL ranged from 1,100 to 2,600 ug/l in Round I and from 580 to 5,900 ug/l in Round II.

TABLE 4-25

VOCs DETECTED ROUNDS I AND II

Well	VOC	Round I Concentration (ug/l)	Round II Concentration (ug/l)
MW-05	1,1,1-Trichloroethane	16	47
	Trichloroethene	5	11
	2-Hexanone	21	ND
MW-06	Methylene Chloride	310	ND
	1,1-Dichloriethane	1400	1700
	trans-1,2-Dichloroethene	55	46
	1,1,1-Trichloroethane	1100	580
	Trichloroethene	53	ND
	4-Methyl-2-pentanone	360	ND
	2-Hexanone	ND	590
MW-10	1,1-Dichloroethane	340	260
	trans-1,2-Dichloroethene	680	490
MW-11	1,1-Dichloroethane	1500	1400
	trans-1,2-Dichloroethene	3700	3300
MW-12	Acetone	400	ND
	1,1-Dichloroethane	580	1000
	trans-1,2-Dichloroethene	3400	5900
	1,1,1-Trichloroethane	2600	5200
	Trichloroethene	290	250
	Methylene Chloride	ND	1800
MW-16	Benzene	5	ND
MW-17	Benzene	10	ND
MW-22	1,1-Dichloroethene	23	67
MW-23	1,1-Dichloroethane	210	220
	trans-1,2-Dichloroethene	140	130
MW-26	1,1-Dichloroethane	190	190
	1,2-Dichloroethene	220	230
MW-27	1,1,1-Trichloroethane	2200	1800
	Trichloroethene	80	130

TABLE 4-25 (Continued)

VOCs DETECTED ROUNDS I AND II

Well	VOC	Round I Concentration (ug/l)	Round II Concentration (ug/l)
MW-35	1,1-Dichloroethane	48	ND
	1,1,1-Trichloroethane	1900	ND
	Trichloroethene	1000	ND
MW-36	1,1-Dichloroethane	ND	160
	1,1,1-Trichloroethane	ND	4000
	Trichloroethene	ND	2700
MW-39	Chloroform	ND	26
	1,1,1-Trichloroethane	ND	10
MW-47	Chloroform	ND	25
MW-50	1,1,1-Trichloroethane	33	7
MW-55	Carbon tetrachloride	15	ND
MW-60	Benzene	28	ND
MW-71	Chloroform	ND	23

ND = Compound analyzed for, but not detected

TCE was detected in these same wells (except for MW6 in Round II) above the MCL in the remaining samples. TCE concentration at or above the MCL ranged from 5 to 1,000 ug/l in Round I and from 11 to 2,900 ug/l in Round II.

BNAs

Round I. Only six wells in Round I were contaminated by BNAs (other than phthalate esters). The location of these wells are shown in Figure 4.5-1 (Volume II, Appendix A). Isophorone was detected in MW-5, MW-6, MW-10, MW-11, MW-22, and MW-23; VOCs were also detected in these wells. Isophorone concentrations ranged from an estimated concentration of 3 ug/l in MW-5 to 210 ug/l in MW-6. The other BNAs detected were 2,4,6-trichlorophenol at 9 ug/l in MW-22 and 2-nitrophenol at 17 ug/l in MW-6.

Bis(2-ethylhexyl)phthalate was detected in MW-36 and MW-38 at concentrations of 18 ug/l and 15 ug/l, respectively. Di-n-octylphthalate was detected in MW-7 at 11 ug/l. All other detections were of bis(2-ethylhexyl)phthalate at estimated concentrations.

Round II. Table 4-26 compares the Round I and Round II BNA results. As indicated in the table, isophorone was detected at MW-6 and MW-22 in both rounds. Isophorone was detected at less than half the Round I concentration in MW-6 and at greater than five times the Round I concentration in MW-22. Although 2-nitrophenol was not detected in the MW-6 Round II sample, this compound was detected close to its detection limit in the first round. Because 2-nitrophenol was detected in soil samples located close to this well nest, this compound may be present in the groundwater. 2,4,6-Trichlorophenol was detected in MW-22 in both sampling rounds. Although isophorone was not detected in the mid-level and deep wells MW-11 and MW-10 in Round II, it was detected in the shallow well MW-12. Isophorone was detected at 82 ug/l in MW-12, along with 2,4-dimethylphenol at 11 ug/l.

TABLE 4-26
BNAs DETECTED IN THE GROUNDWATER

Monitoring Well	Contaminant	Concentration (ug/l) Round I	Round II
MW-06	Isophorone	210	95
	2-Nitrophenol	17	-
MW-05	Isophorone	3 J	-
MW-07	Di-n-Octylphthalate	11	-
MW-10	Bis(2-Ethylhexyl)Phthalate	4 J - 13	13
	Isophorone	13	-
MW-11	Bis(2-Ethylhexyl)Phthalate	-	18
	Isophorone	7	-
MW-12	Bis(2-Ethylhexyl)Phthalate	-	16
	Isophorone	-	82-110
	2,4-Dimethylphenol	-	11
MW-18	Butylbenzylphthalate	-	20
MW-13	Bis(2-Ethylhexyl)Phthalate	7 J	-
MW-19	Di-N-Butylphthalate	-	150
MW-22	Isophorone	4 J	25
	2,4,6-Trichlorophenol	9 J	23
MW-23	Isophorone	10	-
MW-26	Bis(2-Ethylhexyl)Phthalate	8 J	-
MW-31	Bis(2-Ethylhexyl)Phthalate	8 J	-
MW-34	Bis(2-Ethylhexyl)Phthalate	8 J	-
MW-35	Bis(2-Ethylhexyl)Phthalate	9 J	-
MW-36	Bis(2-Ethylhexyl)Phthalate	18	-
MW-37 (Dup.)	Bis(2-Ethylhexyl)Phthalate	4 J	-
MW-38	Bis(2-Ethylhexyl)Phthalate	15	-
MW-39	Bis(2-Ethylhexyl)Phthalate	7 J	-

TABLE 4-26 (Cont.)
BNAs DETECTED IN THE GROUNDWATER

Monitoring Well	Contaminant	Concentration (ug/l) Round I	Round II
MW-54	Bis(2-Ethylhexyl)Phthalate	7 J	-
MW-61	Bis(2-Ethylhexyl)Phthalate	6 J	-
MW-67	Bis(2-Ethylhexyl)Phthalate	-	13
MW-21	Bis(2-Ethylhexyl)Phthalate	-	11
	Butylbenzylphthalate	-	11

The different detections of isophorone in Round I and II may be related to the analytical sensitivity of the various CLP laboratories. The required CLP detection limit of isophorone in low-level water samples is 10 ug/l. As the detections of isophorone in MW-10, MW-11, MW-5, and MW-23 in Round I were at or below this detection limit, the Round I CLP laboratory may have had greater analytical sensitivity than the Round II CLP laboratory. This is one possible explanation. However, it does not explain the detection of isophorone in MW-12 in Round II, but not in Round I. The difference in these sample results may be due to continuing migration of isophorone toward this well nest.

Bis(2-ethylhexyl)phthalate was detected in five Round II samples. However, it was only detected in the same well (comparison of Round I and II) one time. Di-n-octylphthalate, which was detected in MW-7 in Round I, was not detected in the Round II sample. Butylbenzylphthalate and di-n-butylphthalate were detected in several samples in Round II, but were not detected in any samples in Round I. Because phthalate esters are common field and laboratory contaminants and were not detected in the same wells in both rounds, it is expected that detection of these compounds in the groundwater samples was due to field/laboratory contamination and was not contributed from site contamination.

Pesticides/PCBs

In both Round I and Round II groundwater samples, no pesticides or PCBs were detected.

Inorganics

Two sets of filtered and unfiltered samples were collected and analyzed for inorganics in both Round I and Round II.

At the Space Leasing Property, background wells MW-68 and MW-69, had concentrations of iron and manganese which exceeded the secondary maximum contaminant levels (SMCL). However, iron and manganese were above the SMCL

in all background wells indicating that higher concentrations are normal for this area.

Round I. Results of the Round I filtered and unfiltered sample were summarized in Tables 4-27 and 4-28. Several compounds were detected at elevated concentrations in the unfiltered samples, but the parameters were not of significant concern.

In the filtered samples from Round 1, the background samples MW-1, MW-2 and MW-3 had high concentrations of iron and manganese, exceeding Federal Drinking Water Standards. High concentrations of manganese were found in six samples, with concentrations reaching 1,290 ug/l in well MW-12. Iron was detected at 1410 ug/l in well MW-26. Aluminum, calcium, magnesium, nickel, and potassium were found in a number of wells at elevated concentrations. Sodium was high in many wells and detected at 929,000 ug/l in MW-22.

Round II. Results of the Round II filtered and unfiltered samples were summarized in Tables 4-27 and 4-28. In the unfiltered groundwater samples collected in Round II, a number of inorganic compounds were detected at high concentrations in the background wells. These compounds were aluminum (955 ug/l), iron (3,250 ug/l), manganese (217 ug/l) and nickel (16.4 ug/l). Other compounds detected at high concentrations in the background samples included calcium, magnesium, potassium, and sodium. These parameters were detected in many of the samples at high concentrations but were not of significant concern.

The unfiltered Round II samples, aluminum was detected in five wells in concentrations ranging from 1,500 ug/l up to 2,690 ug/l. Nickel was also detected at concentrations greater than background in six wells and in two of the wells, MW-34 and MW-36, concentrations of 2,200 ug/l and 3,120 ug/l were detected, respectively. Chromium was detected in several wells: MW-12 (84.8 ug/l), MW-22 (58.3ug/l), MW-24 (58 ug/l), and MW-58 (94.4 ug/l). MW-16 and MW-38 were the only locations in which mercury was found,

tributaries to the Kankakee River. Contaminants in the groundwater could also be transported to downgradient private wells that are utilized for residential and agricultural water supplies. The contaminants found in the shallow groundwater aquifer may also be transported into the deeper aquifer via man-made or natural hydraulic connections.

Contaminants that have been transported into surface water bodies can volatilize, precipitate or adsorb to the sediments. Contaminants in the sediments can dissolve and re-enter solution (and potentially volatilize) or migrate with suspended sediments when in a stream flow situation.

Bioaccumulation is a contaminant migration pathway and a contaminant fate. Any organism that accumulates contaminants from soils, sediments, surface water or vegetation could carry the contaminants off-site. Consumption of such organisms could complete transport of contaminants to off-site receptors.

The previously described contaminant migration pathways are all possible pathways but several are more probable based on the physical site characteristics and analytical data gathered during the RI. The most pertinent migration pathway for the Fisher-Calo site is the leaching of contaminants into the shallow groundwater aquifer. Transport from the shallow aquifer to the lower aquifer may be possible, however, the current data indicates that the glacial till acts as an aquitard or semi-confining layer between the aquifers within the study area. Although the continuity of the till layer is presently unknown, no contamination was found to be present in the lower aquifer beneath the till.

Since the majority of the site is vegetated, the potential for release of contaminants through wind erosion is low. Additionally, the probability of migration of compounds of concern from surface soils (via run-off or erosion,) is low because of the relatively flat topography and high permeability of the soils. Since contaminated surface soil remediation is planned for spring to fall of 1989 under the U.S. EPA Unilateral Removal

Order, the probability of migration via volatilization will be reduced and/or eliminated, except during the removal action.

Since the site is privately owned and many areas are currently for sale, it is highly probable that future development at the site would involve excavation. During any future excavation activities, volatilization of contaminants of concern could occur, and represent a possible migration pathway due to the high concentrations detected in the subsurface soils. Since the property is currently zoned industrial, it is unlikely that it would be developed for residential use.

Bioaccumulation is a possible pathway from the surface of the site. Vegetation, birds, or animals could accumulate contaminants from the surface soils. However, with the planned remediation of contaminated surface soils on the Two-Line Road property, this pathway will be reduced and/or eliminated.

5.2 CONTAMINANT MIGRATION

A variety of contaminants have been identified at the Fisher-Calo site. Detailed analysis of all compounds is not feasible, so a list of contaminants of concern was developed. This list and the reasoning behind it were described in Section 4.0 of this report. The environmental fate and transport of these compounds is dependent on the physical and chemical properties of the compounds, the environmental transformation processes affecting them and the media through which they migrate. The emphasis of this section is placed on the factors affecting contaminant mobility and persistence in groundwater because this is the most likely contaminant exposure pathway.

5.2.1 PHYSICAL AND CHEMICAL PROPERTIES OF CONTAMINANTS OF CONCERN

The behavior of the contaminants of concern is influenced by the physical and chemical properties of the compounds and site conditions. The form,

transport and ultimate fate of contaminants depend on many factors such as pH, temperature, soil moisture, oxidation-reduction potential, physio-chemical properties of subsurface materials, water chemistry and micro-organisms present. Table 5-1 lists the important physical and chemical properties of the compounds of concern. These properties influence their behavior in the fate and transport process.

5.2.1.1 Solubility

The water solubility of a compound is a critical property affecting environmental fate. Compounds that are highly soluble can be leached from wastes and soils and are generally mobile in groundwater and/or surface water.

5.2.1.2 Vapor Pressure and Henry's Law Constant

The vapor pressure of a compound provides an indication of the rate of transfer of a compound to the gas phase. The greater the vapor pressure, the greater its tendency to volatilize. Additional properties that affect volatilization are the compounds solubility and molecular weight. The Henry's Law constant for a compound takes into account vapor pressure, solubility and molecular weight to provide a more appropriate indication of the compounds tendency to transfer from water to the air. Compounds with Henry's Law constants in the range of 10^{-3} atm m^3/mole and greater can be expected to volatilize readily from water while compounds with values less than 10^{-5} atm m^3/mole volatilize from water only to a limited extent.

5.2.1.3 Octanol/Water Partition Coefficient

The octanol/water partition coefficient (K_{ow}) can be used to provide an estimate of the extent to which an organic chemical will partition from water into lipophilic tissue of organisms (i.e., it's tendency to bioconcentrate). High log K_{ow} values reflect a greater tendency for a

compound to partition in the lipid (fat) phase of a lipid and aqueous solution, such as tissue in a fish or mammal.

5.2.1.4 Organic Carbon Partition Coefficient

The organic carbon partition coefficient (K_{oc}) provides an indication of the tendency of a compound to adsorb to organic matter found in soil. Typical ranges of K_{oc} is from 1 to 10^7, with higher values indicating greater adsorption potential.

5.2.1.5 Specific Gravity

The specific gravity of a compound indicates the tendency of a chemical in dissolved or pure form to sink or float in water. Water has a specific gravity of 1.0. Compounds with a specific gravity greater than 1.0 tend to sink, or migrate downward through an aquifer. Compounds with specific gravity less than 1.0 would tend to float to the top of the water table.

5.2.2 CONTAMINANT BEHAVIOR IN THE UNSATURATED ZONE

The fate of chemicals in the unsaturated zone is a function of a number of factors, including the physical and chemical properties of the constituents, the state of the chemicals at the time of disposal (confined or unconfined in containers and concentrations), the elevation of groundwater relative to the contaminated material, the amount of precipitation, the local geology and the amount and type of ground cover. Some contaminants would be expected to remain very close to their point of origin, but more mobile components would travel vertically downward through the unsaturated zone to a relatively impermeable barrier or to the saturated zone, where other controls determine their ultimate fate.

Some inorganic contaminants are expected to have low mobility in the unsaturated zone. The inorganic compounds of concern, zinc, antimony, cobalt, lead, cadmium, chromium, cyanide, mercury and nickel, have appeared

to be relatively immobile. As discussed in Section 4.2, inorganics in general have not migrated to more than 10 feet below the surface and remain in the unsaturated zone. Also, groundwater data indicate that the inorganic compounds have not moved from the soil into the groundwater.

The migration of inorganic compounds in and from the unsaturated zone may be limited by clayey and organic material. The topsoils within the study area consists of deposits of silty sand to sandy loam, which contain organic material. Some isolated clay is found in this area and up to 0.2% organic material is common in the type of material composing the unsaturated zone. The inorganic compounds could bond with the clay, substituting for calcium, potassium and aluminum within the clay mineralogical structure, thus rendering them relatively immobile. Although adsorption seems to be the most important mechanism for trapping inorganic materials in the subsurface, organic materials may immobilize metals by complexing reactions or cation exchange. Organic material has more available exchange sites than most clays, therefore, fixing metals more readily than clays.

The depth to groundwater is 20 feet on average at this site. Contaminants possessing low solubilities, such as polycyclic aromatic hydrocarbons, phthalates, and pesticides, would not be expected to quickly migrate down to the saturated zone. This is supported by the fact that these contaminants are found in surface and shallow soil samples but not in deeper soils or in the groundwater.

Substances having higher mobility include gases and liquids, as well as solids with high solubilities in water. One mode of transport is through volatilization, which would apply for gases and for liquids with high vapor pressures and Henry's Law Constants (Table 5-1). Volatilization probably does occur from the unsaturated zones at this site, especially where little vegetation occurs and where the topsoil is cultivated for farming in areas A and C. Volatilization may play a significant role in the removal of highly volatile contaminants from the unsaturated zone. Indeed, the two most volatile contaminants of concern, acetone and 1,1-dichloroethane, are

in general present in the surface soils at lower concentrations than in the subsurface soil. This would be expected because volatilization is greater at and near the soil surface due to greater temperature fluctuations and lower water vapor pressures. Acetone and 1,1-dichloroethane are not found to a great extent in the groundwater. Therefore, these compounds have probably been volatilized from the surface soils, trapped in the subsurface unsaturated zone and have not migrated to the saturation zone.

The mobility of liquid or highly soluble gaseous or solid components depends on the amounts disposed, the concentrations of the solvents, and the areas over which they extend. If liquid wastes were present in sufficient quantities, they may travel downward to the water table as a dense non-aqueous liquid phase layer (DNALPL) separate from the water. They could also remain in the unsaturated zone and be dissolved by infiltrating water, traveling to the saturated zone as dissolved constituents. In this latter case, the mobility of contaminants through the unsaturated zone depends on the rate of infiltration of water through this zone as well as the density of the contaminant. Most of the contaminants of concern have specific gravities greater than water (specific gravity of water equals 1.0) and would thus be expected to travel downward under the influence of gravity at a rate marginally greater than infiltrating soil moisture. A few of the contaminants of concern have specific gravities of less than water (Table 5-1). These compounds would tend to migrate vertically downward at a slower rate than water. Once these compounds migrated down to the water table they would tend to float on top, provided their solubilities are low. This appears to be the case at Fisher-Calo because none of the target compounds with specific gravities of less than 1.0 are found in appreciable amounts in the groundwater.

The mobility of liquids in the unsaturated zone also depends on the rate of the infiltration of water through this zone. The amount of available infiltration water is a combination of annual precipitation, run-off from other areas and farm irrigation. The total amount of water from these three sources is unknown. However, natural percolation rates are expected

to be great enough to cause the unsaturated zone to be a continuing source of groundwater contamination where contaminants are present.

Before leached contaminants reach the saturated zone, some of them will be left behind in pore spaces in the unsaturated zone as residuals. For instance, high amounts of many VOCs are present in the unsaturated zone in several soil borings. The residual concentrations could constitute approximately 10 to 30% of the soil's pore space. The subsequent fate of these residual constituents depends on their solubilities and on the rate of the infiltration of water percolating downward toward the saturated zone. Substances of low solubility which dissipate slowly by means such as volatilization or degradation may remain in the unsaturated zone for a considerable period of time, thus constituting an ongoing source of groundwater contamination. Substances with higher solubilities will move through the unsaturated zone faster and may pass through as a slug, rather than constituting an ongoing source of contamination in the soil.

Organic compounds may undergo degradation by chemical or biological means in the unsaturated zone. Organic contaminants can be biologically degraded in the unsaturated zone under aerobic conditions. Due to the availability of oxygen and the small amount of organic material in the unsaturated zone at this site, any biodegradation would be aerobic. Aerobic biodegradation has been found to be very effective in degrading benzene, ethylbenzene, toluene and xylenes (Crell and Garner, 1988); a variety of polycyclic aromatic hydrocarbons (PAHs) (Wilson et al., 1985); acetone, isopropyl alcohol and other alcohols (Novak et al., 1984, Lokke, 1984 Jhaveri and Mazzacca, 1983); many methylated phenols and heterocyclic organic compounds present in some industrial waste waters (Wilson et al., 1986); and trace concentrations of chlorinated benzenes were biotransformed under aerobic conditions (Bouwer, 1984).

Thus, biodegradation is capable of degrading a portion of some of the compounds found at the site in the unsaturated zone, before they enter the groundwater. Biodegradation may affect the distribution of non-chlorinated

VOCs. Degradation may be rapid enough to degrade the non-chlorinated VOCs before they migrate downward to the groundwater. This may account for their high concentrations in the unsaturated zone but low abundance in the groundwater. The degradation products which in some cases may be toxic, can be a source of further contamination. However, the chlorinated hydrocarbons found in the soils and the groundwater at Fisher-Calo are known to degrade primarily under anaerobic conditions. Therefore, biological degradation of chlorinated hydrocarbons may not be a significant means of reducing these constituents in the unsaturated zone.

Chemical degradation may also play a part in the fate of the contaminants at this site. Laboratory microcosm studies of the behavior of organic pollutants during the rapid infiltration of wastewater in soil, have shown a detectable degradation of 1,1-dichloroethane under aerobic conditions (Piwoni, et al., 1984). In the same study, larger portions of chlorobenzene, 1,2-dichlorobenzene, toluene, phenol,2-chlorophenol, 2,4-dichlorophenol and 2,4,6-trichlorophenol were degradated. Levels of sustained high infiltration do not exist at this site, however, at times conditions may be favorable for some chemical degradation to occur. Therefore, chemical degradation may have a contribution to the fate of the contaminants at Fisher-Calo.

In summary, hazardous organic compounds disposed of at the site comprise substances of high and low mobility. Low mobility compounds include the PAH's (naphthalene, anthracene, fluorene and other semi-volatile organic compounds). Compounds with low mobility have low solubilities and are highly adsorped by organic carbon. Their low mobility is exemplified by their presence in the surface soils and shallow subsurface soils and their scarcity in the groundwater. Thus, the PAH's are expected to remain close to where they were deposited, and will likely dissipate slowly through aerobic biodegradation. However, volatilization apparently affects toluene, xylene and ethylbenzene because high concentrations are found in the unsaturated zone, but they are not in the groundwater.

In general, solubility and adsorption are inversely related. Low solubility (hydrophobic) compounds can easily be adsorbed onto any available organic carbon, or in the absence of organic carbon, can adsorb onto inorganic mineral matter. Soluble compounds will tend to travel with the groundwater rather than partition into the solid aquifer material. Once the organic contaminants reach the aquifer, they tend to flow with the groundwater and the ones that are denser than water will tend to sink. The contaminant flow near wells are also affected by drawdown and vertical gradients imposed by pumping. Thus, the ultimate fate of contaminants in groundwater is that they may be destroyed by degradation, adsorbed to solid matter in the subsurface, or they may move along with the groundwater as dissolved constituents, become diluted, and either be discharged to a surface water body or be removed via groundwater extraction.

Inorganic compounds of concern at the FCC site that have been mobilized from the unsaturated zone into the groundwater and are above background values include: aluminum, nickel, chromium, calcium, magnesium, mercury and cyanide. However, none of these were found at levels above applicable standards for drinking water and other than nickel, mercury and chromium may be naturally occurring. Most of the inorganic compounds appear to be mostly in the unsaturated zone with some movement into the groundwater, indicated by the elevated concentrations of some inorganic compounds over background values in the groundwater. However, the amount of inorganic material migrating into the groundwater appears to be minimal, as indicated by the concentrations of all inorganic contaminants being below federal primary maximum contaminant levels (MCL). Mechanisms of attenuation of inorganic compounds in the groundwater include dilution due to groundwater recharge, dispersion due to mixing, diffusion and adsorption onto organics. Other possible mechanisms are exchange reactions, whereby metals substitute into clay minerals and replace constituents such as calcium, potassium and aluminum. However, adsorption, dilution and dispersion are likely the primary mechanisms of distribution of inorganic constituents in the groundwater and possibly account for the low concentration of inorganic contaminants in the groundwater at this site.

Inorganics at the site appear to be fixed in the unsaturated zone. They are found in surface and subsurface soils but have not been found in the groundwater at levels above federal primary maximum contaminant limits (MCL) for safe drinking water. Higher-mobility substances present at the site include the other contaminants of concern.

While contaminants are still in the unsaturated zone, they are dissipated to some extent by volatilization and biological and abiological degradation. Farming of the land within the project area will accelerate the rate of volatilization and will facilitate the removal of some contaminants to off site locations by wind erosion. Also, removal of portions of contaminated surface and subsurface soils will take place from the spring to the fall of 1989. This will also accelerate volatilization and removal of contaminants by wind erosion during the removal period. Therefore, the extent to which the contaminants in the unsaturated zone will contribute to groundwater contamination can not be sufficiently defined until soil removal is completed, so that the extent of contaminated soil remaining at the site, and its potential to act as a continuing source, can be assessed.

5.2.3 CONTAMINANT BEHAVIOR IN THE SATURATED ZONE

Once organic contaminants enter the groundwater, their subsequent fate depends on a number of factors, namely advection, dispersion, diffusion, hydrostratigraphic controls, dilution, solubility, adsorption, and both biologic and natural (abiologic) degradation. Advective flow refers to the average or bulk movement of groundwater as a function of prevailing hydraulic gradients and conductivities. Dispersion refers to departures of contaminant velocity from the average groundwater velocity as a function of mechanical mixing due to heterogeneities in the aquifer. Hydrostratigraphic barriers, such as the cut off of an aquifer by an impermeable zone in the subsurface, would direct groundwater and contaminant flow away from the barrier. Dilution is a function of the recharge of water from the unsaturated to the saturated zone, or the mixing of water within the aquifer. Diffusion refers to the transport of contaminants due to concentration gradients.

5.2.3.1 Advective Transport

Advection and dispersion are involved in the subsurface transport of contaminants. Advection is the transport of a solute by groundwater due to hydraulic gradients. Transport velocities of the advectively transported contaminants of concern will be dependent on natural and imposed groundwater gradients. Average linear groundwater velocities were calculated in Section 3.3. for shallow intermediate and deep groundwater flow in the upper aquifer (Table 3-6). To determine the average linear velocity through the aquifer intergranular void spaces, the Darcian velocity is divided by the effective porosity of the media, thereby incorporating a media-specific component to the velocity equation.

Effective porosity is that portion of pore space in the media that is interconnected and contributes to the bulk flow of water through the aquifer. Effective porosity cannot be quantitatively measured in the field, so it is assumed to be related to bulk porosity in granular materials. For the Fisher-Calo area, an effective porosity of 0.30 (no units) is assumed, based on average porosities for similar materials. The groundwater flow in the upper portion of the aquifer reaches an average velocity of 211 ft./yr. This indicates that the potential exists for mixing and subsequent dispersion of individual contaminant plumes.

Induced vertical gradients due to pumping of the aquifer may also contribute significantly to the mixing of the contaminants. However, there are only 3 production wells at Fisher-Calo and none of these pump on a regular basis.

5.2.3.2 Biodegradation

The mixing of groundwater and infiltration of water from the unsaturated zone will contribute to the biodegradation of contaminants. Infiltration and groundwater mixing will inject oxygen-rich water into the groundwater. Also, due to the low level of organic matter in the aquifer materials,

reduction will be decreased, thus limiting the depletion of oxygen in the saturated zone. Therefore, the rate of biodegradation of constituents that degrade in aerobic environments will be increased and the rate of the biodegradation of constituents that degrade more readily in anaerobic environments will be decreased.

The chlorinated hydrocarbon compounds present in the groundwater tend to be more easily biodegraded under anaerobic conditions (Cline and Viste, 1985). The typical degradation sequences are 1,1,1 TCA degrades to 1,1-DCA and 1,2-DCA; PCE degrades to TCE which in turn degrades to 1,2 DCE and 1,1 DCE. Further degradation of 1,2 DCE may result in vinyl chloride. The time period for the degradation process to occur is dependent on such factors as pH, local microbial population, and availability of nutrients and oxygen. Reported half lives for these degradation sequences can range from 30 days to 6 years. Due to the aquifer material, the relatively shallow depth to groundwater, the small amount of organic-material, and the recharge and mixing of the aquifer, it can be assumed that the subsurface environment is relatively aerobic. This would serve to retard natural biodegradation of chlorinated hydrocarbons. This is indicated by the presence of chlorinated hydrocarbons in the groundwater. This contaminant fate is probably a relatively minor component of the overall fate and transport of the contaminants.

5.2.3.3 Adsorption

There is a wide range in the potential for retardation of organic chemicals in a water saturated environment. If the media were pure silica sand, there would be no retardation of the organic constituents and they would travel at the same velocity as the groundwater. At Fisher-Calo the aquifer material is mainly sand and gravel. No site-specific data was analyzed to determine the organic carbon content of the sands and gravels found at the FCC site. However, for these types of materials, the organic carbon content typically ranges from negligible to 0.2 percent.

The organic carbon content of the aquifer material, coupled with the organic carbon partition coefficient for the compounds being transported through the aquifer, can be used to determine the distribution coefficient for each compound. The distribution coefficient is a measure of the amount of an organic compound present in soil relative to the amount dissolved in groundwater under equilibrium conditions. If the aquifer had zero carbon content, the partition coefficient would be zero, indicating that the compound will not adsorb to the soil. Based on the typical organic carbon content for the materials that make up the aquifer, an upper limit of 0.2 percent organic carbon can be estimated and used to calculate estimated maximum distribution coefficients. These distribution coefficients can be used to determine the magnitude of the effect adsorption will have on contaminant velocities relative to groundwater flow velocities. A compound with a large distribution coefficient indicates that the compound has a greater affinity for the soil and will therefore be less concentrated in the groundwater. Conversely, a compound with a low distribution coefficient will tend to be more concentrated in the groundwater.

The distribution coefficient may be used to calculate a retardation factor for each contaminant (Table 5-2) (Freeze and Cherry, 1979). The retardation factor is a measure of the contaminant transport velocity relative to ambient groundwater velocity. TCE with a retardation factor of about 2.5 would travel about 2.5 times slower than groundwater, whereas acetone with a retardation factor of one would travel at approximately the same velocity as groundwater.

The retardation factor can be used to calculate potential velocities of contaminants based on average groundwater velocities for the project site (Table 3-6). Since the actual organic carbon content in the aquifer is unknown, the effects of adsorption on contaminant velocities may best be addressed by considering the case of negligible organic carbon content with no retardation and the case of 0.2 percent organic carbon with calculated retardation coefficients for each contaminant of concern.

TABLE 5-1

PROPERTIES OF ORGANIC CONTAMINANTS

FISHER-CALO

COMPOUND	CHEMICAL FORMULA	SPECIFIC GRAVITY	MELTING POINT C.	BOILING POINT C.	SOLUBILITY IN WATER	VAPOR PRESSURE mm Hg	HENRY'S LAW CONSTANT
1,1,1-TRICHLOROETHANE	C2H3Cl3	1.3376	-30.6	74.1	INSOLUABLE	100 @ 20C.	
1,1-DICHLOROETHANE	C2H4Cl2	1.1757	-98	57.3	5100ppm	226	0.24
1,2-DICHLOROETHENE	C2H2CL2	1.2743	-80.5	59	9000ppm	400 @ 41C.	
TRICHLOROETHENE	C2HCl3	1.4649	-84.8	86.7	1100ppm	74	0.48
2-HEXANONE	C6H12O	.8113	-57	128	14000ppm	40 @ 62C.	
4-METHYL-2-PENTANONE	C6H1O2	0.801	-84.7	115.8	1910ppm	40.8	
1,2-DICHLOROETHANE	C2H4Cl2	1.2569	-40	83.5	8700ppm	82	0.050
TETRACHLOROETHYLENE	C2Cl4	1.6227	-19	120.8	150ppm	18.6	
ACETONE	C3H6O	0.788	-94	56.5	MISCIBLE	226.3	
2-BUTANONE	C4H8O	0.805	-86	79.6	275000ppm	71.2	
METHYLENE CHLORIDE	CH2Cl2	1.336	-96.7	40	20000ppm	760 @ 40.7C.	
ISOPHORONE	C9H14O	.9229	-8.3	215	12000ppm	40 @ 114.5C.	
NAPHTHALENE	C10H8	1.145	80.2	217.9	30ppm	10 @ 85.8C.	

Table 4-27

Filtered Inorganic Groundwater Samples
(ppb)

	Round I Samples				Round II Samples			
ELEMENT	Maximum Background	Range	Average	# of Samples > Background	Maximum Background	Range	Average	# of samples > Background
ALUMINUM	52.4	32.2 - 226.0	56.6	7	nd	27.0 - 81.2	42.1	9
ANTIMONY	43.7	29.0 - 49.5	38.3	2	nd	0.0 - 0.0	0.0	0
ARSENIC	2.1	1.0 - 18.9	2.8	17	nd	1.9 - 45.9	10.6	9
BARIUM	32.6	4.2 - 168.0	34.4	26	67.5	6.5 - 143.0	33.8	4
BERYLLIUM	nd	0.0 - 0.0	0.0	0	nd	0.1 - 1.0	0.2	7
CADMIUM	nd	5.2 - 8.4	6.6	7	3.5	0.0 - 0.0	0.0	0
CALCIUM	76,100	140.0 - 109,000.0	61,179.0	14	77,200	260.0 - 94,900.0	66,251.0	7
CHROMIUM	nd	10.5 - 10.5	10.5	1	nd	4.7 - 4.7	4.7	1
COBALT	nd	5.3 - 8.5	6.7	6	nd	5.5 - 5.5	5.5	1
COPPER	5.3	5.1 - 28.4	13.4	15	5.0	3.1 - 9.3	4.2	11
CYANIDE	nd	0.0 - 0.0	0.0	0	nd	0.0 - 0.0	0.0	0
IRON	674	21.6 - 1,410.0	198.2	1	1,470	25.8 - 1,097.0	279.0	0
LEAD	nd	2.1 - 5.5	3.4	20	6.1	2.0 - 14.3	5.1	12
MAGNESIUM	25,200	11,300.0 - 30,800.0	19,626.0	7	26,800	2.5 - 32,500.0	17,928.0	5
MANGANESE	171	5.9 - 1,290.0	153.0	19	182	2.7 - 1,180.0	170.4	14
MERCURY	nd	0.0 - 0.0	0.0	0	nd	0.5 - 0.6	0.5	2
NICKEL	nd	9.1 - 18.5	13.1	3	nd	9.0 - 18.3	14.4	4
POTASSIUM	3,160	670.0 - 13,500.0	2,973.0	22	2,970	328.0 - 11,400.0	2,360.0	16
SELENIUM	nd	0.0 - 0.0	0.0	0	nd	2.1 - 4.5	3.3	2
SILVER	nd	0.0 - 0.0	0.0	0	nd	0.0 - 0.0	0.0	0
SODIUM	23,300	1,570.0 - 929,000.0	29,215.0	18	13,300	2,280.0 - 1,170,000	29,974.0	24
THALLIUM	nd	0.0 - 0.0	0.0	0	nd	2.0 - 2.3	2.1	4
TIN	nd	0.0 - 0.0	0.0	0	nd	0.0 - 0.0	0.0	0
VANADIUM	nd	0.0 - 0.0	0.0	0	nd	39.5 - 39.5	39.5	1
ZINC	22	3.4 - 128.0	19.7	22	25.0	3.3 - 44.8	10.9	2

Table 4-28

Unfiltered Inorganic Groundwater Samples
(ppb)

	Round I Samples				Round II Samples			
ELEMENT	Maximum Background	Range	Average	# of Samples > Background	Maximum Background	Range	Average	# of samples > Background
ALUMINUM	1,470	28.5 - 14,800.0	1,199.0	12	955	26.7 - 4,220.0	515.9	10
ANTIMONY	nd	36.2 - 42.8	39.3	3	nd	0.0 - 0.0	0.0	0
ARSENIC	3.5	1.2 - 22.7	4.4	15	2.9	1.3 - 49.5	6.2	13
BARIUM	45.3	10.4 - 179.0	40.5	23	71.9	2.4 - 182.0	39.2	9
BERYLLIUM	nd	1.1 - 1.4	1.2	2	nd	0.1 - 1.2	0.4	11
CADMIUM	nd	6.1 - 6.1	6.1	1	3.5	3.2 - 4.3	3.8	2
CALCIUM	83,000	68.1 - 146,000.0	67,193.0	14	81,600	41,000.0 - 107,000.0	65,432.0	6
CHROMIUM	48.6	6.8 - 81.6	22.1	6	31.2	4.4 - 94.4	19.2	7
COBALT	nd	5.2 - 41.4	10.4	20	nd	4.1 - 7.3	5.6	9
COPPER	23.3	5.6 - 56.2	15.4	8	8.9	2.7 - 29.6	7.3	16
CYANIDE	nd	10.0 - 10.0	10.0	2	nd	12.0 - 12.0	12.0	1
IRON	6,600	16.3 - 31,300.0	3,118.0	7	3,250	138.0 - 8,130.0	177.0	11
LEAD	8.5	1.2 - 41.8	8.8	13	6.3	1.0 - 14.2	5.6	20
MAGNESIUM	28,600	10,900.0 - 54,300.0	22,316.0	10	28,300	11,300.0 - 28,800.0	20,977.0	8
MANGANESE	273	2.4 - 1,290.0	226.6	15	217	14.2 - 1,280.0	194.0	16
MERCURY	nd	0.0 - 0.0	0.0	0	nd	0.3 - 0.4	0.4	2
NICKEL	38	10.1 - 97.8	25.5	6	18.1	8.1 - 3,120.0	184.3	11
POTASSIUM	3,810	158.0 - 10,600.0	3,192.0	16	3,460	370.0 - 9,730.0	2,476.0	16
SELENIUM	nd	0.0 - 0.0	0.0	0	nd	1.4 - 1.4	1.4	1
SILVER	nd	0.0 - 0.0	0.0	0	nd	0.0 - 0.0	0.0	0
SODIUM	10,200	3,130.0 - 920,000.0	29,002.0	36	13,000	1,410.0 - 1,120	27,535.0	27
THALLIUM	nd	0.0 - 0.0	0.0	0	nd	2.0 - 2.1	2.0	2
TIN	nd	0.0 - 0.0	0.0	0	nd	0.0 - 0.0	0.0	0
VANADIUM	nd	4.2 - 27.6	11.6	13	nd	3.2 - 41.3	12.8	9
ZINC	65.4	4.1 - 268.0	39.7	11	43.6	2.9 - 124.0	24.7	8

at 0.4 ug/l and 0.3 ug/l, respectively. Cyanide was found in MW-20 at 20 ug/l, but was not detected in the Round I sample from this well. The concentration of sodium in MW-22 was 1,120,000 ug/l.

In the Round I filtered samples, MW16 was the only location in which mercury was detected at 0.4 ug/l. Again, it was detected at a concentration below the MCL. Cyanide was detected in well MW-20 at 12 ug/l; however, this value is below the Secondary Drinking Water Standard of 200 mg/l.

In the filtered samples of Round II groundwater collections, manganese was again found in a number of wells to be above both background concentrations and above the Drinking Water Standards with a maximum concentration of 1,180 ug/l in well MW-12. Iron was detected in many samples at high concentrations, but were lower than the concentration found in the background samples, 856 ug/l. Other compounds such as calcium, magnesium, potassium, and sodium were present at elevated concentrations in many of the wells, but are not viewed as contaminants of concern for this groundwater characterization.

Comments #1+3

Production Well Samples

Volatiles

In the Round I and Round II samples collected during the RI conducted by CDM, the results for the volatile organic fraction were all below the detection limits established for each parameter.

BNAs and Pesticides/PCBs

No BNAs, pesticides, or PCBs were detected in either Round I or Round II samples.

- Stratification of contaminants within the plumes is evident, as indicated by the concentration levels which were found at various well screen depths. Higher concentrations were found in shallow wells, between 27 and 40 feet.

- VOCs were not detected in monitoring wells located west of Travis Ditch, just south of its confluence with Kingsbury Creek.

- Isophorone and several phenolics were detected in up to six of the wells located in two of the source areas.

- Mercury was detected in Round II at location MW-16 at 0.4 ug/l. The detected concentration, however, was below the MCL of 2.0 ug/l. Cyanide was detected in MW-20 at 12 ug/l, only in Round II. This value, however, was also below the Secondary Drinking Water Standard of 200 ug/l.

- Chromium was detected in several locations in the unfiltered samples. These locations were MW-12, MW-22, MW-24, and MW-58. Chromium was not detected, however, in the filtered samples.

- Results of the production well samples collected during the RI indicated that no VOC contamination was found. However, results obtained during past sampling surveys of the industrial park water supply system (KUC), have shown the presence of VOC contamination. Samples collected by the Indiana Department of Environmental Management (IDEM) from Well A (identified as RI sample location PW-03, shown in Figure 4.5-1, Vol. II) have shown TCE at 21 ug/l and 1-2,DCA at 8.3 ug/l. These concentrations both exceed the MCL for VOC's and have resulted in the cessation of pumping from Well A, as requested by the Indiana Public Water Supply Section in May, 1988.

  The results of past sampling conducted by the IDEM are shown in Table 4-29. The data indicated that VOC contamination has been detected in

TABLE 4-29

SUMMARY OF COMPOUNDS DETECTED IN

KUC WATER SUPPLY SYSTEM[1]

Compounds Detected:	Dates Sampled: 3/88[2]	5/88[3]
Tetrachloroethylene		
Toluene		
Ethyl Benzene		
Xylenes		
Methyl Ethyl Ketone		
Methyl Isobutyl Ketone		
Trichloroethylene	21 ug/l	14 ug/l
1,2-Dichloroethane	8.3 ug/l	
1,1,1-Trichloroethane		3.6 ug/l

[1] Samples collected and analyzed by Indiana Department of Environmental Management.

[2] Samples collected from Well A (PW-03).

[3] Samples collected from water tap located at Cardinal Chemical.

in samples collected from various KUC supply wells and from water taps located at operating facilities that use the KUC water system. Samples collected during the RI were not taken from all of these same locations, therefore, the presence of VOC contamination and the levels detected would not be expected to correlate with the sample results obtained by the IDEM.

The samples taken from Well A (PW-03) during the RI were collected in November of 1988, after the industrial park had stopped pumping from the well. Prior to RI sample collection, water was pumped from Well A only long enough to obtain a representative sample. The volume of water pumped during sample collection would not reflect the volume and duration of pumping utilized during the normal operation of Well A, which was typically used for a period of days during the normal pumping strategy.

The longer duration of pumping during normal use of Well A would have resulted in a larger cone of influence, which could impact the movement of groundwater flow into the area of Well A. This expanded cone of influence may have resulted in the introduction of contaminated groundwater from a nearby plume or source.

The short duration of pumping during RI sample collection from Well A (PW-03) would not have resulted in the same cone of influence on groundwater flow. This may explain why samples collected during the RI did not show the level of contamination that had been previously detected in Well A by the IDEM.

4.6 SUMMARY AND CONCLUSIONS: EXTENT OF CONTAMINATION

Based on the sampling results from Phase I and II RI activities conducted at the Fisher-Calo site, the following summaries and conclusions were developed:

4.6.1 SURFACE WATER/SEDIMENTS

- The surface water sample collected from the discharge lagoon on the Cardinal Chemical Property (Area C) contained high concentations of a number of inorganic compounds including aluminum, barium, chromium, copper, iron, manganese, nickel, potassium, sodium and zinc. The sediment sample at the same location had elevated levels of PCB-1260, chloroform, and Bis(2-Ethylhexyl)phthalate.

- Surface water samples collected from Travis Ditch and Kingsbury Creek did not show elevated concentrations of contaminants, with the exception of sodium, found in both the surface water and the sediment samples taken at the confluence of the two creeks.

- Sediment samples contained higher levels of contaminants than did the surface water samples.

- The downstream sediment sample in Travis Ditch showed high levels of Beta-Benzohexachloride, 1,2-Dichloroethene, Trichloroethene, 1,1-Dichloroethane, aluminum, iron, vanadium, and zinc. This may be a result of wastewater discharge from the Roll Coater facility, however, since the location is just downstream of the discharge pipe.

- Sediments in the pond at the Space Leasing facility (Area F) showed elevated concentrations of toluene, aluminum, and potassium. Toluene was known to have been stored at the Fisher-Calo site.

- The sediments from the wetland area contained high concentrations of aluminum, barium, chromium, lead, potassium, selenium, silver, sodium and vanadium.

- No contamination was detected in the Kankakee River, the receiving water of Travis Ditch and Kingsbury Creek.

4.6.2 SURFACE SOIL/RUNOFF

- In Area A, 1,1,1-Trichloroethane was the major volatile contaminant detected in the surface soils. Bis (2-ethylhexyl)phthalate, Isophorone, and PAHs were also found throughout the study area. Mercury was detected in five samples all located in the southern end of the property and high concentrations of cyanide were detected at four locations.

- In Area B, 1,1,1-Trichloroethane was the most commonly detected volatile organic compound, but at low concentrations. Isophorone and Bis (2-Ethylhexyl)phthalate were also detected at significant concentrations. PCB-1260 was detected at numerous locations at high concentrations.

- In Area C, 1,1,1-Trichloroethane, 4-Methyl-2-Pentanone and toluene were the most often detected volatile compounds. Chloroform was detected in 3 runoff samples. PCB-1254 and PCB-1260 were detected at significant concentrations. Cyanide and high concentrations of inorganic compounds were detected throughout the study area.

- In Area D, 1,1,1-Trichloroethane was the most commonly detected VOC. 4,4-DDT, 4,4-DDE 4, 4,4-DDD; and Endrin Ketone were also detected in the study area. High concentrations of inorganic compounds were detected in the 2 samples closest to the National Packaging Facility.

- In Area E, Acetone was detected at high concentrations. Isophorone and Bis (2-Ethylhexyl)phthalate were the only semi-volatile compounds detected. Aldrin and Heptachlor were also detected.

- High concentrations of contaminants exist in areas where drums currently are, or were stored, where waste lagoons were present at one time, or where waste disposal pits existed (Refer to Figures 4.3-7 through 4.3-11, Vol. II). These areas should be targeted

- The five locations noted above all contain high levels of the components that contribute to groundwater contamination. It is recommended that remediation of these soils be considered in order to reduce additional infiltration of organic contaminants to the saturated zone.

- The patterns of contamination in the subsurface were such that only the unsaturated zone contains extremely high levels of contamination.

- The patterns of contamination in the subsurface soils indicated that at locations where contamination occured, the highest levels were found in the unsaturated zone.

- The contaminants found in surface and subsurface soils were consistent with the history of disposal activities at the site. The following materials were disposed of: paint solvents, industrial chlorinated solvents, metal finishing wastes (metals and cyanide), and caustic and acidic wastes. Thus, the existence at the site of high levels of the VOC chlorinated and non-chlorinated solvents, the semivolatile aromatics, as well as metals and cyanide, was to be expected.

- The presence in soils of high concentrations of toluene, xylenes, and ethylbenzene without high levels of benzene suggests that these constituents were present as a result of leakage/disposal of industrial or paint solvents, rather than originating from gasoline. The presence of high amounts of polycyclic aromatic hydrocarbons (PAHS) in near-surface soils may be due to the disposal of waste oils.

- The contaminants present in the saturated zone compared fairly well between soils and groundwater. Sampling showed that contamination almost exclusively affected the upper and middle portions of the shallow aquifer at discrete locations across the project study area. Most of the same contaminants (mostly chlorinated organics) that were

detected in the groundwater from medium and shallow depth wells were also detected in soil samples from similar depths, and at roughly similar concentrations.

Groundwater:

- The contaminants of concern in groundwater were the chlorinated organics 1,1,1-trichloroethane (TCA), trans-1,2-dichloroethene (DCE), 1,1-dichloroethane (DCA), trichloroethene (TCE), and methylene chloride, which were present at concentrations as high as 5900 ppb; other contaminants of concern were the volatiles 2-hexanone (up to 590 ppb), acetone (400 ppb), 4-methyl-2-pentanone (360 ppb), benzene (28 ppb), and the semivolatile isophorone (210 ppb). Several chlorinated organic and phenolic constituents were detected at concentrations less than 30 ppb. Several inorganics were detected in unfiltered groundwater samples, but their concentrations in filtered samples were well below applicable standards.

- As determined in the hydrogeological investigation, groundwater is flowing in a south-southwesterly direction.

- The main pathway of contaminant migration from the source areas is for mobile constituents to move vertically downward through the unsaturated zone until they enter the saturated zone, where they can subsequently travel downgradient (south-southwest) with the groundwater.

- There appear to be several distinct contributing sources of volatile (VOC) contamination to the groundwater. At least three different resulting plumes have been identified.

  - One was located downgradient of the old waste disposal area at the Fisher-Calo Plant near MW5 and MW6. Contaminants found in MW5 and MW6 included DCA, DCE, TCA, TCE, 2-hexanone, and 4-methyl-2-pentanone.

- The second plume originates near the National Packaging facility with VOCs detected in MW35 in Round I and the same compounds detected in MW36 of Round II. VOCs detected included TCA, DCE, and TCE.

- Based on the compounds detected in each well nest, there was a potential for several plumes to be present near the Cardinal Chemical Company facility. VOCs found in these wells include DCA, DCE, TCA, TCE, acetone, and methylene chloride.

o Isophorone and several phenolics were detected in up to six of the wells in two of the source areas.

o VOCs were not detected in monitoring wells located west of Travis Ditch, just south of its confluence with Kingsbury Creek.

o The presence of phthalates and acetone detected at low concentrations in the investigative samples appeared to be related to laboratory or field contaminants. However, the presence of these contaminants in many of the samples at high concentrations indicates that they also may be related to site contamination. Where this was the case, these constituents are discussed with other contaminants.

o Mercury was detected in Round II at location MW16 at 0.4 ug/l. The detected concentration, however, was below the MCL of 2.0 ug/l/ Cyanide was detected in MW20 at 12 ug/l, only in Round II. This value, however, was also below the Secondary Drinking Water Standard of 200 ug/l.

o Chromium was detected in several locations in the unfiltered samples. These locations were MW12, MW22, MW24, and MW58. Chromium was not detected, however, in the filtered samples.

5.0 CONTAMINANT FATE AND TRANSPORT

This section qualitatively discusses the contaminant migration pathways for the Fisher-Calo site and the potential for the contaminants of concern to migrate along these pathways. The migration of these contaminants is influenced by the physical, geological, and hydrogeological conditions at the site and surrounding areas; the characteristics of the contaminant source areas; and the physical/chemical characteristics of the contaminants themselves. This section will provide a general discussion of the environmental behavior of the contaminants of concern, including their potential for mobility in various media and most probable migration pathways.

5.1 POTENTIAL CONTAMINANT MIGRATION PATHWAYS

The potential pathways for contaminant migration from the site are depicted in Figure 5.1-1 (Volume II). Contaminated surface soils could be transported from the site by surface water run-off or wind erosion. These contaminated soils could be deposited in local surface water bodies or be carried into the atmosphere and deposited elsewhere. Volatile organic compounds in the surface soils may volatilize into the atmosphere. Volatile compounds in the subsurface soil could volatize if the soils or buried waste materials were excavated or otherwise disturbed.

Contaminants could also be transported from contaminated soils and buried wastes into the groundwater via leaching. As water (primarily due to precipitation) percolates through into subsurface soil, it may pick up organic and inorganic constituents and carry them down to the shallow groundwater aquifer. The shallow groundwater aquifer may then transport contaminants to downgradient receptors including surface water bodies and private wells. Contaminants in the groundwater could be transported to Travis Ditch and Kingsbury Creek, which receive groundwater discharge from this shallow aquifer. Both Travis Ditch and Kingsbury Creek are

Inorganics

Manganese was detected in all production well samples in both rounds at concentrations that exceed the SMCL of 50 ug/l. In Round II, iron was detected above the SMCL, at 1,910 ug/l in the unfiltered sample of PW-03. Again, iron and manganese were above the SMCLs, but are due to natural conditions in the area.

4.5.4 SUMMARY AND CONCLUSIONS

Based on the groundwater sampling and analysis, the following summary conclusions can be made:

- As determined by the hydrogeological investigation, groundwater is flowing in a south-southwestern direction.

- There appear to be numerous contributory sources of VOC contamination to the groundwater. At least three different resulting plumes have been identified.

  - One was located downgradient of the old waste disposal area at the Fisher Calo Plant near MW-5 and MW-6. Contaminants found in MW-5 and MW-6 included DCA, DCE, TCA, TCE, 2-hexanone, and 4-methyl-2-pentanone.

  - The second plume originates near the National Packaging facility with VOCs detected in MW-35 in Round I and the same compounds detected in MW-36 of Round II. VOCs found included TCA, DCE, and TCE.

  - Based on the compounds detected in each well nest, there is a potential for several plumes to be present in the area of the Cardinal Chemical Company facility. VOCs found in these wells included DCA, DCE, TCA, TCE, acetone, and methylene chloride.

The latter case probably more closely approximates the actual contaminant behavior at Fisher-Calo because it takes into account the typical percentage of organic carbon for the site. In the case where organic carbon is considered negligible, the contaminant velocities would be the same as the groundwater velocities. The contaminant migration velocities have been calculated, using an organic content of 0.2 percent, for shallow, intermediate and deep groundwater flow velocities of the upper aquifer (Table 5-2).

There are some inherent limitations to these contaminant velocity calculations, other than the limitations already discussed. The contaminant velocity calculations do not take into account factors such as dispersion, dilution, solubility, hydrostratigraphic controls and degradation. However, even with these limitations, the contaminant velocity calculations are useful because they give estimated limits on the rate of contaminant migration within the aquifer system at Fisher-Calo.

5.2.3.4 Density Flow

In addition to the advective transport and dynamic mixing of the contaminants of concern in the aquifer, density gradients will also induce transport in the subsurface. Density flow is a contributing factor to the vertical movement of contaminants within an aquifer. Contaminant constituents with specific gravities of less than water and with low solubility in water will tend to float on top of the water table. Contaminant constituents with specific gravities of greater than water and with low solubilities in water will migrate vertically downward within the aquifer.

The contaminants of concern that are found in the groundwater at Fisher-Calo all have specific gravities greater than 1.0 (specific gravity for water), except for benzene (Table 5-1). Benzene is found only in a few isolated areas and is not present in the deep part of the aquifer. Benzene has a relatively high solubility in water and would be expected to move into the groundwater.

TABLE 5-2

CALCULATION OF RETARDATION FACTORS AND POTENTIAL VELOCITIES FOR CONTAMINANTS OF CONCERN

COMPOUNDS	ORGANIC CARBON PARTITION COEFFICIENT KOC (l/Kg)	FOC1	DISTRIBUTION COEFFICIENT Kd (l/Kg)	RETARDATION FACTOR (DIMENSIONLESS)	POTENTIAL CONTAMINANT VELOCITY (ft./year)		
					SHALLOW	INTERMEDIATE	DEEP
ACETONE	0.28	0.002	0.00056	1.00336	210.29	130.56	40.86
1,1-DICHLOROETHANE	30.0	0.002	0.06	1.360	155.15	96.32	50.15
1,2-DICHLOROETHENE	14.0	0.002	0.028	1.168	180.65	112.16	35.10
4-METHYL-2-PENTANONE	24.0	0.002	0.048	1.228	171.82	106.68	33.39
TRICHLOROETHENE	127.0	0.002	0.254	2.254	83.60	51.90	16.24
1,1,1-TRICHLOROETHANE	152.0	0.002	0.304	2.824	74.72	46.39	14.52
TETRACHLOROETHYLENE	665.0	0.002	1.33	8.98	23.50	14.59	4.57

AVG. POROSITY 0.30 (ESTIMATED FREEZE AND CHERRY, 1979)

AVG. ORGANIC CONTENT .2%

AVG. GROUNDWATER VELOCITY: SHALLOW 211 ft./year, INTREMEDIATE 131 ft./year, DEEP 41 ft./day.

1 FOC = FRAC. ORG. CARBON

The denser contaminant constituents would be expected to travel downward in the saturated environment until they intercept a boundary condition that would induce a change in flow direction. If the contaminants were to encounter an aquitard at depth, the density plume would continue downslope under the influence of gravity. There would be a tendency for the contaminants to pond at the base of the aquifer. The natural depressions in the surface topography of the clay aquitard, as shown in Figure 5.2-2, (Volume II), may tend to pool dense contaminants and may act as a secondary source of groundwater contamination if significant volumes of contaminants are present. However, wells screened in this area, just above the silty clay aquitard, showed no significant contamination. So at present, contaminants do not appear to be collecting in this area and it is probably not a source of contamination in the lower portion of the aquifer.

In summary, the critical parameters in considering contaminant transport at the Fisher-Calo site are the geology of the site area, the density of contaminants, the dynamic flow gradients and the mixing potential in the aquifer. Induced vertical gradients due to pumping will increase the mixing potential for that portion of the contaminants transported by advection. The greater density of the contaminant constituents may draw the contaminants downwards under gravity into the sinks and troughs of the aquitard underlying the aquifer. However, wells screened just above the aquitard in the trough area show no contamination. One well was screened below the aquitard and indicated no contamination. This may indicate that the aquitard is a barrier to contaminants. With distance from the source, the contaminants may eventually segregate, with the dense components migrating down to the top of the aquitard, and the less denser components flowing downgradient, mixing, dispersing, degrading and gradually decreasing in concentration downgradient.

5.2.4 CONTAMINANT BEHAVIOR IN SURFACE WATERS AND ASSOCIATED SEDIMENTS

Surface water bodies at the Fisher-Calo site may receive contamination from several different sources. Surface water bodies can be contaminated by

water runoff coming from regions of contaminated surface soils. Contaminants can be leached into surface water bodies from the surrounding unsaturated zone. Contaminated groundwater may discharge into surface waters.

Samples of surface water and associated sediments were collected from natural surface water at Fisher-Calo. The waters of Kingsbury Creek and Travis Ditch were both found to be contaminant free. This does not necessarily indicate that contamination is not entering these water bodies, but may be that contamination is being diluted by upstream water to below detectable limits. The associated sediments do, however, contain a number of contaminants. By comparing the assemblage of contaminants in the sediments to the assemblages of contaminants in the groundwater and the unsaturated zone, a source of contamination can be inferred.

It appears that only a few of the contaminants contained in the groundwater are in the sediments of Kingsbury Creek or of Travis Ditch (Table 4-2, Area C and E). It should be noted that the contaminants in the groundwater are all volatile organics and may volatilize after entering the surface water. Nevertheless, few of the contaminants found in the sediments are in the groundwater, so groundwater may not be a significant source of contamination. A more likely source of surface water sediment contamination are the contaminants derived from the unsaturated zone including surface soils. Many of the contaminants in the surface water sediments are found in the surrounding surface and subsurface soils (Table 4-2, Areas C and E). The surface waters and sediments appear to be the fate of many of the contaminants at Fisher-Calo, although they may act to dilute and carry some contamination off site.

5.3 CONTAMINANT FATE

The apparent predominant transport mechanism for contaminant migration at Fisher-Calo is advective groundwater transport. However, the contaminant movement and ultimate fate are complex. There are multiple contaminant

sources within the site area and contaminant sources located off site. Two aquifer systems are present at the site separated by at least a partial aquitard. The one well screened in the lower aquifer showed no contamination, so only the upper aquifer will be discussed further.

Even though there appears to be a number of sources and a fairly complex migration and contaminant fate system exists at the Fisher-Calo site, some general trends of contamination migration and fate can be observed and described. Two areas of contamination within the project site that have definable point sources are worth further attention. These two areas are the Fisher-Calo One-Line facility (currently Cardinal Chemical) and the Fisher-Calo Two-Line facility (currently Acid Products). The areas of observed contamination around these sites and other contaminated areas are shown in Figures 5.3-2, 5.3-3, and 5.3-4 (Volume II), plotted with increasing depth, respectively. In general Figures 5.3-2 through 5.3-3 show a decreasing extent of contamination with increasing depth in the aquifer.

The Fisher-Calo Two-Line facility, located in Area A, started waste disposal and solvent reclamation operations by 1978. Several abandoned waste lagoons, drum and tank storage areas, and solid waste pits at this facility that had been used over the years. If it is assumed that this site acted as a contamination point source since 1978, then some estimated distances of contaminant migration in the saturated zone can be calculated. As discussed in Section 3.3, the general groundwater flow direction in the unconfined aquifer is south to southwest at Fisher-Calo. By using the calculated groundwater velocities at Fisher-Calo and retardation factors for the chemicals of concern, an extent of contaminant migration can be estimated (Table 5-2). A maximum range for contaminant migration can be estimated from the Fisher-Calo Two-Line facility by assuming that the contaminants move at the same velocity as the groundwater. Under this case, the maximum distance from the Two-Line facility that contaminants could have traveled in the upper portion of the aquifer (the portion of the aquifer with the highest groundwater velocity) in 11 years would be 2,321

feet. This estimate gives a reasonable maximum extent of contaminant migration in the groundwater from this source.

A more realistic estimate of the range of contaminant migration from the Fisher-Calo Two-Line facility may be calculated using the retardation factors for each contaminant estimated from local conditions (Table 5-2). In this case the distance of contaminant migration is calculated using the contaminant with the lowest retardation factor (1,1-Dichloroethane) moving in the portion of the aquifer with the highest groundwater velocities. This estimate indicates that the contaminant would have migrated 1,707 feet since 1978. In order to estimate a reasonable minimum migration distance, the contaminant with the highest estimated retardation factor (1,1,1-Trichloroethane) moving in the portion of the aquifer with the highest groundwater velocities was used. This estimate indicates that this contaminant may have migrated only 822 feet since 1978. These estimated distances of contaminant migration are consistent with the results of wells monitored downgradient from the point source at Fisher-Calo's Two-Line facility. The furthest well downgradient from the facility that shows contamination is approximately 1,500 ft. away. The next set of wells downgradient from the facility show no detected contaminants. To date, the contaminants probably have not moved downgradient far enough to have affected these wells. However, given enough time, these wells will probably become receptors for the contaminated groundwater. Using the estimated migration rates and groundwater flow direction in this area, it may take 23 years for the contaminant with the lowest retardation factor moving in the shallow portion of the aquifer to reach these wells. This estimate is based on assumptions and is therefore highly speculative, but may be useful for further investigation of the area.

The Fisher-Calo One-Line facility (currently Cardinal Chemical) is located in Area C and may also be considered a point source for groundwater contamination. The site has a number of active and abandoned waste lagoons along with areas of drum and tank storage. The facility has been operating since 1972. Using the same logic as that used for the Fisher-Calo Two-Line

facility, an estimate of the distance of contaminant migration can be derived. Because the hydrogeologic conditions at the two facilities are the same, the same calculations can be applied to the One-Line facility, except acetone has the lowest retardation factor for contaminants at this site. Acetone would be expected to migrate 3,570 feet in 17 years. The major differences are that the contaminants may intersect Travis Ditch and there is only one monitoring well located downgradient outside of the area of confirmed contamination. Using estimated migration rates, the contaminants should have intersected Travis Ditch, located approximately 1800 feet from the source. However, using the case where the contaminants would move at the same rate as the groundwater, the contaminants should not have reached monitoring wells 13 and 14. This in fact may be the case, as there is no contamination detected at these wells.

There is the possibility that groundwater is being discharged in Travis Ditch and the contaminants are not detected in the surface water due to dilution. The ditch only intersects the very top portion of the aquifer and its depth in the water table is small compared to the overall thickness of the groundwater table (Figure 5.3-6, Volume II). Therefore, only the very upper portion of the aquifer would be expected to discharge into Travis Ditch. Some of the groundwater contaminants are probably being intercepted by Travis Ditch, although they are not detected in the surface water. Some of the contaminants in surface water sediments correlate to contaminants in the groundwater, indicating that groundwater contaminants entering the surface water are probably adsorbed in the sediments but are diluted in the water by upstream water. Using the groundwater flow velocity of the intermediate portion of the aquifer and the calculated retardation factor for the fastest moving contaminant present at the point source, it would take an estimated minimum of 29 years for contaminants to flow by Travis Creek to reach monitoring wells 13 and 14. Again, these estimates are highly speculative and are only intended to give broad estimates for the rates of contaminant migration.

Other than making estimates of contaminant migration for the two possible point sources on site, only a few general contaminant migration trends are noteworthy. The apparent predominant transport mechanism for contaminant migration at Fisher-Calo is by advective groundwater transport. The end receptor of advectively transported contaminants would be production wells and the downgradient aquifer. There are only 3 production wells at the project site and they are used sporadically. Therefore, interception of contaminants by these 3 production wells would not constitute a major role in the fate of contaminants at Fisher-Calo. Any contaminants not intercepted by the production wells or the shallow Kingsbury Creek and Travis Ditch will eventually flow downgradient under the regional gradient to residential wells in Tracy, Kingsford, as well as the Kankakee River.

Other potential fates of the contaminants would include retention at the aquitard/aquifer interface, biodegradation and natural weathering in the unsaturated and saturated zone, and volatilization. The volume of contaminants consumed by these fates are considered insignificant in relation to the volume of contaminants observed to be transported to the monitoring wells.

5.4 SUMMARY

Various hazardous materials were deposited at a number of areas in and around the Fisher-Calo site. Most of the material was disposed of in the unsaturated zone. Some of the hazardous constituents such as inorganic compounds, polycyclic aromatic hydrocarbons, phthalates and pesticides are not expected to have migrated from the location of disposal. In fact, many of these compounds have remained within the upper 10 feet of the unsaturated zone.

The migration of mobile contaminants, such as chlorinated hydrocarbons, was found to be significantly controlled by the hydrogeologic conditions of the site and the physical characteristics of the contaminants. Volatilization may have a small contribution to the fate of the contaminants. Other factors were not found to significantly impact the eventual fate of

the contaminants. The most probable migration pathway of contamination is vertical downward migration through the unsaturated zone into the shallow aquifer, contaminating the groundwater.

Advective groundwater transport is the significant contaminant transport mechanism in the upper aquifer. The general groundwater flow direction is south to southwest. Several probable point sources have been identified within the project site and estimated contaminant migration distances and rates have been determined. Production wells probably are not a major receptor of groundwater contaminants. Contaminants in the upper portion of the aquifer may enter Travis Ditch and be volatilized, diluted, or adsorbed onto the sediments. However, the bulk of the groundwater probably moves past Travis Ditch. Contaminants will eventually flow downgradient under the regional gradient to residential wells and the Kankakee River.

6.0 SUMMARY AND CONCLUSIONS

This section summarizes the major conclusions that have been developed from the RI findings and background information. Conclusions pertaining to the geology and hydrogeology of the site are listed in Section 6.1. Conclusions summarizing the nature and extent of contamination are presented in Section 6.2. Section 6.3 lists the conclusions developed from the interpretations concerning the fate and migration of contaminants in the study area.

6.1 GEOLOGY AND HYDROGEOLOGY

The following conclusions were developed from the results of the geologic and hydrogeologic investigation:

- Sand and gravel deposits comprise the upper aquifer and are 44 to 97 feet thick.

- A silty clay aquitard underlies the upper aquifer and is approximately 9 to 17 feet thick. It is encountered throughout much of the study area and serves to at least partially hydraulically separate the two aquifers.

- A lower aquifer lies between the upper aquitard and the underlying hard, dense clayey silt deposit which is believed to be the basal till deposit.

- The overall thickness of the upper and lower aquifers and the separating aquitard is approximately 150 feet thick.

- The surface of the silty clay aquitard exhibits an elongate depression that trends northwest to southeast across the center of the site.

- Groundwater flow in the upper aquifer at Fisher-Calo is to the south and southwest, which is consistent with regional flow patterns.

- Groundwater velocity in the upper aquifer varies according to depth, ranging from 211 ft/yr in the shallow zone, 131 ft/yr in the middle, and 41 ft/yr in the deep portion. However, actual groundwater velocities will vary across the aquifer due to variation in the make-up of the aquifer as well as variations in hydraulic gradient.

- The deep aquifer does not appear to be affected by groundwater contamination. This is based, however, on the sampling results obtained at only one monitoring well, and may not be conclusive.

- Groundwater discharge is occurring at production wells, residential wells, Kingsbury Creek, Travis Ditch, and the Kankakee River.

6.2 NATURE AND EXTENT OF CONTAMINATION

Conclusions developed in this section are based upon the interpretation of analytical data obtained from multi-media sampling activities. General conclusions that can be drawn from the entire study area are:

Surface waters/sediments:

- The surface water samples collected from flowing water bodies (Travis Ditch, Kingsbury Creek, and the Kankakee River) overall did not contain elevated concentrations of contaminants. Sediment samples contained higher levels of contaminants than did the surface waters; however, only one location showed significant levels of contamination. This location, however, was just downstream of the wastewater discharge pipe from the Roll Coater facility and contamination may therefore be attributable to that facility.

- The surface water sample collected from the discharge lagoon on the Cardinal Chemical property (Area C) contained high concentrations of a number of inorganic compounds including aluminum, barium, chromium, copper, iron, manganese, nickel, potassium, sodium, and zinc. The sediment sample at the same location had elevated levels of PCB-1260, chloroform, and bis(2-ethylhexyl)phthalate.

- The sediments in the pond at the Space Leasing Facility (Area F) showed elevated concentrations of toluene, aluminum, and potassium. Toluene is known to have been stored at the Fisher-Calo site.

- The sediments in the wetland area contained high concentrations of aluminum, barium, chromium, lead, potassium, selenium, silver, sodium, and vanadium.

Surface soils:

- Surface soils at the site were most heavily contaminated with the following compounds: acetone, methylene chloride, bis(2-ethylhexyl/phthalate, isophorone, chlorobenzene, ethylbenzene, total PAHs, PCB-1260, cyanide, chromium and zinc. These compounds were identified as contaminants of concern due to their detection at high concentration levels. Other VOCs were detected, but at lower concentrations. Pesticides were found in Areas B, C, D and E. Area A (Fisher-Calo) and Area C (Cardinal Chemical) were the most heavily contaminated areas.

- High concentrations of contaminants existed in areas where drums are or were stored, where waste lagoons were present at one time, or where waste disposal pits existed. Some of these areas have been targeted for the surface soil removal activities currently planned at the Two-Line Road facility. The areas not being addressed by this removal should be the subject of potential future remedial action.

- In all study areas, no pattern of contamination can be established. Contaminant migration occurs vertically down through the unsaturated zone, and not horizontally, which is typical of surface soil contaminant distribution. However, the data may suggest that wide-spread leakage/disposal activities occurred in various areas at the site rather than large-scale, localized dumping/disposal in limited areas. (Refer to Figures 4.3-7 thru 4.3-11.)

- Many of the contaminants detected in the surface soils were also detected in the subsurface soil and groundwater samples. Additional contaminants were found in the subsurface that were not detected in high concentrations at the surface, including highly volatile compounds such as TCE, PCE, toluene, and xylene.

Subsurface soils:

- RI sampling at the Fisher-Calo site showed that at certain locations the shallow part of the subsurface environment (between 5 to 10 feet below land surface) contained high levels of volatile, semivolatile, and inorganic contaminants. (Refer to Figure 4.4-12, Vol. II.)

- However, most semivolatiles and inorganics, as well as some volatile organic constituents, were greatly attenuated in the shallow soils through adsorption onto the soil, volatilization into the atmosphere, and possibly, biodegradation. These constituents were present at low levels only, or were undetected at depths greater than about 10 feet below land surface.

- Five subsurface soil sample locations were identified as having highly contaminated soils that may be contributing sources for contamination of the groundwater. These locations are the soil borings SB-8, 23, 33, and 36 located in Study Areas C, A, B, and F, respectively, and soil gas area A-1 (located within Study Area A). These locations contain very high concentrations of chlorinated

organic solvents (greater than 50,000 ppb total), non-chlorinated organic solvents (toluene, xylenes, and ethylbenzene; greater than 100,000 ppb total); and ketones (acetone and related compounds), as well as high concentrations of semivolatiles and inorganics.

- The five locations noted above all contain high concentrations of the components that have been shown to contribute to groundwater contamination onsite. It is recommended that remediation of these soils focus on reducing additional infiltration of organic contaminants to the saturated zone.

- The patterns of contamination in the subsurface were such that only the unsaturated zone contains extremely high levels of contamination.

- The patterns of contamination in the subsurface soils indicated that at locations where contamination occurs, the highest levels were found in the unsaturated zone.

- The contaminants found in surface and subsurface soils were consistent with the history of disposal activities at the site. The following materials were disposed of: paint solvents, industrial chlorinated solvents, metal finishing wastes (metals and cyanide), and caustic and acidic wastes. Thus, the existence at the site of high levels of the VOC chlorinated and non-chlorinated solvents, the semivolatile aromatics, as well as metals and cyanide, was to be expected.

- The presence in soils of high concentrations of toluene, xylenes, and ethylbenzene without high levels of benzene suggests that these constituents were present as a result of leakage/disposal of industrial or paint solvents, rather than originating from gasoline. The presence of high amounts of polycyclic aromatic hydrocarbons (PAHs) in near-surface soils may be due to the disposal of waste oils.

- The contaminants present in the saturated zone compared fairly well between soils and groundwater. Sampling showed that contamination almost exclusively affected the shallow and intermediate portions of the upper aquifer at discrete locations across the project study area.

Groundwater:

- The contaminants of concern in groundwater were the chlorinated organics 1,1,1-trichloroethane (TCA), trans-1,2-dichloroethene (DCE), 1,1-dichloroethane (DCA), trichloroethene (TCE), and methylene chloride, which were present at concentrations as high as 5900 ppb; other contaminants of concern were the volatiles 2-hexanone (up to 590 ppb), acetone (400 ppb), 4-methyl-2-pentanone (360 ppb), benzene (28 ppb), and the semivolatile isophorone (210 ppb). Several chlorinated organic and phenolic constituents were detected at concentrations less than 30 ppb. Several inorganics were detected in unfiltered groundwater samples, but their concentrations in filtered samples were well below applicable standards.

- As determined in the hydrogeological investigation, groundwater is flowing in a south-southwesterly direction. The main pathway of contaminant migration from the source areas is for mobile constituents to move vertically downward through the unsaturated zone until they enter the saturated zone, where they can subsequently travel downgradient (south) with the groundwater.

- There appear to be several contributing sources of volatile (VOC) contamination to the groundwater. At least three different resulting plumes have been identified.

  - One was located downgradient of the old waste disposal area at the Fisher-Calo Plant near MW5 and MW6. Contaminants

found in MW5 and MW6 included DCA, DCE, TCA, TCE, 2-hexanone, and 4-methyl-2-pentanone.

- The second plume originated near the National Packaging facility with VOCs detected in MW35 in Round I and the same compounds detected in MW36 of Round II. VOCs found included TCA, DCE, and TCE.

- Based on the compounds detected in each well nest, it is apparent that several individual plumes may be present near the Cardinal Chemical Company facility. VOCs found in these wells include DCA, DCE, TCA, TCE, acetone, and methylene chloride.

o Isophorone and several phenolics were detected in up to six of the wells located in two source areas over two rounds of sampling.

o VOCs were not detected in monitoring wells located west of Travis Ditch, just south of its confluence with Kingsbury Creek.

o The presence of phthalates and acetone detected at low concentrations in the investigative samples appeared to be related to laboratory or field contaminants. However, the presence of these contaminants in many of the samples at high concentrations indicated that they also may be related to site contamination. Where this was the case, these constituents were discussed with other contaminants.

6.3 CONTAMINANT FATE AND TRANSPORT

Conclusions based upon fate and transport of contaminants in the project study area were as follows:

- Migration of contaminants are controlled by the site-specific physical and geological/hydrogeological conditions, chemical and physical characteristics of the contaminants, and the extent of contaminant source(s).

- VOC contaminants spilled on the surface are transported vertically downward by the influence of gravity through the unsaturated zone. The volumes of contaminants transported by volatilization and surface runoff are unknown.

- The VOCs of concern appear to have migrated downward through the unsaturated zone into groundwater where they are transported through the saturated zone.

- Contaminants left behind in the soil pore spaces as residuals will most likely, act as continuing sources of contamination.

- Relatively insoluble constituents such as PAHs and heavy metals would most likely be adsorbed to the soil and remain near the surface. These contaminants have mainly been found in the upper 10 feet of the unsaturated zone.

- Due to the low organic carbon content in sands, adsorption does not appear to be a significant factor in retarding the transport of organic contaminants once they reach the saturated zone.

- Due to low rates of degradation of chlorinated organics under aerobic conditions, biodegradation is likely not a major factor controlling the fate of these compounds in groundwater.

- Groundwater movement and contaminant behavior indicate that advective groundwater transport is the primary transport mechanism for contaminants in the aquifer of concern.

- Estimates of the rate of contaminant migration indicated that the maximum contaminant migration rate may be 211 ft/yr, equal to the calculated groundwater flow velocity in the upper portion of the aquifer. An estimate based on an assumed average organic carbon content of soils at the Fisher-Calo site yields retarded transport velocities for the upper portion of the aquifer of concern ranging from 75 to 210 ft/yr, depending on the contaminant.

- Contaminants not intercepted by production wells have the potential to flow beneath Travis Ditch and downgradient towards residential wells in Tracy, Kingsford Heights and the Kankakee River.

- The downgradient residential wells in Tracy, Kingsford Heights, and surrounding areas are the primary potential receptors of groundwater contamination.

6.4 IDENTIFICATION OF POTENTIAL RECEPTORS

Based on the conclusions drawn from previous sections, it is possible to identify potential contaminant receptors located in the vicinity of the site. The nature of the contaminants present, the physical features, and the geology/hydrogeology of the site indicate that groundwater transport is the primary mechanism of migration of contaminants from the site.

Groundwater contaminant migration to potential downgradient receptors could occur in the following ways:

- Contaminants in the shallow depths of the upper aquifer could be intercepted by Travis Ditch and transported into the Kankakee River;

- Contaminants have the potential to flow beneath Travis Ditch to downgradient areas, and toward downgradient residential and municipal wells located in Tracy, Kingsford Heights, and in the surrounding area; and

- Contaminants that are intercepted by the industrial park's production wells may be transported to various consumers who obtain their water through the Kingsbury Utility Company (KUC). KUC supplies water from the industrial park production wells that is distributed for public use to various facilities inside the industrial park and to residences in the surrounding area.

Contamination in the groundwater may be intercepted by Travis Ditch and then transported to the Kankakee River. Travis Ditch and Kingsbury Creek, which joins with Travis Ditch south of the site, both flow into the Kankakee River. These streams mainly provide surface water drainage in the area. The Kankakee River, however, is extensively utilized for various recreational activities, including boating and fishing. The transport of contaminants intercepted by Travis Ditch and carried to downstream areas of the Kankakee River could potentially impact these uses.

Groundwater that may flow beneath Travis Ditch could transport contaminants to downgradient areas, and to the residential and municipal wells located downgradient from the site. Several private wells are located in the vicinity of the site, as shown in Figure 6.4-1. These wells are screened in the upper aquifer, and include both residential wells and a municipal well located in Kingsford Heights. The number of people served by the municipal well is estimated at approximately 1,800 (based on 1980 census figures). The number of downgradient private residential wells in use, and the extent of their use, is not known. However, these wells should be considered potential contaminant receptors. The Kankakee River should also be considered a potential contaminant receptor through the interception of groundwater into the river at a point downgradient from the site.

Groundwater contamination present in the production wells utilized by the KUC could be transported to various facilities within the industrial park and to residential users who purchase water from them. Water supplied to industrial park facilities would be used for manufacturing/processing

applications, and may also be used as a drinking water supply for employees working at these facilities. The residential users supplied by KUC include the population of Tracy, the King's Court trailer park, and the subdivision located off Hupp Road and west of the site. The estimated number of these residential users is approximately 320 people (based on 1980 census). The number of employees working in the industrial park facilities would vary, but is estimated at approximately 250 people.

6.5 FUTURE DATA REQUIREMENTS

The information provided in this report is based primarily on data collected during the performance of Phase I and II RI activities. This data represents the results of tasks which were conducted, as prescribed by the scope of work approved by the U.S. EPA. Adhering to the performance of tasks as defined by the scope of work, changes in the existing site conditions, and changes that were required by site access problems have resulted in some data limitations. These data limitations may require further data to be obtained for some aspects relevant to the RI. In order to insure that the required data is available to develop the Public Health Evaluation and Feasibility Study, the following data needs should be considered:

- The presence of asbestos has been noted in many of the buildings and structures located onsite and in the industrial park area. The potential health risk associated with the presence of this asbestos should be determined.

- The upper and lower aquifers appear to be at least partially hydraulically separate. Further characterization of the lower aquifer may be needed to verify this.

- The potential for contaminant transport by groundwater flowing under Travis Ditch should be verified. The stream elevations and depth of groundwater capture in Travis Ditch should be determined.

Monitoring wells screened just below the depth of groundwater capture should be installed at locations west of Travis Ditch and downgradient from RI sample locations where contamination was detected in the saturated zone. Groundwater from these wells should be assessed in order to verify the potential for contaminant migration.

- Further characterization of the surface water and sediments from onsite water bodies and the wetland area is needed to define the source(s) and extent of contamination. Samples should be taken from the wetland area at a time when standing water is available for sample collection. Deeper sediment samples from the discharge lagoon at Cardinal Chemical should be collected to determine if contamination is migrating. Samples from an offsite standing water body should be collected to provide "clean" background data for comparison.

- The onsite production wells should be resampled during their normal operating pumping strategies, or, in the case of Well A (PW-03), after purging an appropriate volume to reflect the normal pumping strategy. Any onsite or downgradient private wells utilized for public water supply that were not sampled during the RI should be sampled. Any additional samples collected should be analyzed using detection methods that will allow comparison to drinking water standards.

- A survey of the private wells located downgradient from the site should be conducted to determine the nature and extent of their use. Wells used for public water supply (residential or irrigation of food crops) should be sampled and analyzed using detection methods that will allow comparison to drinking water standards.

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