Volume I
(in its entirety except for Section 3 and tab dividers)

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Executive Summary

A RCRA Facility Investigation (RFI) was conducted at Rhône-Poulenc's Marginal Way Facility located in Tukwila, Washington. The RFI was conducted during the spring and summer of 1994 in accordance with conditions stipulated in Administrative Order on Consent No. 1091-11-20-3008(h) by U.S. Environmental Protection Agency Region 10 (U.S. EPA), and in the approved RFI Workplan (December 1993) and Addendum to the RFI Workplan (July 1994). The main objectives of the RFI were to:

- Characterize the environmental setting at the Facility.
- Determine the nature and extent of contamination from releases to soil, groundwater, sediments, or air at, or adjacent to, the Facility.
- Determine whether further actions are warranted and, in particular, whether a Risk Assessment/Media Cleanup Standards (MCS) evaluation is warranted, based on a comparison of concentrations of detected constituents to action levels. The need for a Corrective Measures Study (CMS) will be determined during the Risk Assessment/MCS evaluation.

Summary of Findings

The overall objectives of the RFI were fulfilled through two rounds of field investigation and associated sampling, laboratory analysis, and data evaluation. The hydrogeologic characterization included the analysis of the Facility's hydrostratigraphy based on 73 borings drilled during the RFI. Groundwater elevations were monitored to evaluate groundwater flow conditions, "slug" tests were performed to estimate aquifer hydraulic conductivity, and physical property testing of soil was conducted to measure parameters such as moisture content, porosity, and hydraulic conductivity.

The RFI results indicate that Facility soils have elevated levels of toluene in two general locations: in Area A2 in the north-central portion of the former plant process area (around boring A02-11 [3,600 mg/kg toluene detected]); and in Area A4 near the toluene storage tanks (near borings A04-01 [4,900 mg/kg] and A04-04 [4,400 mg/kg]). However, none of these samples exceeded the action level for toluene in soil (64,000 mg/kg).

Two plumes are evident in the Upper Aquifer groundwater beneath the Facility. One is a toluene plume (with toluene detected at concentrations of up to 600,000 μg/l) centered at monitoring well H11, in approximately the same location where elevated toluene levels in soils were found in Area A4. Other organic compounds are present in this plume above their respective action levels; these compounds are pentachlorophenol, 2-methylphenol, 4-methylphenol, bis(2-ethylhexyl)phthalate, benzene, methylene chloride, acetone, endosulfan I, endosulfan sulfate, and 4,4'-DDD. Based on a comparison of RFI data with historical data from previous investigations, the general size and shape of the toluene plume

do not appear to be changing at this time. The second plume is known as the "Black Liquid" plume and is characterized by dark-colored groundwater. The color of the groundwater appears to result from tannic acid in sulfite liquor that was used and stored onsite. The plume extends from the north-central part of the Facility to the southwest edge where Slip No. 6 meets the Duwamish Waterway. Exceedances of the groundwater action levels for chromium are associated with the Black Liquid plume. As with the toluene plume, the general size and shape of the Black Liquid plume do not appear to be changing based on comparison of the RFI data with historical data.

Light nonaqueous phase liquid (LNAPL) has been detected in the area of the toluene plume. Laboratory analyses of LNAPL samples collected from the Facility indicate that it is composed predominantly of Peneteck oil (white mineral oil) and toluene. The findings of the RFI and Interim Measure activities suggest that there is not a large volume of LNAPL beneath the site. LNAPL has been observed only in a relatively small area of the site and appears to be present in the soil pore space below residual saturation levels. When a measurable amount of LNAPL is present in a well, its thickness varies with time in response to groundwater levels that fluctuate with the tide in the Duwamish Waterway. The monitoring data also show that LNAPL may be present in a monitoring well intermittently; that is, it may "disappear" only to reappear weeks or months later. The cause of the intermittent presence of LNAPL in monitoring wells appears to be related to seasonal fluctuations in the groundwater level.

The RFI findings indicate that while there is toluene contamination of the Upper Aquifer groundwater, it does not appear that toluene-contaminated groundwater has entered the Duwamish Waterway or Slip No. 6. However, because there is the potential for groundwater to impact surface water quality, the action levels used in evaluating the RFI groundwater data (and thereby determining the need for a Risk Assessment/MCS evaluation) include both groundwater and surface water quality standards.

Facility Investigation

The RFI soil investigation consisted of surface and subsurface soil sampling in 10 soil investigation areas and a background area at the Facility. The soil samples were analyzed for a number of chemical constituents, including the preliminary constituents of concern identified in the RFI Workplan. The analytical results were compared to the Washington State Model Toxics Control Act (MTCA) Method C cleanup levels, the soil action levels for the RFI.

The RFI groundwater investigation consisted of the following activities:

- Groundwater samples were collected from the 30 pre-RFI monitoring wells during Round 1. These samples were analyzed for a wide range of parameters including inorganic compounds, volatile and semivolatile organic compounds, total organic carbon (TOC), formaldehyde, and Appendix IX constituents.

- Forty-three groundwater samples were collected from 29 borings during a HydroPunch survey. These samples were analyzed for volatile organic compounds, total petroleum hydrocarbons (TPH), and TOC.

- Groundwater samples were collected during Round 2 from eight new monitoring wells and 11 of the pre-RFI wells. These samples were analyzed for a selected group of constituents based on the Round 1 analytical results. The Round 2 constituents included toluene, total recoverable petroleum hydrocarbons (TRPH), acetone, methylphenol, bis(2)-chloroethlyether, herbicides, antimony, beryllium, and vanadium.

- Constituents that were detected during these analyses were compared to their respective action levels. The action levels for groundwater were defined as the most stringent of the groundwater and surface water standards listed in Section 1 of the report, since groundwater from the Facility appears to discharge to surface water. Only detected constituents exceeding action levels or those without action levels will be further addressed during the Risk Assessment/MCS evaluation.

The sediment investigation included two rounds of sampling and analysis from the shoreline along the intertidal zone of the Duwamish Waterway. The first round of sampling and analysis was conducted in accordance with the RFI Workplan. The second round was designed to comply with the Puget Sound Estuary Program protocols. Washington State Marine Sediment Management Standards were used as the primary action levels, and the analytical results were compared to these action levels during the RFI.

Other RFI activities included an ecological assessment of the Facility, an air emissions investigation, and fate and transport analyses. The fate and transport analyses were prepared for general evaluation purposes and for discussion with U.S. EPA. The analyses included the use of two modeling techniques to estimate the potential for constituents of concern to reach surface water bodies through groundwater migration and discharge. The fate and transport analyses also evaluated the potential impact of naturally occurring biodegradation.

Major Conclusions

Using the results of the RFI, including the Facility characterization and analytical results, the significant factors that may pose risks to human health and/or the environment were identified. The major conclusions were as follows:

- **Hydrogeologic Conditions.** The hydrogeologic information collected during the RFI is generally consistent with the conclusions reached during previous Facility investigations. The Facility is underlain by two distinct aquifers separated by a low-permeability silt and clay stratum that is laterally continuous beneath the Facility and acts as an aquitard. Groundwater levels in

both the Upper and Lower Aquifers are tidally influenced. The vertical hydraulic gradient between the Upper and Lower Aquifers is in the upward direction at all tide stages. This hydraulic condition and the low-permeability aquitard inhibit the downward migration of constituents from the Upper to the Lower Aquifer.

The net groundwater flow direction beneath the Facility appears to be from east to west in both the Upper and Lower Aquifers. However, a groundwater extraction program being conducted at the Kenworth site, immediately north of the Facility, appears to be affecting flow conditions at the Facility. RFI data indicate that the net groundwater flow direction in the Upper Aquifer, beneath the western portion of the Facility, is northward toward the Kenworth site when the extraction system is operating.

- **Soil.** With the exception of single detections of arsenic and mercury, action levels were not exceeded for soil; therefore, soil is not recommended for inclusion in the Risk Assessment/MCS evaluation as the result of action level exceedences. Arsenic and mercury are not considered to be constituents of concern because each constituent was detected only once above its action level; arsenic is known to be present regionally in soil; and during Round 2, a comprehensive investigation of potential mercury contamination demonstrated that the single detection above its action level was an isolated occurrence that could not be confirmed. Several constituents detected in soil did not have action levels; these include cobalt, 2-methylnaphthalene, benzo-(g,h,i)perylene, isopropyl alcohol (2-propanol), and phenanthrene. These compounds will be addressed in the Risk Assessment/MCS evaluation. Other soil contaminants will be addressed in the CMS only to the extent that the soils may leach and compromise the effectiveness and permanence of groundwater remediation.

- **Groundwater Quality.** The results of the groundwater investigation indicate that toluene is the primary constituent of concern in groundwater. Although the groundwater action level for toluene has been exceeded, monitoring well data indicate that toluene has not migrated to the Duwamish Waterway or to any other offsite areas. Other organic compounds were detected above action levels in samples from the area of the toluene plume, but these constituents are considered of secondary concern because they are less widespread than the toluene and they do not exceed their action levels to the same degree as toluene. Total antimony and cadmium were found only in samples from Background Area wells at concentrations exceeding action levels. Silver was detected in only one Facility monitoring well at a concentration above the action level. Other metals exceeded the action levels in samples from the Background Area wells and the Facility monitoring wells; these included arsenic, copper, lead, nickel, vanadium, zinc, chromium, beryllium, and mercury. Copper was used onsite in the vanillin

manufacturing process. Chromium appears to be associated with the Black Liquid plume; it was detected above action levels in nine samples, but groundwater chemistry data indicate that chromium is present in the trivalent form and not the more toxic hexavalent form. LNAPL is currently not present in significant volumes beneath the Facility. Pre-RFI chemical characterization of the LNAPL indicates that it is composed primarily of mineral oil and toluene.

- **Fate and Transport Analyses.** Fate and transport analyses were conducted for several constituents of concern to evaluate the potential for discharge of contaminants in groundwater to the Duwamish Waterway. (These analyses were prepared for general evaluation purposes and for discussion with U.S. EPA.) The results of the analyses indicate that constituents of concern would not discharge to the Waterway at concentrations exceeding applicable surface water quality criteria. This is consistent with the fact that the toluene plume is not encroaching on the shoreline, and toluene is not discharging to the Duwamish Waterway. Further, a comparison of data collected over time (from 1986 to 1994 by Dames & Moore, Landau Associates, and Rhône-Poulenc) indicates that the general size and shape of the toluene plume are not changing at this time.

- **Sediments.** The sediment sampling results indicate that constituents were not detected above action levels or surrounding industrial sediment levels in the Duwamish Waterway intertidal sediments along the western boundary of the Facility. Therefore, sediments are not a medium of concern, do not appear to pose risks to human health or the environment, and do not warrant a CMS. However, the Washington State Department of Ecology has expressed concern that historical point source discharges such as outfalls or seeps may have contaminated sediments in the Waterway and Slip No. 6. In May 1995, Rhône-Poulenc sampled the sediments in the Facility sewers that historically discharged to the Duwamish Waterway or to Slip No. 6; most of these sewers are currently abandoned. Rhône-Poulenc also recently sampled seven seeps in this area. These additional sampling events will be documented, along with the results, in Technical Memoranda to U.S. EPA and the Department of Ecology that will be submitted as addenda to this RFI Report. If contaminants are detected in the sewer sediments, additional sampling of the Waterway sediments may be needed.

- **Air.** The air emissions sampling results show that constituents were detected at very low levels compared to applicable regulatory thresholds and ambient conditions. Therefore, air is not a media of concern, does not appear to pose risks to human health or the environment, and does not warrant a CMS.

Recommendations for Future Actions

The following recommendations for future actions are made:

- A Risk Assessment/MCS evaluation is warranted to address certain groundwater constituents whose detected concentrations exceeded action levels. The following groundwater constituents will be addressed in the evaluation: arsenic, copper, lead, nickel, vanadium, zinc, chromium, beryllium, mercury, and silver (metals), benzo(a)pyrene, chrysene, bis(2chloroethyl)ether, pentachlorophenol, 2-methylphenol, 4-methylphenol, and bis(2-ethylhexyl)-phthalate (semivolatile organic compounds); toluene, benzene, methylene chloride, 1,1-dichloroethane, acetone, formaldehyde (volatile organic compounds); and endosulfan I, endosulfan sulfate, and 4,4'-DDD (pesticides). Silver was detected in only one Facility monitoring well at a concentration above the action level. Other organic compounds were detected above action levels in samples from the area of the toluene plume, but these constituents are considered of secondary concern because they are less widespread than the toluene and they do not exceed their action levels to the same degree as toluene. Groundwater constituents without action levels that will be addressed in the Risk Assessment/MCS evaluation are cobalt, dibenzofuran, and 2-methylnaphthalene.

- The Risk Assessment/MCS evaluation will also address detected soil constituents without action levels. These constituents include cobalt, 2-methylnaphthalene, benzo(g,h,i)perylene, isopropyl alcohol (2-propanol), and phenanthrene.

- The need for a CMS will be based on the results of the Risk Assessment/MCS evaluation. The CMS will evaluate corrective measures that could be applicable to contaminants that exceed Media Cleanup Standards developed in the Risk Assessment/MCS evaluation. At this time, it appears that a CMS may be warranted for the toluene groundwater plume. Any CMS evaluations addressing groundwater remediation may also consider the need to remediate Unsaturated Zone soils to better ensure the effectiveness and permanence of any groundwater remediation.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
AOC	Area of Concern
ARI	Analytical Resources Incorporated
ASIL	Acceptable Source Impact Level
ASTM	American Society for Testing Materials
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
$CaCO_3$	calcium carbonate
CFR	Code of Federal Regulations
CGI	combustible gas indicator
CLP	Contract Laboratory Program
cm/sec	centimeters per second
CMS	Corrective Measures Study
CSO	combined sewer overflow
DO	dissolved oxygen
ft/day	feet per day
ft/ft	feet vertical/feet horizontal
gpm	gallons per minute
LNAPL	light nonaqueous phase liquid
MCL	Maximum Contaminant Level
MCS	Media Cleanup Standard
MCUL	Minimum Cleanup Level
MDL	method detection limit
meq/100g	milli-equivalents per 100 grams
μg/kg	micrograms per kilogram
μg/l	micrograms per liter
mg/kg	milligrams per kilogram
ml	milliliters
ml/g	milliliters per gram
MTCA	Model Toxics Control Act
NGVD	National Geodetic Vertical Datum
OVM	organic vapor monitor
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PID	photoionization detector
ppbv	parts per billion by volume
ppm	parts per million
ppmv	parts per million by volume
PQL	practical quantitation limit
PSEP	Puget Sound Estuary Program
PVC	polyvinyl chloride
QA	quality assurance

QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RPD	relative percent deviation
RPI	Rhône-Poulenc Inc.
SDG	sample delivery group
SQS	Sediment Quality Standards
SWMU	Solid Waste Management Unit
SVOC	semivolatile organic compound
TAL	Target Analyte List
TDS	total dissolved solids
TLV	Threshold Limit Value
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TRPH	total recoverable petroleum hydrocarbons
USCS	Unified Soil Classification System
U.S. EPA	U.S. Environmental Protection Agency
VBL	vanillin black liquor
VOA	volatile organics analysis
VOC	volatile organic compound
WAC	Washington Administrative Code

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Section 1
Introduction

1.1 Statement of Purpose

On May 6, 1993, Rhône-Poulenc Inc. (RPI) and the U.S. Environmental Protection Agency Region 10 (U.S. EPA) entered into an Administrative Order on Consent (the Consent Order). The Consent Order, No. 1091-11-20-3008(h), specifies the Resource Conservation and Recovery Act (RCRA) corrective action requirements for RPI's Marginal Way Facility in Tukwila, Washington (the Facility), which include a RCRA Facility Investigation (RFI). This document, the RFI Report, is being submitted pursuant to Section VI.B of the Consent Order.

The general objectives of the RFI are to:

- Characterize the environmental setting at the Facility.
- Assess the nature and extent of contamination originating from releases of hazardous wastes and/or constituents from the Facility.
- Determine whether further actions are warranted and, in particular, whether a Risk Assessment/Media Cleanup Standards (MCS) evaluation is warranted, based on a comparison of concentrations of detected constituents to action levels. The need for a Corrective Measures Study (CMS) will be determined during the Risk Assessment/MCS evaluation.

The overall objectives of this RFI Report are to:

- Summarize the methods and procedures used to conduct the RFI.
- Present the findings and analytical results of the RFI, including the quality assurance and quality control (QA/QC) information supporting the data collected and analyzed.
- Present the conclusions of the RFI, including an assessment of the need for a Risk Assessment/MCS evaluation.

Potential human health and environmental risks posed by hazardous wastes and/or constituents at the Facility will be addressed in the forthcoming Human Health and Ecological Risk Assessment Report and Proposed MCS evaluation, which will be submitted 30 days after this RFI Report pursuant to Section VI.C of the Consent Order. The MCSs will be used during the CMS to evaluate potential remedial actions.

1.2 RCRA Action Levels

Attachment A to the Consent Order requires that the RFI Workplan process ". . . determine and develop action levels for constituents of concern in soil, groundwater, air, surface water, and sediments." This was done in discussions with U.S. EPA personnel during development of the RFI Workplan (approved by U.S. EPA on January 24, 1994), with the following action levels being identified for this RFI:

- For soil, Washington State Model Toxics Control Act (MTCA) Method C cleanup levels (WAC 173-340).

- For groundwater, the most stringent of the following groundwater and surface water standards (since groundwater from the Facility appears to discharge to surface water):

  Groundwater Standards

  - Federal Maximum Contaminant Levels (MCLs) for Drinking Water (40 CFR Part 141)

  - State Model Toxics Control Act (MTCA) Method B Cleanup Levels for Groundwater (WAC 173-340)

  - State Model Toxics Control Act (MTCA) Method C Cleanup Levels for Groundwater (WAC 173-340)

  - State Groundwater Quality Standards (WAC 173-200)

  Surface Water Standards

  - Federal Aquatic Health Criteria - Freshwater Acute Criterion Maximum Concentrations (40 CFR 131.36[b][1])

  - Federal Aquatic Health Criteria - Freshwater Chronic Criterion Continuous Concentrations (40 CFR 131.36[b][1])

  - State Aquatic Health Criteria - Freshwater Acute Criterion Maximum Concentrations (WAC 173-201A-040[3])

  - State Aquatic Health Criteria - Freshwater Chronic Criterion Continuous Concentrations (WAC 173-201A-040[3])

  - Federal Aquatic Health Criteria - Marine Water Acute Criterion Maximum Concentrations (40 CFR 131.36[b][1])

- Federal Aquatic Health Criteria - Marine Water Chronic Criterion Continuous Concentrations (40 CFR 131.36[b][1])

- State Aquatic Health Criteria - Marine Water Acute Criterion Maximum Concentrations (WAC 173-201A-040[3])

- State Aquatic Health Criteria - Marine Water Chronic Criterion Continuous Concentrations (WAC 173-201A-040[3])

- Federal Human Health Criteria for Consumption of Organisms Only (40 CFR 131.36[b][1])

- State Model Toxics Control Act (MTCA) Method C Cleanup Levels for Surface Water (WAC 173-340)

- For sediments, Washington State Marine Sediment Management Standards (WAC 173-204).

- For fate and transport analyses, state Water Quality Standards—Ambient Water Quality Criteria: Fresh Water (Chronic) (WAC 173-201) were used for comparative purposes. Other criteria, such as federal Water Quality Standards (40 CFR Part 131) and state MTCA Method B cleanup levels for surface water (WAC 173-340), were used for comparison purposes for freshwater quality action levels.

- No formal action levels have been set for air emissions. However, the air emissions data are compared to (1) Threshold Limit Values (TLVs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) and (2) Acceptable Source Impact Levels (ASILs) established by the Washington State Department of Ecology.

In accordance with U.S. EPA guidance, these action levels reference promulgated health-based standards.

Action levels are often used in the RCRA corrective action process as "trigger mechanisms" for the need for a Risk Assessment/MCS evaluation; if no constituents are found at or above action levels in a given medium, further evaluation may not be required for that medium. In this report, constituents detected during the RFI are compared to the action levels cited above. In cases when one or more of these action levels are exceeded, RPI recommends that a Risk Assessment/MCS evaluation and possibly a CMS be conducted to further evaluate appropriate remedial actions for those constituents and media, consistent with current U.S. EPA guidance as presented in the final RCRA Corrective Action Plan (Directive 9902.3-2A, May 31, 1994).

1.3 Organization of This RFI Report

This RFI Report is organized into three documents, as follows:

- Volume I describes the overall technical approach to the RFI, the methods and procedures used for the RFI fieldwork, the RFI field and laboratory QA/QC procedures, the RFI findings and analytical results, the conclusions drawn from these findings and results, and recommendations for future actions.

- Volume II contains figures and tables illustrating and supplementing the information and data presented in Volume I.

- Volume III consists of appendices that provide additional information.

Following Section 1, the contents of Volume I are as follows:

- **Section 2, Summary of RFI Fieldwork.** Section 2 summarizes the overall technical approach to the RFI and the methods and procedures used to conduct the RFI fieldwork.

- **Section 3, Field and Laboratory Quality Assurance/Quality Control.** Section 3 presents the RFI QA/QC methodology and results.

- **Section 4, RFI Findings and Analytical Results.** Section 4 describes the analytical results and related findings of the RFI.

- **Section 5, Conclusions and Recommendations.** Section 5 presents the major conclusions of the RFI and recommendations for future actions, with emphasis on the significance of the RFI findings and results as they relate to the media and Facility areas that may require corrective measures.

1.4 Additional Sampling, Analysis, and Data Evaluation

A third round of groundwater sampling was conducted at the Facility in March 1995, and seeps and surface water were sampled in April 1995. The results from these sampling events will be documented in the Round 3 Data Technical Memorandum, which will be submitted as an addendum to this RFI Report. Additional sampling was also conducted of sewer sediments in May 1995. The results from this sampling will be documented in a second memorandum, the Sewer Sediment Technical Memorandum.

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Section 2
Summary of RFI Fieldwork

This section summarizes the methods and procedures used to conduct the RFI at RPI's Marginal Way Facility. The methods and procedures, along with the proposed scope of the initial field sampling and analysis, are described in detail in the RCRA Facility Investigation Workplan (RPI, December 1993). For reference purposes, the RFI Field Sampling Plan (Section 5 of the RFI Workplan) is included in this report as Appendix A.

As discussed in the RFI Workplan, an observational approach was used to implement the RFI. This was consistent with the phased approach anticipated in Attachment A of the Consent Order, which states:

> A phased investigative approach is envisioned, with decision points that may eliminate the need or expand the scope for certain planned subsequent investigative or remedial phases.

In keeping with this approach, the field sampling and analysis associated with the RFI were performed in two "rounds" between January and September 1994. Round 1 was conducted in accordance with the RFI Workplan and took place from January to June 1994. Round 2 is described in the Addendum to the RFI Workplan (approved by U.S. EPA on July 1, 1994, and provided in this report as Appendix B), and was conducted in August and September 1994.

During the course of the RFI, some of the methods and procedures presented in the Workplan and the subsequent Addendum were modified. For the most part, the modifications were necessary to address the differences between conditions that were assumed and anticipated in the Workplan and the actual field conditions that were encountered during sampling activities. The modifications to the methods and procedures specified in the RFI Workplan and the Addendum have been documented and are presented in this report as Appendix C.

To evaluate the nature, extent, and related risks of Facility contamination, the RFI focused on investigating environmental media and assessing the potential for constituent transport to and from these media. Round 1 included the following activities:

- Hydrogeologic characterization of the Facility
- Soil sampling and analysis
- Groundwater sampling of all 30 pre-RFI monitoring wells (i.e., those installed during previous Facility investigations) and analysis of the samples collected

- A HydroPunch investigation to determine the extent of toluene in groundwater
- Monitoring of light nonaqueous phase liquid (LNAPL)
- Sediment sampling and analysis
- An ecological site assessment
- Inspections to detect seeps from the Facility into the Duwamish Waterway shoreline

Seep sampling and air emissions sampling were also initially planned for Round 1. For the reasons outlined in Section 2.7, seep sampling was not conducted during the RFI but occurred during April 1995. The results of the seep sampling will be documented in a Technical Memorandum to EPA that will be submitted as an addendum to this RFI Report. Air emissions sampling was postponed to Round 2 to permit sampling during warmer weather.

Round 2 consisted of a second RFI groundwater monitoring effort, additional soil and sediment sampling, air emissions sampling, and analysis of the samples collected. Specific Round 2 activities included:

- Drilling of seven soil borings in two investigation areas, collection of soil samples, and analysis for specific constituents
- Collection of shallow soil samples in one investigation area and analysis of the samples to confirm the presence of mercury detected during Round 1 and to evaluate its possible extent
- Installation of eight new monitoring wells in two investigation areas to enlarge the groundwater monitoring network in the vicinity of the toluene contamination investigated in Round 1
- A second round of groundwater sampling at 11 pre-RFI monitoring wells, and sampling of the eight new wells
- Measurements of LNAPL thickness in monitoring wells (this monitoring is ongoing, and data collected through April 1995 are presented in this report).
- Collection of additional sediment samples in the intertidal zone along the Duwamish Waterway
- Air emissions sampling and analysis

A third round of sampling and analysis occurred during March and April 1995. Round 3 consisted of the following activities:

- Groundwater sampling from 34 wells, specifically for speciating chromium; 14 of these wells were sampled for additional parameters

- Sampling and analysis of seven seeps from the shorelines of the Duwamish Waterway and Slip No. 6 and of surface water in the Waterway up- and downgradient from the Facility

Descriptions of the methodology and results of the Round 3 activities are not included in this RFI Report but will be provided in the Round 3 Data Technical Memorandum that will be submitted as an addendum. Additional sampling was also conducted of sewer sediments in May 1995 to address the Department of Ecology's sediment-related concerns; the results from this sampling will be documented in a second memorandum, the Sewer Sediment Technical Memorandum.

The sections that follow describe the overall technical approach to the RFI, the hydrogeologic characterization of the site, and the fieldwork and analyses conducted for the specific environmental media investigations. These sections are:

- 2.1 – Overall Technical Approach
- 2.2 – Hydrogeologic Characterization
- 2.3 – Soil Investigation
- 2.4 – Groundwater Investigation
- 2.5 – Sediment Investigation
- 2.6 – Ecological Site Assessment
- 2.7 – Seep Assessment
- 2.8 – Air Emissions Investigation

All the RFI analytical data were entered into a project-specific database as the work progressed. A printout of detected constituents from this database is provided as Appendix D of this report.

2.1 Overall Technical Approach

In order to provide the basis for the field investigation sampling and analysis plans, an overall technical approach was developed that took into consideration past Facility operations and specific RFI objectives for each environmental medium. The RFI Workplan describes this approach in detail. To reiterate RPI's overall investigative strategy, a summary of the approach is provided in the following two sections.

2.1.1 Identification of Investigation Areas

The Facility was divided into 12 investigation areas, as shown in Figure 2-1. The primary purpose of identifying separate areas was to ensure an efficient Facility investigation that focused on areas of concern. The area designations group together locations at the Facility where similar operational and manufacturing activities occurred and where similar materials were used or handled. These designations also take into account information on Facility conditions obtained from previous investigations. A description of each investigation area was provided in the RFI Workplan, including a discussion of the chemicals formerly handled or used in the area and a summary of historical spills or incidents of record.

Specific sampling and analysis strategies were developed for each area, taking past Facility activities and environmental data into account, in order to characterize conditions related to soils, sediments, seeps, and surface water. The hydrogeologic characterization and groundwater investigation were implemented on a Facility-wide basis.

2.1.2 Identification of Preliminary Constituents of Concern

The RFI Workplan identified preliminary chemical constituents of concern for each of the designated investigation areas at the Facility. These constituents were identified based on knowledge of past Facility operations and data collected during previous investigations by Dames & Moore (1986) and Landau Associates (1991). One of the objectives considered during the development of the sampling and analysis strategy was to confirm whether these constituents are, in fact, present in environmental media in concentrations that exceed current action levels. Table 2-1 lists the preliminary constituents of concern by investigation area and environmental medium.

2.2 Hydrogeologic Characterization

The conceptual hydrogeologic model of the Facility was well developed prior to the RFI. Therefore, the RFI hydrogeologic characterization focused on confirming and augmenting existing Facility information. Additional hydrogeologic information was collected during the RFI through the soil and HydroPunch investigations and during monitoring well installation.

As described in the RFI Workplan, the objectives of the RFI hydrogeologic characterization were to:

- Evaluate the thickness, areal extent, and permeability of the "perching layer" within the upper 10 to 15 feet of the subsurface. This was accomplished by logging the subsurface conditions at 73 borings drilled during the RFI.

- Confirm the lateral continuity and vertical permeability of the Aquitard separating the Upper and Lower Aquifers. This was accomplished by drilling six borings into the Aquitard.

- Evaluate the groundwater flow directions and gradients in the Upper and Lower Aquifers as influenced by the tidal fluctuations in the Duwamish Waterway. This was accomplished by monitoring groundwater elevations over multiple tidal cycles.

- Establish Facility-specific estimates for hydraulic conductivity. This was accomplished by conducting single-well hydraulic conductivity tests (slug tests).

- Measure selected physical properties of the geologic materials. This was accomplished by collecting soil samples and testing them for key physical characteristics, including grain size distribution, moisture content, specific gravity, porosity, hydraulic conductivity, bulk density, organic carbon content, and cation exchange capacity.

2.2.1 Soil and HydroPunch Borings and Monitoring Well Installation

Seventy-three borings were drilled during the RFI to evaluate and define the Facility's hydrostratigraphy, collect soil and groundwater samples, and install monitoring wells. All borings were drilled with a hollow-stem auger drilling rig. During Round 1, 29 borings were drilled during the HydroPunch investigation and 29 additional borings were drilled for soil sampling and hydrogeologic characterization purposes. Fifteen borings were drilled during Round 2, seven for soil sampling and eight for monitoring well installation. The borings ranged in depth from approximately 9 to 80 feet. The borehole diameters were 8 inches for the HydroPunch investigation and 10 inches for the monitoring wells. The locations of all the RFI borings are shown in Figure 2-2; the soil and HydroPunch boring logs are included in Appendix E, and the monitoring well geologic and construction logs are in Appendix F along with those for the pre-RFI monitoring wells.

During drilling, soil samples were collected for laboratory testing (chemical and physical analyses) and geologic logging purposes. The samples were collected using a 2-inch-outside-diameter (18 inches long) or a 3-inch-outside-diameter (18 inches long, extendable to 24 inches) split-spoon sampler driven by a 140-pound drop hammer. Samples were collected continuously in the Unsaturated Zone (from 0 to approximately 12 feet below ground surface [bgs]) and at 2.5-foot intervals below the groundwater table.

During Round 1, groundwater sampling was conducted in the 30 pre-RFI monitoring wells (shown in Figure 2-3). During Round 2, eight new wells were installed to confirm and monitor the horizontal and vertical distribution of the toluene plume and to provide additional locations for monitoring and detecting LNAPL. (Figure 2-4 shows the locations of these wells and the pre-RFI monitoring wells.) The placement of the new wells was based

on the configuration of the toluene plume as identified by the results of the Round 1 HydroPunch investigation and groundwater samples collected from the pre-RFI monitoring wells in the immediate area (these results are presented in Section 4). Of the eight new wells, six (wells MW-14, -15, -17, -18, -19, and -20) were screened in the upper portion of the Upper Aquifer, across the groundwater table, and two (wells MW-13 and MW-16) were screened in the lower portion of the Upper Aquifer. The Round 2 monitoring wells were constructed of 4-inch-inside-diameter polyvinyl chloride (PVC) screen and casing. (All the pre-RFI wells are also constructed of 2-inch-inside-diameter PVC screen and casing except well MW-12, which is constructed of 4-inch-inside-diameter stainless-steel screen and casing.) A summary of the construction details for each of the eight wells and the 30 pre-RFI monitoring wells is provided in Table 2-2, and the well construction logs for all 38 wells are included in Appendix F.

All the soil and HydroPunch borings and Round 2 monitoring wells were surveyed for location and elevation during the RFI. The locations of all the borings and wells were surveyed to the nearest 0.1 foot. The elevations at ground surface of all the borings were surveyed to the nearest 0.1 foot; the elevations of the monitoring wells were surveyed to the nearest 0.01 foot (the well reference point is a notch inscribed at the top of the PVC well casing). The RFI survey data are provided as Appendix G of this report. The 30 pre-RFI monitoring wells were surveyed by CH2M HILL in 1993; the survey information for these older wells is also provided in Appendix G.

The horizontal data are based on an assumed coordinate system established specifically for the Facility. This assumed coordinate system can be tied to the State Plane Coordinate System in the future, if required. Vertical control is referenced to the National Geodetic Vertical Datum (NGVD) of 1929.

2.2.2 Monitoring of Groundwater Elevations and Tidal Fluctuations

Groundwater levels were measured in three ways during the RFI:

- A depth-to-groundwater measurement was made at each well when it was sampled, prior to well purging.
- Groundwater levels were measured manually at all 30 pre-RFI monitoring wells on five different occasions.
- From January 19 through February 15, 1994, groundwater levels in a network of 10 wells were continuously monitored and recorded at 15-minute intervals in order to assess tidally induced changes in groundwater flow directions and gradients. In addition, a stilling well installed in the Duwamish Waterway monitored tidal fluctuations.

With the exception of the 10-well network, all depth-to-groundwater measurements were collected manually using electronic water-level indicators.

Manual Groundwater-Level Monitoring

Groundwater levels were measured manually at all 30 pre-RFI monitoring wells in February and June 1994. Readings were taken using Slope-Indicator electronic water-level indicators with the exception of well MW-12, where an ORS oil/water interface probe was used because of the presence of LNAPL in this well. All measurements were taken from the surveyed reference points at the top of the PVC well casings.

Groundwater levels were measured in the 30 pre-RFI monitoring wells four times on February 4, 1994, to coincide with the following tide stages estimated from tide charts for Seattle (Elliott Bay):

- Mid-tide rising at 7:26 a.m. (the measurement window was 6:56 a.m. to 7:56 a.m.)
- High tide at 10:24 a.m. (the measurement window was 9:54 a.m. to 10:54 a.m.)
- Mid-tide falling at 2:09 p.m. (the measurement window was 1:39 p.m. to 2:39 p.m.)
- Low tide at 5:55 p.m. (the measurement window was 5:25 p.m. to 6:25 p.m.)

In May 1994, RPI learned that Kenworth, Inc., the owner/operator of the property immediately north of the Facility, had been conducting groundwater remediation pursuant to a voluntary action under MTCA. This remediation effort had included groundwater extraction from three wells, located approximately 700 feet from RPI's property line, during February when the RFI groundwater levels were being measured. (Section 4.1.2 provides further discussion of the Kenworth groundwater extraction project.) To assess the potential effects of groundwater extraction at the Kenworth site on the measurement of groundwater levels at the RPI Facility, another round of groundwater-level measurements was conducted during high tide on June 23, 1994. This additional round of groundwater-level measurements was planned to correspond with a time when Kenworth was not pumping groundwater. High tide was at 6:52 p.m.; the measurement window was from 6:22 p.m. to 7:22 p.m.

Continuous Groundwater-Level Monitoring

For the continuous groundwater-level monitoring program in January and February 1994, Geokon GC-3 dataloggers were connected to pressure-sensing transducers that were installed in 10 monitoring wells: wells B1A, H10, DM-1A, DM-2A, and DM-3A screened in the Upper Aquifer, and wells B1B, H1, DM-1B, DM-2B, and DM-3B screened in the Lower Aquifer (Figure 2-5). These were the only locations at the Facility where two monitoring wells were installed in the same place but in different aquifers (the Upper and

Lower Aquifers or the upper and lower portions of the Upper Aquifer). Monitoring these well pairs simultaneously allowed assessment of the vertical and horizontal groundwater flow directions and gradients during multiple tide cycles.

The dataloggers were adjusted to collect readings at 15-minute intervals. In addition, groundwater levels in these wells were measured manually twice each week during the monitoring program to verify the accuracy of the data being recorded.

2.2.3 Hydraulic Conductivity Testing

Field hydraulic conductivity tests (slug tests) have been conducted on 11 monitoring wells (Figure 2-6) to provide estimated hydraulic conductivity values for the Upper and Lower Aquifers. Five wells were tested on October 24, 1991, prior to the RFI; these tests were all conducted on Upper Aquifer wells to verify the appropriateness of a hydraulic conductivity assumption used in an Upper Aquifer groundwater extraction analysis completed by Landau Associates in 1991. During Round 1 of the RFI, six other wells were tested on April 22, 1994, to provide hydraulic conductivity data for additional locations in the Upper Aquifer and for wells screened in the Lower Aquifer.

Because the slug tests were conducted at different times and the field methods differed slightly, the two series of tests are described separately in the following two subsections.

1991 Slug-Testing Methods

In 1991, slug tests were performed on wells H10, H11, B2, B6, and DM-7. The groundwater in each well was displaced with a sealed and weighted 8-foot-long, 1-3/8-inch-diameter pipe or "slug." The slug was attached to monofilament line and lowered quickly into each well, and the recovery of the groundwater level (the falling head) was measured using a pressure-sensing transducer connected to an electronic datalogger. Well B2 was an exception; groundwater levels were measured manually using an electronic water-level indicator because the transducer and datalogger were being used at another well.

When the groundwater in the well recovered to the pre-test static level, the slug was rapidly removed and the groundwater level during the rising head portion of the test was measured and recorded by the datalogger (or the water-level indicator at well B2). To the extent possible, groundwater levels in the wells were also measured manually during each test with an electronic water-level indicator to provide backup and confirmatory data. All equipment lowered into a well was field-decontaminated after each use.

1994 Slug-Testing Methods

In 1994, slug tests were performed on three pairs of monitoring wells: DM-1A/DM-1B, DM-2A/DM-2B, and DM-3A/DM-3B. The groundwater in each well was displaced with a solid 7-foot-long, 1.5-inch-diameter acrylic rod. The slug was attached to monofilament line and lowered quickly into each well until fully submerged. Recovery of the

groundwater level (the falling head) was measured using a pressure-sensing transducer connected to an electronic datalogger. When the groundwater level in the well recovered to the pre-test static level, the slug was rapidly removed and the groundwater level in the rising head portion of the test was measured.

Because of space constraints inside the 2-inch-inside-diameter well casing (a larger-diameter slug was used in 1994), it was not possible to manually monitor the groundwater levels with an electronic water-level indicator at the same time that the slug and the datalogging equipment were in the well. As with the 1991 testing, all equipment lowered into a well was field-decontaminated after each use.

2.2.4 Physical Property Testing

Soil samples were collected from the Unsaturated Zone, the Upper Aquifer, and the Aquitard between the Upper and Lower Aquifers and tested for selected physical properties to identify variations in lithology that may affect groundwater flow, to provide data for fate and transport analyses, and to collect information to evaluate alternative corrective measures and support treatability studies in the future, if deemed necessary.

Samples for physical property testing were collected during drilling operations, including the HydroPunch investigation and monitoring well installation. Bulk density and laboratory hydraulic conductivity samples were collected using either a 3-inch-outside-diameter Shelby tube or a split-barrel ring sampler to provide relatively undisturbed samples.

The physical property testing was performed by Hong West & Associates of Lynnwood, Washington. One or more of the following tests were conducted on the 23 samples collected:

- Grain size distribution with hydrometer analysis as necessary (ASTM D422)
- Moisture content (ASTM D2216)
- Bulk density (ASTM D2937)
- Specific gravity (ASTM D854)
- Porosity (calculated from bulk density and specific gravity data)
- Laboratory hydraulic conductivity (ASTM D5084 or U.S. Army Corps of Engineers Laboratory Manual EM 1110-2-1906, Appendix VII, Section 5)
- Cation exchange capacity (Method SW9080)
- Total organic carbon (Method SW9060)

With the exception of the laboratory hydraulic conductivity testing, all the tests were conducted in accordance with the methods outlined in the approved RFI Workplan. Method ASTM D5084 (a flexible wall permeameter method) was used to determine hydraulic conductivity for all samples tested during Round 1. The above-referenced U.S. Army Corps of Engineers method was used for two samples collected during Round 2.

Table 2-3 shows the number of physical property tests performed by investigation area and hydrostratigraphic unit. The test results are summarized in Section 4 and provided in full in Appendix H.

2.3 Soil Investigation

The field methods for the RFI soil investigation were selected to meet the following objectives:

- Achieve an acceptable level of statistical confidence that the constituents of concern and the investigation areas and media at the Facility are accurately identified and characterized. This was accomplished by applying a nonparametric statistical method based on tolerance limits (Conover, 1980). In each investigation area, seven random soil samples were collected. The selected tolerance limits provided a confidence that 85 percent of the time, 75 percent of the sampled area would be at or below the maximum concentration encountered. In combination with the results of the previous Facility investigations, the nature of possible soil contamination can then be more fully evaluated.

- Compare the concentrations of detected constituents to the action levels in order to assess the need for additional actions. This was accomplished by comparing the soil data to state MTCA Method C cleanup levels.

- Identify the areas within each investigation area where constituent concentrations exceed their respective action levels. This was accomplished by estimating the size and geometry of soil "hot spots" using all available RFI data, including additional data collected during Round 2.

- Evaluate the potential for cross-media contamination from affected soil based on the results of the groundwater, sediment, and air emissions investigations. This was accomplished by assessing the type, magnitude, and vertical distribution of soil contamination relative to its proximity to groundwater and surface water and by conducting air sampling and analysis.

As described in Section 2.1 and in the approved RFI Workplan, the Facility was divided into 11 soil investigation areas for the purpose of assessing possible soil contamination. The investigation areas (Figure 2-1) were delineated according to their association with past

Facility practices and historical analytical data. An independent sampling strategy was developed for each investigation area, as described later in this section.

Some soil sampling points shown in the RFI Workplan were located in areas where onsite obstructions or subsurface conditions precluded sampling. In these cases, alternate sampling points located nearby were chosen. These field modifications to the approved RFI Workplan are documented in the field logbooks and in Appendix C of this report.

Table 2-4 lists the soil investigation areas by name and number, cross-referenced to the Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) identified in the 1990 RCRA Facility Assessment (PRC Environmental Management, 1990). The laboratory analyses performed on samples from each investigation area are listed in Table 2-5. The soil sampling methods and locations are described in the following sections.

2.3.1 Soil Sampling Methods

Two rounds of soil sampling were conducted during the RFI. Round 1 was conducted from January 17 to April 18, 1994, and Round 2 from August 3 to August 25, 1994. Laboratory analysis of the Round 1 soil samples was performed by ETC Laboratories in Redmond, Washington. ETC closed its Redmond laboratory in June 1994 when the firm merged with Pace Environmental and Coast-to-Coast Laboratories; laboratory analysis of Round 2 soil samples was performed by Pace/Mid-Pacific Laboratories in Mountain View, California.

Round 1 sampling followed two general approaches. In investigation areas where only surface contamination was expected (Areas A1, A3, A6, A8, A9, and A10), surface soil samples were collected. In investigation areas where contaminants were suspected or known to be present at depth or where no historical data were available (Areas A2, A4, A5, A7, and BG), a surface sample was collected along with up to two additional subsurface samples. The number of samples obtained from each investigation area and their respective analyses are summarized in Table 2-6.

In Round 2, surface and subsurface soil samples (from the upper 2 feet below ground surface [bgs]) were collected for mercury analysis at 34 locations in Area A6. Round 2 also included drilling seven soil borings (up to 13 feet bgs) in Areas A4 and A5. Fifteen soil samples were obtained from the seven borings and were analyzed for toluene and total recoverable petroleum hydrocarbons (TRPH). The TRPH method (EPA Method 418.1) is an infrared spectroscopy technique for quantifying petroleum hydrocarbons and is similar to the WTPH method (EPA Method 418.1M, modified as required by the Washington State Department of Ecology) used during Round 1 for quantifying TPH (Table 2-6).

In paved areas, the asphalt or concrete pavement was cut and removed and any underlying base-course material (commonly crushed rock) also removed. In unpaved areas, surficial grass, duff, or debris was removed to expose underlying soils. It should be noted that surface soil samples were collected from the first available soil encountered after removal

of the asphalt or concrete pavement, debris, or grass from each location. Once the overburden was removed, the first 6 inches of soil were collected and analyzed as a surface soil sample. As a result, the surface soil depths shown in the RFI database (Appendix D) range up to 2 feet bgs, depending on the thickness of the overburden that was removed.

Surface soil samples were collected using a field-decontaminated stainless-steel spoon or scoop. Samples from greater depths were collected using standard hollow-stem auger drilling equipment and by driving field-decontaminated 3-inch-outside-diameter split-barrel samplers with a drop hammer.

In some cases, surface and subsurface conditions precluded collection of all the samples intended from a particular depth within a boring. Instances of no sample recovery are documented in the soil boring logs (Appendix E).

Split-barrel samples were collected continuously in the Unsaturated Zone. All the surface samples were sent to the laboratory for analysis; selection of the remaining (subsurface) samples for laboratory analysis depended on the headspace result for the surface sample at each boring. A portion of each sample was retained in a closed, resealable plastic bag, and a headspace analysis was conducted using a photoionization detector (PID) in order to identify those samples likely to be most contaminated (the RFI Workplan called for the samples with the two highest PID readings to be analyzed). If the surface sample (i.e., from 0 to 0.5 foot bgs) had one of the highest PID readings, a second, subsurface sample was identified for analysis in addition to the surface sample. If the two highest PID readings came from the subsurface samples, these samples were sent for laboratory analysis along with the surface sample (i.e., a total of three samples were sent to the laboratory).

The portions of the samples used for headspace analysis, along with jarred samples not selected for laboratory analysis, were placed in drums with the drill cuttings following field screening in accordance with the RFI Workplan. The contents of the drums were subsequently sampled and analyzed; the disposition of these materials is currently being evaluated.

2.3.2 Soil Sampling Locations in Areas A1, A3, A6, A8, A9, and A10

Round 1

During Round 1, a minimum of seven surface soil samples were collected in each of the investigation areas A1, A3, A6, A8, A9, and A10. The sampling locations were established based on a random grid as specified in the RFI Workplan. The locations of the six areas are shown in Figure 2-1, and the sampling locations within each area are shown in Figures 2-7 through 2-12.

In Area A3, two additional shallow samples were collected near the former location of a compressor shed in order to evaluate whether polychlorinated biphenyls (PCBs) were present in soil because of possible oil leaks from the compressor.

Area A10 includes the process water and wastewater spill control sumps, API separators, and containment reservoir, which are located in different areas of the Facility. Instead of using a sampling grid, four random soil samples were collected from the outside perimeter of these five structures, for a total of 20 samples. Perimeter sample locations were determined by selecting a random starting point for the first sample location and then locating the remaining samples by dividing the perimeter distance by the number of samples to be collected (four).

Round 2

During Round 2, 38 additional samples were collected for mercury analysis at 34 locations in Area A6 (see Figure 2-13). The additional mercury samples were collected in the immediate vicinity of Round 1 sampling locations A06-01 and A06-03 in order to confirm the presence and, if confirmed, to evaluate the extent of mercury reported at these locations during Round 1 sampling. The samples were collected from two depth intervals (0 to 0.5 foot and 1.5 to 2 feet bgs) at a grid interval of approximately 20 feet. However, four samples were located within 5 feet of sampling location A06-03, which yielded the sample with the highest Round 1 mercury concentration. With the exception of four samples collected adjacent to sampling location A06-03, the subsurface samples were not analyzed by the laboratory because the results for all of the Round 2 surface samples did not indicate a mercury concentration above the MTCA Method C cleanup level (96 milligrams per kilogram [mg/kg]).

2.3.3 Soil Sampling Locations in Areas A2, A4, A5, A7, and BG

Round 1

Round 1 soil samples were obtained from the Unsaturated Zone (up to depths of approximately 9 to 12 feet) in Areas A2, A4, A7, and BG (the Background Area). The locations of these four areas are shown in Figure 2-1, and the sampling locations within each area are shown in Figures 2-14 through 2-17.

During Round 1, surface soil samples (from 0 to 0.5 foot bgs) were collected from seven locations in Area A5 (Figure 2-18). Deeper soil samples were collected from a total of seven borings drilled in Areas A4 and A5 during Round 2, as described below.

Round 2

Subsurface conditions encountered in Areas A4 and A5 during the Round 1 HydroPunch investigation indicated the possible presence of toluene in the Unsaturated Zone soil. Therefore, additional soil samples were collected during Round 2 from multiple depths within the Unsaturated Zone in Areas A4 and A5 (see borings A04-30 and A04-31 in Figure 2-15 and borings A05-10 through A05-14 in Figure 2-18).

2.4 Groundwater Investigation

The field methods for the RFI groundwater investigation were selected to meet the following objectives:

- Evaluate the general presence and distribution of constituents in groundwater across the Facility using the available monitoring well network, and confirm and augment the groundwater data collected by Dames & Moore (1986) and Landau Associates (1991). To accomplish these objectives, two rounds of groundwater sampling and analysis were conducted at wells at the Facility.

- Compare the findings for detected constituents to the action levels in order to assess the need for additional actions. This was accomplished by comparing the groundwater data to the most stringent of the following groundwater and surface water standards:

  Groundwater Standards

  - Federal Maximum Contaminant Levels (MCLs) for Drinking Water (40 CFR Part 141)

  - State Model Toxics Control Act (MTCA) Method B Cleanup Levels for Groundwater (WAC 173-340)

  - State Model Toxics Control Act (MTCA) Method C Cleanup Levels for Groundwater (WAC 173-340)

  - State Groundwater Quality Standards (WAC 173-200)

  Surface Water Standards

  - Federal Aquatic Health Criteria - Freshwater Acute Criterion Maximum Concentrations (40 CFR 131.36[b][1])

  - Federal Aquatic Health Criteria - Freshwater Chronic Criterion Continuous Concentrations (40 CFR 131.36[b][1])

  - State Aquatic Health Criteria - Freshwater Acute Criterion Maximum Concentrations (WAC 173-201A-040[3])

  - State Aquatic Health Criteria - Freshwater Chronic Criterion Continuous Concentrations (WAC 173-201A-040[3])

  - Federal Aquatic Health Criteria - Marine Water Acute Criterion Maximum Concentrations (40 CFR 131.36[b][1])

- Federal Aquatic Health Criteria - Marine Water Chronic Criterion Continuous Concentrations (40 CFR 131.36[b][1])

- State Aquatic Health Criteria - Marine Water Acute Criterion Maximum Concentrations (WAC 173-201A-040[3])

- State Aquatic Health Criteria - Marine Water Chronic Criterion Continuous Concentrations (WAC 173-201A-040[3])

- Federal Human Health Criteria for Consumption of Organisms Only (40 CFR 131.36[b][1])

- State Model Toxics Control Act (MTCA) Method C Cleanup Levels for Surface Water (WAC 173-340)

Only detected constituents exceeding action levels will be addressed further in the Risk Assessment/Media Cleanup Standards (MCS) evaluation. Constituents that were not detected at action levels below the detection limit will not be carried forward to the Risk Assessment/MCS evaluation.

- Investigate the presence and extent of toluene. This was accomplished with a HydroPunch investigation conducted in Areas A1, A4, A5, and A6, at or near the locations where toluene was encountered in groundwater during previous investigations.

- Assess the distribution and identify the physical characteristics of the LNAPL. This was accomplished by monitoring for LNAPL at HydroPunch borings and Facility monitoring wells. In general, the detected volumes of LNAPL were so limited that collection of samples of sufficient quantity for physical property analyses was not possible. However, LNAPL physical property data are available from a sample collected in May 1993 from Landau Associates' monitoring well G5 (replaced in July 1993 by CH2M HILL's well MW-12).

- Investigate the presence of "Black Liquid" and evaluate whether toxic or regulated substances (e.g., chromium) are co-distributed with it. To accomplish these objectives, the extent of the liquid was identified during groundwater sampling, and wells containing the liquid were specifically evaluated for the potential co-distribution of toxic and regulated substances.

2.4.1 HydroPunch Investigation

As part of the groundwater investigation, a HydroPunch investigation was conducted in Areas A1, A4, A5, and A6 during Round 1 of the RFI, between February 25 and April 14, 1994. The objectives were to assess the horizontal and vertical extent of LNAPL above the

groundwater capillary fringe and evaluate the horizontal and vertical distribution of dissolved toluene. The HydroPunch investigation also facilitated the characterization of the Facility's hydrostratigraphy and the collection of soil samples for laboratory analysis (see Sections 2.1 and 2.2).

The Round 1 HydroPunch sampling locations are shown in Figure 2-19. The HydroPunch can be used in two different sampling modes depending on the intended sample media—LNAPL detection mode or groundwater mode. Both sampling modes were employed during the RFI, and they are described in the following two subsections.

LNAPL Detection Mode

In this mode, a borehole or pilot hole is drilled with a conventional hollow-stem auger drill rig to approximately 4 feet above the target sampling depth interval. The HydroPunch is then inserted into the borehole and driven to the sampling depth, exposing a screened sample chamber. The sample is collected from a bailer inserted into the chamber.

Soil was sampled continuously throughout the Unsaturated Zone at all HydroPunch boreholes, which facilitated visual identification of LNAPL. Because the HydroPunch can be used to detect floating product at the capillary fringe, it was always used in the LNAPL mode at the groundwater table. The depth selected for the first HydroPunch sample was estimated based on fluid-level measurements in the nearest monitoring well or recently completed boring. The depth interval was chosen so that the 4-foot-long HydroPunch screen spanned the groundwater capillary fringe when exposed. Prior to each use, the HydroPunch, the PVC screen, and the drive point were field-decontaminated by scrubbing them with Liquinox and water. Then they were steam-cleaned and rinsed with ASTM Type II water.

Upon reaching the top of the target depth interval, the HydroPunch was driven 4 feet ahead of the lead auger, and the outer sleeve of the HydroPunch was drawn back 3.5 feet to expose the screen to the formation. Typically, drilling was halted for 30 minutes to allow sufficient time for fluid recovery in the screened interval. A sample was then withdrawn from the HydroPunch using a laboratory-decontaminated, clear acrylic bailer lowered through the drilling rods from the ground surface.

If LNAPL was present in the bailer when it was recovered from the borehole, its thickness atop the water was measured and recorded. If no LNAPL was present, a sample of the recovered groundwater was collected for analysis. Prior to collection, an aliquot of the groundwater was tested for pH, conductivity, and temperature; a PID headspace measurement was also made of this sample. The remainder of the sample was then used to fill sample containers provided by the analytical laboratory. The containers were labeled and packed in chilled coolers in accordance with the approved RFI Workplan. The analytical methods for the HydroPunch groundwater samples are shown in Table 2-7.

In cases where LNAPL was present in the initial bailer sample, a groundwater sample was not collected. Instead, the borehole was advanced several more feet below the groundwater table so that a groundwater sample free from contact with LNAPL could be collected for analysis. This sample was collected using the HydroPunch in groundwater mode, described below.

Groundwater Mode

In the groundwater mode, the HydroPunch is operated in much the same manner as the LNAPL mode and is used to collect groundwater samples from discrete depths. The HydroPunch is equipped with a 1,250-milliliter stainless-steel collection chamber with Viton check valves at each end (to minimize loss of sample), O-rings, a stainless-steel inlet screen, and a drive point. For the RFI, the inlet screens were decontaminated in the laboratory. All the other parts were decontaminated in the field using the following steps: scrubbing with Liquinox and tap water; rinsing with tap water, methanol, and ASTM Type II water; and air-drying. The body of the HydroPunch was decontaminated by steam-cleaning and rinsing with ASTM Type II water.

Before the HydroPunch was lowered down the hollow-stem auger, all drill-rod joints were sealed with Teflon tape, and the bottom 3 feet of the HydroPunch were covered with a plastic bag and secured with a stainless-steel clamp to avoid the cross-contamination that might occur if the tool were to come in contact with LNAPL inside the auger. The HydroPunch was driven to a point approximately 3 feet ahead of the auger and then pulled back approximately 1 foot to expose the inlet screen. Drilling was typically suspended for approximately 1 hour to allow time for the sample chamber to fill. When possible, the HydroPunch was left in place for longer periods (e.g., overnight). It was then withdrawn, the collection chamber was removed, and the groundwater sample was transferred into laboratory containers in accordance with the approved RFI Workplan.

The laboratory analyses performed on the collected samples included benzene, toluene, ethylbenzene, and xylene (BTEX) in rapid 24- to 48-hour turnaround time and total petroleum hydrocarbons (TPH) and total organic carbon (TOC) in standard turnaround time. Because of the limited capacity available within the chamber of the HydroPunch (1,250 ml), it was not possible to collect samples of sufficient quantity for field parameter analyses (pH, conductivity, and temperature).

The HydroPunch investigation proceeded with the drilling of a series of borings on approximately 50-foot centers in a north-south/east-west-oriented grid. This work began in Area A4, where LNAPL was known to be present and toluene concentrations in groundwater were high. The initial grid consisted of 13 locations within Area A4, as specified in the approved RFI Workplan. As the investigation progressed, HydroPunch locations were added in Areas A1, A5, and A6 for a total of 29 borings (see Figure 2-19). The additional locations were selected based on the presence or absence of LNAPL in nearby monitoring wells and in previously drilled HydroPunch borings; the laboratory toluene results for

samples collected from HydroPunch borings drilled on previous days; and Round 1 groundwater quality data from nearby monitoring wells.

2.4.2 Monitoring Well Sampling and Analysis

Two rounds of groundwater sampling were conducted during the RFI. In Round 1, sampling was conducted at all 30 pre-RFI monitoring wells (Figure 2-3). In Round 2, sampling was conducted at 19 wells (Figure 2-20), eight of which were installed during the Round 2 fieldwork.

Laboratory analysis of the Round 1 groundwater samples was performed by ETC Laboratories in Redmond, Washington. As noted in Section 2.3.1, ETC closed its Redmond laboratory in June 1994; laboratory analysis of Round 2 groundwater samples was performed by Pace/Mid-Pacific Laboratories in Mountain View, California.

Round 1

Round 1 groundwater sampling was performed between January 17 and February 28, 1994. The 30 pre-RFI monitoring wells were sampled for one or more of the following constituent groups: the Appendix IX hazardous substances list, semivolatiles, volatiles, metals, formaldehyde, vanillin, isopropyl alcohol, general groundwater quality indicators (e.g., common ions and total dissolved solids), and selected biological activity indicators (phosphorus, nitrate, and total Kjeldahl nitrogen). Eight of the Round 1 wells representing different locations and depths were analyzed for the comprehensive Appendix IX analyte list. Selection of the analytes for the remaining wells was based on the well locations and the previously identified constituents of concern. The RFI Workplan documents the rationale for the analytical program for groundwater samples. Table 2-8 lists the monitoring wells sampled in Round 1 and the analyses conducted for each well. The analytical methods for the Round 1 groundwater samples are listed in Table 2-9.

The activities involved in Round 1 groundwater sampling included measuring static groundwater elevations, purging wells, recording field parameters, and collecting samples. A brief summary of each activity follows.

Groundwater Elevation Measurements. Groundwater sampling was initiated at each well by unlocking the security cap and inspecting the well for damage and any needed repairs. The depth to the static groundwater level was then measured to the nearest 0.01 foot using a field-decontaminated electronic water-level indicator. If the well was known to have or suspected of having an LNAPL layer, an oil-water interface probe was used to measure the depth to LNAPL and to groundwater. Where LNAPL was detected, the groundwater elevation was corrected to account for the difference in specific gravity between the groundwater and LNAPL. The correction was made using the following equation:

$$W_c = W_m + [(L)(S_l/S_w)]$$

where:

W_c	=	Groundwater elevation (corrected)
W_m	=	Groundwater elevation (measured at LNAPL/groundwater interface)
L	=	LNAPL thickness
S_l	=	Specific gravity of LNAPL
S_w	=	Specific gravity of groundwater

The well number, depth to groundwater, time and date of measurement, total depth of the well, and length of the water column were recorded in the field logbooks.

Well Purging. Monitoring wells were purged prior to sampling by removing a minimum of three casing volumes of water using a laboratory-decontaminated stainless-steel bailer. Three wells, DM-7, H1, and B4, were purged using a Waterra sampling pump (a hand-operated, inertial, positive-displacement pump) because the PVC casing in these wells was misaligned and a bailer would not pass freely to the water in the well. The Waterra pumps were manufacturer-decontaminated and were employed as single-use, disposable purging and sampling pumps for these three wells.

Field Parameter Measurements. Temperature, pH, specific conductance, and the appearance of the purge water were recorded in the field notebook after each casing volume of water was purged. If the field parameter measurements made after the second and third casing volumes were within 10 percent of each other, the well was considered purged and ready for sampling. If not, purging was continued until two consecutive casing volume field parameter measurements were within 10 percent. The total volume purged and the field parameters measured at each well were recorded in the field logbooks and are shown in Table 2-10.

During Round 1, purging in four wells either fell short of or exceeded the three casing volumes. Wells B6 and B2 were purged dry after 2 and 1.7 casing volumes, respectively. Field parameters measured in both wells were within 10 percent for the first and second volumes purged. Four casing volumes of water were purged from Well DM-6 because conductivity measurements varied by 14 percent between the second and third volumes purged. All field parameters measured between the third and fourth volumes purged were within 10 percent.

Purge water was collected in 55-gallon plastic drums and transferred to an onsite storage tank pending laboratory analysis. All purge water was subsequently discharged to the Metro sewer system after receipt of the analytical results.

Groundwater Sample Collection. Groundwater samples were collected from all the Round 1 wells using laboratory-decontaminated stainless-steel bailers, with the exception of wells DM-7, H1, and B4. These wells were sampled using Waterra pumps as described above.

Sampling personnel wore nitrile gloves during sample collection. Gloves were changed, at a minimum, between wells and whenever the potential for cross-contamination or other contamination was suspected.

Groundwater samples were collected in manufacturer-decontaminated, pre-labeled sample bottles. Samples collected for dissolved metals analysis were field-filtered through disposable Nalgene 0.45-micron filtration units prior to preservation to a pH level of <2 pH units with 1:1 nitric acid. Samples for total metals analysis were not filtered. The pH of each preserved dissolved metals sample was field-checked to ensure that the proper level of <2 pH units was achieved. Samples collected for volatiles, formaldehyde, and isopropyl alcohol analyses were collected into 40-ml volatile organics analysis (VOA) vials that were filled in such a way as to achieve minimal agitation and zero headspace.

After collection, all samples were placed into chilled coolers to maintain a temperature of 4°C for the duration of sampling and transporting. At the end of sampling each day, the identification numbers of samples collected that day were added to chain-of-custody forms, and the containers were repacked with additional ice for transport to the laboratory.

Round 2

Round 2 groundwater samples were collected between August 24 and September 1, 1994, from 19 monitoring wells whose locations are shown in Figure 2-20. Table 2-11 lists the analyses conducted for each well. The Addendum to the RFI Workplan (Appendix B of this report) explains the rationale for the analytical program for Round 2 groundwater sampling. Round 2 groundwater sampling activities included measuring groundwater elevations, well purging, recording field parameters, and collecting samples. The primary difference in the groundwater sampling method during Round 2 compared to Round 1 was the use of dedicated Waterra pumps (described previously) to purge and sample all the wells. A brief summary of each Round 2 activity follows.

Groundwater Elevation Measurements. Initial inspection of each monitoring well and subsequent groundwater-level measurements were conducted as described under Round 1 above.

Well Purging. Monitoring wells were purged prior to sampling by removing a minimum of three casing volumes of water using manufacturer-decontaminated, single-use Waterra sampling pumps.

Field Parameter Measurements. The field parameters measured (Table 2-12) and the methods used were the same as those described under Round 1 above, with one addition. Dissolved oxygen (DO) was added as a field parameter for Round 2. DO was measured using a YSI model 51B meter and probe. The probe was lowered into the well until it was submerged in the screened depth interval. The probe was slowly moved up and down after each purge volume was removed. Readings were taken when the DO level stabilized. The

probe and cable were field-decontaminated between wells by washing them with Liquinox and ASTM Type II water and rinsing them with ASTM Type II water.

Well purging exceeded three casing volumes in well H10. DO measurements varied by 60 percent between the second and third well volumes purged, but stabilized between the third and fourth volumes purged. Well H1 was purged dry after 1.6 casing volumes. Field parameters measured between the first and second purge volumes were within 10 percent.

Groundwater Sample Collection. All Round 2 groundwater samples were collected using manufacturer-decontaminated, dedicated, Waterra sampling pumps. Otherwise, the sampling protocols used during Round 2 were as described earlier for Round 1. At five of the wells (H1, MW-13, MW-17, MW-18, and MW-19), disposable polyethylene bailers were used to collect duplicate groundwater samples. This was done to evaluate potential differences in concentrations of volatiles reported for the two sampling methods; the data collected using Waterra pumps and bailers are discussed in Appendix I. The groundwater samples collected with the Waterra pumps are considered the samples of record for Round 2.

2.4.3 LNAPL Monitoring

During the RFI, LNAPL monitoring was conducted at regular intervals in pre-RFI monitoring wells. After the completion of Round 2, the eight new monitoring wells were also monitored for LNAPL. Measurements were made using an oil/water interface probe capable of measuring a thickness of less than one-hundredth of a foot or by collecting a liquid sample from the well with a transparent bailer and visually inspecting the sample for LNAPL. When monitoring with this latter method, the bailer was carefully and slowly lowered partway through the air/fluid interface and then carefully withdrawn.

LNAPL monitoring is ongoing at the Facility. Selected wells are monitored at least once a month as an Interim Measures activity. Since early 1995, LNAPL monitoring at the majority of the wells has been conducted using an oil/water interface probe. LNAPL thickness in well H10 is monitored using a clear bailer.

During March 1994, the LNAPL present in well H10 was measured and removed with a bailer at regular intervals. On March 23, a Model SOS-2 product skimmer manufactured by Clean Environment Equipment was installed in well H10. The skimmer consisted of a floating intake equipped with a hydrophobic membrane, which was controlled by a pneumatic pumping system and timer. By early April, no LNAPL was visibly accumulating in the well; the skimmer was operated until April 11, when it was removed because of diminishing LNAPL thickness and recovery volume.

LNAPL data collected through April 1995 are presented in this report.

2.5 Sediment Investigation

The field methods for the RFI sediment investigation were selected to meet the following objectives:

- Assess the probability of sediment contamination in the investigation area along the Duwamish Waterway shoreline (Area A11). This was accomplished by applying a nonparametric statistical method outlined by Conover (1980), based on predetermined tolerance limits, to sediment sampling. The selected tolerance limits provided a confidence that 85 percent of the time, 75 percent of the sampled area will be at or below the maximum concentration encountered.

- Compare the findings for detected constituents to the action levels and define the boundaries of confirmed contamination in order to assess the need for additional actions. This was accomplished by comparing the sediment data to Washington State Marine Sediment Management Standards (WAC 173-204).

Sediment samples were collected from Area A11 during both rounds of the RFI. The first round of sampling was conducted on March 3, 1994, and the second round on August 18, 1994. Except as noted in this section, Round 1 sampling followed the approved RFI Workplan; however, sample analyses were not conducted specifically to comply with Puget Sound Estuary Program (PSEP) protocols. After consultation with the state Department of Ecology's Sediment Management Unit, the analytical methods were revised for Round 2 and documented in the Addendum to the RFI Workplan. The sampling locations are shown in Figure 2-21, and the analytical methods for both rounds of samples are listed in Table 2-13.

In both rounds, the samples were collected during low tide and the sampling locations were accessed by foot. The samples were collected using a field-decontaminated stainless-steel scoop. Each sample was placed in a field-decontaminated stainless-steel bowl and mixed with the sampling scoop until visibly homogeneous. The homogeneous sample material was then transferred to laboratory-decontaminated, pre-labeled sample jars with Teflon-lined lids. All filled sample jars were stored in a chilled cooler at 4°C until delivered to the laboratory.

Round 1

During Round 1, the sediment samples collected from Area A11 were analyzed for semivolatiles, pesticides/PCBs, metals, and total solids (a physical parameter). Laboratory analysis of Round 1 samples was conducted by ETC Laboratories in Redmond, Washington.

The Round 1 sampling points were located using Pathfinder mobile and base station global positioning equipment. The RFI Workplan specified that sediment samples would be ob-

tained from the depth interval of 0 to 2 centimeters below the mudline. As documented in Appendix C, the Round 1 samples were inadvertently obtained from the depth interval of 0 to 0.5 foot below the mudline. However, the analytical results are useful for comparison with previous sediment sampling conducted by Landau Associates (1991), as the 0- to 0.5-foot depth interval corresponds to the sampling interval chosen by Landau.

Round 2

During Round 2, sediment samples collected from Area A11 were analyzed for semivolatiles, pesticides/PCBs, metals, total organic carbon, sulfide, ammonia, pH, and physical parameters (total solids, grain size, and specific gravity). Round 2 analytes were selected so that the results could be compared with Marine Sediment Management Standards.

Round 2 sediment samples were collected from a depth of 0 to 2 centimeters as specified in the RFI Workplan. Round 2 sampling procedures corresponded to the PSEP protocols. An onshore surveyor was used to position field personnel within 5 feet of the Round 1 sampling stations.

As noted in Sections 2.3.1 and 2.4.2, ETC closed its Redmond laboratory in June 1994. Laboratory analysis of Round 2 sediment samples was performed by Analytical Resources, Inc., of Seattle, Washington. Analysis of the physical parameters grain size and specific gravity was conducted by Soil Technology of Bainbridge Island, Washington.

2.6 Ecological Site Assessment

On August 18, 1994, an ecological assessment of the Facility was conducted in order to qualitatively identify plants and animals that are found onsite and to assess possible effects from hazardous substances currently under investigation.

The Facility consists of two distinct parts: the upland industrial area, which comprises approximately 19.5 acres above the east bank of the Duwamish Waterway, and the shoreline area, which extends from the top of the Waterway bank approximately 165 feet west into the intertidal portion of the Waterway channel.

The ecological assessment was performed by inspecting the upland portion of the Facility and walking along the shoreline area (north and south) of the Duwamish Waterway and west into the Waterway during low tide, along a distance of approximately 90 feet. Activities included observing physical site characteristics and habitat potential, identifying plants and animals, interviewing personnel who have worked at the Facility, and documenting observations of the conditions of the habitat and species encountered. The assessment was conducted in general accordance with U.S. EPA's guidance document *Ecological Assessment of Superfund Sites: An Overview* (1991).

2.7 Seep Assessment

As described in the RFI Workplan, seep sampling was planned for the RFI to assess the quality of groundwater discharging to the Duwamish Waterway and to evaluate the potential for cross-media contamination from groundwater to surface water and sediments.

Prior to and during Round 1 of the RFI, several inspections were made of the riprap and intertidal zone along the Duwamish Waterway in an attempt to locate seeps that could be sampled. The inspections were made during the winter, spring, and summer: on June 6 and December 9, 1993, and January 5 and March 3, 1994. No seeps were observed during any of these inspections.

However, during the Round 2 sediment sampling event, which was conducted during a minus-1-foot tide on August 18, 1994, field personnel were able to walk farther out on the soft intertidal sediments than during previous visits. With the extended vantage point, they observed a lightly flowing clear seep below the riprap along the base of the riverbank near the southwest corner of the Facility. This seep is not visible from the bank or the shoreline during average tides.

Seep sampling was not performed during that site visit because the tide window was limited, prepared laboratory containers were not available, and engineering controls to accumulate and collect seep water (e.g., a notched weir) would have been necessary to collect the volume needed for Appendix IX hazardous substance list samples (as specified in the RFI Workplan). Because seep sampling needs to take place in the intertidal zone, seep sampling occurred at minus-1-foot to minus-2-foot tides during the week of April 17, 1995. Because of the extreme low tides, more seeps were seen along the Facility shoreline.

Seven seeps were sampled: three were located along the bank of Slip No. 6, and four were located between the Duwamish Waterway pier and Slip No. 6. One of the four seeps into the Duwamish Waterway was dark; a duplicate sample was collected from this seep. Both the sample and the duplicate from the dark seep were analyzed for 40 CFR 264 Appendix IX constituents, as discussed in the RFI Workplan. The remaining seeps were analyzed for selected inorganics (metals and ions), volatiles, semivolatiles, and formaldehyde.

Seep analyses were expanded from those in the RFI Workplan to include analysis for guaiacol and resin acids, as requested by the Department of Ecology. Sampling was also expanded to include surface water up- and down-river from the Facility; these surface water samples were analyzed for hexavalent chromium using EPA Method 7197. According to preliminary data, no hexavalent chromium was detected in the surface water or the seeps.

Descriptions of the methodology and results of this Round 3 seep and surface water sampling are not included in this RFI Report, but will be provided in the Round 3 Data Technical Memorandum that will be submitted as an addendum.

2.8 Air Emissions Investigation

The field methods used to evaluate air quality at the Facility were selected to meet the objectives of the RFI air emissions investigation, which included:

- Evaluate existing Facility conditions and assess the potential for air releases.
- Determine the source(s) of any air contaminants onsite.
- Evaluate the physical processes that may emit air contaminants.
- Assess the significance of any emissions and their potential for impacts.

Based on Facility visits by CH2M HILL air quality specialists, it was determined that potential sources of air contaminants existed onsite in two investigation areas, A4 and A8. Area A4 includes an area of known toluene contamination of groundwater and soil; Area A8 is the site of a former maintenance facility where volatile materials were previously used and reportedly disposed of.

On August 11, 1994, during Round 2 of the RFI, soil vapor samples were collected using a flux chamber. The samples were collected in Area A4 and in Area A8 at the west end of the old maintenance shop. The locations of the samples are shown in Figure 2-22.

The air sampling procedures followed the approved RFI Workplan. Soil at the A04-AM-01 location was covered with asphalt paving. In order to access the soil, a 2-foot-diameter opening in the asphalt was cut using a drill rig equipped with an asphalt-cutting bit. The flux chamber was immediately placed on the exposed soil surface. Organic vapor monitor (OVM) readings were taken at 15-second intervals for the first 7 minutes of the test and then at 30-second intervals until no change in concentration was observed (approximately 30 minutes into the testing). After air emissions from the soil stabilized, two air samples were collected in stainless-steel canisters.

At the A08-AM-01 sampling location, an OVM with a PID was used for real-time measurements of concentrations of volatile organic compounds emitted from the soil over time. The flux chamber was placed on the exposed soil surface, and OVM readings were taken at 15-second intervals for the first 7 minutes of the test and then at 30-second intervals until no change in concentration was observed (approximately 30 minutes into the testing). After air emissions from the soil stabilized, two samples were collected in stainless-steel canisters.

A total of four air samples were collected and analyzed for acetone, methylene chloride, benzene, and toluene. Table 2-14 summarizes the information concerning the samples collected.

2.9 References

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Section 4
RFI Findings and Analytical Results

This section presents the findings and results of the RFI at the Marginal Way Facility, with emphasis on the following:

- Hydrogeological conditions at the Facility
- The analytical results of the samples and data collected
- Comparison of the results to the action levels identified for the RFI
- The fate and transport of key constituents of concern in groundwater

As noted in previous sections, the RFI analytical results are compared to action levels in order to assess the need for further actions such as inclusion of constituents of concern in the Risk Assessment/Media Cleanup Standards (MCS) evaluation. Consistent with U.S. EPA guidance, action levels for this Facility have been based on health and environmental exposure levels and established cleanup standards. The action levels for soil are the state MTCA Method C cleanup levels. The action levels for groundwater are the most stringent of the following groundwater and surface water standards:

Groundwater Standards

- Federal Maximum Contaminant Levels (MCLs) for Drinking Water (40 CFR Part 141)
- State Model Toxics Control Act (MTCA) Method B Cleanup Levels for Groundwater (WAC 173-340)
- State Model Toxics Control Act (MTCA) Method C Cleanup Levels for Groundwater (WAC 173-340)
- State Groundwater Quality Standards (WAC 173-200)

Surface Water Standards

- Federal Aquatic Health Criteria - Freshwater Acute Criterion Maximum Concentrations (40 CFR 131.36[b][1])
- Federal Aquatic Health Criteria - Freshwater Chronic Criterion Continuous Concentrations (40 CFR 131.36[b][1])
- State Aquatic Health Criteria - Freshwater Acute Criterion Maximum Concentrations (WAC 173-201A-040[3])

- State Aquatic Health Criteria - Freshwater Chronic Criterion Continuous Concentrations (WAC 173-201A-040[3])
- Federal Aquatic Health Criteria - Marine Water Acute Criterion Maximum Concentrations (40 CFR 131.36[b][1])
- Federal Aquatic Health Criteria - Marine Water Chronic Criterion Continuous Concentrations (40 CFR 131.36[b][1])
- State Aquatic Health Criteria - Marine Water Acute Criterion Maximum Concentrations (WAC 173-201A-040[3])
- State Aquatic Health Criteria - Marine Water Chronic Criterion Continuous Concentrations (WAC 173-201A-040[3])
- Federal Human Health Criteria for Consumption of Organisms Only (40 CFR 131.36[b][1])
- State Model Toxics Control Act (MTCA) Method C Cleanup Levels for Surface Water (WAC 173-340)

For sediments, the action levels are the Minimum Cleanup Levels (MCULs) in the state Marine Sediment Management Standards.

The RFI findings and results are presented as follows in this section:

- 4.1, Hydrogeologic Characterization
- 4.2, Soil Investigation
- 4.3, Groundwater Investigation
- 4.4, Sediment Investigation
- 4.5, Ecological Site Assessment
- 4.6, Seep Assessment
- 4.7, Air Emissions Investigation
- 4.8, Fate and Transport of Constituents in Groundwater

The findings of the hydrogeological characterization are presented first. In this way, the subsequent discussions of the laboratory results for the various media can be presented within the framework of the subsurface conditions controlling the fate and transport of constituents. The description of the hydrogeological conditions is followed by sections presenting the findings and results of the various media investigations and the ecological site and seep assessments. The results indicate that groundwater is the medium of primary concern at the Facility, and Section 4 concludes with analyses of the potential fate and transport of key contaminants in groundwater and their potential to reach the Duwamish Waterway and impact surface water quality.

4.1 Hydrogeologic Characterization

As noted in Section 2.2, the conceptual hydrogeologic model for the Facility was well developed prior to the RFI, and the RFI hydrogeologic characterization focused on confirming and augmenting existing Facility information. Additional hydrogeologic information was collected during the RFI through the soil and HydroPunch investigations, and during monitoring well installation.

4.1.1 Geology and Hydrostratigraphy

Regional and Local Conditions

The geomorphology and soil types of the Puget Sound Lowland were formed as deposits of glacial drift and interglacial sediments. Postglacial changes to this glacial drift plain included erosion and down-cutting from the White, Cedar, Green, and Duwamish Rivers. Alluvial or sedimentary deposits from this erosion subsequently filled the broad Duwamish River Valley embayment area. These sediments consist primarily of silt and sand.

Soils in the Duwamish River Valley were formed in these alluvial deposits and are part of the Oridia-Seattle-Woodinville soil association. These soils are composed of stratified silt loams, silty clay loams, and sandy loams, with layers of peat and muck that are characteristically level and somewhat- to very-poorly drained. Soil permeability is moderate to moderately low for the Oridia soils, moderate for the Seattle series soils, and moderately low for the Woodinville series soils.

Areas along the Duwamish Waterway have been built up and industrialized from the original tide-flat land surfaces. Such industrialized areas contain original soils modified by the addition of 3 to 12 feet of hydraulic fill materials. The fill materials present at the Facility consist of sediments dredged to straighten the meanders in the original Duwamish River and create the Duwamish Waterway.

Facility-Specific Conditions

In the immediate vicinity of the Facility, hydraulic fill consisting of dredged sand and silt is present in the upper 5 to 15 feet of the subsurface. The fill is underlain by alluvial silt and sand to depths of approximately 50 feet bgs. Because of the similarity between the hydraulic fill and the underlying native deposits, a contact point between the units can be difficult to determine visually. However, discontinuous layers or lenses of sand, silt, and clay present in the upper 15 feet of the subsurface appear to typify the hydraulic fill. Sand, silt, and clay deposits of marine origin underlie the above-referenced alluvial sediments.

The hydrostratigraphy of the (approximately) upper 100 feet at the Facility was first described by Dames & Moore (1986) as a five-layer system. The RFI data support this finding. The five-layer conceptual model includes two aquifers: an upper unconfined

aquifer and a lower confined aquifer. The five hydrostratigraphic units are described below (from top to bottom) and depicted in Figure 4-1.

- **Unsaturated Zone.** The Unsaturated Zone (or vadose zone) extends from the ground surface to a depth of 10 to 15 feet and is composed primarily of poorly graded silty sand and sandy silts. Depending on location, much of this material is hydraulic fill from historical dredging conducted to form and maintain the Duwamish Waterway. Localized areas of nonhydraulic construction fill may also be present onsite. Laterally discontinuous low-permeability silts and clays in the Unsaturated Zone cause perched groundwater conditions to form locally.

- **Upper Aquifer.** The Upper Aquifer consists of alluvial sands and silty sands deposited by the Duwamish River prior to dredging. The Upper Aquifer is generally unconfined but may be locally confined or semiconfined by the above-mentioned low-permeability silt and clay beds. Borings drilled before and during the RFI indicate that the Upper Aquifer is approximately 50 feet thick, extending from the groundwater table (approximately 10 to 15 feet bgs depending on location and tide stage) to a depth of 60 to 65 feet bgs.

- **Aquitard.** The Aquitard between the Upper and Lower Aquifers consists of silt and clay of alluvial origin. The Aquitard serves as a confining layer for the Lower Aquifer. Deeper borings drilled before and during the RFI indicate the Aquitard is laterally continuous and ranges in thickness from approximately 10 to 40 feet. The top of the Aquitard ranges in depth from 60 to 65 feet bgs; the bottom ranges in depth from 75 to 100 feet bgs. The average thickness is approximately 20 feet.

- **Lower Aquifer.** Consistent with the approved RFI Workplan, no borings were drilled during the RFI to investigate the Lower Aquifer. However, several borings have been drilled into the Lower Aquifer by Dames & Moore and Landau Associates. The logs for these borings indicate that the Lower Aquifer consists of marine sand and gravel. The potentiometric surface of this aquifer is 5 to 15 bgs. Boring B2, drilled by Dames & Moore near the shore of the Duwamish Waterway in 1979, suggests that the Lower Aquifer may be about 20 feet thick.

- **Lower Aquitard.** Glacial till is reportedly present beneath the Lower Aquifer (Dames & Moore, 1986). The till is underlain by siltstone. The till and siltstone are believed to have relatively low hydraulic conductivity and therefore likely represent an aquitard beneath the Lower Aquifer.

Figure 4-2 shows the locations of the 73 borings drilled during the RFI. These borings supplement existing geologic information provided by Dames & Moore (1979, 1986) and

Landau Associates (1991). The additional information allowed construction of hydrostatigraphic cross-sections that are more detailed than those prepared previously by Dames & Moore or Landau. Four cross-sections were prepared; their locations are shown in Figure 4-3. The cross-sections are illustrated in Figures 4-4 through 4-7. The hydrostratigraphic units are illustrated in the cross-sections and described below.

Unsaturated Zone. All of the 73 borings drilled during the RFI provided additional information on the Unsaturated Zone. Of particular interest were the presence and thickness of the silt and clay layer. Characterization of this layer was an RFI objective because the relatively low permeability of the material may influence the migration of liquid contaminants that infiltrate downward from the ground surface. A silt or clay layer capable of acting as a perching layer for groundwater was encountered in most borings drilled during the RFI. The stratigraphic cross-sections in Figures 4-4 through 4-7 show that the layer has an average thickness in the range of 5 to 8 feet. Figure 4-8 shows the approximate lateral extent of the layer. The presence of a buried root zone was typically observed at the top of the silt and clay. This root zone likely represents the ground surface prior to placement of hydraulic fill at the site.

The results of the physical property testing conducted on the Unsaturated Zone materials are shown in Table 4-1. The range of values for the Unsaturated Zone materials is shown in Table 4-2.

Upper Aquifer. The stratigraphy of the Upper Aquifer is characterized by fine to medium sand with lenses and beds of silty sand and sandy silt; the grain size distribution of the Upper Aquifer material generally becomes finer with depth. Drilling logs indicate that the average thickness of the Upper Aquifer is approximately 50 feet, extending from approximately 10 or 15 feet bgs to 60 or 65 feet bgs.

The results of the physical property testing conducted on the Upper Aquifer materials are shown in Table 4-1. The range of values for the Upper Aquifer materials is shown in Table 4-3.

Aquitard. As specified in the RFI Workplan, none of the RFI borings were drilled through the Aquitard separating the Upper and Lower Aquifers. However, borings A04-06, A04-14, A04-23, A04-24, and A02-05 were drilled into the Aquitard to confirm its presence and to collect samples for various physical tests. To date, 12 borings or wells have been drilled into or through the Aquitard by Dames & Moore (1979, 1986), Landau Associates (1991), and RPI (the above-referenced RFI borings).

The Aquitard is shown in the geologic cross-sections A-A' through D-D'. The boring log data indicate that the Aquitard is latterly continuous and ranges in thickness from 10 to nearly 50 feet; the average thickness is approximately 20 feet. Based on the geologic logs and grain size distribution data, the Aquitard materials consist of plastic silt and clay; however, layers of silty sand and abundant shell fragments have also been noted. As

shown in Tables 4-1 and 4-4, the laboratory hydraulic conductivity of the Aquitard materials ranges from 7.7×10^{-5} to 2.5×10^{-4} ft/day (2.7×10^{-8} to 8.8×10^{-8} cm/sec).

The results of the physical property testing conducted on the Aquitard materials are shown in Table 4-1, and the range of values for these materials is shown in Table 4-4.

Lower Aquifer and Lower Aquitard. As discussed earlier, the Dames & Moore and Landau investigations characterized the Lower Aquifer materials as consisting of marine sand and gravel with an approximate thickness of 20 feet. The underlying Lower Aquitard reportedly consists of glacial till and siltstone.

4.1.2 Groundwater Hydrology

The groundwater hydrology of the Facility is discussed below in two subsections. The first addresses hydraulic parameters for the Upper and Lower Aquifers, including hydraulic conductivity, transmissivity, and porosity; the hydraulic conductivity and porosity of the Aquitard materials are also discussed. The second subsection describes groundwater flow conditions at the Facility.

Hydraulic Parameters

Hydraulic Conductivity of the Upper and Lower Aquifers. As discussed in Section 2.2.3, single-well hydraulic conductivity tests ("slug" tests) were performed on six monitoring wells during the RFI. In addition, RPI conducted slug tests in 1991 on five other monitoring wells. For completeness, the 1991 data are presented here with the RFI data.

Of the 11 monitoring wells where slug tests have been conducted, eight are screened in the Upper Aquifer and three in the Lower Aquifer. These wells are grouped below by aquifer and year tested; their locations are shown in Figure 2-6.

Upper Aquifer Wells	Lower Aquifer Wells
B2 (1991)	DM-1B (1994)
B6 (1991)	DM-2B (1994)
H10 (1991)	DM-3B (1994)
H11 (1991)	
DM-7 (1991)	
DM-1A (1994)	
DM-2A (1994)	
DM-3A (1994)	

Slug test data were analyzed using the method described by Bouwer and Rice (1976) and Bouwer (1989). The rising-head data were used to calculate estimated hydraulic conductivity for the eight Upper Aquifer wells because all of these wells are screened across the

groundwater table. Both rising- and falling-head data were evaluated for the three monitoring wells screened in the Lower Aquifer. The hydraulic conductivity was calculated using the following equation:

$$K = \frac{r_c^2 ln(R_e/r_w)}{2tL_e} ln(y_o/y_t)$$

where:

K	=	hydraulic conductivity (ft/day)
R_e	=	effective radius over which head is dissipated (ft)
r_w	=	borehole radius (ft)
r_c	=	well casing radius (ft)
L_e	=	screen length (ft)
y_o	=	head difference at time t_o (ft)
y_t	=	head difference at time t (ft)
t	=	time since t_o (days)

Bouwer and Rice (1976) present an empirical formula to calculate R_e based on the geometry of the well casing, borehole, and aquifer. Because the Upper Aquifer wells are screened across the groundwater table, drainage occurs in the filter pack around the well screen. To account for this, an equivalent well casing radius (equivalent r_c) was calculated using the method described by Bouwer (1989, p. 305) and assuming a filter-pack porosity of 0.30.

The slug-test results are presented in Table 4-5. The calculated hydraulic conductivity values for the Upper Aquifer wells range from 0.5 to 100 ft/day; the geometric mean is 6.4 ft/day. The results are generally grouped at two ends of this range. Hydraulic conductivity values for wells H10, H11, and DM-7 range from 20 to 100 ft/day; these wells are located in the southwest part of the Facility near the former Tank Farm (see Figure 2-6). The remaining five wells are dispersed throughout the remainder of the Facility; hydraulic conductivity values at these wells range from 0.5 to 4.7 ft/day.

Calculated hydraulic conductivity values for the Lower Aquifer wells were relatively consistent, ranging from 0.2 to 0.6 ft/day; the geometric mean is 0.4 ft/day.

The estimated hydraulic conductivity values derived from the slug test data appear reasonably consistent with literature values for clean to silty fine sand. However, a formal aquifer test using pumping and observation wells would be necessary to design a groundwater extraction system, should such a corrective measure be deemed necessary.

Transmissivity of Upper and Lower Aquifers. Estimated transmissivities can be calculated for the Upper and Lower Aquifers using the equation:

$$T = Kb$$

where:

T	=	transmissivity (ft^2/day)
K	=	hydraulic conductivity (ft/day)
b	=	aquifer thickness (ft)

As discussed above, mean (geometric) hydraulic conductivity values for the Upper and Lower Aquifers are 6.4 and 0.4 ft/day, respectively. Based on data collected during the RFI and previous investigations, the average thicknesses of the Upper and Lower Aquifers are approximately 50 and 20 ft, respectively. Using these data, estimated transmissivities are 300 and 8 ft^2/day for the Upper and Lower Aquifers, respectively.

Hydraulic Conductivity of the Aquitard. The laboratory hydraulic conductivity values for four Aquitard samples are two to three orders of magnitude lower than the hydraulic conductivity results for the Upper and Lower Aquifers. The laboratory hydraulic conductivity values for the Aquitard materials range from 7.7×10^{-5} to 2.5×10^{-4} ft/day (2.7×10^{-8} to 8.8×10^{-8} cm/sec); the geometric mean is 1.6×10^{-4} ft/day (5.7×10^{-8} cm/sec). The laboratory hydraulic conductivity data for the Aquitard materials are presented in Table 4-1.

Porosity. Porosity was measured in the laboratory for selected soil samples collected from the Unsaturated Zone, the Upper Aquifer, and the Aquitard. The porosity of the Unsaturated Zone materials ranges from 37.1 to 46.3 percent, based on testing of five samples (Table 4-2). The porosity of the Upper Aquifer materials ranges from 33.2 to 40.7 percent, based on three samples (Table 4-3). The porosity of the Aquitard materials ranges from 32.2 to 54.5 percent, based on four samples (Table 4-4). The porosity values presented above are consistent with the grain size distribution in each of these hydrostratigraphic units.

Groundwater Flow

A groundwater elevation monitoring program was conducted to evaluate groundwater flow at the Facility. Data were collected to evaluate groundwater levels, horizontal groundwater flow and gradients, and the direction and magnitude of the vertical gradients between the Upper and Lower Aquifers. Of particular interest was the effect of tides in the Duwamish Waterway on the groundwater hydrology. Two types of groundwater-level measurements (electronic and manual) were used to collect data for this evaluation. Groundwater levels in ten monitoring wells and water levels in one surface water location (in the Duwamish Waterway) were monitored continuously from January 19 through February 15, 1994, using electronic datalogging equipment. Manual groundwater-level measurements were

collected four times at all 30 pre-RFI monitoring wells on February 4, 1994, to coincide with four specific tide stages (see Section 2.2.2).

The groundwater elevation data were used to evaluate horizontal and vertical hydraulic gradients and to prepare hydrographs and potentiometric contour maps. These data and associated findings are presented in this section.

It should be noted that the groundwater elevation data for well B1A have not been used in the preparation of potentiometric contour maps. A review of the well construction log for this well and groundwater elevation data for nearby wells indicates that well B1A is screened in a perched groundwater zone just above the Upper Aquifer. This conclusion is supported by groundwater elevation data showing that this well is not influenced by diurnal tides and, therefore, does not appear to be in direct hydraulic connection with the Upper Aquifer.

It should also be noted that a groundwater extraction program was being conducted in 1994 at the Kenworth Truck Company site located immediately north of the RPI Facility. Groundwater-level data collected during the RFI indicate that drawdown induced by the Kenworth extraction wells affected groundwater flow during the RFI in the western end of the RPI Facility. The Kenworth extraction program is addressed below so that the data presented later in this section are viewed in the appropriate context.

Kenworth Groundwater Extraction System. In May 1994 RPI was informed that the Kenworth Truck Company, as part of a voluntary cleanup action under MTCA, had been extracting groundwater at its site from January to May 1994—the same time that most of the RFI groundwater elevation data were collected. Based on information provided to RPI by Kenworth, groundwater had been pumped from three Upper Aquifer extraction wells at a total rate of approximately 60 gallons per minute. The extraction wells are located in the north-central portion of the Kenworth property, approximately 700 feet north of RPI monitoring wells B1A and B1B (Figure 4-3 shows the locations of these wells).

In an attempt to evaluate the potential effects of Kenworth's extraction system on the groundwater flow patterns at the RPI Facility, an additional round of groundwater-level measurements was conducted in June 1994. This round was timed to coincide with a period when Kenworth's system was not in operation.

Potentiometric contour maps for the Upper Aquifer were prepared from RFI groundwater elevation data obtained during periods when Kenworth's extraction system was in operation. These maps were compared to the Upper Aquifer map prepared from the June 1994 round of groundwater-level measurements (which were taken when Kenworth had ceased extraction operations temporarily). A comparison of these maps indicates that drawdown from the Kenworth wells affected groundwater flow in the northwest portion of the RPI Facility. This is further supported by theoretical drawdown calculations (using Facility-specific aquifer parameter data and Kenworth pumping information) indicating that

Kenworth pumping could cause Upper Aquifer groundwater levels in the western portion of the RPI Facility to decline as much as 1 to 2 feet.

In the absence of Kenworth pumping, the net groundwater flow direction in the Upper Aquifer appears to be toward the west, with ultimate discharge to the Duwamish Waterway (or to Slip No. 6). During Kenworth pumping, however, the net groundwater flow direction in part of the Facility appears to be northward, toward the Kenworth property. This is consistent with the location of the Kenworth extraction wells. The potentiometric contour maps and associated discussions are presented later in this section.

Groundwater Elevation Hydrographs. Groundwater elevation hydrographs for each of the electronically monitored wells (see Table 4-6) are presented in Figures 4-9 through 4-14.

- **Wells DM-1A and DM-1B**. Figure 4-9 shows hydrographs of groundwater elevations in wells DM-1A and DM-1B from January 19 through February 15, 1994. The diurnal tidal cycle is evident in both wells, although the response to tidal fluctuations is slightly less pronounced in the Upper Aquifer well DM-1A. The effects of the diurnal tide cycles are less pronounced in this well pair relative to the other wells monitored because these wells are located farther from the Duwamish Waterway and Slip No. 6.

  In addition to tidal trends, it is important to note that an upward vertical gradient exists between the Lower Aquifer (DM-1B) and the Upper Aquifer (DM-1A) at all times during the 27-day monitoring period. The net upward vertical gradient from DM-1B to DM-1A has been calculated as 0.05 (feet vertical/feet horizontal) based on the average of the groundwater-level measurements collected over the 27-day period.

- **Wells DM-2A and DM-2B**. Figure 4-10 shows hydrographs of wells DM-2A and DM-2B from January 19 through February 15, 1994. The diurnal tidal cycle in both wells is very pronounced owing to their location near the Duwamish Waterway and Slip No. 6. Daily groundwater-level variations are greater in the Lower Aquifer (DM-2B) than in the Upper Aquifer (DM-2A), and there is a lag in response time to tidal changes in the Upper Aquifer relative to the Lower Aquifer.

  An upward vertical gradient from DM-2B to DM-2A is apparent from the data. At no time does the DM-2B hydrograph cross below the DM-2A hydrograph, indicating that the gradient is always upward regardless of the tide stage. The net upward vertical gradient from DM-2B to DM-2A has been calculated as 0.05 ft/ft based on the average of the groundwater-level measurements collected over the 27-day period.

The sudden drop in the recorded water level in DM-2B on January 21, 1994, was the result of the transducer being removed from the well so that groundwater sampling could be performed. The anomalous portion of the hydrograph is labeled "groundwater sampling."

- **Wells DM-3A and DM-3B.** Figure 4-11 shows hydrographs of wells DM-3A and DM-3B from January 19 through February 15, 1994. The diurnal tidal cycle is evident in both wells. However, groundwater-level variations are greater in DM-3B (Lower Aquifer) than in DM-3A (Upper Aquifer).

  An upward vertical gradient from DM-3B to DM-3A is apparent from the hydrographs. At no time does the DM-3B hydrograph cross below the DM-3A hydrograph. This indicates that the vertical gradient is always upward at this location, regardless of the tide stage. The net upward vertical gradient from DM-3B to DM-3A is calculated as 0.07 ft/ft based on the average of the groundwater-level measurements collected over the 27-day period.

  Groundwater sampling was performed at wells DM-3A and DM-3B on January 20, 1994. The drop in the groundwater level shown in the hydrographs for these wells was caused by removal of the transducer prior to sampling. The anomalous portions of the hydrographs are labeled "groundwater sampling."

- **Wells H1 and H10.** Figure 4-12 shows hydrographs of wells H1 and H10 from January 19 through February 15, 1994. Both wells are screened in the Upper Aquifer. Well H10 is screened across the groundwater table; well H1 is screened near the bottom of the aquifer. Groundwater elevations in both wells are similar, with no observable time lag in tidal response between the two wells. A very slight net downward gradient of 0.001 ft/ft is calculated for the Upper Aquifer based on average groundwater elevations for the period from January 13 through February 3, 1994.

- **Wells B1A and B1B.** Figure 4-13 shows hydrographs of well B1A (intended as an Upper Aquifer well) and B1B (a Lower Aquifer well) from January 19 through February 15, 1994. Diurnal tidal cycles are not apparent in the hydrograph for B1A but are present in the hydrograph for B1B. Based on (1) the relatively high groundwater elevation compared to nearby wells, (2) the boring log, and (3) the lack of diurnal tidal response, well B1A appears to be screened in a perched water-bearing zone rather than in the Upper Aquifer. Therefore, calculation of a vertical hydraulic gradient between wells B1A and B1B would not be meaningful.

  Monitoring well B1B was sampled on January 19, 1994. The resulting drop in the groundwater level can be seen in the hydrograph and is labeled "groundwater sampling."

- **Stilling Well Water-Level Elevations.** Figure 4-14 shows a hydrograph of water-level elevations measured in the stilling well installed in the Duwamish Waterway. This hydrograph indicates the magnitude and timing of tidal fluctuations during the monitoring period. Water levels in the Duwamish Waterway varied by as much as 12 to 13 feet between high and low tides. Ten minus tides occurred during the 27-day monitoring program (the lowest tide was minus-1.2 feet [mean lower low water] on January 26 and 27, 1994).

Potentiometric Contour Maps. Potentiometric contour maps were developed for the Upper and Lower Aquifers beneath the Facility, as described below:

- **Discrete tidal stages.** Four rounds of groundwater elevation data were collected on February 4, 1994, using electronic water-level indicators. The four rounds corresponded to mid-tide rising, high tide, mid-tide falling, and low tide. Discrete tide-stage potentiometric maps for the Upper and Lower Aquifers were developed from these data. These data were collected at a time when groundwater extraction was occurring at the Kenworth site located immediately north of the RPI Facility.

  An additional round of groundwater elevation data was collected manually on June 23, 1994, during a high-tide event. These data were collected at a time when Kenworth was not pumping in order to evaluate Upper Aquifer groundwater flow under pumping and non-pumping conditions.

- **27-day averages.** Groundwater elevation data collected at 15-minute intervals by an electronic datalogger were averaged for the period January 19 through February 15, 1994. These data were used to create 27-day average potentiometric contour maps for the Upper and Lower Aquifers. The wells monitored during this period are shown in Table 4-7 along with the average groundwater elevations used to develop the contour maps. These data were collected during Kenworth pumping conditions.

Upper Aquifer Potentiometric Groundwater Contour Maps. Each Upper Aquifer groundwater contour map (Figures 4-15 through 4-20) is discussed below. The discussions focus on groundwater flow directions and horizontal hydraulic gradients in the Upper Aquifer.

- **Figure 4-15: Upper Aquifer, Mid-Tide Rising, 2/4/94 at Approximately 0715.** The groundwater elevation contours shown in Figure 4-15 indicate that groundwater flow is from east to west in the eastern two-thirds of the Facility. Upper Aquifer groundwater beneath the Background Area (in the vicinity of wells DM-1A and E3) appears to be flowing toward the process area and toward Slip No. 6. In the western third of the Facility, groundwater flow converges from the east, west, and south forming a north-south-oriented potentiometric trough underlying the Distribution Center. Groundwater below, and north of,

the Distribution Center appears to be flowing northward toward the Kenworth site; this appears to be a consequence of Kenworth's groundwater extraction system.

Hydraulic gradients are relatively flat in the Background Area and the central portion of the Facility. The gradients are steeper along the Duwamish Waterway and Slip No. 6 shorelines where the Upper Aquifer is recharged by these surface water bodies.

- **Figure 4-16: Upper Aquifer, High Tide, 2/4/94 at Approximately 1015.** Figure 4-16 indicates that at high tide, Upper Aquifer groundwater flow conditions are similar to the mid-tide rising stage (Figure 4-15). The potentiometric trough located in the vicinity of the Distribution Center is still present, consistent with the potentiometric depression depicted in the equivalent (high-tide) potentiometric contour map presented by Landau Associates (1991). The Landau contour map depicts groundwater flow converging on the western third of the Facility, resulting in the presence of a potentiometric depression. The inward hydraulic gradient along the shorelines of the Duwamish Waterway and Slip No. 6 is steeper because of the high tide. Based on the conditions shown in Figure 4-16, it appears that the groundwater extraction system at the Kenworth site affects groundwater flow at the RPI Facility.

  The Upper Aquifer groundwater flow direction in most of the Background Area is east to west. However, flow at the east end of Slip No. 6 is reversed relative to Figure 4-15 (mid-tide rising); groundwater is flowing from Slip No. 6 to the east. Of the four tide stages contoured, high tide is the only tide stage where the groundwater flow direction at the east end of Slip No. 6 is from west to east. This flow reversal appears to occur only over a short distance from the shoreline. During the other three tide stages monitored, Upper Aquifer groundwater from the eastern end of the Facility discharges to Slip No. 6.

- **Figure 4-17: Upper Aquifer, Mid-Tide Falling, 2/4/94 at Approximately 1415.** The Upper Aquifer groundwater elevation contours shown in Figure 4-17 for the mid-tide falling stage indicate that the north-south oriented potentiometric trough remains present in the western third of the Facility; again, this appears to be a consequence of Kenworth's groundwater extraction system. Flow remains inward from Duwamish Waterway and Slip No. 6 in the western half of the Facility; however, gradients along the shorelines are flatter compared to high-tide conditions. Recharge to the Upper Aquifer in the Background Area of the Facility is from the east-northeast, with discharge to Slip No. 6. Groundwater flow converges on the west-central portion of the Facility from the east and from Slip No. 6 and the Duwamish Waterway. Discharge from the west-central portion of the Facility is toward the north property line during this tide stage.

Hydraulic gradients in the background area, the central portion of the Facility, and along the shoreline are relatively flat. Away from the shoreline areas, the steepest hydraulic gradients are in the central portion of the Facility.

- **Figure 4-18: Upper Aquifer, Low Tide, 2/4/94 at Approximately 1745.** The groundwater elevation contours shown in Figure 4-18 indicate that Upper Aquifer groundwater flow directions are generally westerly and southwesterly toward the Duwamish Waterway and Slip No. 6 during low tide. The potentiometric trough shown in the previous figures is no longer present. The hydraulic effect of the low-tide condition causes groundwater levels near the shoreline to decline to the extent that drawdown induced by Kenworth pumping is not evident. Recharge to the Upper Aquifer appears to be from the east or the northeast with discharge to the Duwamish Waterway and Slip No. 6. The potentiometric contours shown in Figure 4-18 are consistent with the contour map presented by Landau Associates (1991) for the Upper Aquifer at low tide.

  Surface water elevations were significantly lower than groundwater levels measured in Upper Aquifer monitoring wells along the shoreline, indicating a steep hydraulic gradient along the shorelines of the Duwamish Waterway and Slip No. 6.

- **Figure 4-19: Upper Aquifer, High Tide, 6/23/94 at Approximately 1900.** Groundwater elevations were measured at high tide on June 23, 1994, approximately one month after groundwater extraction had stopped at Kenworth. As discussed previously, the June high-tide measurements were conducted to allow comparison with groundwater elevations and flow conditions as measured during high tide on February 4, 1994, when the Kenworth extraction system was operating (Figure 4-16).

  A comparison of Figure 4-19 with Figure 4-16 shows that a groundwater depression existed in the western third of the site on June 23. Flow toward the Kenworth site is not evident. Groundwater flow conditions in other parts of the site (the Background Area, the east end of Slip No. 6, and the shoreline areas) appear similar for the June 23 and February 4 monitoring events. The inferred groundwater flow toward the Kenworth site on February 4, and the absence of such flow on June 23, supports the previously stated belief that the Kenworth extraction system was influencing groundwater levels and flow conditions at the RPI Facility. Further, groundwater flow depicted for high tide on June 23 is consistent with the equivalent (high-tide) contour map presented by Landau Associates (1991). The Landau potentiometric contour map for the Upper Aquifer at high tide also depicts groundwater converging on the western third of the Facility and the presence of a potentiometric depression.

- **Figure 4-20: Groundwater Contours, Upper Aquifer, 27-Day Average, 1/19/94 through 2/15/94.** Figure 4-20 shows Upper Aquifer groundwater

elevation contours representing the average groundwater levels for the 27-day monitoring period. The contours indicate that net groundwater flow in the eastern two-thirds of the Facility is east to west, consistent with the expectation that local groundwater is moving toward the Duwamish Waterway. However, a potentiometric trough is evident in the western third of the Facility. The trough is formed by groundwater converging from the east, west (from the Duwamish Waterway), and south (from Slip No. 6). Again, the contours in this area are consistent with conditions that would occur if the net groundwater flow direction is northward toward the Kenworth site. This is contrary to the westerly flow (toward the Duwamish Waterway) that would be expected under normal conditions (i.e., in the absence of Kenworth pumping). The groundwater extraction occurring at the Kenworth site during the 27-day period of continuous monitoring appears to be the cause of the apparent northerly flow. This is supported by hydraulic calculations indicating that 1 to 2 feet of drawdown could be induced in the west-central portion of the Facility by groundwater extraction at the Kenworth site at a cumulative rate of 60 gallons per minute (gpm).

The net horizontal hydraulic gradient shown in Figure 4-20 for the eastern two-thirds of the Facility is consistent with the expectation that groundwater is moving west toward the Duwamish Waterway. The horizontal hydraulic gradient across the eastern two-thirds of the Facility is relatively uniform at approximately 0.002 ft/ft. In the western third of the Facility, groundwater appears to converge from the east, south, and west and to flow northward under a relatively low hydraulic gradient. However, current groundwater elevation data for this area of the Facility are not adequate to establish a definitive groundwater flow direction or an estimated gradient.

Lower Aquifer Potentiometric Groundwater Contour Maps. An evaluation of each Lower Aquifer groundwater contour map (Figures 4-21 through 4-26) is presented below. The evaluations focus on inferred groundwater flow directions and hydraulic gradients in the Lower Aquifer. Only four monitoring wells are screened in the Lower Aquifer. Therefore, the groundwater flow directions inferred from the groundwater elevation data must be considered more approximate than those depicted for the Upper Aquifer.

- **Figure 4-21: Lower Aquifer, Mid-Tide Rising, 2/4/94 at Approximately 0715.** The groundwater elevation contours shown in Figure 4-21 indicate that at the time of measurement (mid-tide rising), groundwater in the Lower Aquifer was flowing from the southeast to the northwest across the Facility. During this tide stage, recharge to the Lower Aquifer appears to be from the southeast with discharge to the northwest.

  The hydraulic gradient is approximately 0.002 ft/ft across the Facility during this tide stage.

- **Figure 4-22: Lower Aquifer, High Tide, 2/4/94 at Approximately 1015.** The groundwater elevation contours shown in Figure 4-22 indicate that flow was toward the northeast in the western portion of the Facility and toward the northwest in the eastern and southeastern portions of the Facility. High tide is the only tide stage monitored when Lower Aquifer groundwater is not moving from east to west. The contours shown in Figure 4-22 are consistent with those shown by Landau Associates (1991) for the Lower Aquifer at high tide.

  The hydraulic gradient shown in Figure 4-22 is approximately 0.002 ft/ft, consistent with the gradient depicted by Landau Associates for the Lower Aquifer at high tide.

- **Figure 4-23: Lower Aquifer, Mid-Tide Falling, 2/4/94 at Approximately 1415.** The groundwater elevation contours of the Lower Aquifer shown in Figure 4-23 indicate flow from east to west toward the Duwamish Waterway. The hydraulic gradient across the Facility is approximately 0.002 ft/ft.

- **Figure 4-24: Lower Aquifer, Low Tide, 2/4/94 at Approximately 1745.** The groundwater elevation contours shown in Figure 4-24 indicate flow from east to west toward the Duwamish Waterway, in the same direction shown for the mid-tide falling stage (Figure 4-23). The contours shown in Figure 4-24 are consistent with those shown by Landau Associates (1991) for the Lower Aquifer at low tide.

  The hydraulic gradient shown in Figure 4-24 is steeper (approximately 0.003 ft/ft) than those depicted in the other contour maps for the Lower Aquifer, and is consistent with the gradient depicted by Landau Associates for the Lower Aquifer at low tide.

- **Figure 4-25: Lower Aquifer, High Tide, 6/23/94 at Approximately 1900.** As discussed previously, groundwater elevations were measured at high tide on June 23, 1994, to evaluate the potential hydraulic effect that the Kenworth groundwater extraction system may have had on the groundwater levels measured on February 4, 1994. Comparison of Figure 4-25 with Figure 4-22 shows that there is little difference in the groundwater flow conditions in the Lower Aquifer at high tide. Like the conditions shown for February 4, Lower Aquifer groundwater flow at high tide is toward the northwest in the eastern and southeastern portions of the Facility. The potentiometric contours for the Lower Aquifer at high tide, shown in Figures 4-22 and 4-25 and by Landau Associates, are all consistent in this regard.

- **Figure 4-26: Groundwater Contours, Lower Aquifer, 27-Day Average 1/19/94 through 2/15/94.** The net potentiometric contours for the Lower Aquifer indicate that groundwater flow is generally from east to west toward the Duwamish Waterway. As groundwater enters the western third of the Facility

and approaches the Duwamish Waterway, the flow direction changes from westerly to southwesterly. This change in flow direction may be due to the hydraulic influence of Slip No. 6. The hydraulic gradient in the Lower Aquifer is approximately 0.002 ft/ft across most of the Facility.

Vertical Groundwater Flow Potential and Gradients. Net vertical gradients between the Upper and Lower Aquifers were calculated based on the average of long-term (27-day) groundwater elevation data collected at three well pairs: DM-1A/DM-1B, DM-2A/DM-2B, and DM-3A/DM-3B (wells with the "A" suffix are screened in the Upper Aquifer; wells with the "B" suffix are screened in the Lower Aquifer). The direction of the net vertical gradient is significant because it indicates the direction of the hydraulic head potential and, therefore, the direction of potential groundwater flow across the Aquitard separating the Upper and Lower Aquifers. A downward flow potential would promote the vertical migration of groundwater constituents from the Upper to the Lower Aquifer. Conversely, an upward gradient would inhibit the downward migration of constituents.

The direction of the calculated net vertical gradient at each well is upward from the Lower to the Upper Aquifer. The calculated net vertical gradients are shown in Table 4-8. The directions of the head potential shown in the table are in the upward in all cases, consistent with the hydrographs for well pairs DM-1A/DM-1B, DM-2A/DM-2B, and DM-3A/DM-3B (Figures 4-9, 4-10, and 4-11). Based on the 27-day groundwater elevation monitoring program, these hydrographs indicate that the direction of the vertical gradient between the Lower and the Upper Aquifer is upward at all times and during all tide stages (i.e., the groundwater elevation for a Lower Aquifer well is always higher than the groundwater elevation in the adjacent Upper Aquifer well).

Table 4-9 summarizes the net groundwater-level differences at each of the well pairs monitored during discrete tide stages on February 4, 1994. The 27-day average groundwater level is also shown.

Figures 4-27 through 4-30 show vertical potentiometric contour lines plotted on four hydrostratigraphic cross-sections. The cross-section locations correspond to the locations of cross-sections presented earlier (in Figures 4-4 through 4-7). The groundwater elevations and potentiometric contours shown in the figures represent the average of groundwater-level measurements made during four tide stages on February 4, 1994 (see Section 2.2.2). In all four cross-sections, the upward gradient across the Aquitard separating the Upper and Lower Aquifers is depicted and supported by the groundwater elevations shown.

Tidal Efficiency and Time Lag. Tidal efficiency and time lag were calculated for eight monitoring wells included in the 27-day groundwater elevation monitoring program: wells DM-1A/DM-1B, DM-2A/DM-2B, DM-3A/DM-3B, B1B, and H10. Tidal efficiency and time lag were not calculated for two of the 10 wells monitored (B1A and H1) for the following reasons:

- Well B1A is screened in perched groundwater and is not tidally influenced.

- Well H1 is located immediately adjacent to well H10 and is similarly screened in the Upper Aquifer; a comparison of the hydrographs for these two wells (Figure 4-12) shows that they respond almost identically to tidal influences. Therefore, calculation of tidal efficiency and time lag for both wells would be redundant.

The stilling well installed in the Duwamish Waterway was used as the indicator of tidal fluctuations. Calculations of tidal efficiency and time lag were based on data collected on February 9 and 10, 1994. In order to negate the effects of barometrically induced water-level changes, the data used for the tidal efficiency calculations were corrected for barometric effects. Table 4-10 presents a summary of the calculated tidal efficiency and time lag results for the eight monitoring wells.

As expected, the tidal efficiency of wells screened in the same aquifer decreases with increasing distance from the Duwamish Waterway (or from Slip No. 6). Where there are paired wells screened in both the Upper and Lower Aquifers, the well efficiency for the Lower Aquifer well is always greater than for the Upper Aquifer well. This is consistent with the Facility hydrostratigraphic data indicating that the Lower Aquifer is confined. Well efficiencies are highest in the Lower Aquifer wells adjacent to the Duwamish Waterway (45 percent at DM-2B and 40 percent at DM-3B) and lowest (1 percent) in Upper Aquifer well DM-1A located at the east end of the Facility and distant from the Waterway.

Also as expected, the tidal lag time for wells screened in the same aquifer increases with distance from the Duwamish Waterway. Where there are paired wells screened in both the Upper and Lower Aquifers, the time lag for the Lower Aquifer well is significantly less than that observed for the Upper Aquifer well. The tidal time lag for the Lower Aquifer wells along the Duwamish Waterway (wells DM-2B and DM-3B) is nil, consistent with the hydrostratigraphic data indicating that the Lower Aquifer is confined.

Summary of Groundwater Flow Conditions. Groundwater levels in the Upper and Lower Aquifers oscillate constantly in response to tidal fluctuations in the Duwamish Waterway and Slip No. 6. The tidally induced groundwater-level fluctuations cause horizontal groundwater flow directions and gradients to change constantly. A 27-day groundwater elevation monitoring program was conducted at selected wells to establish the net groundwater flow direction and gradient in each aquifer. The results indicate that the net horizontal groundwater flow direction in the Lower Aquifer is from east to west under a hydraulic gradient of approximately 0.002 ft/ft (see Figure 4-26).

Under natural conditions, horizontal flow in the Upper Aquifer also appears to be from east to west under a hydraulic gradient of approximately 0.002 ft/ft, with Upper Aquifer groundwater ultimately discharging to the Duwamish Waterway or to Slip No. 6. The RFI groundwater elevation data support this assumption for the eastern two-thirds of the

Facility, where groundwater flows in a westerly direction. However, a north-south-oriented potentiometric trough is evident in the western third of the Facility (see Figure 4-20). The data suggest that horizontal groundwater in this western portion of the Facility converges from the west, south, and east and flows in a northerly direction. This northerly groundwater flow appears to be caused by the hydraulic influence of the groundwater extraction system that was in operation at the Kenworth site at the time the groundwater elevation data were collected.

The RFI groundwater elevation data indicate that the vertical hydraulic head potential between the Upper and Lower Aquifers is in the upward direction at all times, regardless of tide stage. The net vertical gradient across the Aquitard separating the Upper and Lower Aquifers ranges from 0.05 to 0.07 ft/ft, depending on location.

4.2 Soil Investigation

As discussed in Sections 2.1 and 2.3, soil samples were collected within each of the 10 soil investigation areas and the Background Area during the RFI. The analytical parameters for the soil samples were specific to each investigation area and included the previously identified preliminary constituents of concern. They were selected based on past Facility practices and the frequency with which they were detected in previous investigations. The parameters selected for each area include a subset of the following: inorganic constituents ("inorganics"), volatile organic compounds ("volatiles"), semivolatile organic compounds ("semivolatiles"), pesticides/PCBs, isopropyl alcohol, total petroleum hydrocarbons (TPH), and formaldehyde.

The results of the Round 1 soil sampling effort are summarized in Figures 4-31 through 4-41. Each figure contains an investigation area map showing the sampling locations and a table summarizing the analytical results. The table presents each detected parameter by chemical group and lists several statistics for that parameter, including the maximum and minimum value detected, the frequency of the detections, and the mean. (Nondetected values were included to calculate the mean and were assigned a value of one-half the method detection limit for this purpose.) The table in each figure also presents the action level for each constituent detected. As discussed earlier in this report, the action levels for soil are the state MTCA Method C cleanup levels. The results for specific samples and parameters are listed in the RFI database presented in Appendix D. (Note: Appendix D lists detected constituents only; nondetected constituents are not listed.)

The Round 2 soil data are summarized in Table 4-11. The results of the physical property tests conducted for soil are provided in Table 4-1 and Appendix H.

A photoionization detector (PID) was used to screen all samples for the presence of volatiles. A discrete sample (separate from that sent to the laboratory) was used for the PID monitoring; the results were recorded in the field logbooks with their corresponding depths.

The laboratory results for toluene were compared to PID field screening data, which are summarized in the plot shown in Figure 4-42. The comparison was conducted to determine if a correlation exists between PID readings and toluene data that would be helpful in further assessing the extent of toluene contamination. The relationship between the PID headspace measurements and laboratory analyses for toluene is relatively poor: a regression analysis of the PID headspace data and laboratory results for toluene yields an R-squared value of 0.27. (The R-squared value is an indicator of the reliability of the regression. The possible values range from 0 [no relationship between the two sets of variables] to 1 [a perfect relationship]). Therefore, PID readings alone do not appear to be a reliable indicator for the presence of toluene in soil.

As described in the RFI Workplan and Section 2.3 of this report, the initial soil sampling strategy called for only surface soil to be sampled in Areas A1, A3, A6, A8, A9, and A10. Areas A2, A4, A5, A7, and BG were to have both surface and subsurface samples collected during the RFI. The results of the surface sampling in Areas A1, A3, A6, A8, A9, and A10 are presented in Section 4.2.1. The results of the surface and subsurface sampling in the other areas are presented in Section 4.2.2. A complete listing of all constituents detected in each investigation area is presented in Figures 4-31 through 4-41. The discussions in Sections 4.2.1 and 4.2.2 do not address every constituent detected in each area, but focus on those constituents that:

- were previously identified as preliminary constituents of concern for soil (see Table 2-1);
- were found to exceed their respective action level at least once; or
- are otherwise noteworthy because of their toxicity, high frequency of detection, historical use at the Facility, or high concentration relative to conditions in Area BG (the Background Area).

The area-specific discussions address selected volatiles and semivolatiles (depending on concentration, frequency of detection, and toxicity), PCBs, TPH, formaldehyde, and isopropyl alcohol (2-propanol). Vanillin, a non-toxic compound, is included because it historically was produced at the Facility. Many of the inorganic constituents detected occur naturally in soil (e.g., aluminum, iron, magnesium, and calcium, among others); detection of these constituents was expected and does not typically indicate an anthropogenic source of contamination unless the concentrations are unusually high. As such, only three inorganic constituents are specifically addressed in Sections 4.1.2 and 4.2.2:

- **Arsenic**. Arsenic is addressed because it has been identified as a preliminary constituent of concern for soil (Table 2-1) and was detected once during the RFI at a concentration exceeding its action level of 57.1 mg/kg.

- **Copper**. Copper is addressed because it was detected in certain investigation areas at concentrations up to one to two orders of magnitude above the average concentration for investigation area BG.

- **Mercury**. Mercury is addressed because it was detected once during the RFI at a concentration above its action level of 96 mg/kg.

4.2.1 Surface Soil Samples

Seven surface soil samples were collected and analyzed in Round 1 from each of the investigation areas A1, A3, A6, A8, A9, and A10. Surface soil is defined as the first soil encountered following the removal of asphalt or concrete paving, debris, or grass at each location (see Section 2.3.1). Samples from a depth interval of 0 to 2 feet below ground surface (bgs) were collected from Area A6 during Round 2. The detected constituents of concern within each investigation area and comparisons with their respective action levels are presented in the following subsections.

Area A1

The seven soil samples collected in Area A1, the Boneyard/Distribution Center, were analyzed for inorganics, volatiles, semivolatiles, and formaldehyde. The sampling locations, analytical results, and comparisons to action levels are presented in Figure 4-31 and Appendix D.

Following is a summary of the soil results for Area A1:

- **Inorganics**. Arsenic, copper, and mercury were detected as follows:

  - Arsenic—detected in all seven samples at concentrations ranging from 2.1 to 7.6 mg/kg, below the action level of 57.1 mg/kg.

  - Copper—detected in six samples at concentrations ranging from 15.1 to 6,850 mg/kg, below the action level of 11,800 mg/kg.

  - Mercury—detected in three samples at concentrations ranging from 0.29 to 0.45 mg/kg, below the action level of 96 mg/kg.

- **Volatiles**. Three volatiles were detected as follows:

  - 2-Butanone—detected in one sample at 0.002 mg/kg, below the action level of 192,000 mg/kg.

  - Acetone—detected in two samples at 0.003 and 0.004 mg/kg, below the action level of 32,000 mg/kg.

- **Copper**. Copper is addressed because it was detected in certain investigation areas at concentrations up to one to two orders of magnitude above the average concentration for investigation area BG.

- **Mercury**. Mercury is addressed because it was detected once during the RFI at a concentration above its action level of 96 mg/kg.

4.2.1 Surface Soil Samples

Seven surface soil samples were collected and analyzed in Round 1 from each of the investigation areas A1, A3, A6, A8, A9, and A10. Surface soil is defined as the first soil encountered following the removal of asphalt or concrete paving, debris, or grass at each location (see Section 2.3.1). Samples from a depth interval of 0 to 2 feet below ground surface (bgs) were collected from Area A6 during Round 2. The detected constituents of concern within each investigation area and comparisons with their respective action levels are presented in the following subsections.

Area A1

The seven soil samples collected in Area A1, the Boneyard/Distribution Center, were analyzed for inorganics, volatiles, semivolatiles, and formaldehyde. The sampling locations, analytical results, and comparisons to action levels are presented in Figure 4-31 and Appendix D.

Following is a summary of the soil results for Area A1:

- **Inorganics**. Arsenic, copper, and mercury were detected as follows:

  - Arsenic—detected in all seven samples at concentrations ranging from 2.1 to 7.6 mg/kg, below the action level of 57.1 mg/kg.

  - Copper—detected in six samples at concentrations ranging from 15.1 to 6,850 mg/kg, below the action level of 11,800 mg/kg.

  - Mercury—detected in three samples at concentrations ranging from 0.29 to 0.45 mg/kg, below the action level of 96 mg/kg.

- **Volatiles**. Three volatiles were detected as follows:

  - 2-Butanone—detected in one sample at 0.002 mg/kg, below the action level of 192,000 mg/kg.

  - Acetone—detected in two samples at 0.003 and 0.004 mg/kg, below the action level of 32,000 mg/kg.

- **Volatiles**. Three volatiles were detected as follows:

  - Methylene chloride—detected in two samples; concentrations ranged from 0.002 to 0.004, below the action level of 5,330 mg/kg.

  - Acetone—detected in two samples at 0.004 mg/kg each, below the action level of 32,000 mg/kg.

  - Toluene—detected in four samples; concentrations ranged from 0.003 to 0.019, below the action level of 64,000 mg/kg.

- **PCBs**. Aroclor-1254 was detected in all of the four samples collected; concentrations ranged from 0.23 to 2.8 mg/kg, below the action level of 5.19 mg/kg.

- **TPH**. TPH was detected in three of the seven samples analyzed; concentrations ranged from 88.8 to 635 mg/kg. While there is no MTCA Method C cleanup level for TPH, the MTCA Method A cleanup level is 200 mg/kg. The TPH concentration in one sample exceeded this criterion (A03-02-01 at 635 mg/kg).

Area A3 Summary: While PCBs, metals, and volatiles were detected, none of the concentrations exceeded its respective action level (the MTCA Method C cleanup level). The TPH concentration in one sample exceeded the MTCA Method A cleanup level of 200 mg/kg; TPH in soil is discussed further in Section 4.2.3.

Area A6

The seven soil samples collected during Round 1 in Area A6, the Maintenance Shop Area, were analyzed for inorganics, volatiles, formaldehyde, and TPH. The sampling locations, analytical results, and comparisons to action levels are presented in Figure 4-36 and Appendix D.

Following is a summary of the Round 1 soil results for Area A6:

- **Inorganics**. Arsenic, copper, and mercury were detected as follows:

  - Arsenic—detected in all seven samples at concentrations ranging from 1.1 to 6.7 mg/kg, below the action level of 57.1 mg/kg.

  - Copper—detected in five of the samples at concentrations ranging from 57.9 to 712 mg/kg, below the action level of 11,800 mg/kg.

  - Mercury—detected in five samples at concentrations ranging from 0.62 to 268 mg/kg. The mercury concentration in sample A06-03-01

was 268 mg/kg, higher than the action level of 96 mg/kg. The concentrations detected in the remaining four samples were below the action level.

- **Volatiles**. Two volatiles were detected as follows:

  - Acetone—detected in one sample at 0.003 mg/kg, below the action level of 32,000 mg/kg.

  - Toluene—detected in five samples at concentrations ranging from 0.002 to 0.025, below the action level of 64,000 mg/kg.

- **Formaldehyde**. Formaldehyde was detected in six samples at concentrations ranging from 0.19 to 0.94 mg/kg, below the action level of 64,000 mg/kg.

- **TPH**. TPH was detected in three samples; concentrations ranged from 92.7 to 645 mg/kg. While there is no MTCA Method C cleanup level for TPH, the MTCA Method A cleanup level is 200 mg/kg. TPH concentrations in two samples exceeded this criterion (A06-01-01 at 645 mg/kg and A06-05-01 at 227 mg/kg).

Only one sample from investigation area A6 exceeded its respective action level—sample A06-03-01, with a mercury concentration of 268 mg/kg (the MTCA Method C level is 96 mg/kg). None of the other six samples analyzed exceeded the action level or even the more restrictive MTCA Method B cleanup level of 24 mg/kg. Because of the one exceedance of the action level, mercury was targeted for additional sampling in Round 2. Unlike arsenic and PAHs, which are known to be present regionally at relatively high concentrations, high mercury concentrations were unexpected and appeared to warrant further investigation. Based on historical information, the only potential source of the mercury detected would have been the former Maintenance Shop, where mercury-containing instruments were likely used. A release from a broken instrument is a possible explanation for the one elevated mercury concentration.

Additional soil sampling was undertaken during Round 2, on August 10, 1994, to confirm the presence of mercury in the vicinity of sampling location A06-03 and to determine its possible distribution in Area A6. Sixty-eight samples were collected from 34 locations. These consisted of 34 surface samples (from 0 to 0.5 foot bgs) and 34 subsurface samples (from 1.5 to 2.0 feet bgs). Of these, 38 samples (34 surface and 4 subsurface) were analyzed for mercury. None of these additional samples indicated mercury concentrations above the action level. Eight of the 38 samples analyzed were taken from the corners of a four-foot-sided square centered on the approximate location of sample A06-03; these samples were taken at the surface and at 1.5 feet bgs. The mercury concentrations of these eight samples ranged from 0.05 mg/kg to 7.0 mg/kg, significantly below the MTCA Method C action level of 96 mg/kg (see Figure 4-43). The remaining 30 subsurface samples were not analyzed because the surface samples collected at the same locations did not

indicate mercury above either the action level or the MTCA Method B cleanup level (24 mg/kg). The analytical results are presented in Table 4-12 and Figure 4-43.

Area A6 Summary: While metals, volatiles, and semivolatiles were detected in the Round 1 soil investigation, only one sample exceeded its respective action level—sample A06-03-01, with a mercury concentration of 268 mg/kg exceeding the MTCA Method C cleanup level of 96 mg/kg. Mercury was targeted for additional sampling that was conducted during Round 2, but the analytical results did not indicate mercury above either its action level or the more restrictive MTCA Method B cleanup level. TPH concentrations in two samples exceeded the MTCA Method A cleanup level of 200 mg/kg. Mercury and TPH in soils are discussed further in Section 4.2.3.

Area A8

Seven soil samples collected in Area A8, the Maintenance Shop Area, were analyzed for inorganics, volatiles, and TPH. The sampling locations, analytical results, and comparisons to action levels are presented in Figure 4-38 and Appendix D.

Following is a summary of the soil results for Area A8:

- **Inorganics**. Arsenic, copper, and mercury were detected as follows:
  - Arsenic—detected in all seven samples at concentrations ranging from 2.6 to 24.7 mg/kg, below the action level of 57.1 mg/kg.
  - Copper—detected in six samples at concentrations ranging from 23.3 to 391 mg/kg, below the action level of 11,800 mg/kg.
  - Mercury—detected in six samples at concentrations ranging from 0.13 to 4.3 mg/kg, below the action level of 96 mg/kg.
- **Volatiles**. Two volatiles were detected as follows:
  - Methylene chloride—detected in four samples at concentrations ranging from 0.001 to 0.0040 mg/kg, below the action level of 5,330 mg/kg.
  - Toluene—detected in one sample at a concentration of 0.001 mg/kg, below the action level of 64,000 mg/kg.
- **TPH**. TPH was detected in two samples at 151 mg/kg and 338 mg/kg. While there is no MTCA Method C cleanup level for TPH, the MTCA Method A cleanup level for industrial soil is 200 mg/kg. TPH concentrations in one sample exceeded this criterion (A08-06-01 at 338 mg/kg).

Area A8 Summary: While metals, volatiles, and TPH were detected, no metals or volatiles exceeded their respective MTCA Method C cleanup levels. TPH was detected in one sample at a concentration above the MTCA Method A cleanup level; TPH in soil is discussed further in Section 4.2.3.

Area A9

Seven soil samples collected in Area A9, the Non-Process Area, were analyzed for inorganics and volatiles. The sampling locations, analytical results, and comparisons to action levels are presented in Figure 4-39 and Appendix D.

Following is a summary of the soil results for Area A9:

- **Inorganics.** Arsenic, copper, and mercury were detected as follows:
  - Arsenic—detected in all seven samples at concentrations ranging from 2.3 to 11.2 mg/kg, below the action level of 57.1 mg/kg.
  - Copper—detected in five samples at concentrations ranging from 22.3 to 1,670 mg/kg, below the action level of 11,800 mg/kg.
  - Mercury—detected in three samples at concentrations ranging from 0.16 to 0.94 mg/kg, below the action level of 96 mg/kg.
- **Volatiles.** Three volatiles were detected as follows:
  - Acetone—detected in one sample at a concentration of 0.012 mg/kg, below the action level of 32,000 mg/kg.
  - Methylene chloride—detected in two samples, both at concentrations of 0.002 mg/kg, below the action level of 5,330 mg/kg.
  - Toluene—detected in two samples at concentrations of 0.012 mg/kg and 0.025 mg/kg, below the action level of 64,000 mg/kg.

Area A9 Summary: Metals and volatiles were detected, but no constituent exceeded its respective action level (the MTCA Method C cleanup level). No further sampling was conducted in Area A9 during Round 2.

Area A10

Twenty soil samples collected in Area A10, the Spill Control Reservoir and Sumps, were analyzed for inorganics and volatiles. The sampling locations, analytical results, and comparisons to action levels are presented in Figure 4-40 and Appendix D.

Following is a summary of the soil results for Area A10:

- **Inorganics.** Arsenic, copper, and mercury were detected as follows:

  - Arsenic—detected in 19 samples at concentrations ranging from 1.2 to 61.4 mg/kg. The concentration of 61.4 mg/kg was detected in one sample (A10MS0301), and this exceeds the action level of 57.1 mg/kg. The concentrations detected in the remaining 18 samples (the maximum was 54.3 mg/kg) were below the action level.

  - Copper—detected in all 20 samples at concentrations ranging from 61.7 to 2,580 mg/kg, below the action level of 11,800 mg/kg.

  - Mercury—detected in all 20 samples at concentrations ranging from 0.10 to 4.2 mg/kg, below the action level of 96 mg/kg.

- **Volatiles.** Seven volatiles were detected as follows:

  - 2-Butanone—detected in one sample at a concentration of 0.003 mg/kg, below the action level of 192,000 mg/kg.

  - Acetone—detected in two samples at a concentration of 0.002 mg/kg and 0.004 mg/kg, below the action level of 32,000 mg/kg.

  - Carbon disulfide—detected in three samples, all at a concentration of 0.002 mg/kg, below the action level of 32,000 mg/kg.

  - Ethylbenzene—detected in one sample at a concentration of 0.11 mg/kg, below the action level of 32,000 mg/kg.

  - Toluene—detected in 10 samples at concentrations ranging from 0.001 to 4.50 mg/kg, below the action level of 64,000 mg/kg.

  - Trichloroethene—detected in five samples at concentrations ranging from 0.001 to 0.009 mg/kg, below the action level of 3,640 mg/kg.

  - Xylene (total)—detected in six samples at concentrations ranging from 0.001 to 0.41 mg/kg, below the action level of 640,000 mg/kg.

Area A10 Summary: None of the constituents detected exceeded its respective action level (the MTCA Method C cleanup level), with the exception of arsenic in one sample. No further sampling was conducted in Area A10 because the widespread distribution of arsenic in surface and subsurface soils at the Facility and in the vicinity has already been established. A discussion of the regional occurrence of arsenic is presented in Appendix J.

4.2.2 Surface and Subsurface Soil Samples

Soil samples were collected from Areas A2, A4, A5, A7, and BG during Round 1. The number of samples collected and analyzed for each area ranged from seven to 36. Samples were collected from both surface and subsurface depth intervals during Round 1 in all the areas except A5. Surface soil is defined as the first soil encountered following the removal of asphalt or concrete paving, debris, or grass at each location (see Section 2.3.1). Initially, during Round 1, only surface soil samples were collected from Area A5; in Round 2, additional samples from both the surface and subsurface soil zones in the area were collected and analyzed.

The detected constituents of concern within each investigation area and comparisons with their respective action levels are presented in the following subsections.

Area A2

Thirty-six soil samples collected from 14 sampling locations in Area A2, the Vanillin Production Area, were analyzed for inorganics, volatiles, and semivolatiles. Twenty-nine of the samples were analyzed for isopropyl alcohol, and four for formaldehyde. The sampling locations, analytical results, and comparisons to action levels are presented in Figure 4-32 and Appendix D.

Following is a summary of the soil results for Area A2:

- **Inorganics**. Arsenic, copper, and mercury were detected as follows:
  - Arsenic—detected in 35 samples at concentrations ranging from 1.2 to 5.6 mg/kg, below the action level of 57.1 mg/kg.
  - Copper—detected in 10 samples at concentrations ranging from 33.4 to 563 mg/kg, below the action level of 11,800 mg/kg.
  - Mercury—detected in five samples at concentrations ranging from 0.13 to 0.62 mg/kg, below the action level of 96 mg/kg.
- **Volatiles**. Eight volatiles were detected. The results for the constituents detected most frequently are summarized as follows:
  - 2-Butanone—detected in 12 samples at concentrations ranging from 0.004 to 0.039 mg/kg, below the action level of 192,000 mg/kg.
  - Acetone—detected in 17 samples at concentrations ranging from 0.006 to 4.8 mg/kg, below the action level of 32,000 mg/kg.

- Toluene—detected in 34 samples at concentrations ranging from 0.002 to 3,600 mg/kg, below the action level of 64,000 mg/kg.

- **Semivolatiles**. Twenty-four semivolatiles were detected. The results for the constituents detected most frequently are summarized as follows:

  - PAHs—fourteen PAHs were detected. Chrysene, fluoranthene, naphthalene, phenanthrene, phenol, and pyrene were detected most frequently (three to nine times out of 36 samples analyzed). The other PAHs were detected only once or twice in the 36 samples analyzed. None of the PAHs detected exceeded its respective action level.

  - Pentachlorophenol—detected in four samples at concentrations ranging from 0.04 to 0.2 mg/kg, below the action level of 333 mg/kg.

  - Methylphenols—2-methylphenol and 4-methylphenol were detected in 12 and 13 samples, respectively, at concentrations ranging from 0.082 to 7.5 mg/kg, below the action level of 16,000 mg/kg for each compound.

- **Isopropyl alcohol**. Isopropyl alcohol was detected in one of the 29 samples analyzed at a concentration of 10 mg/kg. There is no MTCA Method C cleanup level for isopropyl alcohol.

- **Formaldehyde**. Formaldehyde was detected in all four of the samples analyzed; concentrations ranged from 0.34 to 3.4 mg/kg, below the action level of 64,000 mg/kg.

Area A2 Summary: Toluene was the most frequently detected organic compound in soil, detected in 34 of the 36 samples at concentrations ranging from 0.002 to 3,600 mg/kg. However, none of the samples exceeded the action level (the MTCA Method C cleanup level) for toluene (64,000 mg/kg). Because toluene was identified as a preliminary constituent of concern and because it was detected in groundwater (as discussed in Section 4.3), Figure 4-44 was developed to provide a visual representation of the Round 1 toluene concentrations as a function of depth in Area A2. The figure shows that the concentration of toluene was greater in samples collected from soil borings 09, 11, 12, and 13, which are located in the western portion of the Vanillin Production Area.

While metals, volatiles, semivolatiles, and other constituents (including toluene) were detected in Area A2, none of the concentrations exceeded their respective action levels (the MTCA Method C cleanup levels). No additional samples were collected from Area A2 during Round 2.

Area A4

Thirty-one soil samples were collected during Round 1 from the 13 HydroPunch sampling locations in Area A4 and analyzed for inorganics, volatiles, and semivolatiles. The Round 1 sampling locations, analytical results, and comparisons to action levels are presented in Figure 4-34 and Appendix D.

During Round 2, two samples were collected from each of two additional borings (A04-30 and A04-31—see Figure 4-34) that were drilled to collect additional soil samples for toluene and total recoverable petroleum hydrocarbon (TRPH) analyses. The additional Round 2 soil sampling was conducted to further evaluate the extent of toluene in soil and mineral oil in the Unsaturated Zone, using TRPH as a possible indicator of petroleum product. The TRPH analyses were conducted to assess the potential presence of LNAPL at the capillary fringe at the base of the Unsaturated Zone. The Round 2 toluene and TRPH results are shown in Table 4-13.

Following is a summary of the Round 1 soil results for Area A4:

- **Inorganics**. Arsenic, copper, and mercury were detected as follows:
  - Arsenic—detected in all 31 samples at concentrations ranging from 0.98 to 6.8 mg/kg, below the action level of 57.1 mg/kg.
  - Copper—detected in 18 samples at concentrations ranging from 8.5 to 75 mg/kg, below the action level of 11,800 mg/kg.
  - Mercury—detected in three samples at concentrations ranging from 0.27 to 0.4 mg/kg, below the action level of 96 mg/kg.
- **Volatiles**. Ten volatiles were detected. The results for the constituents detected most frequently are summarized as follows:
  - 2-Butanone—detected in 11 samples at concentrations ranging from 0.005 to 1.1 mg/kg, below the action level of 192,000 mg/kg.
  - Acetone—detected in 23 samples at concentrations ranging from 0.007 to 13 mg/kg, below the action level of 32,000 mg/kg.
  - Toluene—detected in 28 samples at concentrations ranging from 0.001 to 4,900 mg/kg, below the action level of 64,000 mg/kg.

- **Semivolatiles.** Twenty-four semivolatiles were detected. The results for the constituents detected most frequently are summarized as follows:

  - PAHs—fifteen PAHs were detected. Benz(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, naphthalene, phenanthrene, 2-methylnaphthalene, and pyrene were detected most frequently (three to five times out of 31 samples analyzed). The other PAHs were detected only once or twice in the 31 samples analyzed. None of the PAHs detected exceeded its respective action level.

  - Pentachlorophenol—detected in six samples at concentrations ranging from 0.055 to 4.8 mg/kg, below the action level of 333 mg/kg.

  - Vanillin—detected in one sample at a concentration of 0.68 mg/kg. There is no MTCA Method C cleanup level for vanillin.

  - Methylphenols—2-methylphenol and 4-methylphenol were detected eight and 10 times, respectively, in the 31 samples analyzed. Concentrations ranged from 0.04 to 5.7, mg/kg, below the action level of 16,000 mg/kg for each compound.

  - Bis(2-ethylhexyl)phthalate—detected in 12 samples at concentrations ranging from 0.051 to 6.8 mg/kg, below the action level of 2,860 mg/kg.

The most frequently detected compound in Area A4 was toluene, which was detected in 28 of the 31 samples analyzed with concentrations ranging from 0.001 to 4,900 mg/kg. Because toluene was identified as a preliminary constituent of concern, and because it was detected in groundwater (as discussed in Section 4.3), Figure 4-44 was developed to provide a visual presentation of the Round 1 toluene concentration as a function of depth for soil in Area A4. The figure shows that the concentration of toluene is generally greater in samples taken from 5 feet bgs than from shallower depths, particularly for samples collected from soil borings A04-01 through A04-07.

As discussed earlier, two samples were collected in Round 2 from each of the soil borings A04-30 and A04-31, in order to further assess the extent of toluene and mineral oil (as indicated by TRPH analyses—see Section 2.3.1 for a discussion of the TRPH method and the distinction between TRPH and TPH). The results are presented in Table 4-13. Consistent with the Round 1 results, toluene was detected in all four of the Round 2 samples. The highest concentration detected was 1.9 mg/kg, below the action level of 64,000 mg/kg.

TRPH was detected in three of the four samples collected from borings A04-30 and A04-31. Where detected, concentrations ranged from 43 to 380 mg/kg. Two TRPH samples (A04-30-02 and A04-31-02) were collected at depths ranging from 10 to 13 feet bgs, the approximate depth of the capillary fringe and the depth where LNAPL floating on the

capillary fringe would occur if present. Of these two, TRPH was not detected in sample A04-30-02 and was detected at 43 mg/kg in sample A04-31-02. This detected concentration is relatively low and is inconsistent with a floating LNAPL condition where the soil pore space is saturated with oil.

Area A4 Summary: While metals, volatiles, and semivolatiles were detected in Area A4, none of the concentrations exceeded its respective action level (the MTCA Method C cleanup level). TPH (as indicated by TRPH analyses) was detected in three of the four samples analyzed. While there is no MTCA Method C cleanup level for TPH, the MTCA Method A cleanup level for TPH is 200 mg/kg. TPH concentrations in one sample exceeded this criterion (A04-31-01 at 380 mg/kg). TPH in soil is discussed further in Section 4.2.3.

Area A5

Seven surface soil samples collected in Area A5, the Tank Farm, were analyzed during Round 1 for inorganics, volatiles, pesticides/PCBs, and formaldehyde. Three of the seven samples were analyzed for semivolatiles. The Round 1 sampling locations, analytical results, and comparisons to action levels are presented in Figure 4-35 and Appendix D.

During Round 2, 11 samples were collected from five additional borings (Borings A05-10 through A05-14—see Figure 4-35) that were drilled to collect additional soil samples for toluene and TRPH analyses. As described earlier under Area A4, the additional Round 2 soil sampling was conducted to further evaluate the extent of toluene in soil and mineral oil in the Unsaturated Zone. The Round 2 toluene and TRPH results are shown in Table 4-13.

Following is a summary of the Round 1 soil results for Area A5:

- **Inorganics.** Arsenic, copper, and mercury were detected as follows:
  - Arsenic—detected in all seven samples at concentrations ranging from 0.5 to 6.4 mg/kg, below the action level of 57.1 mg/kg.
  - Copper—detected in five samples at concentrations ranging from 49.6 to 749 mg/kg, below the action level of 11,800 mg/kg.
  - Mercury—detected in two samples at concentrations ranging from 0.29 to 0.4 mg/kg, below the action level of 96 mg/kg.
- **Volatiles.** Four volatiles were detected. 2-Butanone, carbon disulfide, and trichloroethene were each detected once at concentrations well below their action levels. Toluene was detected in three of the samples at concentrations ranging from 0.003 to .044 mg/kg, below the action level of 64,000 mg/kg.

- **Pesticides.** Thirteen pesticides were detected as shown in Figure 4-35. 4,4-DDD, 4,4-DDE, 4,4-DDT, endosulfan II, endrin, and endrin aldehyde were detected in four of the seven samples analyzed. The other pesticides were detected in less than one-half the samples. None of the pesticides detected exceeded its respective action level.

- **PCBs.** Aroclor-1254 was detected in one sample at 0.65 mg/kg, below the action level of 5.19 mg/kg.

- **Formaldehyde.** Formaldehyde was detected in all seven samples at concentrations ranging from 0.049 to 3.3 mg/kg, below the action level of 64,000 mg/kg.

- **Semivolatiles.** Eight semivolatiles were detected. The results are summarized as follows:

  - Bis(2-ethylhexyl)phthalate—detected in two of the three samples collected at concentrations 0.044 mg/kg in both samples, below the action level of 2,860 mg/kg.

  - PAHs—Seven PAHs were detected in one of the three samples collected (sample A05-07-01). Benz(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene were detected at concentrations less than their respective action levels.

As discussed earlier, 11 samples were collected from five borings during Round 2 to further assess the extent of toluene and mineral oil (as indicated by TRPH analyses). The sampling depth intervals varied from a minimum of 0 to 2 feet to a maximum of 11 to 13 feet. The results are presented in Table 4-13. Consistent with the Round 1 results, toluene was detected in most of the samples (nine) at concentrations ranging up to 29 mg/kg, below the action level of 64,000 mg/kg.

TRPH was detected in only one sample (sample A05-10-02, at a depth interval of 3 to 5 feet—see Figure 4-35 and Table 4-13), at a concentration of 8,200 mg/kg. Four of the 11 samples analyzed for TRPH were collected from or near the capillary fringe (at depths of 10 to 13 feet). No detectable TRPH was identified in any of these samples, suggesting that a floating LNAPL condition does not exist at these locations.

Area A5 Summary: While metals, volatiles, pesticides, PCBs, and semivolatiles were detected in Area A5, none of the concentrations exceeded its respective action level (the MTCA Method C cleanup level). TPH (as indicated by TRPH analyses) was detected in one of the 11 Round 2 samples. While there is no MTCA Method C cleanup level for TPH, the MTCA Method A cleanup level for TPH is 200 mg/kg. The concentration of the single TPH detection exceeded this criterion (A05-10-02 at 8,200 mg/kg). TPH in soil is discussed further in Section 4.2.3.

Area A7

Thirteen soil samples collected from seven locations in Area A7, the Former Railroad Loading/Unloading Area, were analyzed for inorganics and volatiles. The sampling locations, analytical results, and comparisons to action levels are presented in Figure 4-37 and Appendix D.

Following is a summary of the soil results for Area A7:

- **Inorganics**. Arsenic, copper, and mercury were detected as follows:
  - Arsenic—detected in all 13 samples at concentrations ranging from 0.98 to 7.0 mg/kg, below the action level of 57.1 mg/kg.
  - Copper—detected in seven samples at concentrations ranging from 45.9 to 269 mg/kg, below the action level of 11,800 mg/kg.
  - Mercury—detected in seven of the 13 samples at concentrations ranging from 0.13 to 6.4 mg/kg, below the action level of 96 mg/kg.
- **Volatiles**. Six volatiles were detected as follows:
  - 2-Butanone—detected in three samples at concentrations ranging from 0.004 to 0.013 mg/kg, below the action level of 192,000 mg/kg.
  - Acetone—detected in nine samples at concentrations ranging from 0.003 to 0.083 mg/kg, below the action level of 32,000 mg/kg.
  - Carbon disulfide—detected in one sample at a concentration of 0.006 mg/kg, below the action level of 32,000 mg/kg.
  - Toluene—detected in two samples at concentrations of 0.001 mg/kg and 0.047 mg/kg, below the action level of 64,000 mg/kg.
  - Trichloroethene—detected in one sample at a concentration of 0.001 mg/kg, below the action level of 3,640 mg/kg.

Area A7 Summary: While detectable levels of metals and volatiles occurred, none exceeded its respective action level (the MTCA Method C cleanup level). No further sampling was conducted in Area A7 during Round 2.

Area BG

Fourteen soil samples were collected at seven locations in Area BG, the Background Area, and analyzed for inorganics, volatiles, semivolatiles, and formaldehyde. The sampling

locations, analytical results, and comparisons to action levels are presented in Figure 4-41 and Appendix D.

Following is a summary of the soil results for Area BG:

- **Inorganics**. Arsenic, copper, and mercury were detected as follows:

  - Arsenic—detected in all 14 samples at concentrations ranging from 1.85 to 10.4 mg/kg, below the action level of 57.1 mg/kg.

  - Copper—detected in two samples at concentrations ranging from 7.3 to 17.4 mg/kg, below the action level of 11,800 mg/kg.

  - Mercury—detected in one sample at a concentration of 0.12 mg/kg, below the action level of 96 mg/kg.

- **Volatiles**. Three volatiles were detected as follows:

  - 2-Butanone—detected in two samples at concentrations of 0.0040 mg/kg and 0.018 mg/kg, below the action level of 192,000 mg/kg.

  - Acetone—detected in three samples at concentrations ranging from 0.003 to 0.087 mg/kg, below the action level of 32,000 mg/kg.

  - Toluene—detected in all 14 samples at concentrations ranging from 0.001 to 0.018 mg/kg, below the action level of 64,000 mg/kg.

- **Semivolatiles**. Three semivolatiles were detected as follows:

  - PAHs—eleven PAHs were detected in one sample, and five of the same PAHs were detected in another sample. The PAHs detected were anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene. The detected concentrations for PAHs were all below their respective action levels.

  - Bis(2-ethylhexyl)phthalate—detected in three samples at concentrations ranging from 0.06 to 1.1 mg/kg, below the action level of 2,860 mg/kg.

  - Carbazole—detected in one sample at a concentration of 0.053 mg/kg, below the action level of 2,000 mg/kg.

- **Formaldehyde**. Formaldehyde was detected in all 14 samples at concentrations ranging from 0.26 to 15 mg/kg, below the action level of 64,000 mg/kg.

Area BG Summary: While metals, volatiles, and semivolatiles were detected, none exceeded its respective action level (the MTCA Method C cleanup level). Both arsenic and PAHs were detected in Area BG; this was not unexpected because it has been established that arsenic and PAHs are present throughout the region and are not related to past activities at the RPI Facility (see Appendix J).

4.2.3 Soil Investigation Summary

As discussed in Section 2.1, the RFI Workplan identified and discussed a number of preliminary chemicals of concern based on past Facility practices and historical data collected by Dames & Moore (1986) and Landau Associates (1991). The RFI soil sampling and analytical program was tailored to evaluate the presence and extent of these constituents.

The preliminary constituents of concern for soil included arsenic, formaldehyde, PAHs, PCBs, vanillin, and toluene. Although these constituents were detected in a number of soil samples analyzed in Round 1 of the RFI, the action level (the MTCA Method C cleanup level) was not exceeded for any of these constituents, with one exception for arsenic. Arsenic was detected in one sample collected from Area A10 at a concentration (61.4 mg/kg) that slightly exceeds the action level of 57.1 mg/kg. Arsenic is known to be present regionally at elevated concentrations, and an exceedance of the MTCA Method C cleanup level is consistent with conditions at other sites in the vicinity of the RPI Facility and in the region generally (see Appendix J).

The only other constituent detected above action levels was mercury, which was not cited as a preliminary constituent of concern because its use was not associated with past practices at the Facility. Mercury was found to be present in one Round 1 sample from Area A6 (sample A06-03—see Figure 4-43) at a concentration (268 mg/kg) exceeding the action level of 96 mg/kg. During Round 2, 38 additional samples from the immediate vicinity of that sample were analyzed for the purpose of confirming the Round 1 mercury result and to identify its potential extent. Neither the action level nor the more restrictive MTCA Method B cleanup level for mercury was exceeded in any of the 38 samples analyzed during Round 2. Based on the results of the intensive Round 2 sampling and analysis program, mercury was not identified at concentrations exceeding the action level, and the Round 1 exceedance could not be confirmed. Therefore, the single Round 1 exceedance of the mercury action level is considered an anomalous result and does not warrant further investigation or action.

The possible presence of a significant LNAPL layer (consisting primarily of mineral oil) in Area A4 was also identified as a potential concern in the RFI Workplan. The RFI soil and groundwater investigations were designed to identify LNAPL present at saturation, or near-saturation, levels in the soil pore space. The soil sampling results (based on TRPH data collected during Round 2 in Areas A4 and A5) indicate that the soil pore space does not contain the large quantities of petroleum product that would be characteristic of a floating LNAPL condition. This finding is consistent with the findings of the groundwater

investigation (see Section 4.3.4) and the LNAPL monitoring program that is conducted monthly at onsite monitoring wells as an Interim Measure at the Facility.

Data for soil samples collected from the Background Area (Area BG) were also compared to data collected from the other 10 soil investigation areas. Table 4-14 presents a summary of this comparison for selected constituents. As discussed in the RFI Workplan, one objective of the soil investigation in Area BG was to assess the presence of arsenic and PAHs that may represent background conditions (i.e., conditions not attributable to past operations at the Facility). Pre-RFI investigations had indicated the presence in soil of arsenic and the PAHs benzo(a)pyrene, chrysene, benz(a)anthracene, and benzo(k)fluoranthene, none of which was associated with past Facility activities. A comparison of the RFI soil data for Area BG with RFI data for the other areas showed that:

- Arsenic was detected in Area BG at concentrations that were comparable to the concentrations detected in the other 10 areas. These findings are consistent with the belief that arsenic is a regional background constituent (as discussed in detail in Appendix J) and its presence is not attributable to Facility activities.

- PAHs were also detected in Area BG, but at a lower frequency and a slightly lower average concentration. Like arsenic (and as discussed in Appendix J), PAHs are also known to be present regionally in soils. Therefore, while PAH concentrations in Area BG were slightly lower than those detected in other areas, these findings are consistent with the belief that PAHs are regional background constituents and are not attributable to Facility activities.

The RFI Workplan also indicated that formaldehyde, while known to have been in limited use at the Facility, was also suspected of being a background contaminant. Formaldehyde detections are also suspect due to historical difficulties in analytical detection methods. The Workplan noted that comparison of formaldehyde detections in Area BG to the other areas where it was known to have been used or stored (Areas A1, A5, and A6) was an objective of the RFI. The analytical results show that formaldehyde was detected at all seven locations in Area BG. A comparison of these results with the results from the other areas indicates that:

- The frequency of detections in Area BG was similar to the frequency in the other areas.

- The maximum and the mean concentrations detected in Area BG were higher than those in any of the other areas where formaldehyde was known to have been used.

These findings suggest that formaldehyde is likely a background contaminant, especially considering the fact that the highest concentrations of formaldehyde were detected in Area BG, where no use or handling of formaldehyde is known to have occurred.

Based on past operations at the Facility, toluene had been identified as the principal constituent of concern, particularly in Areas A2 and A4. Although toluene was not detected anywhere in soil at concentrations that exceeded its action level, toluene was detected above its action level in groundwater (see Section 4.3).

The locations, vertical extent, and magnitude of toluene-contaminated soil in Areas A2 and A4 were compared to the location of toluene-contaminated groundwater. This qualitative comparison was conducted to assess whether toluene-contaminated soil might be the source of toluene in groundwater (see Section 4.3). Figure 4-45 is a concentration contour map for toluene in soil in Areas A2 and A4. The area of toluene contamination in Area A2 appears to be centered beneath the former location of the building where toluene/bisulfite extraction was conducted. This is consistent with the fact that, historically, the majority of toluene usage was concentrated in this area. The most contaminated soils are generally present in the upper 7 feet of the subsurface within the Unsaturated Zone, and concentrations generally decrease with depth (see Figure 4-44). Groundwater beneath the Area A2 soil contamination is not affected by toluene based on the groundwater sampling conducted to date (see Section 4.3). This is consistent with the data shown in Figure 4-44 indicating that toluene concentrations decrease with depth approaching the groundwater table. In addition, the presence of low-permeability layers in the Unsaturated Zone of this area (Figures 4-6 and 4-8) may restrict toluene to shallower depths.

In contrast to Area A2, RFI data indicate that toluene concentrations in soil in Area A4 do not typically decrease with depth. Toluene concentrations in soil at depths below 9 feet, closer to the groundwater table, are similar to the concentrations detected at shallower depths (Figure 4-44). This area of toluene-contaminated soil coincides with the groundwater toluene plume (as shown in Figure 4-45 and discussed further in Section 4.3) and suggests that toluene-contaminated soil may be, at least to some extent, the source of toluene in groundwater. Any CMS evaluations addressing groundwater remediation may also consider the need to remediate Unsaturated Zone soils to better ensure the effectiveness and permanence of any groundwater remediation.

In summary, no constituent detected in soil at the Facility warrants inclusion in the Risk Assessment/MCS evaluation because of an exceedance of an action level. Although arsenic and mercury were detected once each at concentrations above their respective action levels, their inclusion in the Risk Assessment/MCS evaluation is not warranted. Arsenic is known to be regionally present at elevated concentrations, and the single exceedance of the action level is consistent with this condition (see Appendix J). Further, the concentration for the sample (61.4 mg/kg) exceeded the action level (57.1 mg/kg) by only a few milligrams per kilogram. An extensive sampling and analysis effort conducted during Round 2 failed to confirm the presence of mercury above its action level in Area A6. In addition, the Round 2 sampling indicated that mercury was not present above the more restrictive MTCA Method B cleanup level.

As discussed earlier, there is no MTCA Method C cleanup level for TPH; however, the MTCA Method A cleanup level is 200 mg/kg. The concentrations of six soil samples

collected during the RFI, and analyzed for either TPH or TRPH, exceeded 200 mg/kg. These were:

- Area A3: TPH at 635 mg/kg (A03-02-01)
- Area A4: TRPH at 380 mg/kg (A04-31-01)
- Area A5: TRPH at 8,200 mg/kg (A05-10-01)
- Area A6: TPH at 645 mg/kg (A06-01-01)
  TPH at 227 mg/kg (A06-05-01)
- Area A8: TPH at 338 mg/kg (A08-06-01)

TPH in soil does not warrant inclusion in the Risk Assessment/MCS evaluation for the following reasons:

- The number of samples exceeding the MTCA Method A cleanup level for TPH was relatively small and their locations were widely distributed—no two adjacent samples in an investigation area exceeded the 200 mg/kg MTCA Method A cleanup level.

- With the exception of sample A05-10-01 (TRPH at 8,200 mg/kg), the above-referenced TPH or TRPH concentrations are relatively close to the MTCA Method A cleanup level.

- The RFI soil investigation was comprehensive, with many samples collected and analyzed for a wide variety of organic compounds that could influence TPH concentrations; the results do not indicate the presence of organic compounds above action levels.

- The MTCA Method A cleanup level of 200 mg/kg is based on the protection of groundwater; the potential for contaminants to leach to groundwater and compromise the effectiveness of any future groundwater cleanup will be addressed during a CMS if groundwater remediation is deemed necessary (see above).

- The TPH or TRPH detected in most of the samples exceeding the MTCA Method A cleanup level is likely associated with light mineral oil and not with the toxic fuels or motor oils that the cleanup level presumes.

With respect to the last item above, the four samples from Areas A4, A5, and A6 exceeding the MTCA Method A cleanup level (Figures 4-34, 4-35, and 4-36) are located in or near areas of the Facility where mineral oil (Peneteck oil) has been observed in the Unsaturated Zone. Information on the non-toxic nature of Peneteck oil is included in Appendix L; the nature and presence of the mineral oil and the LNAPL are discussed further in Section 4.3.4. Sample A05-10-01, the sample with the highest concentration (8,200 mg/kg of TRPH), was collected from the central portion of the area where mineral oil has been documented. Because only non-toxic mineral oil was used at the Facility,

further action in Areas A4, A5, and A6 for the sole purpose of addressing TPH in soil is not warranted.

It should also be noted that the mean TPH (or TRPH) concentration for each investigation area is well below the MTCA Method A cleanup level of 200 mg/kg with the exception of Area A5 (the mean is calculated using one-half the detection limit for samples in which TPH or TRPH was not detected). In Area A5, the TRPH result of 8,200 mg/kg at sample location A05-10-01 was the only detection in 11 samples analyzed. This single detection results in a mean of 759 mg/kg and a geometric mean of 26 mg/kg for Area A5.

It should further be noted that there are several other constituents detected in soil at the Facility that do not have an MTCA Method C cleanup level (the RFI action level for soil). These include the following seven inorganic compounds: aluminum, calcium, iron, lead, magnesium, potassium, and sodium. Lead was not detected above the MTCA Method A cleanup level of 250 mg/kg in any of the RFI soil samples. The remaining six inorganics are common elements of soil and rock; their presence in Facility soils was expected. Therefore, these seven inorganics do not warrant inclusion in the Risk Assessment/MCS evaluation.

Vanillin, a non-toxic product that was produced at the Facility, was another compound detected in soil. Appendix L includes information on the non-toxic nature of this compound; vanillin is approved by the U.S. Food and Drug Administration as Generally Recognized As Safe (GRAS). It was included as an RFI constituent of interest only to help distinguish vanillin-related contamination from non-vanillin-related contamination in order to support cost-recovery discussions with the former Facility owner. Because of its non-toxic nature, vanillin will not be included in the Risk Assessment/MCS evaluation.

Other detected constituents that do not have MTCA Method C cleanup levels will be addressed in the Risk Assessment/MCS evaluation. If an RFI soil result for such a constituent exceeds the final Media Cleanup Standard, the constituent will be carried forward and addressed in the CMS. Other constituents detected in soil during the RFI that do not have MTCA Method C cleanup levels and will be subject to analysis in the Risk Assessment/MCS evaluation are as follows:

Inorganics	Semivolatiles
Cobalt	2-methylnaphthalene
	Benzo(g,h,i)perylene
	Isopropyl alcohol (2-Propanol)
	Phenanthrene

In summary, only the above list of detected constituents without action levels will be included in the Risk Assessment/MCS evaluation. Detected constituents that are below their soil action levels will not be carried forward to the Risk Assessment/MCS evaluation. However, if the Risk Assessment/MCS evaluation indicates the need for a CMS, some of

these constituents may be evaluated in the CMS for their potential to leach from soil to groundwater and compromise the effectiveness and permanence of groundwater remediation.

4.3 Groundwater Investigation

The RFI groundwater investigation activities consisted of a HydroPunch survey and two rounds of monitoring well sampling and analysis. This section describes the results of these activities as follows:

- The analytical results of the HydroPunch and monitoring well sampling efforts are described in Sections 4.3.1 and 4.3.2, respectively. (The complete RFI groundwater quality database of detected results is provided in Appendix D.)

- Section 4.3.3 discusses the extent of toluene contamination based on Hydro-Punch and monitoring well data.

- Section 4.3.4 summarizes the LNAPL monitoring results.

- Sections 4.3.5 through 4.3.8 address specific topics including miscellaneous organic compounds detected, metals in groundwater, conventional water quality and biological indicator parameters, and the extent of the "Black Liquid" at the Facility.

- Section 4.3.9 presents a summary of the groundwater investigation.

As previously stated, it appears that groundwater in the Upper Aquifer ultimately discharges to the Duwamish Waterway and Slip No. 6. Because of this, the action levels for groundwater include both groundwater and surface water standards. To be conservative, the most stringent criterion for a specific parameter was used to determine if an action level had been exceeded. Further, attenuation and degradation of contaminants prior to discharge to the surface water were not considered when comparing the results to the action levels. The action level for each specific contaminant is the most stringent of the following groundwater and surface water standards:

<u>Groundwater Standards</u>

- Federal Maximum Contaminant Levels (MCLs) for Drinking Water (40 CFR Part 141)

- State Model Toxics Control Act (MTCA) Method B Cleanup Levels for Groundwater (WAC 173-340)

- State Model Toxics Control Act (MTCA) Method C Cleanup Levels for Groundwater (WAC 173-340)

- State Groundwater Quality Standards (WAC 173-200)

Surface Water Standards

- Federal Aquatic Health Criteria - Freshwater Acute Criterion Maximum Concentrations (40 CFR 131.36[b][1])

- Federal Aquatic Health Criteria - Freshwater Chronic Criterion Continuous Concentrations (40 CFR 131.36[b][1])

- State Aquatic Health Criteria - Freshwater Acute Criterion Maximum Concentrations (WAC 173-201A-040[3])

- State Aquatic Health Criteria - Freshwater Chronic Criterion Continuous Concentrations (WAC 173-201A-040[3])

- Federal Aquatic Health Criteria - Marine Water Acute Criterion Maximum Concentrations (40 CFR 131.36[b][1])

- Federal Aquatic Health Criteria - Marine Water Chronic Criterion Continuous Concentrations (40 CFR 131.36[b][1])

- State Aquatic Health Criteria - Marine Water Acute Criterion Maximum Concentrations (WAC 173-201A-040[3])

- State Aquatic Health Criteria - Marine Water Chronic Criterion Continuous Concentrations (WAC 173-201A-040[3])

- Federal Human Health Criteria for Consumption of Organisms Only (40 CFR 131.36[b][1])

- State Model Toxics Control Act (MTCA) Method C Cleanup Levels for Surface Water (WAC 173-340)

Only detected constituents exceeding action levels will be included in the Risk Assessment/Media Cleanup Standards (MCS) evaluation. Constituents that were not detected with action levels below the detection limit will not be addressed in the Risk Assessment/MCS evaluation. The Risk Assessment/MCS evaluation will be used to determine the scope of the CMS.

4.3.1 HydroPunch Results

Forty-three HydroPunch groundwater samples were collected during Round 1 of the RFI, from February 25 through April 14, 1994. These samples were collected from 29 borings (Figure 2-19) and were analyzed for the following parameters:

- Volatile organic compounds (benzene, toluene, ethylbenzene, and xylene) by EPA Method 8020
- TPH by WTPH-418.1 (modified)
- TOC by EPA Method 415

The HydroPunch borings were drilled to three different depth ranges:

- Three borings (A04-27, -28, and -29) were drilled to the perching layer (in the Unsaturated Zone) to collect perched groundwater samples for analysis.
- Twenty-two borings were drilled into the upper part of the Upper Aquifer (to a maximum sampling depth of 31 feet) to collect shallow groundwater samples. One or two groundwater samples were collected from each of these borings.
- Four borings were drilled to the lower part of the Upper Aquifer (to a maximum sampling depth of 64 feet bgs). Up to five groundwater samples were collected over the vertical extent of the Upper Aquifer from each of these deeper borings.

The HydroPunch analytical results are presented in Table 4-15. Toluene was detected in 37 of the 43 samples collected at concentrations ranging from 0.6 to 510,000 μg/l. Of these 37 samples, the concentrations of 17 exceeded the action level of 1,000 μg/l, the MCL for toluene. The concentrations in six of the samples exceeded 100,000 μg/l. The extent of toluene contamination is discussed further in Section 4.3.3.

Benzene was detected in seven samples at concentrations ranging from 1 to 62 μg/l, which are at or above the action level of 1 μg/l (state Groundwater Quality Standards). Ethylbenzene was detected in five samples at concentrations ranging from 0.6 to 74 μg/l, below the action level (the MCL) of 700 μg/l. Xylene was detected in 13 samples at concentrations ranging from 0.9 to 110 μg/l, below the action level (the MCL) of 10,000 μg/l. TPH was detected in 25 of 40 samples at concentrations ranging from 1.13 to 516 mg/l; the TPH concentration at HydroPunch boring A04-10-W1 was 516 mg/l. TOC was detected in all 35 samples analyzed, at concentrations ranging from 4.59 to 3,800 mg/kg. There is no action level for TOC.

An aliquot from the HydroPunch groundwater samples scheduled for laboratory analysis was collected in a separate container for field headspace monitoring (insufficient sample volume prohibited headspace monitoring in many cases). Headspace measurements to

detect organic vapors in the headspace of the covered containers were made with a PID. The data are summarized in the scatter chart shown in Figure 4-46 (note that only those samples with both toluene and PID detections are plotted). The scatter chart indicates a relationship between the headspace measurements and toluene data at higher concentrations (e.g., above a toluene concentration of 5,000 to 10,000 μg/l). A regression analysis of the data yields an R-squared value of 0.78. (The R-squared value is an indicator of the reliability of the regression. The possible values range from 0 [no relationship between the two sets of variables] to 1 [a perfect relationship]). The data indicate that PID headspace measurements can be used as an indicator of high toluene concentrations in groundwater.

TPH and TOC analyses were included in the HydroPunch investigation to evaluate whether data for either of these constituents could be used as an indicator of toluene for future investigations. TPH was detected in 25 of 40 samples at concentrations ranging from 1.13 to 516 mg/l. TOC was detected in all 35 samples analyzed at concentrations ranging from 4.59 to 3,800 mg/l. As is evident from the data in Table 4-15, there is not a good correlation between TPH and toluene or TOC and toluene.

LNAPL was also observed in some of the HydroPunch borings. LNAPL occurrence, as observed in monitoring wells and HydroPunch borings, is addressed in Section 4.3.4. LNAPL was observed in only three HydroPunch borings—A04-01, A04-08, and A05-24. TPH was detected in the shallow-most groundwater samples collected from each of these three borings (at concentrations ranging from 1.86 to 24.6 mg/l). However, there does not appear to be a correlation between LNAPL presence (i.e., floating product) and TPH concentration. TPH was detected at other HydroPunch borings where LNAPL was not observed. This is reasonable in that the shallow-most HydroPunch groundwater samples were typically collected several feet below the groundwater table, below the elevation where LNAPL would be present.

The MTCA cleanup level has not been applied to the HydroPunch TPH data for two reasons:

1. The Method A cleanup level of 1 mg/l (there is no Method C cleanup level) is not health-based, but was established to avoid adverse aesthetic characteristics for drinking water. As indicated elsewhere in this report, the Upper and Lower Aquifers beneath the Facility are not sources of potable water.

2. As specified in the RFI Workplan, the HydroPunch was used as a screening tool. The data collected were used to direct subsequent RFI groundwater investigations such as the selection of groundwater sampling parameters and the locations and depths of additional monitoring wells. The data collected during the HydroPunch investigation proved to be useful for these purposes. Also, because the HydroPunch groundwater samples were collected from temporary, open boreholes, the potential exists for cross-contamination from the Unsaturated Zone and other parts of the Upper Aquifer. As a result, the HydroPunch data are not as definitive or as representative as the monitoring well data,

although the data are indicative of contaminant trends and of overall aquifer condition.

4.3.2 Groundwater Monitoring Results

Round 1 Detected Constituents

Round 1 groundwater sampling was conducted between January 17 and February 28, 1994, at 30 pre-RFI monitoring wells. Analytical parameters included inorganics, volatiles, semi-volatiles, TOC, formaldehyde, and Appendix IX hazardous substance list constituents. The parameters analyzed varied by well and by investigation area, as described in the RFI Workplan. Metal analyses were conducted on both filtered (dissolved) and unfiltered (total) samples. Table 2-8 shows the target parameters by well for Round 1. The locations of the wells sampled during Round 1 are shown in Figure 2-3.

Table 4-16 presents a statistical summary of the Round 1 groundwater results. Shown for each parameter are the detection frequency, minimum and maximum detected concentrations, and the action levels. Appendix D presents a complete list of all the constituents detected above the laboratory detection limits during Round 1.

Round 2 Detected Constituents

Round 2 groundwater sampling was conducted between August 24 and September 1, 1994. Nineteen monitoring wells were sampled, and the analytical parameters were selected in order to confirm and/or augment groundwater constituents identified during Round 1. The Round 2 parameters included toluene, TRPH, acetone, methylphenol, bis(2)-chloroethylether, herbicides, antimony, beryllium, and vanadium. These parameters were selected for Round 2 analysis for the following reasons:

- Toluene—With the exception of two wells sampled solely for herbicides and TRPH, samples from all the wells were analyzed for BTEX (Method 8020) or volatiles (Method 8240) in order to confirm and further assess the magnitude and extent of toluene in groundwater.

- TRPH—All Round 2 groundwater samples were analyzed for TRPH to provide additional data on the potential presence and extent of mineral oil previously identified as a floating LNAPL layer in some areas of the Facility.

- Acetone, methylphenol, bis(2)-chloroethylether, beryllium, and vanadium—Analyses were performed on samples from selected wells (see Table 2-11) to confirm the presence and concentrations of these constituents reported during Round 1.

- Herbicides—Samples were collected for herbicide analysis at eight monitoring wells (see Table 2-11). The herbicide analyses were included to complete the

Appendix IX analyses conducted in Round 1, as the Round 1 herbicide data did not meet the acceptance criteria for spike recoveries (see Section 3).

Table 2-11 presents a complete list of the parameters analyzed for each well during Round 2.

Table 4-17 provides a statistical summary of the Round 2 groundwater results. Shown for each parameter are the detection frequency, the minimum and maximum detected concentrations, the action level for the compound, and the source of the action level. Appendix D presents a complete list of all the constituents detected above the laboratory detection limits during Round 2.

Appendix I presents the benzene, toluene, ethylbenzene, and xylene (BTEX) results for the five samples collected from wells H1, MW-13, MW-17, MW-18, and MW-19, discussed in Section 2.4.2. These samples were collected with both Waterra pumps and bailers in order to assess the comparability of BTEX data collected by the two methods. A discussion of the results accompanies the presentation of the data in Appendix I. For consistency and comparability, the groundwater data collected with Waterra pumps are considered the data of record for Round 2.

Constituents Exceeding Action Levels

Tables 4-18 and 4-19 summarize the parameters that exceeded action levels in Rounds 1 and 2, respectively. These parameters can be separated into various classes of constituents: metals, volatile organic compounds, semivolatile organic compounds, pesticides, and conventional water quality parameters.

Metals. Concentrations of iron and manganese (both soluble and total) exceeded the action levels in nearly every sample (the action level is 0.05 μg/l for both iron and manganese). This is consistent with regional groundwater quality conditions. Iron and manganese are known to be present in high concentrations in the shallow groundwater of the Duwamish River Valley and the adjacent Kent Valley (*South King County Ground Water Management Plan,* 1991).

The following metals were detected at concentrations exceeding action levels in unfiltered samples and will be included in the Risk Assessment/MCS evaluation:

- Total (unfiltered) arsenic (29 exceedances of the 0.5 μg/l action level out of 30 Round 1 samples ranging from 2.1 to 131 μg/l: only the concentration in well B1B did not exceed the action level)

- Total copper (26 exceedances in Round 1 of the 2.5 μg/l action level: in wells A2 [37.5 μg/l], DM-3A [94.4 μg/l], A9 [119 μg/l], B6 [304 μg/l], DM-4 [11.3 μg/l, B-qualified {detected between the contract-required detection limit and the instrument detection limit}], B2 [4,290 μg/l], DM-5 [47.3 μg/l], B4

[11.7 μg/l, B-qualified], B5 [96.6 μg/l], C1 [66.9 μg/l], MW-12 [84.1 μg/l], H11 [22.7 μg/l], H1 [39.9 μg/l], H10 [26.3 μg/l], DM-2A [226 μg/l], H6 [179 μg/l], DM-8 [43.7 μg/l], H9 [306 μg/l], G3 [224 μg/l], G1 [92.6 μg/l], DM-6 [54.7 μg/l], B1A [21.9 μg/l, B-qualified], B1B [22.5 μg/l, B-qualified], A4 [50 μg/l], and Background Area wells E3 [459 μg/l] and DM-1A [52.5 μg/l])

- Total lead (24 exceedances in Round 1 of the 0.3-3.2 μg/l action level [the action level varies depending on water hardness]: in wells A2 [7.3 μg/l], DM-3A [31.1 μg/l], DM-3B [3.6 μg/l], A9 [23.8 μg/l], B6 [7.8 μg/l], B2 [174.5 μg/l], B4 [3.4 μg/l], B5 [16.65 μg/l], C1 [13.4 μg/l], MW-12 [7.1 μg/l], H11 [4.2 μg/l], H1 [7.4 μg/l], H10 [3.6 μg/l], H6 [9 μg/l], DM-8 [4.8 μg/l], H9 [28.8 μg/l], G3 [29.7 μg/l], G1 [3.2 μg/l], B1A [4.5 μg/l], B1B [24 μg/l], A4 [9.8 μg/l], and Background Area wells E3 [84.7 μg/l] and DM-1B [2.75 μg/l])

- Total nickel (17 exceedances in Round 1 of the 7.9 μg/l action level: in wells A2 [24.9 μg/l, B-qualified], DM-3A [64.3 μg/l], A9 [48.7 μg/l], B6 [26.6 μg/l, B-qualified], B2 [85.95 μg/l], DM-5 [40.4 μg/l], B5 [42.4 μg/l], C1 [55 μg/l], MW-12 [37.1 μg/l], H6 [34.6 μg/l, B-qualified], H9 [74.7 μg/l], G3 [93.7 μg/l], G1 [64.7 μg/l], B1A [20.7 μg/l, B-qualified], A4 [37.2 μg/l, B-qualified], and Background Area wells E3 [358 μg/l] and DM-1A [67.9 μg/l])

- Total vanadium (15 exceedances in Round 1 of the 112 μg/l action level: in wells A2 [134 μg/l], DM-3A [119 μg/l], A9 [161 μg/l], B2 [267.5 μg/l], DM-5 [1,630 μg/l], B5 [207.5 μg/l], C1 [152 μg/l], H11 [901 μg/l], DM-2A [1,330 μg/l], H6 [132 μg/l], DM-8 [1,340 μg/l], H9 [717 μg/l], G3 [545 μg/l], and Background Area wells E3 [860 μg/l] and DM-1A [224 μg/l])

- Total zinc (10 exceedances in Round 1 of the 24.1-76.6 μg/l action level [the action level varies depending on water hardness]: in wells DM-3A [98.8 μg/l], A9 [102 μg/l], B2 [1,605 μg/l], C1 [95.9 μg/l], H6 [73 μg/l], H9 [194 μg/l], G3 [209 μg/l], G1 [847.5 μg/l], and Background Area wells E3 [487 μg/l] and DM-1A [94.8 μg/l])

- Total chromium (nine exceedances in Round 1 of the 50 μg/l action level: in wells B2 [105.5 μg/l], DM-5 [353 μg/l], H11 [88.9 μg/l], DM-2A [148 μg/l], H6 [98 μg/l], DM-8 [144 μg/l], H9 [154 μg/l], G3 [135 μg/l], and Background Area well E3 [240 μg/l])

- Total beryllium (eight exceedances in Round 1 of the 0.020 μg/l action level: in wells B2 [2.4 μg/l, B-qualified], DM-5 [9.9 μg/l], H11 [3.8 μg/l, B-qualified], DM-2A [5.9 μg/l], DM-8 [6.2 μg/l], H9 [3.7 μg/l, B-qualified], G3 [4.3 μg/l, B-qualified], and Background Area well E3 [7.4 μg/l])

- Total mercury (eight exceedances in Round 1 of the 0.012 μg/l action level: in wells A9 [0.22 μg/l], B2 [4.7 μg/l], DM-2A [0.2 μg/l], H6 [0.45 μg/l], H9 [0.87 μg/l], G3 [0.49 μg/l], and Background Area wells E3 [0.5 μg/l] and DM-1A [0.21 μg/l])

- Total antimony (two exceedances of the 6 μg/l action level: in Background Area well E3 in Rounds 1 [69.3 μg/l] and 2 [25.45 μg/l, BJ-qualified])

- Total cadmium (one exceedance in Round 1 of the 2.9 μg/l action level: in Background Area well E3 [8.1 μg/l])

- Total silver (one exceedance in Round 1 of the 1.2 μg/l action level: in well DM-5 [21.5 μg/l])

It should be noted that monitoring wells E3, DM-1A, and DM-1B are located in the Background Area (Area BG) and that wells DM-1B, DM-2B, DM-3B, and B1B are screened in the Lower Aquifer.

Metals concentrations in filtered samples that exceeded action levels were fewer in number:

- Arsenic (23 exceedances in Round 1 of the 0.5 μg/l action level: in wells A2 [49.9 μg/l], DM-3A [4 μg/l, B-qualified], DM-3B [13.9 μg/l], B2 [4.5 μg/l, B-qualified], DM-5 [31.6 μg/l], B5 [2.75 μg/l], C1 [13.5 μg/l], MW-12 [33.4 μg/l], H11 [43.3 μg/l, B-qualified], H10 [9.6 μg/l, B-qualified], DM-2A [22.4 μg/l], DM-2B [16.9 μg/l], H6 [9.3 μg/l, B-qualified], DM-8 [42.9 μg/l], H9 [52.4 μg/l], G3 [18.3 μg/l, B-qualified], DM-7 [10.6 μg/l], G1 [5.15 μg/l], DM-6 [20.3 μg/l], A4 [2.3 μg/l, B-qualified], and Background Area wells E3 [2.2 μg/l, B-qualified], DM-1A [2 μg/l, B-qualified], and DM-1B [23.85 μg/l, B-qualified])

- Copper (13 exceedances in Round 1 of the 2.4-2.5 μg/l action level [the action level varies depending on water hardness]: in wells B2 [8.4 μg/l], DM-5 [49.9 μg/l], B4 [6.4 μg/l, B-qualified], H11 [9.5 μg/l, B-qualified], H1 [11 μg/l, B-qualified], DM-2A [58 μg/l], H6 [20.8 μg/l, B-qualified], DM-8 [34.8 μg/l], H9 [15.3 μg/l, B-qualified], G3 [5.4 μg/l, B-qualified], G1 [5.9 μg/l], DM-6 [9.6 μg/l, B-qualified], and B1B [19.3 μg/l, B-qualified])

- Vanadium (six exceedances in Round 1 of the 112 μg/l action level: in wells B2 [157 μg/l], DM-5 [1,670 μg/l], H11 [945 μg/l], DM-2A [1,300 μg/l], DM-8 [1,390 μg/l], and H9 [469 μg/l])

- Beryllium (five exceedances in Round 1 of the 0.020 μg/l action level: in wells DM-5 [9.9 μg/l], H11 [2.5 μg/l, B-qualified], DM-2A [5.9 μg/l], DM-8 [6.2 μg/l], and H9 [2.5 μg/l, B-qualified])

- Chromium (five exceedances in Round 1 of the 50 μg/l action level: in wells DM-5 [365 μg/l], H11 [95.1 μg/l], DM-2A [149 μg/l], DM-8 [153 μg/l], and H9 [62.3 μg/l])

- Lead (five exceedances in Round 1 of the 0.3-3.2 μg/l action level [the action level varies depending on water hardness]: in wells DM-3B [2 μg/l, B-qualified], MW-12 [2.7 μg/l, B-qualified], DM-8 [4.7 μg/l], B1B [8.9 μg/l], and Background Area well DM-1B [2.3 μg/l])

- Nickel (three exceedances in Round 1 of the 7.9 μg/l action level: in wells DM-5 [43.2 μg/l], MW-12 [32 μg/l, B-qualified], and G1 [31.1 μg/l])

- Silver (one exceedance in Round 1 of the 1.2 μg/l action level: in well DM-5 [23.5 μg/l])

- Zinc (one exceedance in Round 1 of the 76.6 μg/l action level: in well H9 [80.7 μg/l])

Comparison of the total (unfiltered) and filtered metals data indicates that exceedances of the action levels for mercury, antimony, and cadmium are attributable to solids present in unfiltered samples.

Semivolatile Organic Compounds. Of the semivolatiles detected, the concentrations of very few exceeded their respective action levels at more than one location. Those detected more frequently appear to be indicative of background levels (e.g., PAHs). The semivolatiles with concentrations that exceeded action levels were two PAHs (benzo[a]pyrene and chrysene), bis(2-chloroethyl)ether, pentachlorophenol, 2-methylphenol and 4-methylphenol, and bis(2-ethylhexyl)phthalate.

PAHs. PAHs were detected in a number of groundwater samples. With the exception of benzo(a)pyrene and chrysene (discussed below), the other PAH concentrations did not exceed their respective action levels. The other PAHs detected were 2-methylnaphthalene (at a concentration of 10 μg/l [J-qualified (estimated)] at well H11 in Round 1; there is no action level), acenaphthene (6 μg/l at well B6 in Round 1; action level is 960 μg/l), fluoranthene (2 μg/l [J-qualified] at well B2 in Round 1; action level is 225 μg/l), fluorene (2 μg/l at well B6 in Round 1; action level is 640 μg/l), naphthalene (2 μg/l and 7 μg/l at wells B6 and H11 [J-qualified] respectively in Round 1; action level is 32 μg/l), and pyrene (2 μg/l [J-qualified] at well B2 in Round 1; action level is 480 μg/l).

PAHs are characterized by low solubilities and high partition coefficients. As such, they tend to have a high affinity for the aquifer matrix and low mobility in groundwater. Based on these characteristics, it is likely that many of the PAHs detected in RFI groundwater samples were sorbed to the suspended solids present in the samples rather than dissolved in the aqueous phase. Based on historical Facility information, PAHs were never used in manufacturing at the Facility. Landau Associates (1991) reported a number of PAH

detections in both soil and groundwater. It is also known that PAHs are widely distributed across the site and throughout the region, as discussed in Appendix J. Therefore, while detection of PAHs in groundwater at the Facility is not unexpected, PAHs are not associated with Facility operations and are not considered constituents of concern.

Chrysene concentrations exceeded the action level of 0.012 μg/l only in well B2 (1 μg/l, J-qualified) in the Round 1 sampling. Benzo(a)pyrene concentrations exceeded the action level of 0.008 μg/l in Round 1 samples from four monitoring wells, as follows:

- DM-2A (1 μg/l)
- DM-5 (6 μg/l)
- G3 (2 μg/l)
- H11 (7 μg/l)

All the above data are J-qualified. Benzo(a)pyrene and chrysene will be included in the Risk Assessment/MCS evaluation.

Bis(2-chloroethyl)ether. Bis(2-chloroethyl)ether was detected in Round 1 and Round 2 groundwater samples from well A2 only (at concentrations of 2 μg/l and 5.5 μg/l, respectively). The detected concentrations are J-qualified, indicating an estimated value, and are above the action level (0.04 μg/l). Bis(2-chloroethyl)ether is not known to have been used onsite and is not known to be a breakdown product of compounds used onsite. In addition, this well is located adjacent to the Kenworth site, upgradient from the process area. Detection of this compound in only one well indicates that this detection is an isolated occurrence. Bis(2-chloroethyl)ether will be included in the Risk Assessment/MCS evaluation.

Pentachlorophenol. Pentachlorophenol (PCP) was detected in one groundwater sample at a concentration above the action level of 0.7 μg/l. The pentachlorophenol concentration in the Round 1 sample from well H10 (in the center of the toluene plume) was 5 μg/l (J-qualified [estimated] value). Pentachlorophenol was used at the Facility, but its detection in only one well indicates that this is an isolated occurrence. Pentachlorophenol will be included in the Risk Assessment/MCS evaluation.

2-Methylphenol and 4-Methylphenol. 2-methylphenol and 4-methylphenol (also known as o-cresol and p-cresol) were both detected in groundwater samples collected in both Rounds 1 and 2 at concentrations above their respective action levels (800 μg/l for 2-methylphenol and 80 μg/l for 4-methylphenol). 2-methylphenol concentrations exceeded the action level in Round 1 in wells MW-12 (1,100 μg/l, D-qualified [analysis at a secondary dilution factor]) and H11 (1,900 μg/l, D-qualified). 4-methylphenol concentrations exceeded the action level in Round 1 at wells MW-12 (760 μg/l, D-qualified), H11 (1,600 μg/l, D-qualified), and H10 (130 μg/l, D-qualified). All three of these wells are located in the core of the toluene plume area. Wells H11 and MW-12 were sampled again in Round 2 for semivolatile organics. Only the sample from H11 had concentrations exceeding the action levels for the two compounds (1,800 μg/l for 2-methylphenol and 1,100 μg/l for

4-methylphenol). 2-methylphenol and 4-methylphenol will be included in the Risk Assessment/MCS evaluation.

Bis(2-ethylhexyl)phthalate. Bis(2-ethylhexyl)phthalate was detected 14 times in Round 1 and once in Round 2; of these detections, three in Round 1 and one in Round 2 were at concentrations above the action level of 5.9 μg/l. All exceedances were within one order of magnitude of the action level. The Round 1 exceedances were detected at the following wells:

- H11 (53 μg/l, D- and J-qualified)
- H10 (16 μg/l)
- B1B (6 μg/l, J-qualified)

The compound was not detected in the Round 2 sample from H11. The Round 2 exceedance was 32 μg/l in the sample from MW-12; the compound was not detected in the Round 1 sample from MW-12. Well B1B is a Lower Aquifer well; the other three wells are Upper Aquifer wells. MW-12, H10, and H11 are all within the toluene plume, while B1B is adjacent to the Kenworth site, outside and upgradient from the toluene plume and the Black Liquid plume. Bis(2-ethylhexyl)phthalate will be included in the Risk Assessment/MCS evaluation.

The source of the bis(2-ethylhexyl)phthalate may be laboratory contamination or the monitoring well screen and casing. Bis(2-ethylhexyl)phthalate could also be present due to cross-contamination from equipment, because it was present in equipment blanks. This compound is a common plasticizer and is used in PVC and other plastics. As a result, bis(2-ethylhexyl)phthalate is often seen as a laboratory contaminant. If this were the case, samples would vary significantly between sampling rounds as is seen here: the highest concentrations were seen in two different wells in one sampling round and not in the other round. The presence of bis(2-ethylhexyl)phthalate in monitoring wells constructed with PVC screens or casing is also not unusual. Bis(2-ethylhexyl)phthalate is relatively immobile in groundwater; this, along with the locations of the concentrations, indicates it has not migrated vertically from the Upper Aquifer. As discussed above, the hydrogeologic conditions at the Facility also indicate that the vertical migration of any of these compounds from the Upper Aquifer to the Lower Aquifer is unlikely.

Volatile Organic Compounds. Several volatiles exceeded their respective action levels during both Rounds 1 and 2. Apparently these are not isolated incidents. The volatiles were toluene, benzene, methylene chloride, 1,1-dichloroethane, acetone, and formaldehyde.

Toluene. Toluene was detected at concentrations exceeding the action level of 1,000 μg/l three times in Round 1, at wells MW-12 (84,000 μg/l), H11 (600,000 μg/l), and H10 (300,000 μg/l). The action level was exceeded 11 times in Round 2. The higher frequency of exceedances in Round 2 is attributable to the fact that eight new monitoring wells were installed in or near the toluene plume during Round 2. Only groundwater samples collected from monitoring wells in Areas A4 and A5 were found to exceed the

action level for toluene. A detailed discussion of the extent of the toluene contamination is presented in Section 4.3.3. Toluene will be included in the Risk Assessment/MCS evaluation.

Benzene. Benzene was detected at concentrations exceeding the action level of 1 μg/l in Round 1. Benzene was detected at wells DM-7, B5, H10, and H11 at concentrations of 2, 5, 36 [J-qualified], and 230 μg/l, respectively. During Round 2, benzene was detected at well DM-7 at a concentration of 1 μg/l, which is equal to the action level. Benzene was also detected in well H11 during Round 2 but could not be quantified because of matrix interference. Well H11 is in the center of the toluene plume; DM-7 is at the southern edge of the toluene plume. Benzene was an impurity in the toluene feedstock used at the Facility. Benzene will be included in the Risk Assessment/MCS evaluation.

Methylene Chloride. Methylene chloride was detected at well H11 in Round 1 at a concentration of 57 μg/l, above the action level of 5 μg/l. Although methylene chloride is a common laboratory contaminant and may have been introduced during sample bottle preparation, sample collection, sample transport, or cross-contamination in the laboratory, the QA/QC data do not confirm this. Given this and its historical detection at the Facility, methylene chloride appears to be present in groundwater and is not necessarily the result of laboratory contamination of the samples. Methylene chloride will be included in the Risk Assessment/MCS evaluation.

1,1-Dichloroethane. 1,1-dichloroethane was detected at well A2 in Round 1 at a concentration of 2 μg/l, above the action level of 1 μg/l. Like the semivolatile bis(2-chloroethyl)-ether, 1,1-dichloroethane is not known to have been used onsite and is not known to be a breakdown product of compounds used onsite. In addition, well A2 is located adjacent to the Kenworth site, upgradient from the process area. Detection of this compound in only one well suggests that this detection is an isolated occurrence. 1,1-dichloroethane will be included in the Risk Assessment/MCS evaluation.

Acetone. Acetone was detected at well H11 in Round 1 at a concentration of 56,000 μg/l, above the action level of 800 μg/l. Acetone was also detected at well DM-3B (screened in the Lower Aquifer) at a concentration of 370 μg/l, below the action level. The source of the acetone is unknown, but may be due to the past onsite use of isopropyl alcohol (acetone is an oxidation product of isopropyl alcohol). Like benzene, acetone was detected in well H11 during Round 2 but could not be quantified because of matrix interference. Acetone will be included in the Risk Assessment/MCS evaluation.

Formaldehyde. Formaldehyde was detected in 16 of 17 groundwater samples during Round 1 at concentrations above the action level of 1.46 μg/l. Three of these exceedances were in Background Area wells. The concentrations ranged from 32 to 450 μg/l. The three highest concentrations (ranging from 290 to 450 μg/l) were at wells DM-4, A4, and A9 located around the Distribution Center. Formaldehyde is associated with historical Facility practices. Formaldehyde will be included in the Risk Assessment/MCS evaluation.

Pesticides. Endosulfan I, endosulfan sulfate, and 4,4'-DDD were detected at concentrations above their action levels only in well MW-12 in Round 1 (MW-12 is located within the toluene plume area); the action levels for the three compounds are 0.0087 μg/l, 0.056 μg/l, and 0.00084 μg/l, respectively. All of the concentrations were J-qualified. It is not known whether DDT or the endosulfans were used at the Facility, but the detections at only one well suggest that these are isolated occurrences. Endosulfan I, endosulfan sulfate, and 4,4'-DDD will be included in the Risk Assessment/MCS evaluation.

BHC-gamma lindane was also detected in this well Round 1, but the concentration (0.05 μg/l) was below the action level (0.06 μg/l). Because this compound was below the action level, it will not be addressed in the Risk Assessment/MCS evaluation.

Conventional Water Quality Parameters. Round 1 samples from three monitoring wells exceeded the action level (250,000 μg/l, the state Secondary MCL) for chloride. These wells were B4, H1, and DM-2B. Concentrations in 25 monitoring wells and one Background Area well exceeded the action level (500,000 μg/l, Washington Groundwater Quality Standards) for total dissolved solids (TDS). Chloride and TDS concentrations are typically higher in areas where groundwater is affected by salt-water bodies. Groundwater at the Facility is tidally influenced, as described earlier; therefore, chloride and TDS are expected to be present at high concentrations, especially at wells near the shoreline. Chloride and TDS will not be addressed in the Risk Assessment/MCS evaluation.

Four monitoring wells and one Background Area well were out of the action level range for pH (6.5 to 8.5) during Round 1; during Round 2, seven monitoring wells and one Background Area well were out of the action level range. All except two of these pH "exceedances" are between 6.0 and 6.5 and between 8.5 and 9.0. The only higher pH value (11.2) was detected at well MW-16, which was installed during Round 2; this high pH value may be caused by cement used in constructing the wellhead. Three of the pH exceedance wells are in the Lower Aquifer (DM-3B, B1B, and DM-1B). Well DM-1B is located in the Background Area, and was the second well with a pH value greater than 9.0. In Round 1 the pH values for the Lower Aquifer wells were 8.59, 8.8, and 8.97, respectively. Wells DM-3B and B1B were not sampled in Round 2; the pH value for DM-1B was 9.1, indicating that the pH of the Lower Aquifer tends to be higher than the Upper Aquifer, but still close to the action level. pH will not be addressed in the Risk Assessment/MCS evaluation.

A detailed discussion of conventional water quality parameters and biological indicator parameters is provided in Section 4.3.7.

Organic Constituents Detected in the Lower Aquifer

During Round 1, three organic compounds were detected in samples collected from three Lower Aquifer monitoring wells (no action levels were exceeded). This is inconsistent with the hydrogeologic conditions at the Facility that suggest that vertical migration of constituents from the Upper to the Lower Aquifer is unlikely. Investigations of the Facility

have demonstrated that a laterally extensive, low-permeability aquitard separates the Upper and Lower Aquifers and that there is an upward vertical hydraulic gradient between the two aquifers. These factors combine to significantly inhibit the vertical migration of constituents from the Upper to the Lower Aquifer.

Acetone, toluene, and bis(2-ethylhexyl)phthalate were detected in Round 1 Lower Aquifer groundwater samples as follows:

- Background Area well DM-1B—Bis(2-ethylhexyl)phthalate (1 μg/l, field duplicate and J-qualified [estimated] result)
- Well DM-3B—Acetone (370 μg/l), toluene (3 μg/l), and bis(2-ethylhexyl)phthalate (2 μg/l, J-qualified [estimated] result)
- Well B1B—Toluene (1 μg/l) and bis(2-ethylhexyl)phthalate (6 μg/l, J-qualified [estimated] result)

It is likely that these compounds were introduced into the Lower Aquifer in the past by contaminated surface water entering the flush-mounted (at the ground surface) wellhead structures. In the case of bis(2-ethylhexyl)phthalate, as noted earlier, it is also possible that the PVC monitoring well materials are the source, as this compound is a common PVC plasticizer. Its presence in monitoring wells constructed with PVC screen or casing is not unusual. Bis(2-ethylhexyl)phthalate is also relatively immobile in groundwater, indicating that it has not migrated vertically from the Upper Aquifer. Although bis (2-ethylhexyl) phthalate was detected in well B1B above the action level (5.9 μg/l), the detected concentration of 6 μg/l is essentially the same as the action level. As discussed above, the Facility's hydrogeologic conditions indicate that vertical migration of any of these compounds from the Upper Aquifer to Lower Aquifer is unlikely.

4.3.3 Extent of Toluene

The data collected during, and prior to, the RFI indicate that a plume of dissolved toluene is present in the Upper Aquifer in three investigation areas—Areas A4, A5, and A6. Landau Associates detected the plume during their 1991 Facility investigation. At that time, concentrations in groundwater were reported to be up to 330,000 μg/l for three monitoring wells: G5 (now replaced by MW-12), H10, and H11. Trace concentrations of toluene ($<$10 μg/l) were reported by Landau in wells B4 and B6 in Area A2, immediately northeast of the three wells mentioned above.

Based on the concentrations reported by Landau Associates, a HydroPunch investigation was conducted during Round 1 of the RFI to further delineate the magnitude and extent (horizontal and vertical) of the toluene plume. As discussed in Section 4.3.1, 43 HydroPunch groundwater samples were collected from 29 borings. The samples were analyzed for BTEX, TPH, and TOC. Two groundwater sampling events were then conducted during the Round 1 and Round 2 investigations. Round 2 included the installation of eight

new monitoring wells in the vicinity of Areas A4, A5, and A6 to better delineate the horizontal and vertical extent of the toluene plume.

The results of the HydroPunch investigation and monitoring well sampling are presented in Section 4.3.1 and Tables 4-15 through 4-20. As discussed earlier, toluene was the organic compound detected most frequently. Benzene, ethylbenzene, and xylene were impurities in the toluene feedstock used by RPI and were also detected, but less frequently and at lower concentrations. These three compounds were detected at or near the toluene plume.

The following sections address the horizontal and vertical extent of the toluene plume as identified by the Round 1 data (from HydroPunch and monitoring well sampling) and Round 2 data (from monitoring well sampling).

Horizontal Extent of Toluene

Figures 4-47 and 4-48 show concentration contours representing the magnitude and estimated horizontal extent of the toluene plume based on the Round 1 and Round 2 data, respectively. Figure 4-47 is based on a compilation of the Round 1 groundwater monitoring data (collected in January and February 1994) and the HydroPunch data (collected in February, March, and April 1994). Figure 4-48 shows conditions based on the Round 2 data; the figure includes data for the eight new monitoring wells installed during the Round 2 investigation.

As can be seen from Figure 4-47, the extent of the toluene plume based on the Round 1 monitoring well and Hydropunch data is centered over Area A4 and is located in approximately the same area where the highest concentrations of toluene were detected in soils (see Section 4.2.3 and Figure 4-48). The area inside the 1,000 μg/l contour line is approximately 1.5 acres. Toluene concentrations in the center of the plume are up to several hundred thousand micrograms per liter. Concentration gradients along the outer edges of the plume are relatively steep: for example, concentrations decrease from approximately 500,000 μg/l to trace levels over distances of 40 to 150 feet. The low groundwater flow velocity may be responsible, in part, for the limited dispersion of the plume. However, natural anaerobic biodegradation, whose ability to decompose toluene exceeds that of aerobic biodegradation, may also contribute to the relatively steep concentration gradients.

Figure 4-48 shows concentration contours representing the horizontal extent of toluene based on the Round 2 data. Because the contours represent data from monitoring wells only, and not from HydroPunch data, the number of data points is fewer than that shown in Figure 4-47.

A comparison of the results of Rounds 1 and 2 indicates that the configuration of the plume (as shown in Figures 4-47 and 4-48) is consistent. The shape and size of the plume indicated by the Round 2 data are similar to those depicted by the Round 1 data. Like the Round 1 data, the Round 2 data indicate that toluene concentrations in the center of the plume are up to several hundred thousand micrograms per liter (the maximum toluene

concentration is 340,000 μg/l at well H11). Also, the concentration gradients remain relatively steep along the outer edge of the plume. Whatever the cause of this steep gradient, the extent of the toluene plume has been defined for the purposes of the RFI.

Vertical Extent of Toluene

Most of the groundwater samples collected during the Round 1 HydroPunch investigation were collected within the upper 15 feet of the Upper Aquifer. However, a number of samples were collected from greater depths in the aquifer to characterize the vertical distribution of toluene. These deeper samples were collected from HydroPunch borings including A04-06, A04-14, A04-23, and A05-24. Data from these borings (see Table 4-15) indicate that toluene is present throughout the vertical extent of the Upper Aquifer, but concentrations in the lower half of the aquifer are typically two to three orders of magnitude lower than near the top of the aquifer. Boring A05-24, drilled near the center of the toluene plume, is an exception; toluene concentrations at this location were found to increase with depth to a maximum of 94,000 μg/l at a depth of 62 feet bgs (approximately 48-foot NGVD). As discussed below, MW-16 is a new well installed in approximately the same location as boring A05-24 and screened in the lower half of the aquifer. In contrast, the deepest toluene samples collected from HydroPunch borings A04-06, A04-14, and A04-23 ranged from 5 to 960 μg/l, which does not exceed the action level and is two to three orders of magnitude below concentrations in the upper part of the Upper Aquifer.

After installation of the eight new monitoring wells during Round 2, the groundwater monitoring network in the toluene plume area included three wells screened near the bottom of the Upper Aquifer (wells H1, MW-13, and MW-16—see Figure 4-48). Each well is located within a few feet of a well screened across the groundwater table in the Upper Aquifer (wells H10, H11, and MW-15, respectively). Therefore, paired wells H10/H1, H11/MW-13, and MW-15/MW-16 represent locations where the vertical extent of toluene in the Upper Aquifer can be assessed at a single location.

Figures 4-49 and 4-50 show the estimated vertical extent of toluene contamination. These cross-sections depict both Round 1 HydroPunch data and Round 2 monitoring well data, with the following exception: Data from HydroPunch boring A05-24 are not shown because Round 2 monitoring well MW-16 is drilled in the same location (within a few feet). The toluene result from well MW-16 (1,100 μg/l) is shown because it is more recent, it was collected from a monitoring well that was properly constructed and developed, and it is consistent with concentrations detected in other samples collected from the lower half of the Upper Aquifer.

Samples from HydroPunch boring A05-24 were taken from depths of approximately 22, 45, and 62 feet bgs (approximately 8, 31, and 48 feet NGVD, respectively); the toluene concentrations in all these samples were in the same order of magnitude (26,000 μg/l, 59,000 μg/l, and 94,000 μg/l, respectively)—unlike all the other multiple-depth groundwater samples taken from HydroPunch boreholes, which showed an overall decrease in toluene with depth. According to the field notes, the 62-foot-bgs sample was collected in

a deposit of sand and non-plastic silt that becomes finer with depth near the bottom of the Upper Aquifer (65 feet bgs). Because the aquifer grades gradually from sand to silts, samples were often difficult to obtain; the 45-foot-bgs sample took 75 minutes to collect, and contained only 800 ml. The HydroPunch was left open to the aquifer formation overnight for the 62-foot-bgs sample in order to try to obtain 1,200 ml of sample required by the laboratory, but only about 850 ml of sample were obtained.

Because of the toluene concentrations detected in boring A05-24, wells MW-15 and MW-16 were installed in approximately the same location in an effort to verify the toluene findings. MW-15 was screened from 5 to 30 feet bgs in the upper part of the aquifer, while MW-16 was screened from 40 to 50 feet bgs in the lower part of the Aquifer. Because of the extremely low productivity of the very lowest part of the Upper Aquifer, well MW-16 was not placed at the absolute bottom of the aquifer because of the poor well yield that would result. The Round 2 groundwater sampling results for toluene in wells MW-15 and MW-16 were 99,000 μg/l and 1,100 μg/l, respectively; these results are consistent with other sample results from the toluene plume area, which indicate a decreasing toluene concentration with depth. Specifically, the toluene concentration at MW-16 (1,100 μg/l) is similar to the results for other samples collected from the same approximate depth.

As can be seen from Figures 4-49 and 4-50, toluene was detected across the vertical extent of the Upper Aquifer in the central portion of the plume. The highest toluene concentrations (up to 480,000 μg/l) are in the upper 20 feet of the aquifer. Concentrations in the lower half of the aquifer range from 110 to 1,200 μg/l (in wells H1, MW-13, and MW-16, and in HydroPunch boring A04-23).

It should be noted that during Round 2, toluene was detected in well H1 for the first time; previous data for this well (from Landau Associates and Round 1 of the RFI) did not indicate any toluene. Therefore, the Round 2 result for well H1 is considered provisional and will require confirmation in the third round of groundwater monitoring.

4.3.4 LNAPL Occurrence

LNAPL has been noted in several borings and wells at the Facility over the past 4 years. LNAPL was first detected in 1991 atop the groundwater surface in well G5, a 2-inch-diameter monitoring well installed by Landau Associates. RPI subsequently replaced this well with monitoring well MW-12 in August 1993. Over time, LNAPL has been detected intermittently in several wells screened across the groundwater table and located in Areas A4 and A5. These include wells H1, H6, H9, H10, H11, MW-12, MW-15, MW-18, and MW-19. The locations of wells where LNAPL has been detected at least once are shown in Figure 4-51.

Since the summer of 1993, efforts to recover LNAPL from certain wells have been attempted as an Interim Measure. Specifically, several LNAPL recovery devices (passive and pneumatic hydrophobic membrane devices) have been installed in wells MW-12 and

H10. From October through December 1993, a passive skimmer was used in well MW-12 to recover LNAPL. In October 1993, prior to the recovery effort, there were approximately 14 inches of LNAPL in MW-12. By December 1993, the thickness had been reduced to approximately 2 inches. Approximately 30 gallons of LNAPL were recovered from well MW-12 during this period. Several months later, in late March and early April 1994, a pneumatic skimmer was installed and operated in well H10 resulting in approximately 1 gallon of LNAPL being removed over a period of 2-1/2 weeks. Nearly all the LNAPL removed was collected during the first few days of this period.

The composition and extent of the LNAPL and the relationship between LNAPL presence and fluctuating groundwater levels are discussed in the following subsections.

LNAPL Composition

The composition of the LNAPL was identified by RPI in pre-RFI laboratory tests using an LNAPL sample collected in May 1993 from well G5. The laboratory analyses were conducted by CH2M HILL's Applied Sciences Laboratory in Corvallis, Oregon. The tests compared the LNAPL with commercial Peneteck oil (a white mineral oil) formerly used in vanillin production at the Facility. (Peneteck oil is composed of straight-chain hydrocarbons in the C_5 to C_{16} range and is not classified as a toxic or a hazardous material; the Material Safety Data Sheet and a description of Peneteck oil from the Hazardous Substances Data Bank are provided in Appendix L.) The results indicated that the LNAPL had a specific gravity of 0.815 and included approximately 81.6 percent Peneteck oil and 11.1 percent toluene. The remaining 7.3 percent of the LNAPL could not be precisely identified analytically, but was qualitatively identified as Peneteck oil and toluene degradation products.

Dates, sources, and results of analyses for LNAPL from wells G5, H10, and MW-18, including the May 1993 well G5 data described above, are presented in Table 4-20A. Available laboratory reports are included in Appendix L. As shown in Table 4-20A, LNAPL samples collected from wells G5 and H10 by RPI in 1991 contained 9.3 and 19.0 percent toluene, respectively, as compared to 11.1 percent for the 1993 well G5 sample. In contrast, a recent sample of LNAPL from well MW-18 contained 92.0 percent toluene and 2.96 percent Peneteck oil. The LNAPL in this latter well is present in two phases or layers, one of which may be an emulsion layer between the LNAPL and the groundwater. This second phase contained only 0.048 percent toluene. An LNAPL sample from well H10, taken in April 1995, contained 48.8 percent Peneteck oil.

LNAPL Extent

As discussed earlier, RPI removed LNAPL from the Facility in the summer and fall of 1993 as an Interim Measure. In July 1993, RPI abandoned well G5 and replaced it with a 4-inch-diameter well to facilitate recovery of the LNAPL. The replacement well (MW-12) was installed approximately 8 feet west of well G5. In the months prior to its abandonment, the LNAPL thickness in well G5 ranged from 0.1 foot to 2.3 feet. Monitoring of

MW-12 in the first few months after its installation indicated LNAPL thicknesses ranging from approximately 1.0 to 2.7 feet. Also, up to 0.2 foot of LNAPL was noted in well H10 in September 1993.

As discussed in Sections 2.4.1 and 2.4.3, work was conducted during the RFI to further assess the extent of the LNAPL. This was accomplished in two ways:

1. A temporary well screen was installed at the groundwater table at the 29 Hydro-Punch boring locations. After allowing time for water and LNAPL (if present) to enter the well screen, the screen contents were sampled with a transparent bailer (see Section 2.4.1 for further discussion of the methodology).

2. The extent of the LNAPL was assessed by periodic monitoring of Upper Aquifer monitoring wells. This was accomplished by lowering a transparent bailer partway through the liquid surface in each well and examining the recovered sample for the presence of immiscible liquid, or by measuring the LNAPL thickness with an oil/water interface probe (see Section 2.4.2; the bailer method was generally used prior to 1995, and the interface probe was used during 1995).

The results of both types of monitoring are discussed below. The locations of the borings and monitoring wells where LNAPL has been observed are shown in Figure 4-51.

LNAPL was encountered in three of the 29 HydroPunch borings drilled during the RFI (borings A04-08, A05-24, and A04-01—see Figure 4-51). LNAPL was observed in HydroPunch bailer samples recovered from A05-24 and A04-01. LNAPL was noted on the drilling tools at boring A04-08, but not in the bailer sample.

All the Upper Aquifer monitoring wells screened across the groundwater table (31 wells) have been monitored for LNAPL. Of these, wells located in the vicinity of well MW-12 and the Tank Farm have been monitored periodically since late 1993. The monitoring results through April 1995 are presented in Table 4-21. Multiple measurements taken in individual wells on the same day indicate that LNAPL thickness varies with groundwater-level fluctuations (e.g., see the March 10, 11, and 17, 1994 data for well H10). As can be seen from Table 4-21, LNAPL has been noted at least once since late 1993 in nine monitoring wells screened across the groundwater table: H1, H6, H9, H10, H11, MW-12, MW-15, MW-18, and MW-19 (see Figure 4-51). In September 1994, oily sheens were observed in wells H6 and H9, the first time LNAPL had been observed in these wells. An LNAPL thickness of 0.12 foot was also observed in well H11 at that time, the first time a measurable thickness of LNAPL had been observed in this well. In addition, a measurable LNAPL layer was noted in well MW-18 for the first time on March 31, 1995, at a thickness of nearly 1 foot (see Table 4-21).

Relationship of Groundwater Levels to LNAPL Presence

LNAPL information collected to date suggests that there is not a large volume of LNAPL beneath the Facility. LNAPL monitoring has been conducted at approximately 40 locations (i.e., Hydropunch borings and monitoring wells), and monitoring continues on a regular schedule at selected monitoring wells in Areas A4 and A5. In spite of the significant monitoring effort that has occurred, LNAPL has only been observed in wells located in a relatively small area of the Facility, and then only intermittently. When LNAPL is present in a well, its thickness varies with time in response to groundwater levels that fluctuate in response to tides in the Duwamish Waterway. However, the monitoring data also show that LNAPL may be present in a monitoring well for a few weeks or months and then subsequently "disappear," only to reappear at a later time (e.g., weeks or months later; see Table 4-21). The cause for the intermittent presence of LNAPL in monitoring wells appears to be related, at least in part, to seasonal groundwater-level fluctuations induced by the annual changes in mean tide levels. This relationship was assessed during the RFI and the results indicate that a correlation exists, as discussed below.

Figure 4-51A shows the mean monthly tide level (datum is mean sea level) for the last 3 years. The figure indicates that the mean monthly tide level fluctuates up to approximately 1 foot over a year and reaches a peak height in the months of December through February. Figure 4-51B depicts LNAPL thickness data for wells H10, MW-12, and MW-18 superimposed on the mean monthly tide levels for the period from February 1994 through April 1995. Figure 4-51B also shows a correlation between the mean monthly tide elevation and the occurrence of LNAPL in these wells. In February and March 1994 when the mean monthly tide level was high, LNAPL was present and exceeded 1 foot in thickness. The LNAPL essentially disappeared from well H10 by the end of March 1994, coinciding with a period of low mean monthly tide elevations lasting several months. The mean monthly tide elevation began to increase in the fall of 1994, and LNAPL reappeared in well H10 in January 1995. LNAPL subsequently appeared in wells MW-12 and MW-18 in late 1994 and early 1995. Because the groundwater level at the site is tidally influenced, the month-to-month change in the mean tide in the Duwamish Waterway is assumed to have a corresponding effect on the mean groundwater elevation. In turn, it appears that the presence of LNAPL in the above-referenced wells is related to the fluctuations in the mean groundwater level for the Upper Aquifer.

In summary, the LNAPL monitoring data collected to date suggest that there is not a large volume of LNAPL beneath the site. LNAPL appears to be present within the capillary fringe at residual saturation levels. The appearance and disappearance of LNAPL from a monitoring well appears to be related to long-term fluctuations in the groundwater level. These fluctuations cause the LNAPL to migrate into wells when the mean groundwater level is high. During periods of lower mean groundwater levels, the LNAPL may become "smeared" across the lower portion of the unsaturated zone and the capillary fringe. In this condition, the LNAPL is more likely to be present at residual saturation levels, making it less mobile and less likely to accumulate in monitoring wells.

Monthly LNAPL monitoring and documentation are continuing at the Facility as an Interim Measure.

4.3.5 Miscellaneous Organic Compounds

A number of organic compounds were detected in RFI groundwater samples infrequently and at relatively low concentrations (i.e., below action levels). These are discussed below.

Semivolatile Organic Compounds

Semivolatiles detected in the RFI groundwater samples and not addressed previously are discussed below.

2,4-Dimethylphenol. 2,4-dimethylphenol was detected once in Round 1 at a concentration of 26 μg/l, below the action level of 110 μg/l. This compound will not be addressed in the Risk Assessment/MCS evaluation.

Dibenzofuran. Dibenzofuran was detected at 2 μg/l in well B6 at Round 1. No action level exists for this compound; therefore, it will be included in the Risk Assessment/MCS evaluation.

Phenol. Phenol was detected at three wells at concentrations ranging from 3 μg/l to 730 μg/l in Round 1 and at two wells in Round 2 at concentrations of 2 μg/l and 895 μg/l. All of these concentrations are below the action level of 9,600 μg/l. This compound will not be addressed in the Risk Assessment/MCS evaluation.

Di-N-Butyl Phthalate. Di-N-butyl phthalate was detected in two wells in Round 2 at concentrations of 2 μg/l and 5.5 μg/l, below the action level of 1,600 μg/l. This compound will not be addressed in the Risk Assessment/MCS evaluation.

Diethyl Phthalate. Diethyl phthalate was detected in one well in Round 2 at a concentration of 7 μg/l, below the action level of 12,800 μg/l. This compound will not be addressed in the Risk Assessment/MCS evaluation.

N-Nitrosodiphenylamine. N-nitrosodiphenylamine was detected in one well in Round 2 at a concentration of 5.5 μg/l, below the action level of 16 μg/l. This compound will not be addressed in the Risk Assessment/MCS evaluation.

Vanillin. Vanillin, which was produced at the Facility, was detected in 10 groundwater samples during Round 1. The concentrations ranged from 1 to 35 μg/l (seven of the 10 detections were J-qualified [estimated]). All the detections were in the Upper Aquifer. The three highest concentrations (5 to 35 μg/l, not J-qualified) were in wells DM-2A, DM-7, and DM-8. These wells are located around the perimeter of the Tank Farm. There is no action level for vanillin, which is a non-toxic compound as discussed earlier and in

Appendix L. Because of its non-toxic nature, vanillin will not be addressed in the Risk Assessment/MCS evaluation.

Volatile Organic Compounds

Volatiles detected in the RFI groundwater samples at relatively low concentrations (i.e., below action levels) and not addressed previously are discussed below.

2-Butanone. 2-butanone (methyl ethyl ketone) was detected once in Round 1, at well H10 at a concentration of 1,300 μg/l, which is below the action level of 4,800 μg/l. It was also detected in Round 2 at well H11 but could not be quantified because of matrix interference. The source of the 2-butanone is unknown. Because this compound was detected below the action level, it will not be addressed in the Risk Assessment/MCS evaluation.

Xylene. Xylene was detected once in Round 1 at a concentration of 110 μg/l and once in Round 2 at a concentration of 14 μg/l; both concentrations are below the action level of 10,000 μg/l. Xylene was detected at well H11 in Round 1 and at well MW-20 in Round 2. Because the concentrations detected were below the action level, this compound will not be addressed in the Risk Assessment/MCS evaluation.

TPH

TPH does not have an action level in the groundwater and surface water standards listed earlier. However, TPH does have a MTCA Method A groundwater cleanup level of 1,000 μg/l. Groundwater samples were not analyzed for TPH during the RFI; however, groundwater samples were analyzed for TRPH. Although TRPH was detected in seven wells (H10, H11, MW-12, MW-15, MW-17, MW-18, and MW-19) at concentrations exceeding the MTCA Method A cleanup level for TPH, all these wells are within the toluene plume area. Because of this, the TRPH concentrations are likely associated with the toluene, although there is not good correlation between TPH concentrations and toluene concentrations in groundwater. However, the highest TRPH concentrations are found at wells H10 and H11, which are located in the center of the toluene plume.

TPH is not a specific compound but an indicator analyte for a complex mixture of petroleum-related compounds. Because of this, TPH does not have specific reference doses (RfDs), carcinogenic potency factors (CPFs), or other risk indices that can be used to develop Media Cleanup Standards. Many of the known compounds comprising TPH that were detected at the Facility and that could pose a threat to human health or the environment are found in the 40 CFR 264 Appendix IX analyses. Because the groundwater was analyzed for Appendix IX constituents and the Appendix IX constituents exceeding action levels will be addressed in the Risk Assessment/MCS evaluation, TPH in groundwater will not be addressed in the Risk Assessment/MCS evaluation.

4.3.6 Metals in Groundwater

This section focuses on metals detected in groundwater at the Facility. Many of the metals detected in monitoring well samples are not of particular concern as they are present naturally in groundwater. They are not considered contaminants when present at normal concentrations. Certain metals were detected, however, that may originate from anthropogenic sources as evidenced by their absence or low concentrations at upgradient monitoring wells (e.g., wells in the Background Area). Other metals, such as chromium and copper, are also addressed here because of their toxicity to marine organisms and their potential introduction to the Duwamish Waterway via groundwater discharge. Chromium, in particular, requires discussion as its oxidation state determines its toxicity to both humans and marine organisms.

Round 1 metals analyses were performed on unfiltered and filtered groundwater samples. Unfiltered samples contain both particulate and dissolved forms, whereas filtered samples contain only the dissolved form. Round 3 groundwater samples (to be documented in the Round 3 Data Technical Memorandum that will be submitted as an addendum to this report) were collected using a low-flow micro-purge sampling method and were analyzed for total, unfiltered metals. This low-flow sampling method tends to minimize turbidity in groundwater samples, so the unfiltered metals results are more representative of the aquifer.

Total metals detected above action levels in Rounds 1 and 2 were arsenic, copper, lead, nickel, vanadium, zinc, chromium, beryllium, mercury, antimony, cadmium, and silver. Antimony and cadmium were only detected in the Background Area wells. Other total metals that were detected in the Background Area wells were arsenic, copper, lead, nickel, vanadium, zinc, chromium, beryllium, and mercury; beryllium was only detected in one of the two Background Area wells screened in the Upper Aquifer. Table 4-21A lists the metals detected, their action levels, and the total and dissolved concentrations found in the Upper Aquifer wells in the Background Area. The sources of the action levels are shown in Table 4-18.

Two metals were detected only in the Background Area (Area BG). These metals, antimony and cadmium, were detected in an unfiltered sample from well E3 at concentrations of 69.3 and 8.1 μg/l, respectively (the action levels are 6 and 5 μg/l, respectively). Therefore, antimony and cadmium are not considered constituents of concern because they were detected at the upgradient end of the Facility and the data indicate that their detection is associated with sediment in the sample (these two metals were not detected in filtered samples).

Of the other metals detected in the Background Area wells, arsenic is known to be a background contaminant in this region (see Appendix J). Beryllium was never used at the Facility and has been found at other sites along the Duwamish Waterway. As discussed earlier, the King County Airport is upgradient from the Facility; metals such as cadmium, chromium, lead, mercury, and zinc are typically associated with aircraft maintenance

activities such as plating and painting, and these metals are not believed to be associated with Facility operations. It is not known what vanadium could have been used for; most concentrations detected onsite are below 200 μg/l for total vanadium. The highest concentrations of vanadium were detected at wells DM-5 (1,670 μg/l dissolved, 1,630 μg/l total), DM-2A (1,300 μg/l dissolved, 1,330 μg/l total), and DM-8 (1,390 μg/l dissolved, 1,340 μg/l total). Copper was detected in a number of wells in both the Background Area and non-background areas. Copper was used at the Facility in the vanillin manufacturing process.

As discussed in Section 4.3.8 and as shown in Figure 4-52, there is a correlation between the occurrence of dissolved chromium in the Upper Aquifer and the presence of Black Liquid, although there are some exceptions to this association. Dissolved chromium was detected in two wells, B5 and G3, located outside the Black Liquid area but along its eastern edge (see Figure 4-52). Dissolved chromium was not detected at wells MW-12, H10, and B6 even though they are located within the Black Liquid area. Chromium was detected, however, in unfiltered groundwater samples collected from these three wells.

It should be noted that dissolved chromium concentrations, even within the Black Liquid area, are lower than the action level (50 μg/l) in all but five cases. The monitoring wells that indicated dissolved chromium concentrations higher than the action level during Round 1 were H9 (62.3 μg/l), H11 (95.1 μg/l), DM-2A (149 μg/l), DM-8 (153 μg/l), and DM-5 (365 μg/l).

In general, total chromium followed a pattern similar to that of dissolved chromium. Wells that exceeded the action level for total chromium included those that exceeded the action level for dissolved chromium. Wells H6 and B2, both within the Black Liquid plume, also exceeded the action level for total chromium. Total chromium also exceeded the action level in well G3, located along the east side of the Black Liquid plume, and in Background Area well E3.

The action level of 50 μg/l is for total chromium, in both trivalent and hexavalent forms. A rationale for including both the chemically reduced (trivalent) and oxidized (hexavalent) forms was that trivalent chromium might become oxidized to the more toxic hexavalent form when the water is treated with an oxidizing substance, such as a biocide, or enters an oxidizing environment prior to its distribution for potable uses. Groundwater beneath the RPI Facility has several characteristics of a chemically reducing environment (as discussed in Section 4.3.7), and conditions strongly mitigate against conversion to the hexavalent form. All chromium at the site is present in the trivalent form, according to Round 3 data (these data will be reported and discussed in the Round 3 Data Technical Memorandum that will be submitted as an addendum to this report).

Highly colored water or the presence of elevated concentrations of certain metals, including iron, can give "false positive" results for many hexavalent chromium analytical methods. Groundwater beneath the RPI Facility is colored in some areas and contains iron and

manganese. Indirect methods of inferring the oxidation state of chromium at the Facility have been used.

Groundwater from a number of locations was sampled and analyzed for dissolved chromium and for other constituents that can provide strong indications for the presence or absence of hexavalent chromium during Round 1. The other constituents that served as indicators of the oxidation state of chromium are divalent iron (dissolved), divalent manganese (dissolved), and total organic carbon. Detection of any of these constituents in groundwater, especially at elevated concentrations, suggests chemically reducing conditions that are inconsistent with the existence of hexavalent chromium. In fact, the presence of dissolved iron in the ferrous (divalent) state would rule out the potential for chromium to exist in the hexavalent state. The results of Round 1 testing (Table 4-22) were used to guide any additional testing during Round 2.

Samples analyzed for dissolved chromium were discolored because of the presence of spent sulfite liquor (lignin—see Section 4.3.8). In Round 2, dissolved oxygen measurements of groundwater within selected wells (Table 4-23) were relied upon to support chemically reducing (low-oxygen) conditions in groundwater, as noted above. The dissolved oxygen concentrations in the wells that were sampled ranged from 0.1 to 1.4 mg/l, whereas the oxygen concentration in water that was saturated with air at the temperatures reported in Table 4-23 would fall between approximately 9.5 and 10.5 mg/l. The combination of elevated iron and manganese, low dissolved-oxygen values, and elevated TOC strongly support a chemically reducing environment in which chromium could not exist in the hexavalent state. In Round 3, EPA Methods 7197 and 218.6 were used to analyze samples of groundwater; no hexavalent chromium was detected using either method. The Round 3 data will be reported in the Round 3 Data Technical Memorandum that will be submitted as an addendum to this report.

4.3.7 Conventional Water Quality and Biological Indicator Parameters

Selected groundwater samples collected during the RFI were analyzed for conventional water quality and biological activity indicators. These analyses were performed to characterize the general groundwater chemistry and evaluate conditions relating to current or potential biological degradation (biodegradation) of organic contaminants in groundwater.

The general water quality parameters included the following:

- Alkalinity
- Hydroxide alkalinity
- Bicarbonate
- Calcium (for hardness)
- Carbonate
- Chloride

- Magnesium
- pH
- Specific conductance
- Temperature
- Total dissolved solids
- Total organic carbon

With the exception of temperature and specific conductance, all the above data were collected during Round 1. Temperature and specific conductance data were collected during both Rounds 1 and 2.

Biological activity indicators included the following:

- Dissolved oxygen (Round 2 only)
- Kjeldahl nitrogen
- Nitrate
- Nitrite
- Orthophosphate
- Phosphorus
- Sulfate
- Sulfide

With the exception of dissolved oxygen (DO), all the above data were collected during Round 1. DO measurements were collected during Round 2 only.

The conventional water quality and biological indicator data collected at the Facility were used to:

- Assess whether biological degradation is taking place at the Facility, and the types of reactions that may be occurring.

- Identify and evaluate conditions that may limit or control biodegradation rates (e.g., the supply of nutrients and other reactants).

- Aid in selecting input parameters to be used in fate and transport analyses (see Section 4.8).

- Provide preliminary information for assessing remediation alternatives during the CMS.

The results of the conventional water quality parameter analyses are presented in Table 4-24. Table 4-25 provides the biological indicator results.

The data in Table 4-25 indicate that subsurface conditions are chemically reducing (i.e., have low redox potential). DO concentrations measured *in situ* (in the screened portion of

each well) are consistently low (less than 1.5 mg/l), even in groundwater that is upgradient (east) from the toluene plume. Concentrations of other parameters also indicate reducing conditions; for example, nitrate and sulfate concentrations are also low. As presented in Section 4.3.6, both iron and manganese are present in groundwater in their dissolved forms. The soluble, chemically reduced forms of these metals indicate a reducing environment. The redox conditions are addressed further in Section 4.3.6.

Biodegradation of organic contaminants is the result of biochemical reactions that are mediated by microorganisms. The organisms metabolize the contaminants to obtain energy and cell "building blocks." As such, there is an order of preference in the type of degradation activity that will take place in the subsurface, depending on the energy released by the biochemical reactions. The order of preference is:

- Aerobic degradation, using oxygen
- Anaerobic degradation by reduction of nitrate
- Anaerobic degradation by reduction of sulfate
- Anaerobic degradation by methanogenesis

Oxygen is the most efficient reactant, with the result that most contaminants are readily degraded under aerobic conditions. However, oxygen flux into an aquifer is typically limited. In most cases, available oxygen is depleted by aerobic biodegradation of organic species faster than it is replenished. Thus, oxygen is typically the limiting factor in aerobic biodegradation. The low DO concentrations in groundwater at the RPI Facility suggest that little oxygen is available for aerobic activity, even in groundwater upgradient of the toluene plume and in Area BG. Because DO is low across the Facility, aerobic degradation of toluene does not currently appear to be a significant process.

The order of preference listed above for biodegradation processes corresponds to redox conditions. As the more oxidized species are depleted, conditions become more reducing. In a low-oxygen environment, such as that indicated by the water quality data in Tables 4-24 and 4-25, contaminants may undergo anaerobic degradation by organisms that reduce nitrate or sulfate, or by methanogens (methane-producers) in the most highly reduced environments. An assessment of which anaerobic processes may be occurring includes examining the data for spacial trends in either the reactants or the products of each reaction; consulting literature for documented cases of degradation of a specific contaminant via each process; and considering redox potential.

For example, if nitrate or sulfate reduction were occurring at the RPI Facility, the nitrate or sulfate concentrations should be higher in wells upgradient (east) of the toluene plume, and lower within and downgradient (west) of the area of highest contamination. The groundwater data do not show this trend for either of these reactants. Concentrations of nitrate and nitrite are uniformly low; therefore, there is no evidence of biodegradation via nitrate reduction. Concentrations of sulfate are highly variable and the data are inconclusive. Groundwater with higher levels of sulfate (around 50 mg/l and higher) may support degradation via sulfate reduction, while sulfate reduction is unlikely for sulfate levels below

around 10 mg/l. (The presence of sulfide is an indicator of low redox potential; however, its use as an indicator of sulfate reduction activity is limited since sulfide levels are probably controlled by the precipitation of ferrous iron.) The data in Tables 4-24 and 4-25 do not provide direct evidence of degradation via sulfate reduction, but the potential exists for toluene degradation through this process.

Under highly reducing conditions such as those indicated by groundwater data for the RPI Facility, anaerobic degradation may occur via a process called methanogenesis. During methanogenesis, the organic contaminant is broken down into carbon dioxide (or acetate) and methane. Methane is the most effective monitoring parameter for assessing the presence and extent of methanogenesis, since it is a by-product of the reaction. Because of the expectation of aerobic conditions in shallow groundwater, samples collected during the RFI were not analyzed for methane. However, health and safety-related air monitoring measurements conducted at monitoring well well-heads during the RFI fieldwork suggest that methane might be present. These air quality measurements were often conducted using both a combustible gas indicator (CGI) and a PID. The CGI will respond to all explosive organic vapors (at detectable concentrations), including methane. In contrast, the PID only detects organics with certain ionization potentials; methane is not among these and therefore is not detected by a PID. Comparison of CGI and PID data collected at open well-heads for wells B4 and DM-5 suggests the presence of methane in the well casing.

The groundwater quality data alone do not indicate conclusively that toluene biodegradation is occurring by anaerobic degradation. However, the steep concentration gradient around the perimeter of the toluene plume (Figures 4-47 and 4-48) suggests that biodegradation is occurring. Toluene has been shown to be readily degraded anaerobically by both sulfate reduction and methanogenesis under laboratory and field conditions at other sites. Past studies indicate that the rate of anaerobic degradation of toluene by methanogenesis can be competitive with that of aerobic degradation of toluene, with the highest rates achieved by methanogenesis. The data collected to date suggest that biodegradation may be occurring via methanogenesis, and possibly sulfate reduction.

Other data presented in Tables 4-24 and 4-25 provide useful information regarding the parameters affecting the potential for biodegradation to occur at the Facility. Concentrations of nitrogen and phosphorus are sufficiently high that these nutrients are probably not limiting reaction rates. The pH and temperature are in the acceptable range for most biodegradation processes. Depending on the type of biological processes under consideration, alkalinity data may be used to calculate buffering capacity for pH changes that can occur as a result of biological processes that affect redox potential.

4.3.8 Extent of Black Liquid

As discussed in the RFI Workplan, part of the Facility is underlain by groundwater that is dark brown to black in color. The groundwater is not oily or viscous but resembles water that is rich in tannic acid, and for convenience it has been termed "Black Liquid."

Conventional groundwater chemistry data suggest this dark-colored groundwater is high in TOC and bicarbonate compared to groundwater in other areas of the Facility. The high bicarbonate concentration appears to be evidenced by effervescence when groundwater is poured into acidified sample bottles. Samples taken from wells DM-5, H11, and DM-8 effervesced when placed in acidified sample bottles during at least one sample round; bicarbonate concentrations measured in Round 1 in these wells were 3,110 mg/l, 1,460 mg/l, and 1,180 mg/l, respectively. Wells outside the Black Liquid plume had significantly lower bicarbonate concentrations overall and ranged from 84 to 492 mg/l (in wells A9 and A2, respectively).

The RFI objectives for groundwater quality included 1) investigating the presence and extent of the Black Liquid in the Upper Aquifer, and 2) evaluating whether toxic or regulated substances are co-distributed with the liquid. The estimated extent of the Black Liquid was evaluated during the RFI by visually inspecting monitoring-well purge water generated during the Round 1 groundwater sampling effort (conducted in January and February 1994). An assessment of the chemical characteristics of the Black Liquid and of the presence or absence of toxic substances was accomplished by analyzing groundwater samples during Rounds 1 and 2.

Figure 4-52 shows the estimated areal extent of the Black Liquid at the Facility. The configuration of the liquid area is similar to that identified in July 1994 (see Figure 4-19 in the RFI Workplan), indicating that the location and configuration of the liquid did not change significantly in 6 months. The source of the liquid appears to be the spent sulfite liquor (lignin) that was stored and used onsite. The source of the chromium in the liquid may be chromic acid that was reportedly used by the lignin supplier to clean its storage vessels.

A comparison of groundwater data indicates that there is a correlation between the presence of the Black Liquid and the presence of chromium (see Section 4.3.6). No other toxic substances are known to be specifically associated with the liquid based on a review of the available data.

4.3.9 Groundwater Investigation Summary

Groundwater quality at the Facility was assessed during the RFI in several ways. Round 1 of the investigation included collection and analysis of samples from all 30 pre-RFI monitoring wells (Figure 2-3). A HydroPunch investigation was also conducted during Round 1 in Areas A2, A4, A5, and A6 (Figure 2-19) to assess the magnitude and extent of the toluene plume. During Round 2, 19 monitoring wells were sampled including eight new wells installed in the vicinity of the toluene plume (Figure 2-20). Monitoring to assess the presence and extent of LNAPL was also conducted during the HydroPunch investigation and on a monthly basis at monitoring wells.

The groundwater quality results were compared to action levels. The results indicate that toluene in groundwater beneath the Tank Farm area (Figures 4-47 and 4-48) is the primary constituent of concern at the Facility. Toluene was found to exceed the 1,000 μg/l action level at 10 Facility monitoring wells (wells H1, H10, H11, MW-12, MW-14, MW-15, MW-16, MW-17, MW-18, and MW-19). The area where toluene exceeds the 1,000 μg/l action level is approximately 1.5 acres. Concentrations in the upper 10 feet of the Upper Aquifer range up to several hundred thousand micrograms per liter and decrease significantly with depth. Toluene concentrations in the lower half of the Upper Aquifer are two to three orders of magnitude lower than those in the upper 10 feet of the aquifer (Figures 4-49 and 4-50). RFI groundwater monitoring data indicate that the toluene plume has not migrated offsite, either to adjacent properties or to surface water bodies.

Several other organic compounds are present within the boundaries of the toluene plume at concentrations exceeding action levels. These compounds include benzo(a)pyrene, pentachlorophenol, 2-methylphenol, 4-methylphenol, bis(2-ethylhexyl)phthalate, benzene, methylene chloride, acetone, endosulfan I, endosulfan sulfate, and 4,4'-DDD. These compounds are of secondary concern because they are less widespread and generally do not exceed their respective action levels to the same degree as toluene.

Three organic compounds were detected in the Lower Aquifer. Bis(2-ethylhexyl)phthalate, acetone, and toluene were detected in Lower Aquifer wells DM-1B, DM-3B, and B1B at relatively low concentrations. Only bis(2-ethylhexyl)phthalate was detected above its respective action level; however, the detected concentration is essentially equivalent to the action level (the reported concentration is 6 μg/l [J-qualified], compared to the action level of 5.9 μg/l). Given the hydrogeologic conditions at the Facility, it is unlikely that these organic compounds migrated from Upper Aquifer to the Lower Aquifer. It is possible that constituents entered the Lower Aquifer via surface water infiltrating the flush-mounted wellheads for these wells. It is also possible that the source of the bis(2-ethylhexyl)phthalate is laboratory contamination or the PVC monitoring well construction materials, as this compound is a common plastizer in PVC and was also detected at low concentrations in 11 Upper Aquifer wells.

The other organics that exceeded action levels outside the toluene plume were benzene, benzo(a)pyrene, chrysene, bis(2-chloroethyl)ether, and 1,1-dichloroethane. Benzene exceeded its action level at well DM-7, which is located at the edge of the toluene plume; this detection is probably associated with the toluene plume. Bis(2-chloroethyl)ether and 1,1-dichloroethane were only detected at well A2, which is adjacent to the Kenworth site; the concentrations exceeded the action levels. These two compounds are not known to be associated with Facility activities and may result from offsite sources. All of these organic compounds will be included in the Risk Assessment/MCS evaluation.

Total metals detected above action levels in Rounds 1 and 2 were arsenic, copper, lead, nickel, vanadium, zinc, chromium, beryllium, mercury, antimony, cadmium, and silver. Antimony and cadmium were only detected in the Background Area wells. Other total metals that were detected in the Background Area wells were arsenic, copper, lead, nickel,

vanadium, zinc, chromium, beryllium, and mercury; beryllium was only detected in one of the two Background Area wells screened in the Upper Aquifer. Copper was used in the Facility manufacturing process and is elevated onsite. All of these metals with action level exceedances will be included in the Risk Assessment/MCS evaluation.

Based on the findings of the HydroPunch investigation and the monthly LNAPL monitoring that is being conducted as an Interim Measure activity, LNAPL is not present beneath the Facility in significant or recoverable volumes. Chemical characterization of the LNAPL conducted prior to the RFI indicates that it is composed primarily of non-toxic mineral oil (Peneteck oil; see Appendix L). LNAPL is not recommended for inclusion in the Risk Assessment/MCS evaluation. If a recoverable volume of LNAPL is noted in a Facility monitoring well in the future, it will be removed from the well as an Interim Measure.

In summary, two metals (antimony and cadmium) exceeded groundwater action levels only in the Background Area wells; these two metals will not be addressed in the Risk Assessment/MCS evaluation. All other constituents exceeding action levels in groundwater will be included in the Risk Assessment/MCS evaluation. Most of the organic compounds exceeding action levels are located within the toluene plume. The Risk Assessment/MCS evaluation will include an examination of statistical differences and similarities between constituents detected above action levels onsite and in the Background Area (e.g., metals in groundwater).

A number of constituents detected in groundwater at the Facility do not have action levels. These will be included in the Risk Assessment/MCS evaluation. If a RFI groundwater result for such a constituent exceeds its final Media Cleanup Standard, the constituent will be carried forward and addressed in the CMS. Inorganic and general water quality constituents present naturally in groundwater or that act as indicator parameters will not be addressed in the Risk Assessment/MCS evaluation. These are:

Conventional Water Quality Parameters	Inorganics
Alkalinity	Aluminum
Bicarbonate	Calcium
Carbonate	Magnesium
Kjeldahl nitrogen	Potassium
Orthophosphate	Sodium
Phosphorus	
Sulfate	
Sulfide	
Total organic carbon	
Total dissolved solids	

Vanillin is a semivolatile organic compound that was detected in groundwater and does not have an action level. As noted previously, vanillin is a non-toxic product that was

produced at the Facility. Appendix L includes information on the non-toxic nature of this compound; it is approved by the U.S. Food and Drug Administration as Generally Recognized As Safe (GRAS). It was included as an RFI constituent of interest only to help distinguish vanillin-related contamination from non-vanillin-related contamination in order to support cost-recovery discussions with the former Facility owner. Because of its non-toxic nature, vanillin will not be addressed in the Risk Assessment/MCS evaluation.

The following parameters were detected at the Facility, do not have action levels, and will be included in the Risk Assessment/MCS evaluation:

Inorganics	Semivolatiles
Total cobalt	Dibenzofuran 2-methylnaphthalene

4.4 Sediment Investigation

The RFI sediment investigation was conducted using a nonparametric sampling approach, as described in the RFI Workplan. As described in Section 2.5, sediment sampling was conducted during two low-tide events (one each during Round 1 and Round 2 of the RFI) in the offshore investigation Area A11 along the western portion of the Facility.

The samples collected during Round 1 and Round 2 were analyzed for inorganics (metals), semivolatiles (including PAHs), pesticides, PCBs, TOC, and other conventional parameters, and physical parameters including grain size and specific gravity, as summarized in Table 2-13. A minimum of seven, and maximum of 14, samples were analyzed depending on the constituent group. Figure 4-53 shows the sampling locations and a tabular statistical summary of the analytical results.

The Department of Ecology has applied the Washington State Marine Sediment Management Standards for Puget Sound (WAC 173-204) to the Duwamish Waterway sediments, including this section of the Waterway adjacent to the RPI Facility (personal communication with Dr. Teresa Michelsen, Washington State Department of Ecology, October 27, 1994). Sluggish flow in the Duwamish Waterway and strong tidal forces allow a saltwater wedge to intrude into the Duwamish Waterway upstream of the Facility. Table 4-26 compares the chemical parameter results from Round 1 and Round 2 to the Marine Sediment Management Standards, including the Sediment Quality Standards (SQSs; WAC 173-204-320, Table I) and the Minimum Cleanup Levels (MCULs; WAC 173-204-520, Table III). The SQS sediment criteria are screening levels that correspond to chemical concentrations that result in no adverse effects on biological resources or significant health risk to humans. The marine sediment MCUL chemical criteria are also the Puget Sound Marine Sediment Cleanup Screening levels; these MCULs are considered the action levels for the RFI.

4.4.1 Sediment Investigation Results

The results of both the Round 1 and Round 2 sampling events for the RFI sediment investigation are summarized in the following sections. As discussed in Section 2.5, TOC analyses were performed on samples collected during Round 2 only. The TOC results from Round 2 have been used to normalize dry-weight station sample results for non-polar organic compounds (e.g., PAHs and PCBs) from Round 1 and Round 2 to allow comparison to the Marine Sediment Management Standards (Table 4-26). To calculate TOC-normalized concentrations, the dry-weight concentrations are divided by the decimal fraction representing the percent organic carbon in the sediment. The TOC-normalized results are discussed in the following sections, as applicable. Note that Table 4-26 shows both detected and nondetected results, unlike data tables presented previously for soil and groundwater. The nondetected results are presented so that detection limits can be compared to the Marine Sediment Management Standards.

Inorganic Compounds (Metals)

A total of 19 metals were detected during Round 1 sampling (Figure 4-53). Metals concentrations in the sediments did not exceed the Marine Sediment Management Standards (Table 4-26). The following metals, listed with their concentration ranges in parentheses, were detected in all samples:

- Arsenic (2.8 mg/kg to 9.9 mg/kg)
- Chromium (12.5 mg/kg to 25 mg/kg)
- Copper (13.2 mg/kg to 57.4 mg/kg)
- Lead (5.2 mg/kg to 26 mg/kg)
- Zinc (32.4 mg/kg to 92.5 mg/kg)

One sample, collected at sampling station 5, was analyzed for metals during Round 2. As shown in Table 4-26, the results were comparable to the Round 1 results for station 5.

Semivolatile Organic Compounds

Twenty-one semivolatiles, including PAHs, were detected in 14 sediment samples collected during Rounds 1 and 2. Figure 4-53 summarizes the frequency of detection and detected concentration ranges for these parameters. The following semivolatiles, listed with their concentration ranges in parentheses, were detected in all samples:

- Fluoranthene (42 μg/kg to 1,200 μg/kg)
- Pyrene (37 μg/kg to 890 μg/kg)
- Bis(2-ethylhexyl)phthalate (29 μg/kg to 710 μg/kg)

The most frequently detected semivolatile organic compounds in the sediment samples were PAHs. Although PAHs were never used at the RPI Facility for processing or manufacturing, the presence of PAHs is expected because of their widespread distribution reported

for the Duwamish Waterway and Elliott Bay (e.g., *Elliott Bay Waterfront Decontamination Study, Literature Search,* Washington State Department of Ecology, 1993). A summary of PAH occurrences in sediments and other media in the vicinity of the RPI Facility is included in Appendix J.

The Marine Sediment Management Standards for PAHs and other non-polar semivolatile organic compounds are expressed in terms of mg/kg-organic carbon (Table 4-26). In accordance with the standards, if chemical analysis identifies an undetected value for one or more compounds, the detection limit is reported as the result based on TOC. The TOC-normalized concentrations are calculated as described above.

No exceedances of the Marine Sediment Management Standards occurred for samples where PAHs or other non-polar semivolatile organic compounds were detected. However, TOC-normalized non-detected values from Round 1 results (i.e., the method detection limits) exceeded SQS criteria and, in some cases, MCULs. The analytical laboratory achieved lower detection limits for analyses performed on the Round 2 samples. The Round 2 TOC-based detection limits did not exceed the Sediment Management Standards with the exception of SQS criteria for hexachlorobenzene (the SQS is 0.38 parts per million [ppm] TOC) and 1,2,4-trichlorobenzene (the SQS is 0.81 ppm TOC).

Sediment criteria for polar organic compounds, such as phenols, are expressed in dry weight. No exceedances of the Marine Sediment Management Standards for these compounds occurred for samples with detectable concentrations. The analytical results for Round 1 had method detection limits elevated above the Marine Sediment Management Standards for some polar organic compounds. The Round 2 analyses achieved lower detection limits and confirmed that polar organic compounds were not present at concentrations at or above the Marine Sediment Management Standards.

Pesticides

Pesticides were analyzed during both rounds of the sediment investigation. Figure 4-53 summarizes the frequency of detection and detected concentration ranges for pesticides. The most frequently detected pesticides in the samples, listed with their concentration ranges in parentheses, were:

- Gamma-chlordane, detected in 13 samples (0.88 μg/kg to 4.4 μg/kg)
- 4,4′-DDD, detected in 11 samples (4.3 μg/kg to 160 μg/kg)
- 4,4′-DDE, detected in 9 samples (2 μg/kg to 45 μg/kg)
- 4,4′-DDT, detected in 10 samples (3.2 μg/kg to 180 μg/kg)

Pesticides were not detected in all samples. Regulatory criteria have not been established for pesticides in sediments. For comparison purposes, these concentrations do not exceed MTCA Method C or Method B cleanup levels for pesticides in soil.

PCBs

The Marine Sediment Management Standards are expressed in terms of total PCBs normalized to TOC (Table 4-26). Total PCBs represents the sum of individual isomers where, if a chemical analysis identifies an undetected value for one or more individual isomers, the detection limit is used to calculate the sum. The TOC-normalized values are calculated as described earlier for the non-polar organic compounds.

Two PCB isomers were detected in the sediment samples collected during Round 1 and Round 2 (Figure 4-53). The PCBs detected, listed with their concentration ranges in parentheses, were:

- Aroclor-1254, detected in 7 samples (24 μg/kg to 210 μg/kg)
- Aroclor-1260, detected in 3 samples (29 μg/kg to 50 μg/kg)

PCBs were not in all samples.

TOC-normalized PCB totals calculated from Round 1 data exceeded the marine SQS (12 ppm-TOC) at all sediment sampling stations. TOC-normalized PCB totals calculated from Round 2 data where lower method detection limits were achieved, exceeded the marine SQS at sampling station 4 only. The exceedance observed at station 4 was for Aroclor 1254 at 210 μg/kg; no other PCB isomers were detected in the sample. The marine sediment MCUL (65 ppm-TOC) was not exceeded at any station.

PCBs are widespread contaminants in Duwamish Waterway and Elliott Bay sediments (e.g., *Elliott Bay Waterfront Decontamination Study, Literature Search,* Washington State Department of Ecology, 1993). Many potential sources of PCBs (present and historical) in the area include combined sewer overflow (CSO) outfalls in the vicinity, such as the Norfolk Street CSO that discharges approximately 1/2 mile upstream of the Facility, and former industrial facilities and practices in the Duwamish Corridor.

Conventional Parameters

Sediment samples collected during Round 2 were analyzed for ammonia, sulfide (as S), TOC, pH, preserved total solids, and total volatile solids. The results for conventional parameters were as follows:

- Ammonia concentrations ranged from 1.62 mg/kg to 15.3 mg/kg
- Sulfide concentrations ranged from <2.73 mg/kg to 136 mg/kg
- TOC ranged from 1.78 percent to 2.61 percent
- pH values for sediments ranged from 6.96 to 7.86
- Preserved total solids ranged from 51.02 percent to 76.47 percent
- Total volatile solids ranged from 12,100 mg/kg to 32,900 mg/kg

The conventional parameter results are within expected concentration ranges for natural marine/alluvial sediment deposits. No regulatory criteria exist for these parameters.

Physical Parameters

The results of grain size, percent solids, and specific gravity testing performed during Round 2 are summarized in Table 4-27. The data confirm field observations that the shoreline sediments grade from predominantly medium sands in the south, near Slip No. 6, to fine sands and sandy silts to the north.

4.4.2 Sediment Investigation Summary

In summary, the RFI sediment investigation results do not indicate chemical parameter concentrations detected at or above the marine sediment MCULs, which are considered the action levels for the RFI.

PCB totals calculated for the Round 2 data indicated one exceedance of the marine SQS. One station with an exceedance of the marine SQS is not sufficient to define "a station cluster of potential concern" (WAC 173-204-510); such a station cluster would be defined if the average contaminant concentration for any three stations (with the highest concentrations for any particular contaminant) exceeded the cleanup screening levels (marine sediment MCULs) (WAC 173-204-520).

The PCB totals calculated for the Round 1 data, which had higher method detection limits, are considered to be superseded by the Round 2 data results. The Round 2 results achieved lower detection limits and are therefore considered more representative of sediment quality at the RPI Facility. Further, PCBs are known to be widespread in the sediments of the Duwamish Waterway and Elliott Bay, with likely sources including discharge from CSOs and historical industrial practices in the region. The PCBs detected appear to be associated with this regional condition, and not with the RPI Facility.

4.4.3 Additional Sediment Sampling

Overall, sediments in the Duwamish Waterway are not contaminated by releases from the RPI Facility. However, Ecology has expressed concern over historical point source discharges that are no longer in use. Because of this concern, sediments in storm sewers leading from the process areas upgradient from the outfalls were sampled and analyzed during May and June 1995. The results will be documented in a Technical Memorandum to EPA and Ecology. The samples were analyzed for the sediment parameters discussed in the RFI Workplan (semivolatile organics, metals, and PCBs) and were also sampled for toluene (a known site contaminant that, if present, could indicate a potential source of contamination to nearby soils or groundwater), total organic carbon (so that the non-polar compounds can be compared to the Sediment Management Standards [SMS] Sediment Quality Standards [SQS] [WAC 173-204-320]) and for the other parameters that were analyzed in sediments during the RFI (pH, grain size, and specific gravity). These

parameters include those constituents that may be present in the sewer sediments because of historical operations. If contamination above the Sediment Quality Standards is found in the sewer sediments, the entire line will be cleaned out before the line is returned to service. Contamination will be followed offsite and the concentrations in sediments near the outfall will be characterized.

In addition to the above storm-sewer sampling, seep samples were taken from visible seeps during the week of April 17, 1995, as discussed in Section 4.6. These samples were analyzed as discussed in the RFI Workplan. In addition to the parameters specified in the Workplan, the samples were analyzed for chromium speciation and non-chlorinated guaiacol and resin acids. If the seep sample results indicate the presence of contaminants, sediment samples may be taken. The results of the seep sampling will be presented in the Round 3 Data Technical Memorandum that will be submitted as an addendum to this report.

4.5 Ecological Site Assessment

As described in Section 2.6, an ecological site assessment was conducted at the Facility to qualitatively identify plants and animals onsite and assess possible effects on them from hazardous constituents currently under investigation. The site assessment was performed on August 18, 1994, during a low (minus-1-foot) tide, which exposed much of the intertidal mud flats of the shoreline area. Weather conditions were typical for August: sunny, hot, and dry, providing a good opportunity to observe the Facility.

4.5.1 Facility Observations

The upland area of the site has been extensively developed, with large portions covered by gravel for blacktop, or by cement. Several structures have been removed, leaving cement slab foundations and short foundation walls. Intact buildings near the entrance to the Facility are landscaped with domestic shrubs and small trees.

Cover for birds and small mammals is primarily provided by common invasive species such as blackberries, common tansy, and Scotch broom found at the edges of the site. A mature big-leaf maple was found growing at the southeastern boundary. Birds observed in the upland portions of the site include California quail, killdeer, starlings, song sparrows, robins, and crows. While not seen during this assessment, rabbits have also reportedly been observed on the site. Overall, wildlife habitat value on this portion of the site is limited because of structural development and site disturbance.

The shoreline area, which is less affected by site development, supports healthier vegetative growth on the riverbank, which in turn provides resting and feeding areas for wildlife. The shoreline area starts with a steep bank of medium to large boulders, and drops approximately 15 to 20 feet in elevation to the high water mark of the Duwamish Waterway.

Vegetation on the bank is fairly dense and lush and includes blackberry, common tansy, flat peavine, pepperwort, douglas aster, and velvet grass.

Below the waterline, the property extends an additional 150 feet into the river channel over an area of intertidal sediments. Algal mats were observed covering the northern third of the exposed sediments during the low tide. This area also contains the remains of a pier, several pilings, and a log boom. Common shore birds observed in this area include Thayer's, ring-billed, and Bonaparte's gulls; belted kingfishers; cormorants; Barrow's and common goldeneyes; and mallards. Migrating and over-wintering birds observed in the shoreline area during the late winter include goldeneyes, mergansers, and grebes. Great blue herons have also been observed flying over the site. While not seen during this assessment, river otters and nesting Canada geese have also been observed on the shoreline and the riverbank, respectively.

The Duwamish River is a migration route for salmonids (including coho, chinook, and chum salmon), as either smolts or mature returning salmon. The adult residence time in the river along the shoreline area is limited, minimizing the opportunity for exposure from any Facility releases. Juveniles do spend more time in the lower reaches of the river, which includes the Facility shoreline.

In general, wildlife species observed during the site assessment and other RFI activities do not appear to be stressed or adversely affected by the operations of the Facility or constituents historically used there. No known species designated as threatened or endangered by federal or state agencies have been observed on the site in either the upland or shoreline areas.

4.5.2 Site Assessment Summary

The Facility is characterized by a variety of plants and animals that do not appear potentially affected by the constituents of concern that were investigated in the RFI. Wildlife species do not appear to be stressed or adversely affected by the operations of the Facility or constituents historically used there. No known species designated as threatened or endangered by federal or state agencies have been observed on the site. The upland area of the Facility has limited wildlife habitat value because of past structural development and disturbance, but the shoreline area supports healthier vegetative growth that provides resting and feeding areas for wildlife.

4.6 Seep Assessment

As described in the RFI Workplan, seep sampling was planned for the RFI to assess the quality of groundwater discharging to the Duwamish Waterway and evaluate the potential for cross-media contamination from groundwater to surface water and sediments. Several inspections were made of the riprap and intertidal zone along the Duwamish Waterway during the Round 1 investigation in an attempt to identify seeps that could be sampled. No

seeps were observed until the Round 2 investigation. During the Round 2 sediment sampling conducted during a minus-1-foot tide on August 18, 1994, a small seep was observed along the base of the rip-rap bank at the southwest corner of the Facility. At that time, however, seep sampling was deferred for the reasons outlined in Section 2.7.

Seven seep samples and two surface water samples (from the Duwamish Waterway up- and downgradient from the seeps) were collected during the week of April 17, 1995, at minus-1-foot to minus-2-foot tides. One dark-colored seep was noted; duplicate samples were taken from this seep and analyzed for 40 CFR 264 Appendix IX compounds, as described in the RFI Workplan. The remaining seep samples were analyzed for selected inorganics (metals and ions), volatile organic compounds, semivolatile organic compounds, and formaldehyde, as described in the RFI Workplan. In addition, the seep samples were analyzed for guaiacol and resin acids, as requested by Ecology. The Duwamish Waterway samples were only analyzed for chromium speciation.

The results of the seep sampling and analysis will be presented in the Round 3 Data Technical Memorandum that will be submitted as an addendum to this RFI Report.

4.7 Air Emissions Investigation

As described in Section 2.8, air samples were collected on August 11, 1994, in Area A4 and in Area A8 at the west end of the old Maintenance Shop (the sampling locations are shown in Figure 2-22). The purpose of the air emissions investigation was to assess the potential release of volatile emissions from the soils and the potential impacts of such releases.

Table 4-28 shows the air sampling results in concentration and flux emission rates along with Acceptable Source Impact Levels (ASILs) and Threshold Limit Values (TLVs). (TLVs are values established by the American Conference of Governmental Industrial Hygienists [ACGIH] for workplace exposures. ASILs are guidelines established by the state Department of Ecology to evaluate the effects of new sources of air toxics in ambient air.)

The organic vapor monitor (OVM) was calibrated with a 100 parts per million by volume (ppmv) isobutylene standard using a 10.6-electronVolt lamp and a response factor of 1.0. The concentration values listed in Table 4-28 are those observed in the samples from the flux chamber. Therefore, these results are diluted with 5 liters per minute sweep air in the approximate flux chamber volume of 0.032 m^3. The flux rates have been calculated using the chamber area of 0.13 m^2 and sweep air flow rate of 5 liters per minute.

Acetone, benzene, and toluene were all detected (Table 4-28). The concentrations observed in these samples were generally low, being at or near the method detection limits. The results were also near the equipment blank values and, in the case of toluene, below the equipment blank values. Acetone and toluene were detected in the two field samples

and in the equipment blank. The results ranged from 6.9 to 9.3 ppbv for acetone and 1.2 to 11.5 ppbv for toluene. Benzene was detected in the sample from Area A4 only (sample A04-AM-01), at a concentration of 3.6 ppbv. As with acetone and toluene, this result is only slightly higher than the equipment blank result (< 1.0 ppbv).

There are no defined action levels for air. However, the sample concentrations from the flux chamber were below the TLVs for all parameters and below the ASILs for all measurable parameters. The method detection limits for methylene chloride and benzene are not sufficiently sensitive to show concentrations below the ASILs for these two compounds.

4.8 Fate and Transport of Constituents in Groundwater

Fate and transport analyses were conducted for selected constituents of concern detected in groundwater at the Facility. These analyses were prepared for general evaluation purposes and for discussion with EPA only; the results should not be construed as a rationale for not performing a CMS for toluene or for other constituents. The initial two analyses consisted of calculations of constituent migration rates and predictions of constituent concentrations in the Upper Aquifer at the boundary with the Duwamish Waterway. Predictions of toluene concentrations in the Upper Aquifer were then made using Bioplume II modeling.

4.8.1 Migration Rates of Constituents in Groundwater

An evaluation of potential constituent migration in groundwater was conducted for two volatile organic compounds, two semivolatile organic compounds, and two inorganic compounds (metals). These constituents were selected because they are known to be associated with the Facility and are among the most mobile constituents detected there. They are listed by chemical category in Table 4-29.

Approach

The estimate of the migration rate of each of the constituents listed in Table 4-29 is based on two physical processes: the rate at which groundwater moves in the subsurface, and the tendency for the constituent to sorb to soil particles in the aquifer. Constituents that do not naturally sorb to solids in the aquifer will move at a rate comparable to that of the prevailing groundwater flow velocity. Constituents that do sorb to the aquifer solids are "retarded" in their movement, and migrate at a rate that is slower than the effective groundwater velocity.

The groundwater flow velocity was estimated for the Upper Aquifer at the Facility. Estimates of velocity are based on hydrogeologic parameters measured at a site, including hydraulic conductivity, porosity, and the hydraulic gradient over the site. An average hydraulic gradient of 0.002 ft/ft was used, based on the 27-day continuous groundwater elevation monitoring program conducted from January 19 through February 15, 1994. As

discussed in Section 4.1.2, the data collected during periods when groundwater extraction was occurring at Kenworth's site indicate that the net groundwater flow in the western portion of the Facility does not flow to the Duwamish Waterway or to Slip No. 6 as expected; instead, groundwater flow in the Upper Aquifer appears to be converging from the east, west, and south, and flowing north toward the Kenworth site. Under normal conditions, groundwater in the Upper Aquifer likely flows toward the Duwamish Waterway and Slip No. 6. Therefore, in order to evaluate the potential constituent migration under normal conditions (i.e., in the absence of pumping by Kenworth), the average net gradient from the eastern portion of the Facility was applied to the model (0.002 ft/ft). Appendix K contains the equation and the input parameters used to calculate the groundwater velocity.

Typically, organic compounds exhibit the tendency to sorb to soil particles. This sorption effectively slows the rate of migration of a constituent relative to the rate of groundwater flow. A retardation factor is often used to denote the velocity of a constituent in groundwater relative to the actual groundwater velocity. In this case, the retardation factor was calculated from a constituent's organic carbon partition coefficient (a measure of its tendency to sorb to the soil matrix), and from the bulk density, porosity, and fraction of organic carbon in the soil matrix of the Upper Aquifer. (This is described in more detail in Appendix K.)

Although inorganic metals may also be retarded in their movement in groundwater, the sorption of metals is quite complex. It is a function of the speciation of the metal and is dependent on soil conditions such as pH and redox potential. This information and these relationships have not been quantified for the Facility; therefore, for the purposes of this analysis it was conservatively assumed that chromium and copper move at the same velocity as groundwater (i.e., they are not retarded).

Details of the estimates of constituent-specific retardation factors and migration rates, along with associated equations, are provided in Appendix K.

Results

Table 4-30 presents the results of the migration rate analysis. The table shows the following for each of the six chemicals considered:

- Organic carbon partition coefficient (ml/g)
- Chemical-specific sorption coefficient (ml/g)
- Retardation factor (unitless)
- Groundwater velocity (ft/day)
- Contaminant velocity (ft/day)

The most mobile of the organic compounds listed in Table 4-30 is acetone (migrating at a rate of 10 feet per year), followed by toluene and 2-methylphenol (8 feet per year). Pentachlorophenol is more highly sorbed, and hence moves at a relatively slower rate in the Upper Aquifer (3 feet per year). The average groundwater flow velocity at the Facility is

11 feet per year; the migration rate for pentachlorophenol, the most highly sorbed contaminant, is approximately 25 percent of the rate of groundwater flow.

It should be noted that tidal influences on groundwater flow rates and directions at the Facility are significant, especially at the western edge of the Facility (see Section 4.1.2). The calculated migration rates are considered conservative because constituents present in groundwater in the western portion of the Facility do not migrate directly to the Duwamish Waterway; instead, on their path to the Waterway they oscillate back and forth under the influence of tidal action.

4.8.2 Estimates of Constituent Concentrations in Groundwater

A major objective of these fate and transport analyses was to assess potential impacts to the Duwamish Waterway, the nearest potential environmental receptor. This was accomplished by estimating constituent "exit" concentrations in groundwater at the boundary between the Upper Aquifer and the Duwamish Waterway. (No allowance was made in the model for dilution in the Waterway.) The predicted maximum constituent concentrations in groundwater at the Aquifer/Waterway boundary were then compared to available surface water quality standards.

These available standards are considered action levels for the purposes of this fate and transport evaluation and for assessing potential threats to surface water from groundwater discharge. Note that these action levels are different than the action levels used earlier to determine whether a constituent will be included in the Risk Assessment/MCS evaluation. The action levels for this fate and transport evaluation are as follows:

- Toluene: 17,500 μg/l (federal Water Quality Standards, 40 CFR Part 131; maximum value; no chronic criterion available)
- Pentachlorophenol: 4.91 μg/l (MTCA Method B cleanup level for surface water, WAC 173-340)
- Copper: 11.06 to 19.21 μg/l (varies based on water hardness; Federal Water Quality Standards, 40 CFR Part 131)
- Chromium: 224 μg/l (for trivalent chromium, based on a groundwater hardness of 110 mg/l at Upper Aquifer monitoring well DM-5; federal Water Quality Standards, 40 CFR Part 131)

There are no applicable surface water quality standards for acetone and 2-methylphenol.

A two-phased approach was used to estimate concentrations in groundwater at the Duwamish Waterway. First, a conservative screening-level analysis was performed for the six constituents listed in Table 4-29 in order to determine whether any constituent could possibly be expected to discharge to the Duwamish Waterway at a concentration exceeding

action levels. Constituents that were found to exceed action levels as a result of this screening-level analysis were further evaluated using Bioplume II, a more sophisticated numerical flow and transport model that considers constituent attenuation by biodegradation and adsorption. These evaluation methods and their results are discussed in the following two sections.

Screening-Level Estimates of Constituent Concentrations in Groundwater

Approach. A simple analytical model that considers steady one-dimensional flow and two-dimensional dispersion in directions perpendicular to the flow path was applied to the six constituents listed in Table 4-29. The model was used to predict constituent "exit" concentrations at the Upper Aquifer/Duwamish Waterway boundary based on the presence of plumes of constant concentration at the Facility.

A groundwater constituent is typically subject to a number of physical, chemical, and biological processes along its transport path that tend to reduce its concentration; in some cases these processes will remove the constituent entirely. This screening-level analysis for predicting concentrations is conservative in that it ignores many of these factors, such as chemical and biological reactions. In addition, a constant constituent source was assumed, adding another layer of conservatism to the analysis. As such, this screening process is particularly useful in identifying those constituents that would never be expected to discharge to the Duwamish Waterway at concentrations exceeding action levels.

The governing equations, input parameter calculations, and detailed assumptions used in this analysis are presented in Appendix K.

The analytical model considers the following Facility features:

- The assumed width and depth of each constituent plume (based on the RFI groundwater quality data)
- The distance from the downgradient edge of each plume to the Duwamish Waterway (assumed to be the middle of the intertidal zone)
- The average constituent concentration at the source of the plume (note that dissolved concentration data were used for the two metals evaluated)
- The groundwater flow velocity as calculated from hydraulic conductivity, hydraulic gradient, and porosity (all based on Facility-specific data)
- The dispersivity and dispersion coefficient (estimates based on literature values)

The analysis requires that assumptions be made about the hydrogeology of the Facility. The groundwater flow direction is assumed to be east-northeast to west-southwest, discharging to the Duwamish Waterway. The depth to the groundwater table is assumed to be

12 feet, and the thickness of the Upper Aquifer 50 feet. The groundwater velocity is 0.03 ft/day, consistent with the assumed gradient of 0.002 discussed earlier in Section 4.8.1.

Assumptions about the presence of contamination and the ability of the medium to disperse the contamination were also made for the purposes of this analysis. Five of the constituents included in the analysis were assumed to be present in a plume that extends to a depth of 12 feet in the Upper Aquifer (i.e., the stated concentration is assumed to be representative of the upper 25 percent of the aquifer). Toluene was assumed to extend to a depth of 25 feet (the upper one-half of the aquifer). The concentrations assumed for all the constituent plumes are listed in Table 4-31. The transverse dispersivity for the Upper Aquifer was assumed to be 1 foot. For conditions close to the Duwamish Waterway where tidal effects are greater, a less conservative and more realistic transverse dispersivity of 10 feet was assumed.

Figures 4-54 through 4-59 show the plume locations and concentrations assumed for each of the six constituents modeled.

It should be noted that the concentration for the toluene plume was assumed to be 100,000 μg/l in the upper 25 feet of the Upper Aquifer. This is a simplification of actual plume conditions (see Figures 4-47 to 4-50). Actual toluene data indicate that toluene concentrations greater than 100,000 μg/l only occur in the upper 10 feet of the Upper Aquifer and concentrations greater than 10,000 μg/l are restricted to the upper 20 feet of the Upper Aquifer. Upper Aquifer toluene concentrations range from 110 to 1,200 μg/l in the lower 30 feet of the aquifer (Figures 4-49 and 4-50). Given the actual magnitude and distribution of toluene in the Upper Aquifer, the assumption that 100,000 μg/l of toluene is uniformly distributed in the upper 25 feet is considered conservative for this screening-level analysis.

Results. Table 4-31 presents the results of the screening-level fate and transport analysis. The table indicates the assumed depth and width of each constituent plume and its assumed average concentration, the distance from the edge of the plume to the middle of the intertidal zone in the Duwamish Waterway (including a factor of 1.4 to account for net movement throughout a tidal cycle), and the predicted concentration at the Waterway for assumed values of dispersivity of the aquifer system. Table 4-31 also shows action levels (surface water quality standards are available for four of the six constituents) for purposes of comparison. Hardness-dependent surface water quality criteria for chromium and copper were calculated using a groundwater hardness of 110 mg/l (at well DM-5) and 210 mg/l (the average for wells DM-2A and DM-8), based on actual calcium and magnesium groundwater concentrations measured at the Facility.

As can be seen from Table 4-31, the predicted exit concentrations at the Upper Aquifer/ Duwamish Waterway boundary are less than the action levels, with the exception of copper (for the 1-foot dispersivity case, in the vicinity of wells DM-2A and DM-8) and toluene.

No state or federal surface water standards are available for acetone or 2-methylphenol. The predicted exceedances for copper and toluene are discussed below.

The predicted concentration for copper exiting to the Duwamish Waterway from the vicinity of wells DM-2A and DM-8 is 20.4 μg/l for the 1-foot dispersivity case. This just exceeds the action level (federal water quality criterion of 19.21 μg/l) for copper (a criterion based on a hardness of 210 mg/l). The assumed source concentration for copper in groundwater at DM-2A and DM-8 was 46 μg/l, the average for the dissolved copper concentrations detected at the two wells during Round 1 of the RFI.

Given the proximity of wells DM-2A and DM-8 to the Waterway, a higher value of transverse dispersivity may be more realistic. Advective and dispersive fluxes are significantly higher close to the shoreline than they are farther inland. When the exit copper concentration was re-evaluated using the same transport analysis but using a higher, less conservative dispersivity of 10 feet, the resulting estimated copper concentration at the Upper Aquifer/ Duwamish Waterway boundary is 10.8 μg/l, less than the action level.

Using a dispersivity of 1 foot yields an exit copper concentration that is relatively close to the action level. Using a dispersivity of 10 feet yields an exit copper concentration that is less than the criterion. However, it is expected that the actual copper concentration at wells DM-2A and DM-8 will decrease with time now that the Facility is closed and the copper sources have been or are being removed.

The action level (maximum federal Water Quality Standard) for toluene is 17,500 μg/l; the concentration predicted in this analysis for groundwater discharging to the Waterway from the Upper Aquifer is 64,068 μg/l for the 1-foot dispersivity case and 43,221 μg/l for the 10-foot dispersivity case. It should be noted that the toluene concentration at the eastern edge of the Duwamish Waterway predicted by this analysis is far greater than what has been observed at the Facility. The RFI sampling indicates that the toluene is not migrating offsite in any direction and, more specifically, is not migrating to the Duwamish Waterway or Slip No. 6. This is evidenced by data from several Upper Aquifer monitoring wells located along the shoreline on the south and east sides of the Facility. The configuration of the toluene plume (a steep concentration gradient, as shown in Figure 4-48) indicates that toluene is undergoing chemical or biological degradation that is not considered in this screening-level analysis. Therefore, toluene was further analyzed using more sophisticated modeling techniques as discussed in the following section.

Bioplume II Modeling of Toluene Concentrations in Groundwater

The screening-level analysis discussed above indicates that toluene could potentially exceed action levels in groundwater discharging to the Duwamish Waterway. As a result, Bioplume II, a numerical flow and transport model developed with U.S. EPA's cooperation, was applied to the Facility to further refine estimates of toluene concentrations over time in Upper Aquifer groundwater. The primary objective of the Bioplume II evaluation was to

consider the potential attenuation of the toluene plume caused by biodegradation. It is a logical follow-on to the screening-level analysis.

The following description of the modeling and associated results is not intended to dismiss the need for future corrective action. The purpose of the following discussion is to document the modeling and the results, including the input parameters used (supporting information is provided in Appendix K). If needed, modeling to support remediation alternatives will be included in the CMS and will be discussed with EPA at that time.

Approach. Bioplume II, a two-dimensional steady-state groundwater flow and transient contaminant transport model, was used to provide a more realistic estimate of toluene concentrations at the Facility. This model goes beyond the preliminary screening analysis in that it considers the effects of anaerobic and aerobic biodegradation, longitudinal dispersion, and chemical retardation on toluene concentrations. It is also capable of simulating both instantaneous and constant contaminant sources. The Bioplume II model is discussed in more detail in Appendix K.

It is important to note that this approach does not consider variations in groundwater concentrations with depth in the Upper Aquifer. HydroPunch and monitoring well data have indicated that the majority of toluene contamination is within the upper half of the 50-foot-thick aquifer. The model assumes that the concentrations are also representative of toluene at depth in the aquifer; therefore, this approach is conservative in that it does not consider vertical dispersion that could potentially occur.

Two scenarios were modeled using Bioplume II:

1. An instantaneous source (i.e., the existing constituent plume represents all the toluene that is available to groundwater; no further toluene is introduced to the system over time).

2. A constant source (i.e., the existing constituent plume is used to represent initial conditions, and contaminated soils are assumed to provide a constant source of pure-phase toluene over time). For this model, the constant source was represented in the model using injections wells in four cells representing an area where toluene concentrations in soil are known to be high. The constituent was introduced at a rate that was calculated using mass-balance techniques. This scenario represents a worst-case condition.

Figures 4-60a and 4-61a show the concentration distribution for the initial condition that was assumed for both scenarios. Figures 4-61b through 4-61d indicate the locations where toluene is introduced to groundwater from overlying soil in the constant-source scenario.

Groundwater flow was modeled to simulate an average or net gradient occurring over a tidal cycle. Constant head nodes were used to represent the current understanding of the Facility hydraulics (e.g., a radial flow pattern at low tide toward the Duwamish Waterway

and Slip No. 6). Appendix K describes the input parameters for the Bioplume II model, including the grid geometry, constant hydraulic head values, aquifer parameters, chemical sorption coefficients, biodegradation rates, and dissolved oxygen concentrations assumed to be available for aerobic biodegradation.

Results of Instantaneous Contaminant Source Scenario. The Bioplume II model was used to simulate transport of the toluene plume as it is currently known to exist in groundwater at the site for elapsed periods of 10, 25, and 50 years. This scenario assumes that no additional toluene is leached from overlying soil to groundwater over time. The results are presented as Figures 4-60a through 4-60d, and show the assumed initial toluene concentration and the concentrations of toluene estimated by the model to occur in groundwater at 10, 25, and 50 years from the present time. All toluene concentrations at the site had decreased to below 1 mg/l after 52 years.

The results indicate that in the case of an instantaneous source, the toluene from the plume would not enter the Duwamish Waterway or Slip No. 6 at concentrations exceeding the action level of 17,500 μg/l. Biodegradation (primarily anaerobic) would have a significant effect in attenuating toluene concentrations within the plume. (See Appendix K for further discussion of the effects of biodegradation.)

Results of Constant Contaminant Source Scenario. The Bioplume II model was also used to simulate the transport of toluene when a constant source is introduced to groundwater. Estimates of toluene concentrations were made for elapsed periods of 10, 50, and 100 years. The results of this analysis are presented as Figures 4-61a through 4-61d. The red-colored toluene concentration values in Figures 4-61a through 4-61d indicate cells in the model where toluene was injected at a constant rate over time, in order to simulate releases of toluene from soil to groundwater. The results indicate that in the case where a constant source of toluene is introduced to groundwater, the toluene from the plume would not enter the Duwamish Waterway or Slip No. 6 at concentrations exceeding the action level of 17,500 μg/l. In this case, biodegradation (primarily anaerobic) of toluene appears to balance the continual leaching of the constituent from soil to groundwater. (See Appendix K for further discussion of the effects of biodegradation.) Figure 4-61 shows that concentrations at the Duwamish Waterway and Slip No. 6 do not exceed 3,000 μg/l at 50 years or 100 years, despite the assumed constant source in the area of contaminated soils.

4.8.3 Summary of Fate and Transport Analyses

The fate and transport analyses indicated that toluene was the only constituent (of the six analyzed) that warranted use of more sophisticated techniques to address its potential impact on the Duwamish Waterway. Additional fate and transport analyses may be needed in the CMS. Screening-level analyses indicated that surface water action levels for the other constituents (acetone, 2-methylphenol, pentachlorophenol, dissolved copper, and dissolved chromium) were not exceeded at the Upper Aquifer/Duwamish Waterway boundary. As

such, these constituents are not considered to be of concern, and do not warrant further action.

Further modeling was performed to determine whether toluene might be naturally attenuated to acceptable concentrations as a result of biological degradation. The results of the Bioplume II modeling indicate that anaerobic biodegradation is probably a significant degradation mechanism for toluene at the Facility. Simulation of an instantaneous toluene source using Bioplume II indicates that anaerobic biodegradation would significantly reduce concentrations of toluene in groundwater, such that the surface water action level (17,500 μg/l) is not exceeded at the Upper Aquifer/Duwamish Waterway boundary. Under the conservative assumption that a constant source of pure-phase toluene from overlying soils is indefinitely available for continuous leaching into the plume, the model results indicate that anaerobic biodegradation may reduce concentrations in groundwater such that toluene in groundwater at the Aquifer/Waterway boundary will not exceed the surface water action level.

4.9 References

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Section 5
Conclusions and Recommendations

Data obtained during the two rounds of field sampling and analysis, as presented in this RFI Report, have provided information that meets the objectives of the RFI. These objectives were to:

- Characterize the environmental setting at the Facility.
- Assess the nature and extent of contamination originating from releases of hazardous wastes and/or constituents from the Facility.
- Determine whether further actions are warranted and, in particular, whether a Risk Assessment/Media Cleanup Standards (MCS) evaluation is warranted, based on a comparison of concentrations of detected constituents to action levels. The need for a Corrective Measures Study (CMS) will be determined during the Risk Assessment/MCS evaluation.

As stated in the RFI Workplan, another objective of the RFI was to confirm and augment information on hydrogeologic conditions at the Facility that had been developed by Dames & Moore (1986) and Landau Associates (1991). This objective was also met. In general, the results of the RFI were consistent with the conceptual hydrogeologic model of the Facility developed from pre-RFI data.

5.1 Summary of Major Findings

The RFI results indicate that Facility soils have elevated levels of toluene in two general locations: in Area A2 in the north-central portion of the former plant process area (around boring A02-11 [3,600 mg/kg toluene detected]); and in Area A4 near the toluene storage tanks (near borings A04-01 [4,900 mg/kg] and A04-04 [4,400 mg/kg]). However, none of these samples exceeded the action level for toluene in soil (64,000 mg/kg).

Two plumes are evident in the Upper Aquifer groundwater beneath the Facility. One is a toluene plume (with toluene detected at concentrations of up to 600,000 μg/l) centered at monitoring well H11, in approximately the same location where elevated toluene levels in soils were found in Area A4. Other organic compounds are present in this plume above their respective action levels; these compounds are pentachlorophenol, 2-methylphenol, 4-methylphenol, bis(2-ethylhexyl)phthalate, benzene, methylene chloride, acetone, endosulfan I, endosulfan sulfate, and 4,4'-DDD. Based on a comparison of RFI data with historical data from previous investigations, the general size and shape of the toluene plume do not appear to be changing at this time. The second plume is known as the "Black Liquid" plume and is characterized by dark-colored groundwater. The color of the groundwater appears to result from tannic acid in sulfite liquor that was used and stored onsite.

The plume extends from the north-central part of the Facility to the southwest edge where Slip No. 6 meets the Duwamish Waterway. Exceedances of the groundwater action levels for chromium are associated with the Black Liquid plume. As with the toluene plume, the general size and shape of the Black Liquid plume do not appear to be changing based on comparison of RFI data with historical data.

Light nonaqueous phase liquid (LNAPL) has been detected in the area of the toluene plume. Laboratory analyses of LNAPL samples collected from the Facility indicate that it is composed predominantly of Peneteck oil (white mineral oil) and toluene. The findings of the RFI and Interim Measure activities suggest that there is not a large volume of LNAPL beneath the site. LNAPL has been observed only in a relatively small area of the site and appears to be present in the soil pore space below residual saturation levels. When a measurable amount of LNAPL is present in a well, its thickness varies with time in response to groundwater levels that fluctuate with the tide in the Duwamish Waterway. The monitoring data also show that LNAPL may be present in a monitoring well intermittently; that is, it may "disappear" only to reappear weeks or months later. The cause of the intermittent presence of LNAPL in monitoring wells appears to be related to seasonal fluctuations in the groundwater level.

The RFI findings indicate that while there is toluene contamination of the Upper Aquifer groundwater, it does not appear that toluene-contaminated groundwater has entered the Duwamish Waterway or Slip No. 6. However, because there is the potential for groundwater to impact surface water quality, the action levels used in evaluating the RFI groundwater data (and thereby determining the need for a Risk Assessment/MCS evaluation) include both groundwater and surface water quality standards.

5.2 Conclusions

The following conclusions are drawn from the information and data presented in this RFI Report:

1. The RFI data, in combination with previously developed data, provide information that characterizes the hydrogeology and environmental setting of the Facility. The physical properties of subsurface materials have been identified, and groundwater flow directions and gradients have been assessed in adequate detail to allow necessary fate and transport analyses of possible constituents of concern. The hydrogeologic characterization demonstrated that:

    - The conceptual hydrogeologic model presented in previous Facility investigation reports is valid.

    - The Facility is underlain by two distinct aquifers—the Upper and Lower Aquifers. The two aquifers are separated by a low-

permeability silt and clay stratum that acts as an aquitard. The aquitard is laterally continuous beneath the Facility. The permeability of the aquitard is low, on the order of 10^{-4} ft/day (approximately 10^{-8} cm/sec.), and inhibits the downward migration of constituents from the Upper Aquifer to the Lower Aquifer.

- Groundwater levels in both the Upper and Lower Aquifers are tidally influenced. The vertical hydraulic gradient between the Upper and Lower Aquifers (across the aquitard) is in the upward direction at all times, regardless of the tide stage, and also inhibits the downward migration of constituents from the Upper Aquifer to the Lower Aquifer.

- Under normal conditions, the net groundwater flow direction beneath the Facility appears to be from east to west (toward the Duwamish Waterway and Slip No. 6). However, a groundwater extraction program being conducted at the Kenworth site (immediately north of the Facility) appears to cause a northward net groundwater flow direction in the western portion of the Facility when the extraction system is operating.

2. The results of the soil, groundwater, sediment, and air emissions investigations have provided a comprehensive identification of the nature and extent of contamination at the Facility. The RFI results are, in general, consistent with information developed during previous Facility investigations as well as with documented results for constituents present in environmental media within the region.

3. Only two constituents were found to exceed action levels for soil: arsenic and mercury were detected once each at concentrations exceeding their action levels. Arsenic and mercury are not considered to be constituents of concern, however, because their action levels were exceeded only once; arsenic is present in soil at similar levels throughout the region; and during the RFI, a comprehensive investigation of potential mercury contamination demonstrated that the single detection above its action level was an isolated occurrence that could not be confirmed. No other constituents were detected in soil above their respective action levels—including the preliminary constituents of concern identified in the RFI Workplan.

4. The results of the groundwater investigation indicate that toluene is the primary constituent of concern in groundwater. Specifically, the area of concern is the toluene plume located beneath the Tank Farm. Toluene is present in this area at concentrations above the 1,000 μg/l action level. Several other organic compounds are present in the toluene plume area at concentrations exceeding action levels. These are of secondary concern

because they are less widespread than the toluene and they do not exceed their action levels to the same degree as toluene.

Two metals, antimony and cadmium, were detected only in Background Area wells at concentrations above their action levels; these metals will not be addressed in the Risk Assessment/MCS evaluation. Silver was detected only in one Facility monitoring well at a concentration above the action level. The remaining metals (arsenic, copper, lead, nickel, vanadium, zinc, chromium, beryllium, and mercury) were detected at concentrations above their respective action levels in both the Background Area wells and the Facility monitoring wells. Groundwater chemistry data indicate that chromium exists in the trivalent form and not in the more toxic hexavalent form.

5. LNAPL is currently not present in significant volumes beneath the Facility. Pre-RFI chemical characterization of the LNAPL indicates that it is composed primarily of mineral oil and toluene.

6. Fate and transport analyses were conducted for several constituents of concern to evaluate the potential for discharge of contaminants in groundwater to the Duwamish Waterway at concentrations exceeding applicable surface water criteria. These analyses were prepared for general evaluation purposes and for discussion with EPA. Because toluene is known to be biodegradable—susceptible to both aerobic and anaerobic biodegradation—the Bioplume II fate and transport model was used to assess the potential for offsite migration of toluene under conservative assumptions. The model results indicate that anaerobic biological decomposition of toluene will significantly reduce toluene concentrations. The results also indicate that degradation of the plume, as predicted by the model, will occur such that toluene will not be discharged to the Duwamish Waterway at concentrations exceeding applicable surface water quality criteria.

   Data collected from Facility groundwater monitoring wells support these findings. The toluene plume is not encroaching on the shoreline, and toluene is not discharging to the Duwamish Waterway. Further, a comparison of data collected over time (from 1986 to 1994 by Dames & Moore, Landau Associates, and RPI) indicates that the general size and shape of the toluene plume are not changing at this time.

7. The sediment sampling results indicate that constituents were not detected above action levels or above concentrations documented to be present in the Duwamish Waterway/Elliott Bay area. Therefore, sediments are not considered a medium of concern at this time. However, the Washington State Department of Ecology has expressed some concern about sediments at point source discharges such as old outfalls and at seeps. Additional sampling has been conducted to address these concerns; the seep sampling and sewer

sediment sampling will be addressed in the Round 3 Data and Sewer Sediment Technical Memoranda that will be submitted as addenda to this RFI Report.

8. Volatile organic compounds were detected at low levels during the air emissions investigation. The detected concentrations are very low compared to applicable regulatory thresholds and ambient conditions. Therefore, air is not a medium of concern.

5.3 Recommendations for Future Actions

As stated in Section 1 of this RFI Report and consistent with current U.S. EPA guidance as presented in the final RCRA Corrective Action Plan (Directive 9902.3-2A, May 31, 1994), one of the objectives of an RFI is to assess the need for a Risk Assessment/MCS evaluation. Typically, the primary consideration in such an assessment is to identify constituents that are present (1) in environmental media as a result of a past release from a Solid Waste Management Unit (SWMU), and (2) at concentrations that exceed action levels. An exceedance of an action level under these circumstances typically "triggers" the need for a Risk Assessment/MCS evaluation. Conversely, a Risk Assessment/MCS evaluation is generally considered unnecessary if no exceedance occurs.

Based on these criteria and the conclusions cited above, RPI recommends that a Risk Assessment/MCS evaluation be conducted to evaluate the need for remedial measures at the Facility.

With exception of arsenic and mercury, no constituents in Facility soils exceeded their respective action levels. Arsenic is known to be present in soils regionally at concentrations exceeding its action level. Mercury was detected once above its action level, but comprehensive follow-up sampling during Round 2 did not confirm this exceedance. Therefore, no metals are recommended for inclusion in the Risk Assessment/MCS evaluation based on an action level exceedance. However, the following detected constituents did not have action levels and will be addressed in the Risk Assessment/MCS evaluation:

Inorganics	Semivolatiles
Cobalt	2-methylnaphthalene
	Benzo(g,h,i)perylene
	Isopropyl alcohol (2-propanol)
	Phenanthrene

The following constituents detected in groundwater above their respective action levels will be addressed in the Risk Assessment/MCS evaluation:

Inorganics	Semivolatiles
Total arsenic	Benzo(a)pyrene
Total copper	Chrysene
Total lead	Bis(2-chloroethyl)ether
Total nickel	Pentachlorophenol
Total vanadium	2-methylphenol
Total zinc	4-methylphenol
Total chromium	Bis(2-ethylhexyl)phthalate
Total beryllium	
Total mercury	Volatiles
Total silver	
	Toluene
Pesticides	Benzene
	Methylene chloride
Endosulfan I	1,1-dichloroethane
Endosulfan sulfate	Acetone
4,4'-DDD	Formaldehyde

Constituents in groundwater that do not have action levels and will be addressed in the Risk Assessment/MCS evaluation are:

Inorganics	Semivolatiles
Total cobalt	Dibenzofuran
	2-methylnaphthalene

A third round of groundwater sampling was conducted at the Facility in March 1995, and seeps and surface water were sampled in April 1995. The results from these sampling events will be documented in the Round 3 Data Technical Memorandum, which will be submitted as an addendum to this RFI Report. Additional sampling was also conducted of sewer sediments in May 1995; the results of this sampling and analysis will be documented in a second memorandum, the Sewer Sediment Technical Memorandum. Since low flow sampling was used in Round 3, the Round 3 groundwater metals analyses will be used in the Risk Assessment/MCS evaluation. The other results documented in these memoranda may also influence the information that is used as a basis for the Risk Assessment/MCS evaluation.

The scope of a CMS will be determined based on the results of the Risk Assessment/MCS evaluation. If a CMS is necessary, the CMS will evaluate corrective measures that could be applicable to contaminants that exceed Media Cleanup Standards developed in the Risk Assessment/MCS evaluation. Because there are no exceedances of soil action levels

requiring a Risk Assessment/MCS evaluation, a CMS for soils is not needed. Any future CMS evaluation addressing groundwater remediation may also consider the need to remediate Unsaturated Zone soils in order to better ensure the effectiveness and permanence of any groundwater remediation.

Pursuant to the Consent Order, the Human Health and Ecological Risk Assessment Report and Proposed Media Cleanup Standards evaluation will be submitted to U.S. EPA 30 days after the RFI Report or at an agreed-to date (pending review by U.S. EPA's new project manager of the assumptions to be used in the Risk Assessment; these assumptions were sent to U.S. EPA in a letter from Edwin Liu/Rhône-Poulenc Inc. to Sylvia Burges/U.S. EPA Region 10, dated June 15, 1995). The information developed in the Risk Assessment/ MCS evaluation will be used primarily to evaluate the need for, and the scope of, future remedial actions. The evaluation will focus on the groundwater action-level exceedances, most of which are associated with the toluene plume. Anthropogenic chemical constituents that do not have action levels but were detected in soil and groundwater will also be addressed.

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cover/ SPINE

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Volume II—Figures

ERRATA—Figures 4-32, 4-34, and 4-35 in Volume II of the RFI Report

One small correction is needed to each of these three figures. Please mark your copies accordingly. The changes are as follows:

Figure 4-32

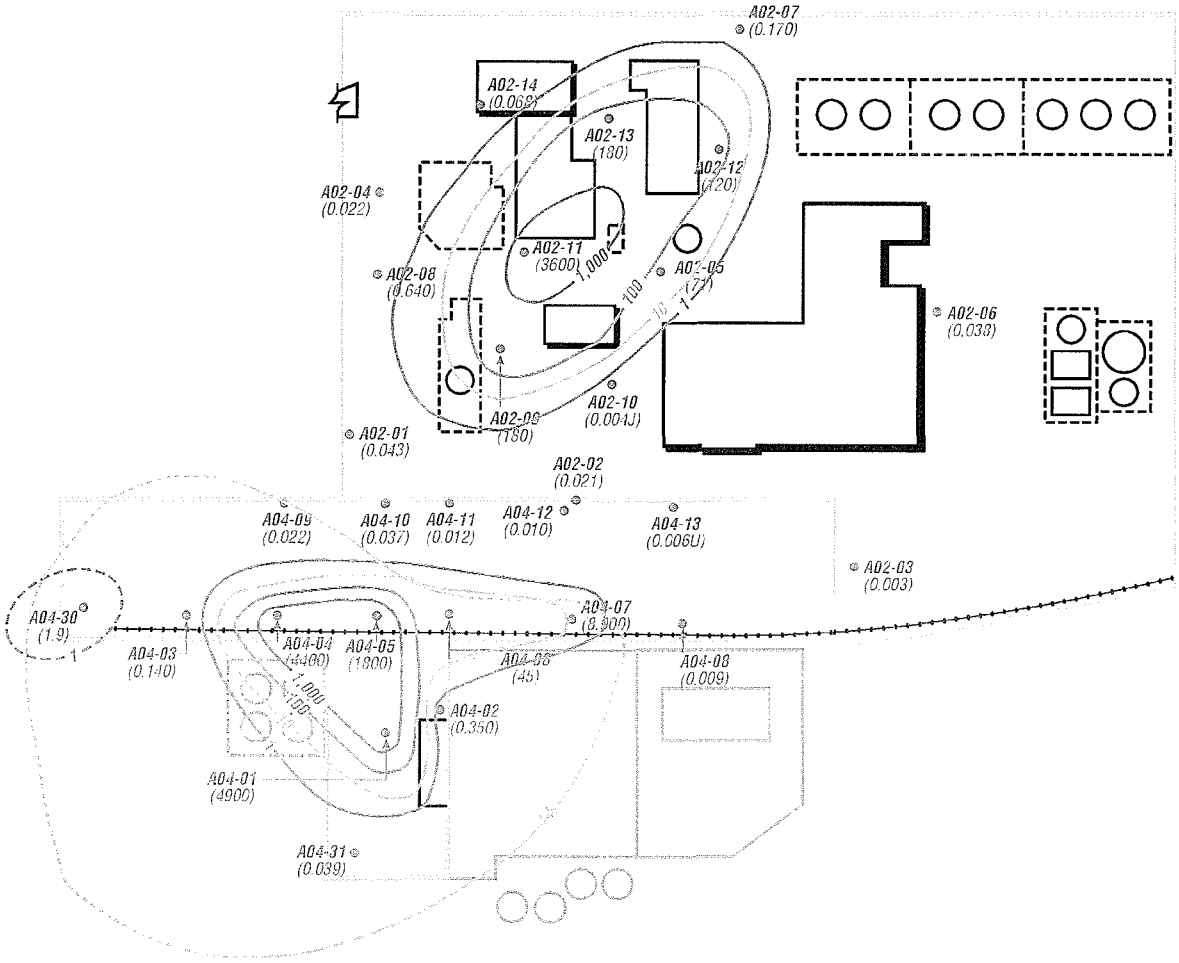
In the table in this figure, under "Comparison to action levels," the MTCA Method C cleanup level for 4-Methylphenol is given as 1.60E+04. The correct cleanup level is 1.60E+03.

Figure 4-34

In the table in this figure, under "Comparison to action levels," the MTCA Method C cleanup level for 4-Methylphenol is given as 1.60E+04. The correct cleanup level is 1.60E+03.

Figure 4-35

The table in this figure is missing one entry under "Comparison to action levels." The MTCA Method C cleanup level for Endrin is 9.60E+01.



LEGEND

Toluene concentration (mg/kg) contour (dashed where inferred) [logarithmic interval]

(4900) Concentration (mg/kg)

CH2M HILL soil sampling location (samples collected from soil boring)

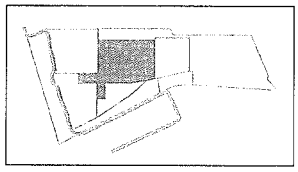
Structure that remains onsite

Approximate boundary of the groundwater toluene plume exceeding action level (see Section 4.3.3 and Figure 4-48)

NORTH

0 50 100

Approximate Scale in Feet



Notes:

1. *Concentrations in mg/kg.*
2. *Contour lines drawn based on the highest concentration detected at soil borings regardless of depth. (Grab sample data representing the upper 6 inches are ignored.)*
3. *Concentrations less than 1 mg/kg are not contoured.*

Figure 4-45

Contour Map of Toluene Concentrations in Soil for Investigation Areas A2 and A4

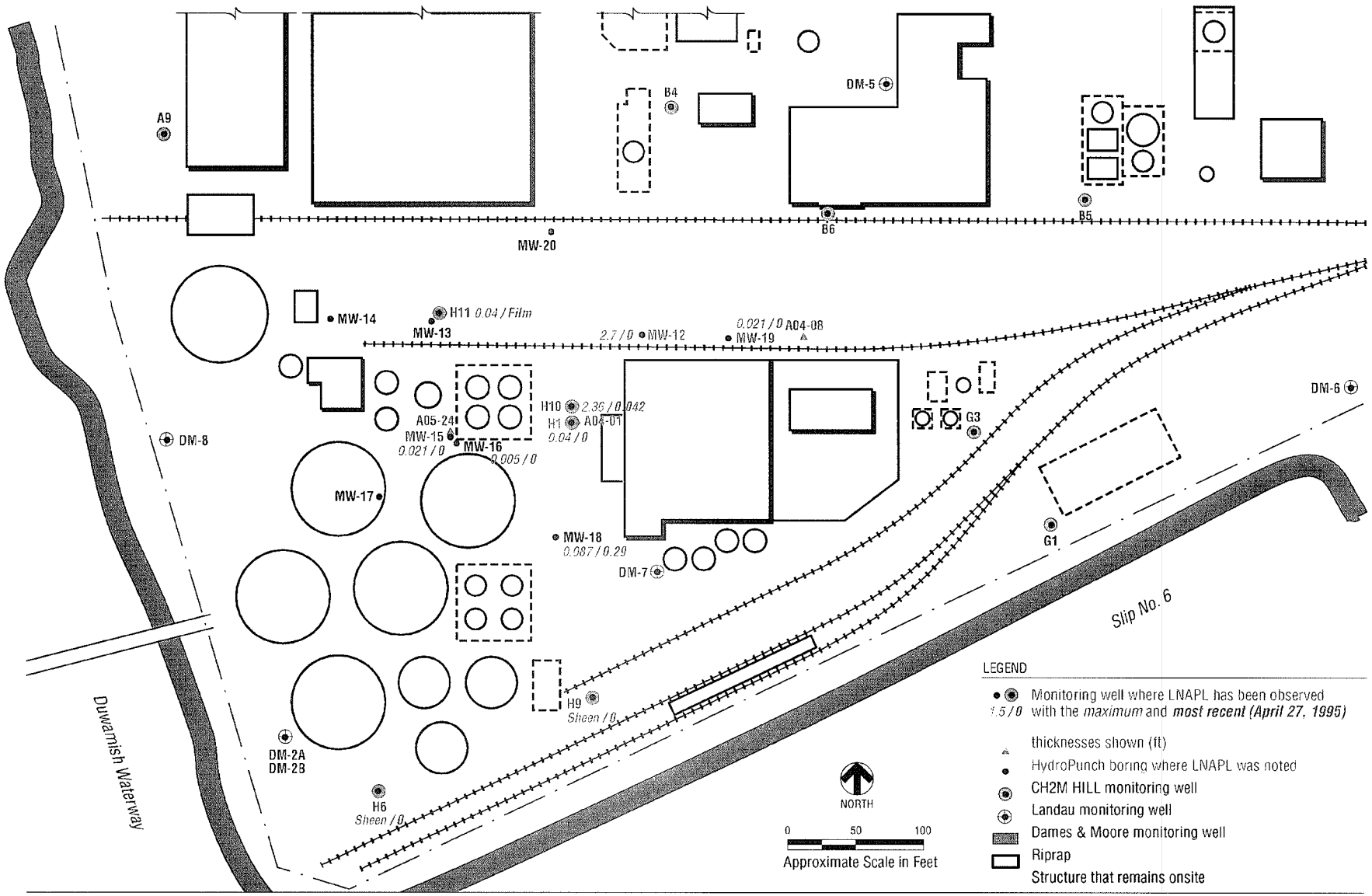


Figure 4-51
Locations where LNAPL has been Observed

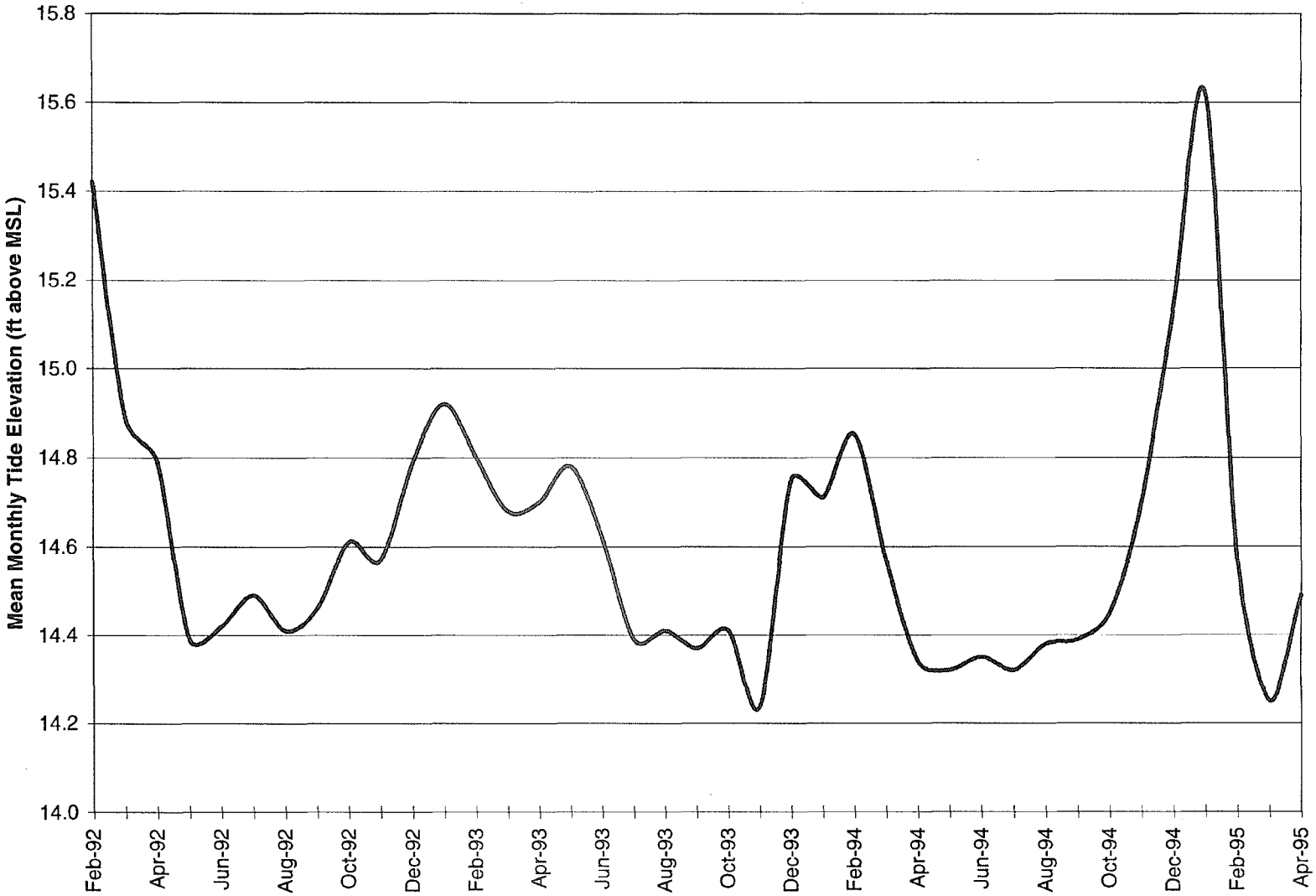


Figure 4-51A
Mean Monthly Tide Elevation

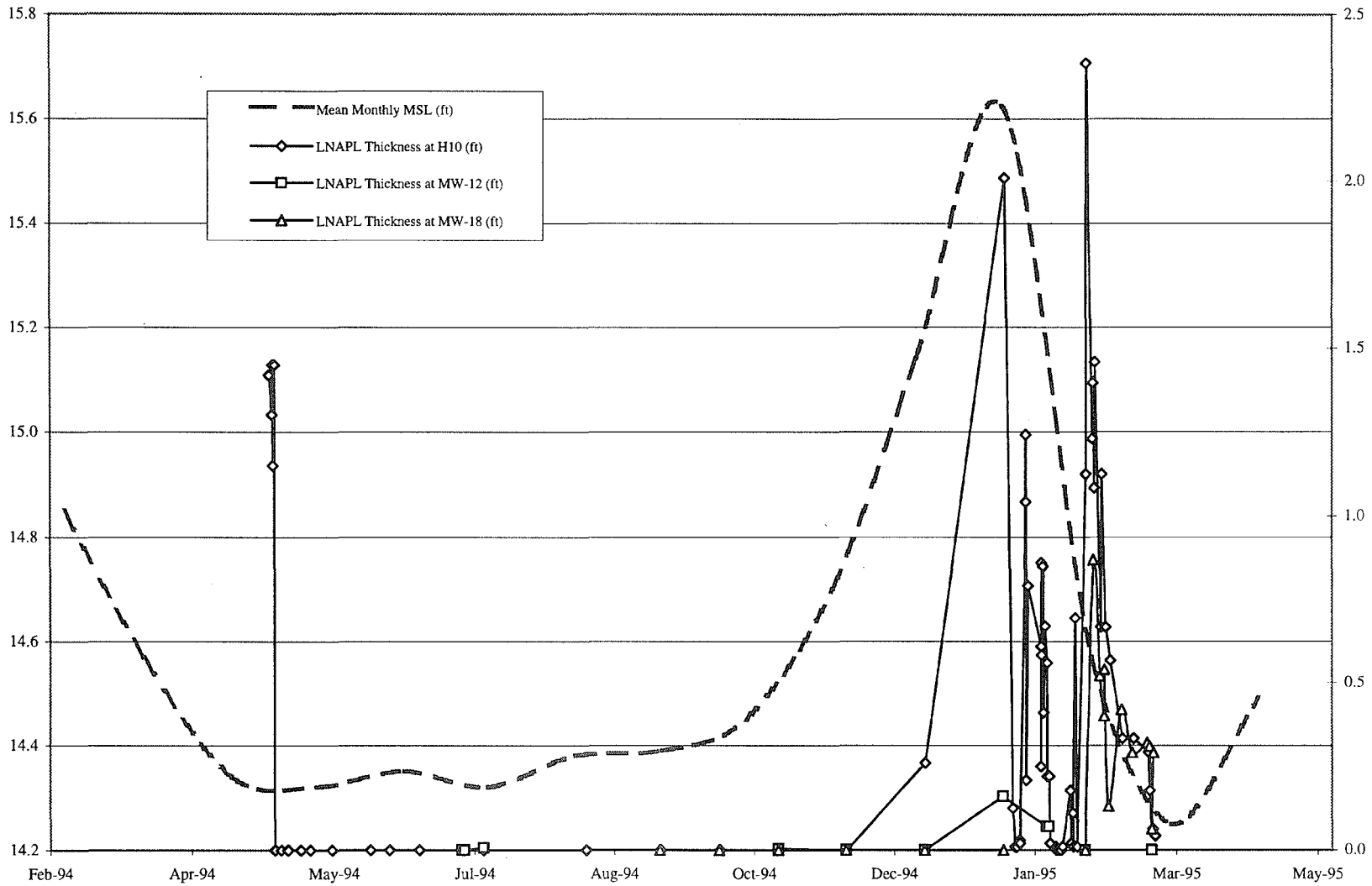


Figure 4-51B

Mean Monthly Tide Elevation vs. LNAPL Thickness in Wells H10, MW-12, and MW-18

Volume II—Tables

Table 2-5
Soil Sample Analyses by Investigation Area

Investigation Area	Inorganics[1]	Volatiles[2]	Semivolatiles	Pesticides/ PCBs	Vanillin[3]	Formaldehyde	Isopropyl Alcohol	Pentachlorophenol	TPH
A1/Boneyard/ Distribution Center	x	x			x	x		x	
A2/Vanillin Production Area	x	x	x		x		x		
A3/Laboratory and Compressor Area	x	x		x					x
A4/Toluene Area	x	x	x						
A5/Tank Farm	x	x		x	x	x	x		
A6/Maintenance Shop	x	x				x			x
A7/Former Railroad Loading/Unloading Area	x	x							
A8/Former Maintenance Area	x	x							x
A9/Non-Process Area	x	x							
A10/Spill Control Reservoir and Sumps	x	x							
BG/Background Area	x	x	x[4]			x			

[1]Including mercury.
[2]Including chlorinated benzenes in Area A3, and toluene.
[3]Vanillin is a non-toxic compound that was produced at the Facility. Vanillin was included as an RFI constituent of interest only to help distinguish vanillin-related contamination from non-vanillin-related contamination.
[4]PAHs only.

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Table 4-15
HydroPunch Groundwater Data

Area	Sample No.	Sample Interval (ft) bgs Top	Bottom	Benzene (µg/l) (Action Level = 1 µg/l)[1]	Toluene (µg/l) (Action Level = 1,000 µg/l)[1]	Ethylbenzene (µg/l) (Action Level = 700 µg/l)[1]	Xylene, Total (µg/l) (Action Level = 10,000 µg/l)[1]	TPH (mg/l)	TOC (mg/l)
A1	A01-26-W1	13.4	15	0.5 U	7	0.5 U	0.5 U	1.18	48.5
A4	A04-01-W1	22	22	1	17,000	4.7	6.6	20.7	NA
A4	A04-02-W1	13	15	500 U	510,000	500 U	500 U	112	19.7
A4	A04-03-W1	12.5	15	62	270,000	74	110	49.3	89
A4	A04-04-W1	13.7	15	500 U	450,000	500 U	500 U	34.6	336
A4	A04-05-W1	22	22	50 U	1,600	50 U	50 U	28.5	20.6
A4	A04-06-W1	12.5	15	5 U	7,900	5 U	41	129	42.6
A4	A04-06-W2	30	30	0.5 U	52	0.5 U	1.2	6.04	NA
A4	A04-06-W3	35	35	0.5 U	91	0.5 U	0.9	13.1	12.2
A4	A04-06-W4	50.5	50.5	0.5 U	0.5 U	0.5 U	0.5 U	NA	NA
A4	A04-06-W5	54	54	0.5 U	4.5	0.5 U	0.5 U	1.3 U	9.07
A4	A04-07-W1	12.6	15	500 U	230,000	500 U	500 U	169	225
A4	A04-08-W1	22	22	0.5 U	890	5.6	11	24.6	NA
A4	A04-09-W1	13.3	15	0.5 U	0.5 U	0.5 U	6.7	1.02 U	41
A4	A04-10-W1	13	15	500 U	46,000	500 U	500 U	516	19.5
A4	A04-10-W2	25	25	15	83	0.5 U	6.6	10.1	17.3
A4	A04-11-W1	13.2	15	5.8	0.5 U	0.5 U	25	63.8	23.5
A4	A04-12-W1	12.4	14	0.5 U	0.5 U	0.5 U	2.3	12	8.52
A4	A04-13-W1	11	15	1.8	0.5 U	0.5 U	9.4	0.985 U	19.6
A4	A04-13-W2	31	31	0.5 U	5.2	0.5 U	0.5 U	2.9 U	NA
A4	A04-14-W1	11	15	50,000 U	470,000	50,000 U	50,000 U	16.9	26.6
A4	A04-14-W2	30	30	1.5	34	0.5 U	0.5 U	NA	NA
A4	A04-14-W3	45	45	0.5 U	110	0.5 U	0.5 U	1.13	11.7
A4	A04-14-W4	60	60	5 U	120	5 U	5 U	1.3 U	6.35
A4	A04-15-W1	12.5	15	0.5 U	3.3	0.5 U	0.5 U	1.01 U	14.8
A4	A04-16-W1	14.5	15	6.1	24,000	3.6	15	1.04 U	55.4
A4	A04-17-W1	12.8	16	0.5 U	4.1	0.5 U	0.5 U	0.966 U	82.8
A4	A04-18-W1	12.7	15	0.5 U	2.2	0.5 U	0.5 U	0.985 U	5.86
A4	A04-21-W1	13.2	15	0.5 U	0.5 U	0.5 U	0.5 U	1.12 U	10.5
A4	A04-23-W1	12.7	15	500 U	480,000	500 U	500 U	23.5	38.8
A4	A04-23-W2	31	31	0.5 U	4,000	0.6	1.1	7.72	NA
A4	A04-23-W3	47	47	0.5 U	260	0.5 U	0.5 U	5.53	5.96
A4	A04-23-W4	64	64	5 U	960	5 U	5 U	NA	NA
A4	A04-27-W1	3.3	7	0.5 U	0.6	0.5 U	0.5 U	0.976 U	4.59
A4	A04-28-W1	3.2	4.5	0.5 U	17,000	0.5 U	0.5 U	1.57	5.19
A4	A04-29-W1	6	8	0.5 U	0.4	0.5 U	0.5 U	5.47	5.02
A5	A05-19-W1	13.3	15	500 U	7,700	500 U	5 U	0.976 U	3,800
A5	A05-20-W1	13.4	15	0.5 U	0.8	0.5 U	0.5 U	1.12 U	124
A5	A05-22-W1	22	22	5 U	57	5 U	5 U	1.87	81.6
A5	A05-24-W2	22	23	500 U	26,000	500 U	500 U	1.86	179
A5	A05-24-W3	45	45	5,000 U	59,000	5,000 U	5,000 U	3.06	188
A5	A05-24-W4	62	62	5,000 U	94,000	5,000 U	5,000 U	1.39 U	295
A5	A05-25-W1	12.9	15	0.5 U	25	0.5 U	0.5 U	1.03 U	40.9

[1]The RFI action levels for groundwater are as stated in Tables 4-16 and 4-17.

bgs = Below ground surface.

U = Not detected above the detection limit. Detection limit may vary due to dilution.

NA = Not analyzed because of limited sample recovery.

Monsanto Company 104(e) Response

Monsanto 2A002118

Table 4-16
Groundwater Data Statistical Summary, Round 1

Parameter	Units	Number of Detections	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Most Stringent Action Level	Source of Most Stringent Action Level [a]	No. of Non-Background Samples Above Action Level	No. of Background Samples Above Action Level [b]
CONVENTIONALS AND FIELD PARAMETERS										
CHLORIDE	µg/l	30	30	1.00	449	402,000	250,000	GW ST SMCL (µg/l)	3	
NITRATE NITROGEN	µg/l	4	12	0.33	113	316	10,000	GW FED MCL (µg/l)		
NITRITE NITROGEN	µg/l		12				1,000	GW FED MCL (µg/l)		
PHOSPHATE, ORTHO	mg/l	7	12	0.58	0.179	17.8				
SPECIFIC CONDUCTANCE	umhos/cm	30	30	1.00	70	3,900				
SULFATE	µg/l	29	30	0.97	113	151,000	250,000	GW GWQS (µg/l)		
TEMPERATURE	°C	30	30	1.00	10.7	25				
pH, Field	-log+H	30	30	1.00	6.32	8.97	6.5 - 8.5	GW GWQS (µg/l)	4	1
ALKALINITY (AS CACO3)	mg/l	30	30	1.00	84	3,110				
ALKALINITY HYDROXIDE (AS CACO3)	mg/l		30							
BICARBONATE (FROM ALKALINITY)	mg/l	30	30	1.00	84	3,110				
CARBONATE (FROM ALKALINITY)	mg/l	1	30	0.03	12	12				
NITROGEN, KJELDAHL	mg/l	13	13	1.00	1.89	35.8				
PHOSPHORUS	mg/l	13	13	1.00	2.36	38.3				
SULFIDE AS S	mg/l	20	30	0.67	0.224	3.4				
TOTAL DISSOLVED SOLIDS	µg/l	29	29	1.00	110,000	5,340,000	500,000	GW GWQS (µg/l)	22	1
TOTAL ORGANIC CARBON	mg/l	30	30	1.00	5.585	786				
INORGANICS										
ALUMINUM, DISSOLVED	µg/l	24	30	0.80	36.7	6220				
ALUMINUM, TOTAL	µg/l	30	30	1.00	205	181,000				
ANTIMONY, DISSOLVED	µg/l		30				6	GW FED MCL (µg/l)		
ANTIMONY, TOTAL	µg/l	1	30	0.03	69.3	69.3	6	GW FED MCL (µg/l)		1
ARSENIC, DISSOLVED	µg/l	23	30	0.77	2	52.4	0.05	GW MTCA B (µg/l)	20	3
ARSENIC, TOTAL	µg/l	29	30	0.97	2.1	131	0.05	GW MTCA B (µg/l)	26	3
BARIUM, DISSOLVED	µg/l	14	30	0.47	20.3	337	1,000	GW GWQS (µg/l)		
BARIUM, TOTAL	µg/l	25	30	0.83	30.9	475	1,000	GW GWQS (µg/l)		
BERYLLIUM, DISSOLVED	µg/l	5	30	0.17	2.5	9.9	0.02	GW MTCA B (µg/l)	5	
BERYLLIUM, TOTAL	µg/l	8	30	0.27	2.4	9.9	0.02	GW MTCA B (µg/l)	7	1
CADMIUM, DISSOLVED	µg/l		30				0.3 - 2.6 [c]	Multiple Source		
CADMIUM, TOTAL	µg/l	1	30	0.03	8.1	8.1	0.3 - 2.9 [c]	Multiple Source		1
CALCIUM, DISSOLVED	µg/l	30	30	1.00	3,310	80,400				
CALCIUM, TOTAL	µg/l	30	30	1.00	3,805	76,400				
CHROMIUM, DISSOLVED	µg/l	13	30	0.43	11.9	365	50	GW GWQS (µg/l)	5	
CHROMIUM, TOTAL	µg/l	26	30	0.87	11.9	353	50	GW GWQS (µg/l)	8	1
COBALT, DISSOLVED	µg/l	4	30	0.13	12.1	36.8				
COBALT, TOTAL	µg/l	17	30	0.57	10.9	272				
COPPER, DISSOLVED	µg/l	13	30	0.43	5.4	58	2.4 - 2.5 [c]	Multiple Source	13	
COPPER, TOTAL	µg/l	26	30	0.87	11.3	4,290	2.5	SW MWA ST (µg/l)	24	2
CYANIDE, TOTAL	µg/l		8				1	SW MWA FED (µg/l)		
IRON, DISSOLVED	µg/l	30	30	1.00	185	82,100	300	GW ST SMCL (µg/l)	26	2

Table 4-16
Groundwater Data Statistical Summary, Round 1

Parameter	Units	Number of Detections	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Most Stringent Action Level	Source of Most Stringent Action Level [a]	No. of Non-Background Samples Above Action Level	No. of Background Samples Above Action Level [b]
IRON, TOTAL	µg/l	30	30	1.00	471	409,000	300	GW ST SMCL (µg/l)	27	3
LEAD, DISSOLVED	µg/l	8	30	0.27	2	8.9	0.3 - 3.2 [c]	Multiple Source	4	1
LEAD, TOTAL	µg/l	26	30	0.87	2	174.5	0.3 - 3.2 [c]	Multiple Source	21	3
MAGNESIUM, DISSOLVED	µg/l	30	30	1.00	2,360	42,400				
MAGNESIUM, TOTAL	µg/l	30	30	1.00	2,480	49,700				
MANGANESE, DISSOLVED	µg/l	30	30	1.00	28.7	6,250	50	GW ST SMCL (µg/l)	25	2
MANGANESE, TOTAL	µg/l	30	30	1.00	33.6	6,280	50	GW ST SMCL (µg/l)	26	2
MERCURY, DISSOLVED	µg/l		30				0.012	SW FWC FED (µg/l)		
MERCURY, TOTAL	µg/l	8	30	0.27	0.2	4.7	0.012	SW FWC FED (µg/l)	6	2
NICKEL, DISSOLVED	µg/l	3	30	0.10	31.1	43.2	7.9	SW MWC ST (µg/l)	3	
NICKEL, TOTAL	µg/l	17	30	0.57	20.7	358	7.9	SW MWC ST (µg/l)	15	2
POTASSIUM, DISSOLVED	µg/l	27	30	0.90	2,405	19,550				
POTASSIUM, TOTAL	µg/l	29	30	0.97	3,750	21,400				
SELENIUM, DISSOLVED	µg/l	1	30	0.03	3.15	3.15	5	SW FWC FED (µg/l)		
SELENIUM, TOTAL	µg/l		30				5	SW FWC FED (µg/l)		
SILVER, DISSOLVED	µg/l	1	30	0.03	23.5	23.5	0.12 - 1.2 [c]	Multiple Source	1	
SILVER, TOTAL	µg/l	1	30	0.03	21.5	21.5	0.13 - 1.2 [c]	Multiple Source	1	
SODIUM, DISSOLVED	µg/l	30	30	1.00	21,700	1,410,000				
SODIUM, TOTAL	µg/l	30	30	1.00	24,300	1,410,000				
THALLIUM, DISSOLVED	µg/l		30				2	GW FED MCL (µg/l)		
THALLIUM, TOTAL	µg/l		30				2	GW FED MCL (µg/l)		
TIN, DISSOLVED	µg/l		8				9,600	GW MTCA B (µg/l)		
TIN, TOTAL	µg/l		8				9,600	GW MTCA B (µg/l)		
VANADIUM, DISSOLVED	µg/l	26	30	0.87	12.2	1,670	112	GW MTCA B (µg/l)	6	
VANADIUM, TOTAL	µg/l	29	30	0.97	19.4	1,630	112	GW MTCA B (µg/l)	13	2
ZINC, DISSOLVED	µg/l	12	30	0.40	10.6	80.7	22.5 - 76.6 [c]	Multiple Source	1	
ZINC, TOTAL	µg/l	25	30	0.83	10.4	1605	24.1 - 76.6 [c]	Multiple Source	8	2
PESTICIDES/PCBs										
DIMETHOATE	µg/l		8				3.2	GW MTCA B (µg/l)		
DISULFOTON	µg/l		8				0.64	GW MTCA B (µg/l)		
ETHYL PARATHION	µg/l		8				0.013	SW FWC ST (µg/l)		
FAMPHUR	µg/l		8							
METHYL PARATHION	µg/l		8				4	GW MTCA B (µg/l)		
PHORATE	µg/l		8							
THIONAZIN	µg/l		8							
AROCLOR-1016	µg/l		8				0.000045	SW HH FED FISH (µg/l)		
AROCLOR-1221	µg/l		8							
AROCLOR-1232	µg/l		8							
AROCLOR-1242	µg/l		8							
AROCLOR-1248	µg/l		8				0.000045	SW HH FED FISH (µg/l)		
AROCLOR-1254	µg/l		8							

Table 4-16
Groundwater Data Statistical Summary, Round 1

Parameter	Units	Number of Detections	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Most Stringent Action Level	Source of Most Stringent Action Level [a]	No. of Non-Background Samples Above Action Level	No. of Background Samples Above Action Level [b]
AROCLOR-1260	µg/l		8							
PCB's (TOTAL)	µg/l		8							
4,4'-DDD	µg/l	1	8	0.13	0.07	0.07	0.00084	SW HH FED FISH (µg/l)	1	
4,4'-DDE	µg/l		8				0.00059	SW HH FED FISH (µg/l)		
4,4'-DDT	µg/l		8				0.00059	SW HH FED FISH (µg/l)		
ALDRIN	µg/l		8				0.00014	SW HH FED FISH (µg/l)		
ALPHA-CHLORDANE	µg/l		8				0.00059	SW HH FED FISH (µg/l)		
BHC-ALPHA	µg/l		8				0.001	GW GWQS (µg/l)		
BHC-BETA	µg/l		8				0.046	SW HH FED FISH (µg/l)		
BHC-DELTA	µg/l		8							
BHC-GAMMA(LINDANE)	µg/l	1	8	0.13	0.05	0.05	0.06	GW GWQS (µg/l)		
DIELDRIN	µg/l		8				0.00014	SW HH FED FISH (µg/l)		
ENDOSULFAN I	µg/l	1	8	0.13	0.04	0.04	0.0087	SW MWC ST (µg/l)	1	
ENDOSULFAN II	µg/l		8							
ENDOSULFAN SULFATE	µg/l	2	8	0.25	0.03	0.06	0.056	SW FWC ST (µg/l)	1	
ENDRIN	µg/l		8				0.0023	SW FWC FED (µg/l)		
ENDRIN ALDEHYDE	µg/l		8				0.0023	SW FWC FED (µg/l)		
ENDRIN KETONE	µg/l		8				0.0023	SW FWC FED (µg/l)		
GAMMA-CHLORDANE	µg/l		8				0.00059	SW HH FED FISH (µg/l)		
HEPTACHLOR	µg/l		8				0.00021	SW HH FED FISH (µg/l)		
HEPTACHLOR EPOXIDE	µg/l		8				0.00011	SW HH FED FISH (µg/l)		
METHOXYCHLOR	µg/l		8				20.91	SW MTCA C (µg/l)		
TOXAPHENE	µg/l		8				0.0002	SW FWC FED (µg/l)		
SEMIVOLATILES										
1,2,4,5-TETRACHLOROBENZENE	µg/l		8				4.8	GW MTCA B (µg/l)		
1,2,4-TRICHLOROBENZENE	µg/l		30				70	GW FED MCL (µg/l)		
1,2-DICHLOROBENZENE	µg/l		30				10	GW FED SMCL (µg/l)		
1,3-DICHLOROBENZENE	µg/l		30				2600	SW HH FED FISH (µg/l)		
1,3-DINITROBENZENE	µg/l		8				1.6	GW MTCA B (µg/l)		
1,4-DICHLOROBENZENE	µg/l		30				1.82	GW MTCA B (µg/l)		
1,4-NAPHTHOQUINONE	µg/l		8							
1-NAPHTHYLAMINE	µg/l		8							
2,2'-OXYBIS(1-CHLOROPROPANE)	µg/l		30							
2,3,4,6-TETRACHLOROPHENOL	µg/l		8				480	GW MTCA B (µg/l)		
2,4,5-TRICHLOROPHENOL	µg/l		30				1600	GW MTCA B (µg/l)		
2,4,6-TRICHLOROPHENOL	µg/l		30				4	GW GWQS (µg/l)		
2,4-DICHLOROPHENOL	µg/l		30				48	GW MTCA B (µg/l)		
2,4-DIMETHYLPHENOL	µg/l	1	30	0.03	26	26	110	SW MWC FED (µg/l)		
2,4-DINITROPHENOL	µg/l		30				32	GW MTCA B (µg/l)		
2,4-DINITROTOLUENE	µg/l		30				0.1	GW GWQS (µg/l)		
2,6-DICHLOROPHENOL	µg/l		8							

Table 4-16
Groundwater Data Statistical Summary, Round 1

Parameter	Units	Number of Detections	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Most Stringent Action Level	Source of Most Stringent Action Level [a]	No. of Non-Background Samples Above Action Level	No. of Background Samples Above Action Level [b]
2,6-DINITROTOLUENE	µg/l		30				0.1	GW GWQS (µg/l)		
2-ACETYLAMINOFLUORENE	µg/l		8							
2-CHLORONAPHTHALENE	µg/l		30							
2-CHLOROPHENOL	µg/l		30				80	GW MTCA B (µg/l)		
2-METHYLNAPHTHALENE	µg/l	1	30	0.03	10	10				
2-METHYLPHENOL	µg/l	3	30	0.10	210	1,900	800	GW MTCA B (µg/l)	2	
2-NAPHTHYLAMINE	µg/l		8							
2-NITROANILINE	µg/l		30							
2-NITROPHENOL	µg/l		30							
2-PICOLINE	µg/l		8							
2SEC-BUTYL-4,6-DINITROPHENOL	µg/l		8				7	GW FED MCL (µg/l)		
3,3'-DICHLOROBENZIDINE	µg/l		30				0.077	SW HH FED FISH (µg/l)		
3-METHYLCHOLANTHRENE	µg/l		8							
3-NITROANILINE	µg/l		30							
4,6-DINITRO-2-METHYLPHENOL	µg/l		30							
4-AMINOBIPHENYL	µg/l		8							
4-BROMOPHENYL PHENYL ETHER	µg/l		30							
4-CHLORO-3-METHYLPHENOL	µg/l		30							
4-CHLOROANILINE	µg/l		30				64	GW MTCA B (µg/l)		
4-CHLOROPHENYL PHENYL ETHER	µg/l		30							
4-METHYLPHENOL	µg/l	3	30	0.10	130	1,600	80	GW MTCA B (µg/l)	3	
4-NITROANILINE	µg/l		30							
4-NITROPHENOL	µg/l		30							
4-NITROQUINOLINE-1-OXIDE	µg/l		8							
5-NITRO-O-TOLUIDINE	µg/l		8				2.65	GW MTCA B (µg/l)		
7,12-DIMETHYLBENZ(A)ANTHRACENE	µg/l		8							
A,A-DIMETHYLPHENETHYLAMINE	µg/l		8							
ACENAPHTHENE	µg/l	1	30	0.03	6	6	960	GW MTCA B (µg/l)		
ACENAPHTHYLENE	µg/l		30							
ACETOPHENONE	µg/l		8				1,600	GW MTCA B (µg/l)		
ANILINE	µg/l		8				14	GW GWQS (µg/l)		
ANTHRACENE	µg/l		30				4,800	GW MTCA B (µg/l)		
ARAMITE	µg/l		8							
BENZO(A)ANTHRACENE	µg/l		30				0.012	GW MTCA B (µg/l)		
BENZO(A)PYRENE	µg/l	4	30	0.13	1	7	0.008	GW GWQS (µg/l)	4	
BENZO(B)FLUORANTHENE	µg/l		30				0.012	GW MTCA B (µg/l)		
BENZO(GHI)PERYLENE	µg/l		30							
BENZO(K)FLUORANTHENE	µg/l		30				0.012	GW MTCA B (µg/l)		
BENZYL ALCOHOL	µg/l		30							
BENZYL BUTYL PHTHALATE	µg/l		30				3,131.15	SW MTCA C (µg/l)		
BIS(2-CHLOROETHOXY) METHANE	µg/l		30							

Table 4-16
Groundwater Data Statistical Summary, Round 1

Parameter	Units	Number of Detections	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Most Stringent Action Level	Source of Most Stringent Action Level [a]	No. of Non-Background Samples Above Action Level	No. of Background Samples Above Action Level [b]
BIS(2-CHLOROETHYL)ETHER	µg/l	1	30	0.03	2	2	0.04	GW MTCA B (µg/l)	1	
BIS(2-ETHYLHEXYL)PHTHALATE	µg/l	14	30	0.47	1	53	5.9	SW HH FED FISH (µg/l)	3	
CARBAZOLE	µg/l		22				4.375	GW MTCA B (µg/l)		
CHLOROBENZILATE	µg/l		8				0.32	GW MTCA B (µg/l)		
CHRYSENE	µg/l	1	30	0.03	1	1	0.012	GW MTCA B (µg/l)	1	
DI-N-BUTYL PHTHALATE	µg/l		30				1600	GW MTCA B (µg/l)		
DI-N-OCTYL PHTHALATE	µg/l		30				320	GW MTCA B (µg/l)		
DIALLATE	µg/l		8				1	GW GWQS (µg/l)		
DIBENZO(A,H)ANTHRACENE	µg/l		30				0.012	GW MTCA B (µg/l)		
DIBENZOFURAN	µg/l	1	30	0.03	2	2				
DIETHYL PHTHALATE	µg/l		30				12,800	GW MTCA B (µg/l)		
DIMETHYL PHTHALATE	µg/l		30				16,000	GW MTCA B (µg/l)		
ETHYL METHANESULFONATE	µg/l		8							
FLUORANTHENE	µg/l	1	30	0.03	2	2	225.44	SW MTCA C (µg/l)		
FLUORENE	µg/l	1	30	0.03	2	2	640	GW MTCA B (µg/l)		
HEXACHLOROBENZENE	µg/l		30				0.00077	SW HH FED FISH (µg/l)		
HEXACHLOROBUTADIENE	µg/l		30				0.56	GW MTCA B (µg/l)		
HEXACHLOROCYCLOPENTADIENE	µg/l		30				50	GW FED MCL (µg/l)		
HEXACHLOROETHANE	µg/l		30				6.25	GW MTCA B (µg/l)		
HEXACHLOROPROPENE	µg/l		8							
INDENO(1,2,3-CD)PYRENE	µg/l		30				0.012	GW MTCA B (µg/l)		
ISODRIN	µg/l		8							
ISOPHORONE	µg/l		30				92.1	GW MTCA B (µg/l)		
ISOSAFROLE	µg/l		8							
METHAPYRILENE	µg/l		8							
METHYL METHANESULFONATE	µg/l		8							
N-NITROSO-DI-N-PROPYLAMINE	µg/l		30				0.01	GW GWQS (µg/l)		
N-NITROSODI-N-BUTYLAMINE	µg/l		8				0.016	GW MTCA B (µg/l)		
N-NITROSODIETHYLAMINE	µg/l		8				0.0005	GW GWQS (µg/l)		
N-NITROSODIMETHYLAMINE	µg/l		8				0.0017	GW MTCA B (µg/l)		
N-NITROSODIPHENYLAMINE	µg/l		30				16	SW HH FED FISH (µg/l)		
N-NITROSOMETHYLETHYLAMINE	µg/l		8				0.004	GW MTCA B (µg/l)		
N-NITROSOMORPHOLINE	µg/l		8							
N-NITROSOPIPERIDINE	µg/l		8							
N-NITROSOPYRROLIDINE	µg/l		8				0.04	GW GWQS (µg/l)		
NAPHTHALENE	µg/l	2	30	0.07	2	7	32	GW MTCA B (µg/l)		
NITROBENZENE	µg/l		30				8	GW MTCA B (µg/l)		
O,O,O-TRIETHYLPHOSPHOROTHIOATE	µg/l		8							
O-TOLUIDINE	µg/l		8				0.2	GW GWQS (µg/l)		
P-(DIMETHYLAMINO)AZOBENZENE	µg/l		8							
PENTACHLOROBENZENE	µg/l		8				12.8	GW MTCA B (µg/l)		

Table 4-16
Groundwater Data Statistical Summary, Round 1

Parameter	Units	Number of Detections	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Most Stringent Action Level	Source of Most Stringent Action Level [a]	No. of Non-Background Samples Above Action Level	No. of Background Samples Above Action Level [b]
PENTACHLORONITROBENZENE	µg/l		8				0.34	GW MTCA B (µg/l)		
PENTACHLOROPHENOL	µg/l	1	30	0.03	5	5	0.73	GW MTCA B (µg/l)	1	
PHENACETIN	µg/l		8							
PHENANTHRENE	µg/l		30							
PHENOL	µg/l	3	30	0.10	3	730	9,600	GW MTCA B (µg/l)		
PRONAMIDE	µg/l		8				1,200	GW MTCA B (µg/l)		
PYRENE	µg/l	1	30	0.03	2	2	480	GW MTCA B (µg/l)		
PYRIDINE	µg/l		8				16	GW MTCA B (µg/l)		
SAFROLE	µg/l		8							
SYM-TRINITROBENZENE	µg/l		8				0.8	GW MTCA B (µg/l)		
TETRAETHYL DITHIOPYROPHOSPHATE	µg/l		8				8	GW MTCA B (µg/l)		
VANILLIN	µg/l	10	30	0.33	1	35				
VOLATILES										
FORMALDEHYDE	µg/l	16	17	0.94	32	450	1.46	GW MTCA B (µg/l)	13	3
2-PROPANOL (ISOPROPANOL)	mg/l		26							
1,1,1,2-TETRACHLOROETHANE	µg/l		8				1.68	GW MTCA B (µg/l)		
1,1,1-TRICHLOROETHANE	µg/l		30				200	GW FED MCL (µg/l)		
1,1,2,2-TETRACHLOROETHANE	µg/l		30				0.219	GW MTCA B (µg/l)		
1,1,2-TRICHLOROETHANE	µg/l		30				0.77	GW MTCA B (µg/l)		
1,1-DICHLOROETHANE	µg/l	1	30	0.03	2	2	1	GW GWQS (µg/l)	1	
1,1-DICHLOROETHENE	µg/l		30				0.073	GW MTCA B (µg/l)		
1,2,3-TRICHLOROPROPANE	µg/l		8				48	GW MTCA B (µg/l)		
1,2-DIBROMO-3-CHLOROPROPANE	µg/l		8				0.0312	GW MTCA B (µg/l)		
1,2-DIBROMOETHANE	µg/l		8				0.0005	GW MTCA B (µg/l)		
1,2-DICHLOROETHANE	µg/l		30				0.48	GW MTCA B (µg/l)		
1,2-DICHLOROPROPANE	µg/l		30				0.6	GW GWQS (µg/l)		
2-BUTANONE	µg/l	1	30	0.03	1,300	1,300	4,800	GW MTCA B (µg/l)		
2-HEXANONE	µg/l		30							
4-METHYL-2-PENTANONE	µg/l		30				400	GW MTCA B (µg/l)		
ACETONE	µg/l	2	30	0.07	370	56,000	800	GW MTCA B (µg/l)	1	
ACETONITRILE	µg/l		8				48	GW MTCA B (µg/l)		
ACROLEIN	µg/l		8				780	SW HH FED FISH (µg/l)		
ACRYLONITRILE	µg/l		8				0.07	GW GWQS (µg/l)		
ALLYL CHLORIDE	µg/l		8				800	GW MTCA B (µg/l)		
BENZENE	µg/l	4	30	0.13	2	230	1	GW GWQS (µg/l)	4	
BROMODICHLOROMETHANE	µg/l		30				0.3	GW GWQS (µg/l)		
BROMOFORM	µg/l		30				5	GW GWQS (µg/l)		
BROMOMETHANE	µg/l		30				11.2	GW MTCA B (µg/l)		
CARBON DISULFIDE	µg/l		30				800	GW MTCA B (µg/l)		
CARBON TETRACHLORIDE	µg/l		30				0.3	GW GWQS (µg/l)		
CHLOROBENZENE	µg/l		30				100	GW FED MCL (µg/l)		

Table 4-16
Groundwater Data Statistical Summary, Round 1

Parameter	Units	Number of Detections	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Most Stringent Action Level	Source of Most Stringent Action Level [a]	No. of Non-Background Samples Above Action Level	No. of Background Samples Above Action Level [b]
CHLOROETHANE	µg/l		30							
CHLOROFORM	µg/l		30				7	GW GWQS (µg/l)		
CHLOROMETHANE	µg/l		30				3.37	GW MTCA B (µg/l)		
CIS-1,2-DICHLOROETHYLENE	µg/l		30				70	GW FED MCL (µg/l)		
CIS-1,3-DICHLOROPROPENE	µg/l		30							
DIBROMOCHLOROMETHANE	µg/l		30				0.5	GW GWQS (µg/l)		
DIBROMOMETHANE	µg/l		8				80	GW MTCA B (µg/l)		
DICHLORODIFLUOROMETHANE	µg/l		8				1,600	GW MTCA B (µg/l)		
ETHYL METHACRYLATE	µg/l		8				720	GW MTCA B (µg/l)		
ETHYLBENZENE	µg/l		30				700	GW FED MCL (µg/l)		
IODOMETHANE	µg/l		8							
ISOBUTYL ALCOHOL	µg/l		8				4,800	GW MTCA B (µg/l)		
METHACRYLONITRILE	µg/l		8				1.6	GW MTCA B (µg/l)		
METHYL METHACRYLATE	µg/l		8				640	GW MTCA B (µg/l)		
METHYLENE CHLORIDE	µg/l	1	30	0.03	57	57	5	GW FED MCL (µg/l)	1	
PENTACHLOROETHANE	µg/l		8							
PROPIONITRILE	µg/l		8							
STYRENE	µg/l		30				1.46	GW MTCA B (µg/l)		
TETRACHLOROETHENE	µg/l		30				0.8	GW GWQS (µg/l)		
TOLUENE	µg/l	5	30	0.17	1	600,000	1,000	GW FED MCL (µg/l)	3	
TRANS-1,2-DICHLOROETHENE	µg/l		8				100	GW FED MCL (µg/l)		
TRANS-1,3-DICHLOROPROPENE	µg/l		30							
TRANS-1,4-DICHLORO-2-BUTENE	µg/l		8							
TRICHLOROETHENE	µg/l		30				3	GW GWQS (µg/l)		
TRICHLOROFLUOROMETHANE (FREON 11)	µg/l		8				2,400	GW MTCA B (µg/l)		
VINYL ACETATE	µg/l		8				8,000	GW MTCA B (µg/l)		
VINYL CHLORIDE	µg/l		30				0.02	GW GWQS (µg/l)		
XYLENE (TOTAL)	µg/l	1	30	0.03	110	110	10,000	GW FED MCL (µg/l)		

[See next page for notes]

Table 4-16
Groundwater Data Statistical Summary, Round 1

Parameter	Units	Number of Detections	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Most Stringent Action Level	Source of Most Stringent Action Level [a]	No. of Non-Background Samples Above Action Level	No. of Background Samples Above Action Level [b]

[a] Source of the Most Stringent Action Level:

GW FED MCL	Federal Maximum Contaminant Levels (MCLs) for drinking water (40 CFR 141 and 142)
GW ST SMCL	Washington State Secondary Maximum Contaminant Levels (State MCLs) for drinking water (WAC 246-290)
GW GWQS	Washington Groundwater Quality Standards (WAC 173-200)
GW MTCA B	Washington State Model Toxic Control Act Cleanup Level Method B for Groundwater (WAC 173-340)
GW MTCA C	Washington State Model Toxic Control Act Cleanup Level Method C for Surfacewater (WAC 173-340)
SW MWC ST	Washington Water Quality Standards for Marine Water Chronic (WAC 173-201A)
SW FWC ST	Washington Water Quality Standards for Freshwater, Chronic (WAC 173-201A)
SW MWA ST	Washington Water Quality Standards for Marine Water Acute (WAC 173-201A)
SW FWC ST	Washington Water Quality Standards for Freshwater, Acute (WAC 173-201A)
SW FWC FED	Federal Freshwater Chronic - Federal Water Quality Criteria for Surface Water, Freshwater Chronic (40 CFR 131)
SW MWC FED	Federal Marine Chronic - Federal Water Quality Criteria for Surface Water, Marine Chronic (40 CFR 131)
SW FWA FED	Federal Water Quality Criteria for Surface Water, Freshwater Acute (40 CFR 131)
SW FMA FED	Federal Water Quality Criteria for Surface Water, Marine Acute (40 CFR 131)
SW HH FED FISH	Federal Water Quality Criteria for the Consumption of Organisms Only (40 CFR 131)

[b] Background area samples collected from upgradient monitoring wells DM- 1A, DM-1B, and E3.

[c] Sample specific hardness may be used to calculate the most stringent action level. Thus for a given analyte, the most stringent action level may be different for each sample.

Monsanto Company 104(e) Response

Monsanto 2A002126

Table 4-17
Groundwater Data Statistical Summary, Round 2

Parameter	Units	Number of Detections	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Most Stringent Action Level	Source of Most Stringent Action Level [a]	No. of Non-Background Samples Above Action Level	No. of Background Samples Above Action Level [b]
FIELD PARAMETERS										
DISSOLVED OXYGEN	mg/l	19	19	1.00	0.1	1.4				
SPECIFIC CONDUCTANCE	umhos/cm	19	19	1.00	230	10,000				
TEMPERATURE	°C	19	19	1.00	13.6	18.9				
pH, Field	-log+H	19	19	1.00	6	11.2	6.5 - 8.5	GW GWQS (µg/l)	7	1
INORGANICS										
ANTIMONY, TOTAL	µg/l	1	2	0.50	25.45	25.45	6	GW FED MCL (µg/l)		1
BERYLLIUM, TOTAL	µg/l		2				0.02	GW MTCA B (µg/l)		
VANADIUM, TOTAL	µg/l	2	2	1.00	13.3411	19.35	112	GW MTCA B (µg/l)		
HERBICIDES										
2,4,5-TRICHLOROPHENOXYACETIC ACID	µg/l		8				160	GW MTCA B (µg/l)		
2,4-DICHLOROPHENOXYACETIC ACID	µg/l		8				70	GW FED MCL (µg/l)		
2-(2,4,5-TRICHLOROPHENOXY) PROPIONIC ACID	µg/l		8				10	GW GWQS (µg/l)		
SEMIVOLATILES										
1,2,4-TRICHLOROBENZENE	µg/l		3				70	GW FED MCL (µg/l)		
1,2-DICHLOROBENZENE	µg/l		3				10	GW FED SMCL (µg/l)		
1,3-DICHLOROBENZENE	µg/l		3				2,600	SW HH FED FISH (µg/l)		
1,4-DICHLOROBENZENE	µg/l		3				1.82	GW MTCA B (µg/l)		
2,2'-OXYBIS(1-CHLOROPROPANE)	µg/l		3							
2,4,5-TRICHLOROPHENOL	µg/l		3				1,600	GW MTCA B (µg/l)		
2,4,6-TRICHLOROPHENOL	µg/l		3				4	GW GWQS (µg/l)		
2,4-DICHLOROPHENOL	µg/l		3				48	GW MTCA B (µg/l)		
2,4-DIMETHYLPHENOL	µg/l		3				110	SW MWC FED (µg/l)		
2,4-DINITROPHENOL	µg/l		3				32	GW MTCA B (µg/l)		
2,4-DINITROTOLUENE	µg/l		3				0.1	GW GWQS (µg/l)		
2,6-DINITROTOLUENE	µg/l		3				0.1	GW GWQS (µg/l)		
2-CHLORONAPHTHALENE	µg/l		3							
2-CHLOROPHENOL	µg/l		3				80	GW MTCA B (µg/l)		
2-METHYLNAPHTHALENE	µg/l		3							
2-METHYLPHENOL	µg/l	2	3	0.67	74	1,800	800	GW MTCA B (µg/l)	1	
2-NITROANILINE	µg/l		3							
2-NITROPHENOL	µg/l		3							
3,3'-DICHLOROBENZIDINE	µg/l		3				0.077	SW HH FED FISH (µg/l)		
3-NITROANILINE	µg/l		3							
4,6-DINITRO-2-METHYLPHENOL	µg/l		3							
4-BROMOPHENYL PHENYL ETHER	µg/l		3							
4-CHLORO-3-METHYLPHENOL	µg/l		3							
4-CHLOROANILINE	µg/l		3				64	GW MTCA B (µg/l)		
4-CHLOROPHENYL PHENYL ETHER	µg/l		3							
4-METHYLPHENOL	µg/l	2	3	0.67	13	1,100	80	GW MTCA B (µg/l)	1	
4-NITROANILINE	µg/l		3							
4-NITROPHENOL	µg/l		3							
ACENAPHTHENE	µg/l		3				960	GW MTCA B (µg/l)		
ACENAPHTHYLENE	µg/l		3							
ANTHRACENE	µg/l		3				4,800	GW MTCA B (µg/l)		

Table 4-17
Groundwater Data Statistical Summary, Round 2

Parameter	Units	Number of Detections	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Most Stringent Action Level	Source of Most Stringent Action Level [a]	No. of Non-Background Samples Above Action Level	No. of Background Samples Above Action Level [b]
BENZO(A)ANTHRACENE	µg/l		3				0.012	GW MTCA B (µg/l)		
BENZO(A)PYRENE	µg/l		3				0.008	GW GWQS (µg/l)		
BENZO(B)FLUORANTHENE	µg/l		3				0.012	GW MTCA B (µg/l)		
BENZO(GHI)PERYLENE	µg/l		3							
BENZO(K)FLUORANTHENE	µg/l		3				0.012	GW MTCA B (µg/l)		
BENZYL BUTYL PHTHALATE	µg/l		3				3,131.15	SW MTCA C (µg/l)		
BIS(2-CHLOROETHOXY) METHANE	µg/l		3							
BIS(2-CHLOROETHYL)ETHER	µg/l	1	3	0.33	5.5	5.5	0.04	GW MTCA B (µg/l)	1	
BIS(2-ETHYLHEXYL)PHTHALATE	µg/l	1	3	0.33	32	32	5.9	SW HH FED FISH (µg/l)	1	
CARBAZOLE	µg/l		3				4.375	GW MTCA B (µg/l)		
CHRYSENE	µg/l		3				0.012	GW MTCA B (µg/l)		
DI-N-BUTYL PHTHALATE	µg/l	2	3	0.67	2	5.5	1,600	GW MTCA B (µg/l)		
DI-N-OCTYL PHTHALATE	µg/l		3				320	GW MTCA B (µg/l)		
DIBENZO(A,H)ANTHRACENE	µg/l		3				0.012	GW MTCA B (µg/l)		
DIBENZOFURAN	µg/l		3							
DIETHYL PHTHALATE	µg/l	1	3	0.33	7	7	12,800	GW MTCA B (µg/l)		
DIMETHYL PHTHALATE	µg/l		3				16,000	GW MTCA B (µg/l)		
FLUORANTHENE	µg/l		3				225.44	SW MTCA C (µg/l)		
FLUORENE	µg/l		3				640	GW MTCA B (µg/l)		
HEXACHLOROBENZENE	µg/l		3				0.00077	SW HH FED FISH (µg/l)		
HEXACHLOROBUTADIENE	µg/l		3				0.56	GW MTCA B (µg/l)		
HEXACHLOROCYCLOPENTADIENE	µg/l		3				50	GW FED MCL (µg/l)		
HEXACHLOROETHANE	µg/l		3				6.25	GW MTCA B (µg/l)		
INDENO(1,2,3-CD)PYRENE	µg/l		3				0.012	GW MTCA B (µg/l)		
ISOPHORONE	µg/l		3				92.1	GW MTCA B (µg/l)		
N-NITROSO-DI-N-PROPYLAMINE	µg/l		3				0.01	GW GWQS (µg/l)		
N-NITROSODIPHENYLAMINE	µg/l	1	3	0.33	5.5	5.5	16	SW HH FED FISH (µg/l)		
NAPHTHALENE	µg/l		3				32	GW MTCA B (µg/l)		
NITROBENZENE	µg/l		3				8	GW MTCA B (µg/l)		
PENTACHLOROPHENOL	µg/l		3				0.73	GW MTCA B (µg/l)		
PHENANTHRENE	µg/l		3							
PHENOL	µg/l	2	3	0.67	2	895	9,600	GW MTCA B (µg/l)		
PYRENE	µg/l		3				480	GW MTCA B (µg/l)		
VOLATILES										
1,1,1-TRICHLOROETHANE	µg/l		1				200	GW FED MCL (µg/l)		
1,1,2,2-TETRACHLOROETHANE	µg/l		1				0.219	GW MTCA B (µg/l)		
1,1,2-TRICHLOROETHANE	µg/l		1				0.77	GW MTCA B (µg/l)		
1,1-DICHLOROETHANE	µg/l		1				1	GW GWQS (µg/l)		
1,1-DICHLOROETHENE	µg/l		1				0.073	GW MTCA B (µg/l)		
1,2-DICHLOROETHANE	µg/l		1				0.48	GW MTCA B (µg/l)		
1,2-DICHLOROETHENE (TOTAL)	µg/l		1							
1,2-DICHLOROPROPANE	µg/l		1				0.6	GW GWQS (µg/l)		
2-BUTANONE	µg/l		1				4,800	GW MTCA B (µg/l)		
2-HEXANONE	µg/l		1							
4-METHYL-2-PENTANONE	µg/l		1				400	GW MTCA B (µg/l)		

Table 4-17
Groundwater Data Statistical Summary, Round 2

Parameter	Units	Number of Detections	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Most Stringent Action Level	Source of Most Stringent Action Level [a]	No. of Non-Background Samples Above Action Level	No. of Background Samples Above Action Level [b]
ACETONE	µg/l		1				800	GW MTCA B (µg/l)		
BENZENE	µg/l	2	17	0.12	0.8	1	1	GW GWQS (µg/l)		
BROMODICHLOROMETHANE	µg/l		1				0.3	GW GWQS (µg/l)		
BROMOFORM	µg/l		1				5	GW GWQS (µg/l)		
BROMOMETHANE	µg/l		1				11.2	GW MTCA B (µg/l)		
CARBON DISULFIDE	µg/l		1				800	GW MTCA B (µg/l)		
CARBON TETRACHLORIDE	µg/l		1				0.3	GW GWQS (µg/l)		
CHLOROBENZENE	µg/l		1				100	GW FED MCL (µg/l)		
CHLOROETHANE	µg/l		1							
CHLOROFORM	µg/l		1				7	GW GWQS (µg/l)		
CHLOROMETHANE	µg/l		1				3.37	GW MTCA B (µg/l)		
CIS-1,3-DICHLOROPROPENE	µg/l		1							
DIBROMOCHLOROMETHANE	µg/l		1				0.5	GW GWQS (µg/l)		
ETHYLBENZENE	µg/l		17				700	GW FED MCL (µg/l)		
METHYLENE CHLORIDE	µg/l		1				5	GW FED MCL (µg/l)		
STYRENE	µg/l		1				1.46	GW MTCA B (µg/l)		
TETRACHLOROETHENE	µg/l		1				0.8	GW GWQS (µg/l)		
TOLUENE	µg/l	13	17	0.76	0.5	340,000	1,000	GW FED MCL (µg/l)	10	
TRANS-1,3-DICHLOROPROPENE	µg/l		1							
TRICHLOROETHENE	µg/l		1				3	GW GWQS (µg/l)		
VINYL CHLORIDE	µg/l		1				0.02	GW GWQS (µg/l)		
XYLENE (TOTAL)	µg/l	1	17	0.06	14	14	10,000	GW FED MCL (µg/l)		
TOTAL PETROLEUM HYDROCARBONS										
GASOLINE RANGE ORGANICS	µg/l		13							
TOTAL RECOVERABLE PETROLEUM HYDROCARBO	mg/l	7	19	0.37	3.2	54				

[a] Source of the Most Stringent Action Level:

GW FED MCL	Federal Maximum Contaminant Levels (MCLs) for drinking water (40 CFR 141 and 142)
GW ST SMCL	Washington State Secondary Maximum Contaminant Levels (State MCLs) for drinking water (WAC 246-290)
GW GWQS	Washington Groundwater Quality Standards (WAC 173-200)
GW MTCA B	Washington State Model Toxic Control Act Cleanup Level Method B for Groundwater (WAC 173-340)
GW MTCA C	Washington State Model Toxic Control Act Cleanup Level Method C for Surfacewater (WAC 173-340)
SW MWC ST	Washington Water Quality Standards for Marine Water Chronic (WAC 173-201A)
SW FWC ST	Washington Water Quality Standards for Freshwater, Chronic (WAC 173-201A)
SW MWA ST	Washington Water Quality Standards for Marine Water Acute (WAC 173-201A)
SW FWC ST	Washington Water Quality Standards for Freshwater, Acute (WAC 173-201A)
SW FWC FED	Federal Freshwater Chronic - Federal Water Quality Criteria for Surface Water, Freshwater Chronic (40 CFR 131)
SW MWC FED	Federal Marine Chronic - Federal Water Quality Criteria for Surface Water, Marine Chronic (40 CFR 131)
SW FWA FED	Federal Water Quality Criteria for Surface Water, Freshwater Acute (40 CFR 131)
SW FMA FED	Federal Water Quality Criteria for Surface Water, Marine Acute (40 CFR 131)
SW HH FED FISH	Federal Water Quality Criteria for the Consumption of Organisms Only (40 CFR 131)

[b] Background area samples collected from upgradient monitoring wells DM-1A, DM-1B, and E3.

Monsanto Company 104(e) Response

Monsanto 2A002129

Table 4-18
Detected Groundwater Results Above Action Levels, Round 1

Area	Sample No.	Monitoring Well	Chemical Grouping	Parameter	Result	Qualifier	Units	Most Stringent Action Level	Source of Most Stringent Action Level [a]
A1	09-MWA2	A2	VOC	FORMALDEHYDE	450		µg/l	1.46	GW MTCA B (µg/l)
A1	09-MWA2	A2	CONV	TOTAL DISSOLVED SOLIDS	699,000		µg/l	500,000	GW GWQS (µg/l)
A1	09-MWA2	A2	IORG	ARSENIC, DISSOLVED	49.9		µg/l	.05	GW MTCA B (µg/l)
A1	09-MWA2	A2	IORG	ARSENIC, TOTAL	43		µg/l	.05	GW MTCA B (µg/l)
A1	09-MWA2	A2	IORG	COPPER, TOTAL	37.5		µg/l	2.5	SW MWA ST (µg/l)
A1	09-MWA2	A2	IORG	IRON, DISSOLVED	37,400		µg/l	300	GW ST SMCL (µg/l)
A1	09-MWA2	A2	IORG	IRON, TOTAL	47,800		µg/l	300	GW ST SMCL (µg/l)
A1	09-MWA2	A2	IORG	LEAD, TOTAL	7.3		µg/l	2.2	SW FWC ST (µg/l)
A1	09-MWA2	A2	IORG	MANGANESE, DISSOLVED	1,390		µg/l	50	GW ST SMCL (µg/l)
A1	09-MWA2	A2	IORG	MANGANESE, TOTAL	1,500		µg/l	50	GW ST SMCL (µg/l)
A1	09-MWA2	A2	IORG	NICKEL, TOTAL	24.9	B	µg/l	7.9	SW MWC ST (µg/l)
A1	09-MWA2	A2	IORG	VANADIUM, TOTAL	134		µg/l	112	GW MTCA B (µg/l)
A1	09-MWA2	A2	SVO	BIS(2-CHLOROETHYL)ETHER	2	J	µg/l	.040	GW MTCA B (µg/l)
A1	09-MWA2	A2	VOC	1,1-DICHLOROETHANE	2		µg/l	1	GW GWQS (µg/l)
A1	10-DM3A	DM-3A	CONV	pH, Field	6.32		-log+H	6.5 - 8.5	GW GWQS (µg/l)
A1	10-DM3A	DM-3A	IORG	ARSENIC, DISSOLVED	4	B	µg/l	.05	GW MTCA B (µg/l)
A1	10-DM3A	DM-3A	IORG	ARSENIC, TOTAL	16.8		µg/l	.05	GW MTCA B (µg/l)
A1	10-DM3A	DM-3A	IORG	COPPER, TOTAL	94.4		µg/l	2.5	SW MWA ST (µg/l)
A1	10-DM3A	DM-3A	IORG	IRON, DISSOLVED	1,860		µg/l	300	GW ST SMCL (µg/l)
A1	10-DM3A	DM-3A	IORG	IRON, TOTAL	36,700		µg/l	300	GW ST SMCL (µg/l)
A1	10-DM3A	DM-3A	IORG	LEAD, TOTAL	31.1		µg/l	1.8	SW FWC ST (µg/l)
A1	10-DM3A	DM-3A	IORG	MANGANESE, DISSOLVED	246		µg/l	50	GW ST SMCL (µg/l)
A1	10-DM3A	DM-3A	IORG	MANGANESE, TOTAL	694		µg/l	50	GW ST SMCL (µg/l)
A1	10-DM3A	DM-3A	IORG	NICKEL, TOTAL	64.3		µg/l	7.9	SW MWC ST (µg/l)
A1	10-DM3A	DM-3A	IORG	VANADIUM, TOTAL	119		µg/l	112	GW MTCA B (µg/l)
A1	10-DM3A	DM-3A	IORG	ZINC, TOTAL	98.8		µg/l	76.6	SW MWC ST (µg/l)
A1	11-DM3B	DM-3B	CONV	pH, Field	8.59		-log+H	6.5 - 8.5	GW GWQS (µg/l)
A1	11-DM3B	DM-3B	CONV	TOTAL DISSOLVED SOLIDS	965,000		µg/l	500,000	GW GWQS (µg/l)
A1	11-DM3B	DM-3B	IORG	ARSENIC, DISSOLVED	13.9		µg/l	.05	GW MTCA B (µg/l)
A1	11-DM3B	DM-3B	IORG	ARSENIC, TOTAL	13.2		µg/l	.05	GW MTCA B (µg/l)
A1	11-DM3B	DM-3B	IORG	IRON, DISSOLVED	618		µg/l	300	GW ST SMCL (µg/l)
A1	11-DM3B	DM-3B	IORG	IRON, TOTAL	1060		µg/l	300	GW ST SMCL (µg/l)
A1	11-DM3B	DM-3B	IORG	LEAD, DISSOLVED	2	B	µg/l	.8	SW FWC ST (µg/l)
A1	11-DM3B	DM-3B	IORG	LEAD, TOTAL	3.6		µg/l	.8	SW FWC ST (µg/l)
A1	16-MWA9	A9	VOC	FORMALDEHYDE	290		µg/l	1.46	GW MTCA B (µg/l)

Table 4-18
Detected Groundwater Results Above Action Levels, Round 1

Area	Sample No.	Monitoring Well	Chemical Grouping	Parameter	Result	Qualifier	Units	Most Stringent Action Level	Source of Most Stringent Action Level [a]
A1	16-MWA9	A9	IORG	ARSENIC, TOTAL	13.6		µg/l	.05	GW MTCA B (µg/l)
A1	16-MWA9	A9	IORG	COPPER, TOTAL	119		µg/l	2.5	SW MWA ST (µg/l)
A1	16-MWA9	A9	IORG	IRON, DISSOLVED	930		µg/l	300	GW ST SMCL (µg/l)
A1	16-MWA9	A9	IORG	IRON, TOTAL	69,300		µg/l	300	GW ST SMCL (µg/l)
A1	16-MWA9	A9	IORG	LEAD, TOTAL	23.8		µg/l	2.1	SW FWC ST (µg/l)
A1	16-MWA9	A9	IORG	MANGANESE, DISSOLVED	419		µg/l	50	GW ST SMCL (µg/l)
A1	16-MWA9	A9	IORG	MANGANESE, TOTAL	1,960		µg/l	50	GW ST SMCL (µg/l)
A1	16-MWA9	A9	IORG	MERCURY, TOTAL	0.22		µg/l	.012	SW FWC FED (µg/l)
A1	16-MWA9	A9	IORG	NICKEL, TOTAL	48.7		µg/l	7.9	SW MWC ST (µg/l)
A1	16-MWA9	A9	IORG	VANADIUM, TOTAL	161		µg/l	112	GW MTCA B (µg/l)
A1	16-MWA9	A9	IORG	ZINC, TOTAL	102		µg/l	76.6	SW MWC ST (µg/l)
A2	12-MWB6	B6	VOC	FORMALDEHYDE	160		µg/l	1.46	GW MTCA B (µg/l)
A2	12-MWB6	B6	CONV	TOTAL DISSOLVED SOLIDS	653,000		µg/l	500,000	GW GWQS (µg/l)
A2	12-MWB6	B6	IORG	ARSENIC, TOTAL	5.6	B	µg/l	.05	GW MTCA B (µg/l)
A2	12-MWB6	B6	IORG	COPPER, TOTAL	304		µg/l	2.5	SW MWA ST (µg/l)
A2	12-MWB6	B6	IORG	IRON, DISSOLVED	9,750		µg/l	300	GW ST SMCL (µg/l)
A2	12-MWB6	B6	IORG	IRON, TOTAL	25,800		µg/l	300	GW ST SMCL (µg/l)
A2	12-MWB6	B6	IORG	LEAD, TOTAL	7.8		µg/l	1.2	SW FWC ST (µg/l)
A2	12-MWB6	B6	IORG	MANGANESE, DISSOLVED	274		µg/l	50	GW ST SMCL (µg/l)
A2	12-MWB6	B6	IORG	MANGANESE, TOTAL	431		µg/l	50	GW ST SMCL (µg/l)
A2	12-MWB6	B6	IORG	NICKEL, TOTAL	26.6	B	µg/l	7.9	SW MWC ST (µg/l)
A2	17-DM4	DM-4	VOC	FORMALDEHYDE	350		µg/l	1.46	GW MTCA B (µg/l)
A2	17-DM4	DM-4	CONV	TOTAL DISSOLVED SOLIDS	821,000		µg/l	500,000	GW GWQS (µg/l)
A2	17-DM4	DM-4	IORG	ARSENIC, TOTAL	2.1	B	µg/l	.05	GW MTCA B (µg/l)
A2	17-DM4	DM-4	IORG	COPPER, TOTAL	11.3	B	µg/l	2.5	SW MWA ST (µg/l)
A2	17-DM4	DM-4	IORG	IRON, DISSOLVED	24,200		µg/l	300	GW ST SMCL (µg/l)
A2	17-DM4	DM-4	IORG	IRON, TOTAL	25,300		µg/l	300	GW ST SMCL (µg/l)
A2	17-DM4	DM-4	IORG	MANGANESE, DISSOLVED	814		µg/l	50	GW ST SMCL (µg/l)
A2	17-DM4	DM-4	IORG	MANGANESE, TOTAL	782		µg/l	50	GW ST SMCL (µg/l)
A2	18-MWB2	B2	CONV	TOTAL DISSOLVED SOLIDS	984,000		µg/l	500,000	GW GWQS (µg/l)
A2	18-MWB2	B2	IORG	ARSENIC, DISSOLVED	4.5	B	µg/l	.05	GW MTCA B (µg/l)
A2	18-MWB2	B2	IORG	ARSENIC, TOTAL	13.6		µg/l	.05	GW MTCA B (µg/l)
A2	18-MWB2	B2	IORG	BERYLLIUM, TOTAL	2.4	B	µg/l	.02	GW MTCA B (µg/l)
A2	18-MWB2	B2	IORG	CHROMIUM, TOTAL	105.5		µg/l	50	GW GWQS (µg/l)
A2	18-MWB2	B2	IORG	COPPER, DISSOLVED	8.4	B	µg/l	2.5	SW MWA ST (µg/l)

Table 4-18
Detected Groundwater Results Above Action Levels, Round 1

Area	Sample No.	Monitoring Well	Chemical Grouping	Parameter	Result	Qualifier	Units	Most Stringent Action Level	Source of Most Stringent Action Level [a]
A2	18-MWB2	B2	IORG	COPPER, TOTAL	4,290		µg/l	2.5	SW MWA ST (µg/l)
A2	18-MWB2	B2	IORG	IRON, DISSOLVED	14,800		µg/l	300	GW ST SMCL (µg/l)
A2	18-MWB2	B2	IORG	IRON, TOTAL	61,000		µg/l	300	GW ST SMCL (µg/l)
A2	18-MWB2	B2	IORG	LEAD, TOTAL	174.5		µg/l	3.2	SW MWC FED (µg/l)
A2	18-MWB2	B2	IORG	MANGANESE, DISSOLVED	532		µg/l	50	GW ST SMCL (µg/l)
A2	18-MWB2	B2	IORG	MANGANESE, TOTAL	1,010		µg/l	50	GW ST SMCL (µg/l)
A2	18-MWB2	B2	IORG	MERCURY, TOTAL	4.7		µg/l	.012	SW FWC FED (µg/l)
A2	18-MWB2	B2	IORG	NICKEL, TOTAL	85.95		µg/l	7.9	SW MWC ST (µg/l)
A2	18-MWB2	B2	IORG	VANADIUM, DISSOLVED	157		µg/l	112	GW MTCA B (µg/l)
A2	18-MWB2	B2	IORG	VANADIUM, TOTAL	267.5		µg/l	112	GW MTCA B (µg/l)
A2	18-MWB2	B2	IORG	ZINC, TOTAL	1,605		µg/l	76.6	SW MWC ST (µg/l)
A2	18-MWB2	B2	SVO	CHRYSENE	1	J	µg/l	.012	GW MTCA B (µg/l)
A2	19-DM5	DM-5	CONV	TOTAL DISSOLVED SOLIDS	5,340,000		µg/l	500,000	GW GWQS (µg/l)
A2	19-DM5	DM-5	IORG	ARSENIC, DISSOLVED	31.6		µg/l	.05	GW MTCA B (µg/l)
A2	19-DM5	DM-5	IORG	ARSENIC, TOTAL	56.8		µg/l	.05	GW MTCA B (µg/l)
A2	19-DM5	DM-5	IORG	BERYLLIUM, DISSOLVED	9.9		µg/l	.020	GW MTCA B (µg/l)
A2	19-DM5	DM-5	IORG	BERYLLIUM, TOTAL	9.9		µg/l	.020	GW MTCA B (µg/l)
A2	19-DM5	DM-5	IORG	CHROMIUM, DISSOLVED	365		µg/l	50	GW GWQS (µg/l)
A2	19-DM5	DM-5	IORG	CHROMIUM, TOTAL	353		µg/l	50	GW GWQS (µg/l)
A2	19-DM5	DM-5	IORG	COPPER, DISSOLVED	49.9		µg/l	2.5	SW MWA ST (µg/l)
A2	19-DM5	DM-5	IORG	COPPER, TOTAL	47.3		µg/l	2.5	SW MWA ST (µg/l)
A2	19-DM5	DM-5	IORG	IRON, DISSOLVED	53,900		µg/l	300	GW ST SMCL (µg/l)
A2	19-DM5	DM-5	IORG	IRON, TOTAL	53,500		µg/l	300	GW ST SMCL (µg/l)
A2	19-DM5	DM-5	IORG	MANGANESE, DISSOLVED	734		µg/l	50	GW ST SMCL (µg/l)
A2	19-DM5	DM-5	IORG	MANGANESE, TOTAL	717		µg/l	50	GW ST SMCL (µg/l)
A2	19-DM5	DM-5	IORG	NICKEL, DISSOLVED	43.2		µg/l	7.9	SW MWC ST (µg/l)
A2	19-DM5	DM-5	IORG	NICKEL, TOTAL	40.4		µg/l	7.9	SW MWC ST (µg/l)
A2	19-DM5	DM-5	IORG	SILVER, DISSOLVED	23.5		µg/l	1.2	SW MWA ST (µg/l)
A2	19-DM5	DM-5	IORG	SILVER, TOTAL	21.5		µg/l	1.2	SW MWA ST (µg/l)
A2	19-DM5	DM-5	IORG	VANADIUM, DISSOLVED	1,670		µg/l	112	GW MTCA B (µg/l)
A2	19-DM5	DM-5	IORG	VANADIUM, TOTAL	1,630		µg/l	112	GW MTCA B (µg/l)
A2	19-DM5	DM-5	SVO	BENZO(A)PYRENE	6	J	µg/l	.008	GW GWQS (µg/l)
A2	31-MWB4	B4	CONV	CHLORIDE	329,000	D	µg/l	250,000	GW ST SMCL (µg/l)
A2	31-MWB4	B4	VOC	FORMALDEHYDE	32		µg/l	1.46	GW MTCA B (µg/l)
A2	31-MWB4	B4	CONV	TOTAL DISSOLVED SOLIDS	1,460,000		µg/l	500,000	GW GWQS (µg/l)
A2	31-MWB4	B4	IORG	ARSENIC, TOTAL	2.4	B	µg/l	.05	GW MTCA B (µg/l)

Table 4-18
Detected Groundwater Results Above Action Levels, Round 1

Area	Sample No.	Monitoring Well	Chemical Grouping	Parameter	Result	Qualifier	Units	Most Stringent Action Level	Source of Most Stringent Action Level [a]
A2	31-MWB4	B4	IORG	COPPER, DISSOLVED	6.4	B	µg/l	2.5	SW MWA ST (µg/l)
A2	31-MWB4	B4	IORG	COPPER, TOTAL	11.7	B	µg/l	2.5	SW MWA ST (µg/l)
A2	31-MWB4	B4	IORG	IRON, DISSOLVED	2,040		µg/l	300	GW ST SMCL (µg/l)
A2	31-MWB4	B4	IORG	IRON, TOTAL	4,480		µg/l	300	GW ST SMCL (µg/l)
A2	31-MWB4	B4	IORG	LEAD, TOTAL	3.4		µg/l	.9	SW FWC ST (µg/l)
A2	31-MWB4	B4	IORG	MANGANESE, DISSOLVED	77.4		µg/l	50	GW ST SMCL (µg/l)
A2	31-MWB4	B4	IORG	MANGANESE, TOTAL	97.9		µg/l	50	GW ST SMCL (µg/l)
A2	MW-B05 [b]	B5	CONV	TOTAL DISSOLVED SOLIDS	556,000		µg/l	500,000	GW GWQS (µg/l)
A2	MW-B05 [b]	B5	IORG	ARSENIC, DISSOLVED	2.75		µg/l	.05	GW MTCA B (µg/l)
A2	MW-B05 [b]	B5	IORG	ARSENIC, TOTAL	12.45		µg/l	.05	GW MTCA B (µg/l)
A2	MW-B05 [b]	B5	IORG	COPPER, TOTAL	96.6		µg/l	2.5 [c]	SW MWA ST (µg/l)
A2	MW-B05 [b]	B5	IORG	IRON, DISSOLVED	4950		µg/l	300	GW ST SMCL (µg/l)
A2	MW-B05 [b]	B5	IORG	IRON, TOTAL	37,400		µg/l	300	GW ST SMCL (µg/l)
A2	MW-B05 [b]	B5	IORG	LEAD, TOTAL	16.65		µg/l	1.8 [c]	SW FWC ST (µg/l)
A2	MW-B05 [b]	B5	IORG	MANGANESE, DISSOLVED	146		µg/l	50	GW ST SMCL (µg/l)
A2	MW-B05 [b]	B5	IORG	MANGANESE, TOTAL	337		µg/l	50	GW ST SMCL (µg/l)
A2	MW-B05 [b]	B5	IORG	NICKEL, TOTAL	42.4		µg/l	7.9 [c]	SW MWC ST (µg/l)
A2	MW-B05 [b]	B5	IORG	VANADIUM, TOTAL	207.5		µg/l	112	GW MTCA B (µg/l)
A2	MW-B05 [b]	B5	VOC	BENZENE	5		µg/l	1	GW GWQS (µg/l)
A3	05-MWC1	C1	IORG	ARSENIC, DISSOLVED	13.5		µg/l	.05	GW MTCA B (µg/l)
A3	05-MWC1	C1	IORG	ARSENIC, TOTAL	22.1		µg/l	.05	GW MTCA B (µg/l)
A3	05-MWC1	C1	IORG	COPPER, TOTAL	66.9		µg/l	2.5	SW MWA ST (µg/l)
A3	05-MWC1	C1	IORG	IRON, DISSOLVED	11,100		µg/l	300	GW ST SMCL (µg/l)
A3	05-MWC1	C1	IORG	IRON, TOTAL	46,700		µg/l	300	GW ST SMCL (µg/l)
A3	05-MWC1	C1	IORG	LEAD, TOTAL	13.4		µg/l	3.2	SW MWC FED (µg/l)
A3	05-MWC1	C1	IORG	MANGANESE, DISSOLVED	297		µg/l	50	GW ST SMCL (µg/l)
A3	05-MWC1	C1	IORG	MANGANESE, TOTAL	573		µg/l	50	GW ST SMCL (µg/l)
A3	05-MWC1	C1	IORG	NICKEL, TOTAL	55		µg/l	7.9	SW MWC ST (µg/l)
A3	05-MWC1	C1	IORG	VANADIUM, TOTAL	152		µg/l	112	GW MTCA B (µg/l)
A3	05-MWC1	C1	IORG	ZINC, TOTAL	95.9		µg/l	76.6	SW MWC ST (µg/l)
A4	15-MW12	MW-12	VOC	FORMALDEHYDE	230		µg/l	1.46	GW MTCA B (µg/l)
A4	15-MW12	MW-12	CONV	TOTAL DISSOLVED SOLIDS	1,030,000		µg/l	500,000	GW GWQS (µg/l)
A4	15-MW12	MW-12	IORG	ARSENIC, DISSOLVED	33.4		µg/l	.05	GW MTCA B (µg/l)

Table 4-18
Detected Groundwater Results Above Action Levels, Round 1

Area	Sample No.	Monitoring Well	Chemical Grouping	Parameter	Result	Qualifier	Units	Most Stringent Action Level	Source of Most Stringent Action Level [a]
A4	15-MW12	MW-12	IORG	ARSENIC, TOTAL	24.5		µg/l	.05	GW MTCA B (µg/l)
A4	15-MW12	MW-12	IORG	COPPER, TOTAL	84.1		µg/l	2.5	SW MWA ST (µg/l)
A4	15-MW12	MW-12	IORG	IRON, DISSOLVED	63,200		µg/l	300	GW ST SMCL (µg/l)
A4	15-MW12	MW-12	IORG	IRON, TOTAL	69,000		µg/l	300	GW ST SMCL (µg/l)
A4	15-MW12	MW-12	IORG	LEAD, DISSOLVED	2.7	B	µg/l	1.5	SW FWC ST (µg/l)
A4	15-MW12	MW-12	IORG	LEAD, TOTAL	7.1		µg/l	1.4	SW FWC ST (µg/l)
A4	15-MW12	MW-12	IORG	MANGANESE, DISSOLVED	2,330		µg/l	50	GW ST SMCL (µg/l)
A4	15-MW12	MW-12	IORG	MANGANESE, TOTAL	2,400		µg/l	50	GW ST SMCL (µg/l)
A4	15-MW12	MW-12	IORG	NICKEL, DISSOLVED	32	B	µg/l	7.9	SW MWC ST (µg/l)
A4	15-MW12	MW-12	IORG	NICKEL, TOTAL	37.1	B	µg/l	7.9	SW MWC ST (µg/l)
A4	15-MW12	MW-12	PEST	4,4'-DDD	0.07	J	µg/l	.00084	SW HH FED FISH (µg/l)
A4	15-MW12	MW-12	PEST	ENDOSULFAN I	0.04	J	µg/l	.0087	SW MWC ST (µg/l)
A4	15-MW12	MW-12	PEST	ENDOSULFAN SULFATE	0.06	J	µg/l	.056	SW FWC ST (µg/l)
A4	15-MW12	MW-12	SVO	2-METHYLPHENOL	1,100	D	µg/l	800	GW MTCA B (µg/l)
A4	15-MW12	MW-12	SVO	4-METHYLPHENOL	760	D	µg/l	80	GW MTCA B (µg/l)
A4	15-MW12	MW-12	VOC	TOLUENE	84,000	D	µg/l	1,000	GW FED MCL (µg/l)
A4	30-MWH11	H11	VOC	FORMALDEHYDE	69		µg/l	1.46	GW MTCA B (µg/l)
A4	30-MWH11	H11	CONV	TOTAL DISSOLVED SOLIDS	2,360,000		µg/l	500,000	GW GWQS (µg/l)
A4	30-MWH11	H11	IORG	ARSENIC, DISSOLVED	43.3	B	µg/l	.05	GW MTCA B (µg/l)
A4	30-MWH11	H11	IORG	ARSENIC, TOTAL	56.4		µg/l	.05	GW MTCA B (µg/l)
A4	30-MWH11	H11	IORG	BERYLLIUM, DISSOLVED	2.5	B	µg/l	.02	GW MTCA B (µg/l)
A4	30-MWH11	H11	IORG	BERYLLIUM, TOTAL	3.8	B	µg/l	.02	GW MTCA B (µg/l)
A4	30-MWH11	H11	IORG	CHROMIUM, DISSOLVED	95.1		µg/l	50	GW GWQS (µg/l)
A4	30-MWH11	H11	IORG	CHROMIUM, TOTAL	88.9		µg/l	50	GW GWQS (µg/l)
A4	30-MWH11	H11	IORG	COPPER, DISSOLVED	9.5	B	µg/l	2.5	SW MWA ST (µg/l)
A4	30-MWH11	H11	IORG	COPPER, TOTAL	22.7	B	µg/l	2.5	SW MWA ST (µg/l)
A4	30-MWH11	H11	IORG	IRON, DISSOLVED	82,100		µg/l	300	GW ST SMCL (µg/l)
A4	30-MWH11	H11	IORG	IRON, TOTAL	92,400		µg/l	300	GW ST SMCL (µg/l)
A4	30-MWH11	H11	IORG	LEAD, TOTAL	4.2		µg/l	2.4	SW FWC ST (µg/l)
A4	30-MWH11	H11	IORG	MANGANESE, DISSOLVED	3,730		µg/l	50	GW ST SMCL (µg/l)
A4	30-MWH11	H11	IORG	MANGANESE, TOTAL	4,050		µg/l	50	GW ST SMCL (µg/l)
A4	30-MWH11	H11	IORG	VANADIUM, DISSOLVED	945		µg/l	112	GW MTCA B (µg/l)
A4	30-MWH11	H11	IORG	VANADIUM, TOTAL	901		µg/l	112	GW MTCA B (µg/l)
A4	30-MWH11	H11	SVO	2-METHYLPHENOL	1,900	D	µg/l	800	GW MTCA B (µg/l)
A4	30-MWH11	H11	SVO	4-METHYLPHENOL	1,600	D	µg/l	80	GW MTCA B (µg/l)
A4	30-MWH11	H11	SVO	BENZO(A)PYRENE	7	J	µg/l	.008	GW GWQS (µg/l)
A4	30-MWH11	H11	SVO	BIS(2-ETHYLHEXYL)PHTHALAT	53	DJ	µg/l	5.9	SW HH FED FISH (µg/l)

Table 4-18
Detected Groundwater Results Above Action Levels, Round 1

Area	Sample No.	Monitoring Well	Chemical Grouping	Parameter	Result	Qualifier	Units	Most Stringent Action Level	Source of Most Stringent Action Level [a]
A4	30-MWH11	H11	VOC	ACETONE	56,000	DJ	µg/l	800	GW MTCA B (µg/l)
A4	30-MWH11	H11	VOC	BENZENE	230		µg/l	1	GW GWQS (µg/l)
A4	30-MWH11	H11	VOC	METHYLENE CHLORIDE	57		µg/l	5	GW FED MCL (µg/l)
A4	30-MWH11	H11	VOC	TOLUENE	600,000	D	µg/l	1,000	GW FED MCL (µg/l)
A4	32-MWH1	H1	CONV	CHLORIDE	402,000	D	µg/l	250,000	GW ST SMCL (µg/l)
A4	32-MWH1	H1	CONV	TOTAL DISSOLVED SOLIDS	1,610,000		µg/l	500,000	GW GWQS (µg/l)
A4	32-MWH1	H1	IORG	ARSENIC, TOTAL	6.1	B	µg/l	.05	GW MTCA B (µg/l)
A4	32-MWH1	H1	IORG	COPPER, DISSOLVED	11	B	µg/l	2.5	SW MWA ST (µg/l)
A4	32-MWH1	H1	IORG	COPPER, TOTAL	39.9		µg/l	2.5	SW MWA ST (µg/l)
A4	32-MWH1	H1	IORG	IRON, DISSOLVED	2,710		µg/l	300	GW ST SMCL (µg/l)
A4	32-MWH1	H1	IORG	IRON, TOTAL	19,900		µg/l	300	GW ST SMCL (µg/l)
A4	32-MWH1	H1	IORG	LEAD, TOTAL	7.4		µg/l	1.9	SW FWC ST (µg/l)
A4	32-MWH1	H1	IORG	MANGANESE, DISSOLVED	105		µg/l	50	GW ST SMCL (µg/l)
A4	32-MWH1	H1	IORG	MANGANESE, TOTAL	261		µg/l	50	GW ST SMCL (µg/l)
A4	33-MWH10	H10	VOC	FORMALDEHYDE	270		µg/l	1.46	GW MTCA B (µg/l)
A4	33-MWH10	H10	CONV	TOTAL DISSOLVED SOLIDS	546,000		µg/l	500,000	GW GWQS (µg/l)
A4	33-MWH10	H10	IORG	ARSENIC, DISSOLVED	9.6	B	µg/l	.05	GW MTCA B (µg/l)
A4	33-MWH10	H10	IORG	ARSENIC, TOTAL	11.2		µg/l	.05	GW MTCA B (µg/l)
A4	33-MWH10	H10	IORG	COPPER, TOTAL	26.3		µg/l	2.5	SW MWA ST (µg/l)
A4	33-MWH10	H10	IORG	IRON, DISSOLVED	8,990		µg/l	300	GW ST SMCL (µg/l)
A4	33-MWH10	H10	IORG	IRON, TOTAL	13,600		µg/l	300	GW ST SMCL (µg/l)
A4	33-MWH10	H10	IORG	LEAD, TOTAL	3.6		µg/l	3.1	SW FWC ST (µg/l)
A4	33-MWH10	H10	IORG	MANGANESE, DISSOLVED	1,030		µg/l	50	GW ST SMCL (µg/l)
A4	33-MWH10	H10	IORG	MANGANESE, TOTAL	1,120		µg/l	50	GW ST SMCL (µg/l)
A4	33-MWH10	H10	SVO	4-METHYLPHENOL	130	D	µg/l	80	GW MTCA B (µg/l)
A4	33-MWH10	H10	SVO	BIS(2-ETHYLHEXYL)PHTHALAT	16		µg/l	5.9	SW HH FED FISH (µg/l)
A4	33-MWH10	H10	SVO	PENTACHLOROPHENOL	5	J	µg/l	.73	GW MTCA B (µg/l)
A4	33-MWH10	H10	VOC	BENZENE	36	J	µg/l	1	GW GWQS (µg/l)
A4	33-MWH10	H10	VOC	TOLUENE	300,000	D	µg/l	1,000	GW FED MCL (µg/l)
A5	13-DM2A	DM-2A	CONV	TOTAL DISSOLVED SOLIDS	3,760,000		µg/l	500,000	GW GWQS (µg/l)
A5	13-DM2A	DM-2A	IORG	ARSENIC, DISSOLVED	22.4		µg/l	.05	GW MTCA B (µg/l)
A5	13-DM2A	DM-2A	IORG	ARSENIC, TOTAL	26.1		µg/l	.05	GW MTCA B (µg/l)
A5	13-DM2A	DM-2A	IORG	BERYLLIUM, DISSOLVED	5.9		µg/l	.02	GW MTCA B (µg/l)
A5	13-DM2A	DM-2A	IORG	BERYLLIUM, TOTAL	5.9		µg/l	.02	GW MTCA B (µg/l)
A5	13-DM2A	DM-2A	IORG	CHROMIUM, DISSOLVED	149		µg/l	50	GW GWQS (µg/l)

Table 4-18
Detected Groundwater Results Above Action Levels, Round 1

Area	Sample No.	Monitoring Well	Chemical Grouping	Parameter	Result	Qualifier	Units	Most Stringent Action Level	Source of Most Stringent Action Level [a]
A5	13-DM2A	DM-2A	IORG	CHROMIUM, TOTAL	148		µg/l	50	GW GWQS (µg/l)
A5	13-DM2A	DM-2A	IORG	COPPER, DISSOLVED	58		µg/l	2.5	SW MWA ST (µg/l)
A5	13-DM2A	DM-2A	IORG	COPPER, TOTAL	226		µg/l	2.5	SW MWA ST (µg/l)
A5	13-DM2A	DM-2A	IORG	IRON, DISSOLVED	8,050		µg/l	300	GW ST SMCL (µg/l)
A5	13-DM2A	DM-2A	IORG	IRON, TOTAL	8,570		µg/l	300	GW ST SMCL (µg/l)
A5	13-DM2A	DM-2A	IORG	MANGANESE, DISSOLVED	340		µg/l	50	GW ST SMCL (µg/l)
A5	13-DM2A	DM-2A	IORG	MANGANESE, TOTAL	348		µg/l	50	GW ST SMCL (µg/l)
A5	13-DM2A	DM-2A	IORG	MERCURY, TOTAL	0.2		µg/l	.012	SW FWC FED (µg/l)
A5	13-DM2A	DM-2A	IORG	VANADIUM, DISSOLVED	1,300		µg/l	112	GW MTCA B (µg/l)
A5	13-DM2A	DM-2A	IORG	VANADIUM, TOTAL	1,330		µg/l	112	GW MTCA B (µg/l)
A5	13-DM2A	DM-2A	SVO	BENZO(A)PYRENE	1	J	µg/l	.008	GW GWQS (µg/l)
A5	14-DM2B	DM-2B	CONV	CHLORIDE	374,000	D	µg/l	250,000	GW ST SMCL (µg/l)
A5	14-DM2B	DM-2B	CONV	TOTAL DISSOLVED SOLIDS	1,080,000		µg/l	500,000	GW GWQS (µg/l)
A5	14-DM2B	DM-2B	IORG	ARSENIC, DISSOLVED	16.9		µg/l	.05	GW MTCA B (µg/l)
A5	14-DM2B	DM-2B	IORG	ARSENIC, TOTAL	15.2		µg/l	.05	GW MTCA B (µg/l)
A5	14-DM2B	DM-2B	IORG	IRON, TOTAL	471		µg/l	300	GW ST SMCL (µg/l)
A5	14-DM2B	DM-2B	IORG	MANGANESE, DISSOLVED	67		µg/l	50	GW ST SMCL (µg/l)
A5	14-DM2B	DM-2B	IORG	MANGANESE, TOTAL	68.2		µg/l	50	GW ST SMCL (µg/l)
A5	26-MWH6	H6	CONV	TOTAL DISSOLVED SOLIDS	1,590,000		µg/l	500,000	GW GWQS (µg/l)
A5	26-MWH6	H6	IORG	ARSENIC, DISSOLVED	9.3	B	µg/l	.05	GW MTCA B (µg/l)
A5	26-MWH6	H6	IORG	ARSENIC, TOTAL	26.3		µg/l	.05	GW MTCA B (µg/l)
A5	26-MWH6	H6	IORG	CHROMIUM, TOTAL	98		µg/l	50	GW GWQS (µg/l)
A5	26-MWH6	H6	IORG	COPPER, DISSOLVED	20.8	B	µg/l	2.5	SW MWA ST (µg/l)
A5	26-MWH6	H6	IORG	COPPER, TOTAL	179		µg/l	2.5	SW MWA ST (µg/l)
A5	26-MWH6	H6	IORG	IRON, DISSOLVED	8,560		µg/l	300	GW ST SMCL (µg/l)
A5	26-MWH6	H6	IORG	IRON, TOTAL	43,400		µg/l	300	GW ST SMCL (µg/l)
A5	26-MWH6	H6	IORG	LEAD, TOTAL	9		µg/l	1.4	SW FWC ST (µg/l)
A5	26-MWH6	H6	IORG	MANGANESE, DISSOLVED	245		µg/l	50	GW ST SMCL (µg/l)
A5	26-MWH6	H6	IORG	MANGANESE, TOTAL	561		µg/l	50	GW ST SMCL (µg/l)
A5	26-MWH6	H6	IORG	MERCURY, TOTAL	0.45		µg/l	.012	SW FWC FED (µg/l)
A5	26-MWH6	H6	IORG	NICKEL, TOTAL	34.6	B	µg/l	7.9	SW MWC ST (µg/l)
A5	26-MWH6	H6	IORG	VANADIUM, TOTAL	132		µg/l	112	GW MTCA B (µg/l)
A5	26-MWH6	H6	IORG	ZINC, TOTAL	73		µg/l	70.8	SW FWC ST (µg/l)
A5	27-DM8	DM-8	VOC	FORMALDEHYDE	52		µg/l	1.46	GW MTCA B (µg/l)
A5	27-DM8	DM-8	CONV	TOTAL DISSOLVED SOLIDS	2,620,000		µg/l	500,000	GW GWQS (µg/l)

Table 4-18
Detected Groundwater Results Above Action Levels, Round 1

Area	Sample No.	Monitoring Well	Chemical Grouping	Parameter	Result	Qualifier	Units	Most Stringent Action Level	Source of Most Stringent Action Level [a]
A5	27-DM8	DM-8	IORG	ARSENIC, DISSOLVED	42.9		µg/l	.05	GW MTCA B (µg/l)
A5	27-DM8	DM-8	IORG	ARSENIC, TOTAL	43.4		µg/l	.05	GW MTCA B (µg/l)
A5	27-DM8	DM-8	IORG	BERYLLIUM, DISSOLVED	6.2		µg/l	.02	GW MTCA B (µg/l)
A5	27-DM8	DM-8	IORG	BERYLLIUM, TOTAL	6.2		µg/l	.02	GW MTCA B (µg/l)
A5	27-DM8	DM-8	IORG	CHROMIUM, DISSOLVED	153		µg/l	50	GW GWQS (µg/l)
A5	27-DM8	DM-8	IORG	CHROMIUM, TOTAL	144		µg/l	50	GW GWQS (µg/l)
A5	27-DM8	DM-8	IORG	COPPER, DISSOLVED	34.8		µg/l	2.5	SW MWA ST (µg/l)
A5	27-DM8	DM-8	IORG	COPPER, TOTAL	43.7		µg/l	2.5	SW MWA ST (µg/l)
A5	27-DM8	DM-8	IORG	IRON, DISSOLVED	79,400		µg/l	300	GW ST SMCL (µg/l)
A5	27-DM8	DM-8	IORG	IRON, TOTAL	80,900		µg/l	300	GW ST SMCL (µg/l)
A5	27-DM8	DM-8	IORG	LEAD, DISSOLVED	4.7		µg/l	3.2	SW MWC FED (µg/l)
A5	27-DM8	DM-8	IORG	LEAD, TOTAL	4.8		µg/l	3.2	SW MWC FED (µg/l)
A5	27-DM8	DM-8	IORG	MANGANESE, DISSOLVED	6,250		µg/l	50	GW ST SMCL (µg/l)
A5	27-DM8	DM-8	IORG	MANGANESE, TOTAL	6,280		µg/l	50	GW ST SMCL (µg/l)
A5	27-DM8	DM-8	IORG	VANADIUM, DISSOLVED	1,390		µg/l	112	GW MTCA B (µg/l)
A5	27-DM8	DM-8	IORG	VANADIUM, TOTAL	1,340		µg/l	112	GW MTCA B (µg/l)
A6	25-MWH9	H9	VOC	FORMALDEHYDE	64		µg/l	1.46	GW MTCA B (µg/l)
A6	25-MWH9	H9	CONV	TOTAL DISSOLVED SOLIDS	1,690,000		µg/l	500,000	GW GWQS (µg/l)
A6	25-MWH9	H9	IORG	ARSENIC, DISSOLVED	52.4		µg/l	.05	GW MTCA B (µg/l)
A6	25-MWH9	H9	IORG	ARSENIC, TOTAL	68.9		µg/l	.05	GW MTCA B (µg/l)
A6	25-MWH9	H9	IORG	BERYLLIUM, DISSOLVED	2.5	B	µg/l	.02	GW MTCA B (µg/l)
A6	25-MWH9	H9	IORG	BERYLLIUM, TOTAL	3.7	B	µg/l	.02	GW MTCA B (µg/l)
A6	25-MWH9	H9	IORG	CHROMIUM, DISSOLVED	62.3		µg/l	50	GW GWQS (µg/l)
A6	25-MWH9	H9	IORG	CHROMIUM, TOTAL	154		µg/l	50	GW GWQS (µg/l)
A6	25-MWH9	H9	IORG	COPPER, DISSOLVED	15.3	B	µg/l	2.5	SW MWA ST (µg/l)
A6	25-MWH9	H9	IORG	COPPER, TOTAL	306		µg/l	2.5	SW MWA ST (µg/l)
A6	25-MWH9	H9	IORG	IRON, DISSOLVED	9,380		µg/l	300	GW ST SMCL (µg/l)
A6	25-MWH9	H9	IORG	IRON, TOTAL	80,600		µg/l	300	GW ST SMCL (µg/l)
A6	25-MWH9	H9	IORG	LEAD, TOTAL	28.8		µg/l	3.2	SW MWC FED (µg/l)
A6	25-MWH9	H9	IORG	MANGANESE, DISSOLVED	497		µg/l	50	GW ST SMCL (µg/l)
A6	25-MWH9	H9	IORG	MANGANESE, TOTAL	1,190		µg/l	50	GW ST SMCL (µg/l)
A6	25-MWH9	H9	IORG	MERCURY, TOTAL	0.87		µg/l	.012	SW FWC FED (µg/l)
A6	25-MWH9	H9	IORG	NICKEL, TOTAL	74.7		µg/l	7.9	SW MWC ST (µg/l)
A6	25-MWH9	H9	IORG	VANADIUM, DISSOLVED	469		µg/l	112	GW MTCA B (µg/l)
A6	25-MWH9	H9	IORG	VANADIUM, TOTAL	717		µg/l	112	GW MTCA B (µg/l)
A6	25-MWH9	H9	IORG	ZINC, DISSOLVED	80.7		µg/l	76.6	SW MWC ST (µg/l)
A6	25-MWH9	H9	IORG	ZINC, TOTAL	194		µg/l	76.6	SW MWC ST (µg/l)

Table 4-18
Detected Groundwater Results Above Action Levels, Round 1

Area	Sample No.	Monitoring Well	Chemical Grouping	Parameter	Result	Qualifier	Units	Most Stringent Action Level	Source of Most Stringent Action Level [a]
A6	28-MWG3	G3	VOC	FORMALDEHYDE	200		µg/l	1.46	GW MTCA B (µg/l)
A6	28-MWG3	G3	CONV	TOTAL DISSOLVED SOLIDS	647,000		µg/l	500,000	GW GWQS (µg/l)
A6	28-MWG3	G3	IORG	ARSENIC, DISSOLVED	18.3	B	µg/l	.05	GW MTCA B (µg/l)
A6	28-MWG3	G3	IORG	ARSENIC, TOTAL	56.5		µg/l	.05	GW MTCA B (µg/l)
A6	28-MWG3	G3	IORG	BERYLLIUM, TOTAL	4.3	B	µg/l	.02	GW MTCA B (µg/l)
A6	28-MWG3	G3	IORG	CHROMIUM, TOTAL	135		µg/l	50	GW GWQS (µg/l)
A6	28-MWG3	G3	IORG	COPPER, DISSOLVED	5.4	B	µg/l	2.5	SW MWA ST (µg/l)
A6	28-MWG3	G3	IORG	COPPER, TOTAL	224		µg/l	2.5	SW MWA ST (µg/l)
A6	28-MWG3	G3	IORG	IRON, DISSOLVED	6,720		µg/l	300	GW ST SMCL (µg/l)
A6	28-MWG3	G3	IORG	IRON, TOTAL	104,000		µg/l	300	GW ST SMCL (µg/l)
A6	28-MWG3	G3	IORG	LEAD, TOTAL	29.7		µg/l	3.2	SW MWC FED (µg/l)
A6	28-MWG3	G3	IORG	MANGANESE, DISSOLVED	673		µg/l	50	GW ST SMCL (µg/l)
A6	28-MWG3	G3	IORG	MANGANESE, TOTAL	1,990		µg/l	50	GW ST SMCL (µg/l)
A6	28-MWG3	G3	IORG	MERCURY, TOTAL	0.49		µg/l	.012	SW FWC FED (µg/l)
A6	28-MWG3	G3	IORG	NICKEL, TOTAL	93.7		µg/l	7.9	SW MWC ST (µg/l)
A6	28-MWG3	G3	IORG	VANADIUM, TOTAL	545		µg/l	112	GW MTCA B (µg/l)
A6	28-MWG3	G3	IORG	ZINC, TOTAL	209		µg/l	76.6	SW MWC ST (µg/l)
A6	28-MWG3	G3	SVO	BENZO(A)PYRENE	2	J	µg/l	.008	GW GWQS (µg/l)
A6	29-DM7	DM-7	VOC	FORMALDEHYDE	210		µg/l	1.46	GW MTCA B (µg/l)
A6	29-DM7	DM-7	CONV	TOTAL DISSOLVED SOLIDS	819,000		µg/l	500,000	GW GWQS (µg/l)
A6	29-DM7	DM-7	IORG	ARSENIC, DISSOLVED	10.6		µg/l	.05	GW MTCA B (µg/l)
A6	29-DM7	DM-7	IORG	ARSENIC, TOTAL	17.9		µg/l	.05	GW MTCA B (µg/l)
A6	29-DM7	DM-7	IORG	IRON, DISSOLVED	40,300		µg/l	300	GW ST SMCL (µg/l)
A6	29-DM7	DM-7	IORG	IRON, TOTAL	48,550		µg/l	300	GW ST SMCL (µg/l)
A6	29-DM7	DM-7	IORG	MANGANESE, DISSOLVED	2,895		µg/l	50	GW ST SMCL (µg/l)
A6	29-DM7	DM-7	IORG	MANGANESE, TOTAL	3,125		µg/l	50	GW ST SMCL (µg/l)
A6	29-DM7	DM-7	VOC	BENZENE	2		µg/l	1	GW GWQS (µg/l)
A7	MW-G01[b]	G1	CONV	TOTAL DISSOLVED SOLIDS	659,000		µg/l	500,000	GW GWQS (µg/l)
A7	MW-G01[b]	G1	IORG	ARSENIC, DISSOLVED	5.15		µg/l	.05	GW MTCA B (µg/l)
A7	MW-G01[b]	G1	IORG	ARSENIC, TOTAL	32.05		µg/l	.05	GW MTCA B (µg/l)
A7	MW-G01[b]	G1	IORG	COPPER, DISSOLVED	5.9		µg/l	2.5 [c]	SW MWA ST (µg/l)
A7	MW-G01[b]	G1	IORG	COPPER, TOTAL	92.6		µg/l	2.5 [c]	SW MWA ST (µg/l)
A7	MW-G01[b]	G1	IORG	IRON, DISSOLVED	43,050		µg/l	300	GW ST SMCL (µg/l)
A7	MW-G01[b]	G1	IORG	IRON, TOTAL	73,650		µg/l	300	GW ST SMCL (µg/l)

Table 4-18
Detected Groundwater Results Above Action Levels, Round 1

Area	Sample No.	Monitoring Well	Chemical Grouping	Parameter	Result	Qualifier	Units	Most Stringent Action Level	Source of Most Stringent Action Level [a]
A7	MW-G01[b]	G1	IORG	LEAD, TOTAL	27.95		µg/l	3.2 [c]	SW MWC FED (µg/l)
A7	MW-G01[b]	G1	IORG	MANGANESE, DISSOLVED	993		µg/l	50	GW ST SMCL (µg/l)
A7	MW-G01[b]	G1	IORG	MANGANESE, TOTAL	1,140		µg/l	50	GW ST SMCL (µg/l)
A7	MW-G01[b]	G1	IORG	NICKEL, DISSOLVED	31.1		µg/l	7.9 [c]	SW MWC ST (µg/l)
A7	MW-G01[b]	G1	IORG	NICKEL, TOTAL	64.7		µg/l	7.9 [c]	SW MWC ST (µg/l)
A7	MW-G01[b]	G1	IORG	ZINC, TOTAL	847.5		µg/l	76.6 [c]	SW MWC ST (µg/l)
A8	22-DM6	DM-6	IORG	ARSENIC, DISSOLVED	20.3		µg/l	.05	GW MTCA B (µg/l)
A8	22-DM6	DM-6	IORG	ARSENIC, TOTAL	21.7		µg/l	.05	GW MTCA B (µg/l)
A8	22-DM6	DM-6	IORG	COPPER, DISSOLVED	9.6	B	µg/l	2.5	SW MWA ST (µg/l)
A8	22-DM6	DM-6	IORG	COPPER, TOTAL	54.7		µg/l	2.5	SW MWA ST (µg/l)
A8	22-DM6	DM-6	IORG	IRON, DISSOLVED	7,490		µg/l	300	GW ST SMCL (µg/l)
A8	22-DM6	DM-6	IORG	IRON, TOTAL	13,700		µg/l	300	GW ST SMCL (µg/l)
A8	22-DM6	DM-6	IORG	MANGANESE, DISSOLVED	283		µg/l	50	GW ST SMCL (µg/l)
A8	22-DM6	DM-6	IORG	MANGANESE, TOTAL	417		µg/l	50	GW ST SMCL (µg/l)
A9	06-MWB1A	B1A	CONV	TOTAL DISSOLVED SOLIDS	538,000		µg/l	500,000	GW GWQS (µg/l)
A9	06-MWB1A	B1A	IORG	ARSENIC, TOTAL	3.2	B	µg/l	.05	GW MTCA B (µg/l)
A9	06-MWB1A	B1A	IORG	COPPER, TOTAL	21.9	B	µg/l	2.5	SW MWA ST (µg/l)
A9	06-MWB1A	B1A	IORG	IRON, DISSOLVED	1,530		µg/l	300	GW ST SMCL (µg/l)
A9	06-MWB1A	B1A	IORG	IRON, TOTAL	13,600		µg/l	300	GW ST SMCL (µg/l)
A9	06-MWB1A	B1A	IORG	LEAD, TOTAL	4.5		µg/l	3.2	SW MWC FED (µg/l)
A9	06-MWB1A	B1A	IORG	MANGANESE, DISSOLVED	415		µg/l	50	GW ST SMCL (µg/l)
A9	06-MWB1A	B1A	IORG	MANGANESE, TOTAL	518		µg/l	50	GW ST SMCL (µg/l)
A9	06-MWB1A	B1A	IORG	NICKEL, TOTAL	20.7	B	µg/l	7.9	SW MWC ST (µg/l)
A9	07-MWB1B	B1B	CONV	pH, Field	8.8		-log+H	6.5 - 8.5	GW GWQS (µg/l)
A9	07-MWB1B	B1B	CONV	TOTAL DISSOLVED SOLIDS	575,000		µg/l	500,000	GW GWQS (µg/l)
A9	07-MWB1B	B1B	IORG	COPPER, DISSOLVED	19.3	B	µg/l	2.5	SW MWA ST (µg/l)
A9	07-MWB1B	B1B	IORG	COPPER, TOTAL	22.5	B	µg/l	2.5	SW MWA ST (µg/l)
A9	07-MWB1B	B1B	IORG	IRON, DISSOLVED	507		µg/l	300	GW ST SMCL (µg/l)
A9	07-MWB1B	B1B	IORG	IRON, TOTAL	907		µg/l	300	GW ST SMCL (µg/l)
A9	07-MWB1B	B1B	IORG	LEAD, DISSOLVED	8.9		µg/l	.3	SW FWC ST (µg/l)
A9	07-MWB1B	B1B	IORG	LEAD, TOTAL	24		µg/l	.3	SW FWC ST (µg/l)
A9	07-MWB1B	B1B	IORG	MANGANESE, TOTAL	51.1		µg/l	50	GW ST SMCL (µg/l)
A9	07-MWB1B	B1B	SVO	BIS(2-ETHYLHEXYL)PHTHALAT	6	J	µg/l	5.9	SW HH FED FISH (µg/l)

Table 4-18
Detected Groundwater Results Above Action Levels, Round 1

Area	Sample No.	Monitoring Well	Chemical Grouping	Parameter	Result	Qualifier	Units	Most Stringent Action Level	Source of Most Stringent Action Level [a]
A9	08-MWA4	A4	CONV	pH, Field	6.49		-log+H	6.5 - 8.5	GW GWQS (µg/l)
A9	08-MWA4	A4	VOC	FORMALDEHYDE	73		µg/l	1.46	GW MTCA B (µg/l)
A9	08-MWA4	A4	IORG	ARSENIC, DISSOLVED	2.3	B	µg/l	.05	GW MTCA B (µg/l)
A9	08-MWA4	A4	IORG	ARSENIC, TOTAL	10.1		µg/l	.05	GW MTCA B (µg/l)
A9	08-MWA4	A4	IORG	COPPER, TOTAL	50		µg/l	2.5	SW MWA ST (µg/l)
A9	08-MWA4	A4	IORG	IRON, DISSOLVED	45,200		µg/l	300	GW ST SMCL (µg/l)
A9	08-MWA4	A4	IORG	IRON, TOTAL	56,000		µg/l	300	GW ST SMCL (µg/l)
A9	08-MWA4	A4	IORG	LEAD, TOTAL	9.8		µg/l	3.2	SW MWC FED (µg/l)
A9	08-MWA4	A4	IORG	MANGANESE, DISSOLVED	1,660		µg/l	50	GW ST SMCL (µg/l)
A9	08-MWA4	A4	IORG	MANGANESE, TOTAL	1,700		µg/l	50	GW ST SMCL (µg/l)
A9	08-MWA4	A4	IORG	NICKEL, TOTAL	37.2	B	µg/l	7.9	SW MWC ST (µg/l)
BG	01-MWE3	E3	VOC	FORMALDEHYDE	47		µg/l	1.46	GW MTCA B (µg/l)
BG	01-MWE3	E3	IORG	ANTIMONY, TOTAL	69.3		µg/l	6	GW FED MCL (µg/l)
BG	01-MWE3	E3	IORG	ARSENIC, DISSOLVED	2.2	B	µg/l	.05	GW MTCA B (µg/l)
BG	01-MWE3	E3	IORG	ARSENIC, TOTAL	131		µg/l	.05	GW MTCA B (µg/l)
BG	01-MWE3	E3	IORG	BERYLLIUM, TOTAL	7.4		µg/l	.02	GW MTCA B (µg/l)
BG	01-MWE3	E3	IORG	CADMIUM, TOTAL	8.1		µg/l	2.9	SW FWC ST (µg/l)
BG	01-MWE3	E3	IORG	CHROMIUM, TOTAL	240		µg/l	50	GW GWQS (µg/l)
BG	01-MWE3	E3	IORG	COPPER, TOTAL	459		µg/l	2.5	SW MWA ST (µg/l)
BG	01-MWE3	E3	IORG	IRON, DISSOLVED	17,700		µg/l	300	GW ST SMCL (µg/l)
BG	01-MWE3	E3	IORG	IRON, TOTAL	409,000		µg/l	300	GW ST SMCL (µg/l)
BG	01-MWE3	E3	IORG	LEAD, TOTAL	84.7		µg/l	3.2	SW MWC FED (µg/l)
BG	01-MWE3	E3	IORG	MANGANESE, DISSOLVED	238		µg/l	50	GW ST SMCL (µg/l)
BG	01-MWE3	E3	IORG	MANGANESE, TOTAL	3,140		µg/l	50	GW ST SMCL (µg/l)
BG	01-MWE3	E3	IORG	MERCURY, TOTAL	0.5		µg/l	.012	SW FWC FED (µg/l)
BG	01-MWE3	E3	IORG	NICKEL, TOTAL	358		µg/l	7.9	SW MWC ST (µg/l)
BG	01-MWE3	E3	IORG	VANADIUM, TOTAL	860		µg/l	112	GW MTCA B (µg/l)
BG	01-MWE3	E3	IORG	ZINC, TOTAL	487		µg/l	76.6	SW MWC ST (µg/l)
BG	02-DM1A	DM-1A	VOC	FORMALDEHYDE	37		µg/l	1.46	GW MTCA B (µg/l)
BG	02-DM1A	DM-1A	IORG	ARSENIC, DISSOLVED	2	B	µg/l	.05	GW MTCA B (µg/l)
BG	02-DM1A	DM-1A	IORG	ARSENIC, TOTAL	31.6	B	µg/l	.05	GW MTCA B (µg/l)
BG	02-DM1A	DM-1A	IORG	COPPER, TOTAL	52.5		µg/l	2.5	SW MWA ST (µg/l)
BG	02-DM1A	DM-1A	IORG	IRON, TOTAL	75,400		µg/l	300	GW ST SMCL (µg/l)
BG	02-DM1A	DM-1A	IORG	LEAD, TOTAL	46.8		µg/l	3.2	SW MWC FED (µg/l)
BG	02-DM1A	DM-1A	IORG	MANGANESE, DISSOLVED	61.3		µg/l	50	GW ST SMCL (µg/l)
BG	02-DM1A	DM-1A	IORG	MANGANESE, TOTAL	405		µg/l	50	GW ST SMCL (µg/l)

Table 4-18
Detected Groundwater Results Above Action Levels, Round 1

Area	Sample No.	Monitoring Well	Chemical Grouping	Parameter	Result	Qualifier	Units	Most Stringent Action Level	Source of Most Stringent Action Level [a]
BG	02-DM1A	DM-1A	IORG	MERCURY, TOTAL	0.21		µg/l	.012	SW FWC FED (µg/l)
BG	02-DM1A	DM-1A	IORG	NICKEL, TOTAL	67.9		µg/l	7.9	SW MWC ST (µg/l)
BG	02-DM1A	DM-1A	IORG	VANADIUM, TOTAL	224		µg/l	112	GW MTCA B (µg/l)
BG	02-DM1A	DM-1A	IORG	ZINC, TOTAL	94.8		µg/l	76.6	SW MWC ST (µg/l)
BG	03-DM1B	DM-1B	CONV	pH, Field	8.97		-log+H	6.5 - 8.5	GW GWQS (µg/l)
BG	DM-01B [b]	DM-1B	VOC	FORMALDEHYDE	51.5		µg/l	1.46	GW MTCA B (µg/l)
BG	DM-01B [b]	DM-1B	CONV	TOTAL DISSOLVED SOLIDS	501,500		µg/l	500,000	GW GWQS (µg/l)
BG	DM-01B [b]	DM-1B	IORG	ARSENIC, DISSOLVED	23.85		µg/l	.05	GW MTCA B (µg/l)
BG	DM-01B [b]	DM-1B	IORG	ARSENIC, TOTAL	22		µg/l	.05	GW MTCA B (µg/l)
BG	DM-01B [b]	DM-1B	IORG	IRON, DISSOLVED	516		µg/l	300	GW ST SMCL (µg/l)
BG	DM-01B [b]	DM-1B	IORG	IRON, TOTAL	1,270		µg/l	300	GW ST SMCL (µg/l)
BG	DM-01B [b]	DM-1B	IORG	LEAD, DISSOLVED	2.3		µg/l	.3 [c]	SW FWC ST (µg/l)
BG	DM-01B [b]	DM-1B	IORG	LEAD, TOTAL	2.75		µg/l	.3 [c]	SW FWC ST (µg/l)

[a] Source of the Most Stringent Action Level:

GW FED MCL	Federal Maximum Contaminant Levels (MCLs) for drinking water (40 CFR 141 and 142)
GW ST SMCL	Washington State Secondary Maximum Contaminant Levels (State MCLs) for drinking water (WAC 246-290)
GW GWQS	Washington Groundwater Quality Standards (WAC 173-200)
GW MTCA B	Washington State Model Toxic Control Act Cleanup Level Method B for Groundwater (WAC 173-340)
GW MTCA C	Washington State Model Toxic Control Act Cleanup Level Method C for Surfacewater (WAC 173-340)
SW MWC ST	Washington Water Quality Standards for Marine Water Chronic (WAC 173-201A)
SW FWC ST	Washington Water Quality Standards for Freshwater, Chronic (WAC 173-201A)
SW MWA ST	Washington Water Quality Standards for Marine Water Acute (WAC 173-201A)
SW FWC ST	Washington Water Quality Standards for Freshwater, Acute (WAC 173-201A)
SW FWC FED	Federal Freshwater Chronic - Federal Water Quality Criteria for Surface Water, Freshwater Chronic (40 CFR 131)
SW MWC FED	Federal Marine Chronic - Federal Water Quality Criteria for Surface Water, Marine Chronic (40 CFR 131)
SW FWA FED	Federal Water Quality Criteria for Surface Water, Freshwater Acute (40 CFR 131)
SW FMA FED	Federal Water Quality Criteria for Surface Water, Marine Acute (40 CFR 131)
SW HH FED FISH	Federal Water Quality Criteria for the Consumption of Organisms Only (40 CFR 131)

[b] Average of Duplicate Samples.
[c] The hardness value of the native samples was used to determine the most stringent action level.
B = Below Contract-Required Detection Limit
D = Dilution
J = Estimated

Table 4-19
Detected Groundwater Results Above Action Levels, Round 2

Area	Sample No.	Monitoring Well	Chemical Grouping	Parameter	Result	Qualifier	Units	Most Stringent Action Level	Source of Most Stringent Action Level [a]
A1	12-MWA9	A9	CONV	pH, Field	6.43		-log+H	6.5 - 8.5	GW GWQS (µg/l)
A1	MW-A02 [b]	A2	SVO	BIS(2-CHLOROETHYL)ETHER	5.5		µg/l	.040	GW MTCA B (µg/l)
A2	11-MW20	MW-20	CONV	pH, Field	6.4		-log+H	6.5 - 8.5	GW GWQS (µg/l)
A4	05-MW12	MW-12	SVO	BIS(2-ETHYLHEXYL)PHTHALATE	32		µg/l	5.9	SW HH FED FISH (µg/l)
A4	05-MW12	MW-12	VOC	TOLUENE	4,000		µg/l	1,000	GW FED MCL (µg/l)
A4	19-MWH10	H10	CONV	pH, Field	6.15		-log+H	6.5 - 8.5	GW GWQS (µg/l)
A4	19-MWH10	H10	VOC	TOLUENE	240,000		µg/l	1,000	GW FED MCL (µg/l)
A4	20-MW14	MW-14	CONV	pH, Field	6.38		-log+H	6.5 - 8.5	GW GWQS (µg/l)
A4	20-MW14	MW-14	VOC	TOLUENE	3,400		µg/l	1,000	GW FED MCL (µg/l)
A4	21-MW18	MW-18	CONV	pH, Field	6		-log+H	6.5 - 8.5	GW GWQS (µg/l)
A4	21-MW18	MW-18	VOC	TOLUENE	56,000		µg/l	1,000	GW FED MCL (µg/l)
A4	26-MWH1	H1	VOC	TOLUENE	1,200		µg/l	1,000	GW FED MCL (µg/l)
A4	30-MW19	MW-19	CONV	pH, Field	6.42		-log+H	6.5 - 8.5	GW GWQS (µg/l)
A4	30-MW19	MW-19	VOC	TOLUENE	9,400		µg/l	1,000	GW FED MCL (µg/l)
A4	MW-H11 [b]	H11	SVO	2-METHYLPHENOL	1,800		µg/l	800	GW MTCA B (µg/l)
A4	MW-H11 [b]	H11	SVO	4-METHYLPHENOL	1,100		µg/l	80	GW MTCA B (µg/l)
A4	MW-H11 [b]	H11	VOC	TOLUENE	340,000		µg/l	1,000	GW FED MCL (µg/l)
A5	06-MW15	MW-15	VOC	TOLUENE	99,000		µg/l	1,000	GW FED MCL (µg/l)
A5	07-MW16	MW-16	CONV	pH, Field	11.2		-log+H	6.5 - 8.5	GW GWQS (µg/l)
A5	07-MW16	MW-16	VOC	TOLUENE	1,100		µg/l	1,000	GW FED MCL (µg/l)
A5	28-MW17	MW-17	VOC	TOLUENE	120,000		µg/l	1,000	GW FED MCL (µg/l)
BG	08-DM1B	DM-1B	CONV	pH, Field	9.1		-log+H	6.5 - 8.5	GW GWQS (µg/l)
BG	10-MWE3	E3	IORG	ANTIMONY, TOTAL	25.45	BJ	µg/l	6	GW FED MCL (µg/l)

[a] Source of the Most Stringent Action Level:

GW FED MCL	Federal Maximum Contaminant Levels (MCLs) for drinking water (40 CFR 141 and 142)
GW GWQS	Washington Groundwater Quality Standards (WAC 173-200)
GW MTCA B	Washington State Model Toxic Control Act Cleanup Level Method B for Groundwater (WAC 173-340)
SW HH FED FISH	Federal Water Quality Criteria for the Consumption of Organisms Only (40 CFR 131)

[b] Average of Duplicate Samples.
B = Below Contract-Required Detection Limit
J = Estimated

Table 4-20
Groundwater Data, Round 2

Area	Monitoring Well	Parameter	Concentration	Units	Action Level[a]
		INORGANICS			
BG	E3	ANTIMONY, TOTAL	25.45 BJ	µg/l	6
BG	DM-1B	VANADIUM, TOTAL[b]	19.35 J	µg/l	112
BG	E3	VANADIUM, TOTAL	13.3411 BJ	µg/l	112
		SEMIVOLATILES			
A4	H11	2-METHYLPHENOL	1800	µg/l	800
A4	MW-12	2-METHYLPHENOL	74	µg/l	800
A4	H11	4-METHYLPHENOL	1100	µg/l	80
A4	MW-12	4-METHYLPHENOL	13 J	µg/l	80
A1	A2	BIS(2-CHLOROETHYL)ETHER[b]	5.5	µg/l	0.04
A4	MW-12	BIS(2-ETHYLHEXYL)PHTHALATE	32	µg/l	5.9
A1	A2	DI-N-BUTYL PHTHALATE[b]	5.5	µg/l	1600
A4	MW-12	DI-N-BUTYL PHTHALATE	2 J	µg/l	1600
A4	MW-12	DIETHYL PHTHALATE	7 J	µg/l	12800
A1	A2	N-NITROSODIPHENYLAMINE[b]	5.5	µg/l	16
A4	H11	PHENOL	895	µg/l	9600
A4	MW-12	PHENOL	2 J	µg/l	9600
		TOTAL RECOVERABLE PETROLEUM HYDROCARBONS			
A4	MW-12	TRPH	24	mg/l	
A4	H11	TRPH	54	mg/l	
A4	H10	TRPH	28	mg/l	
A4	MW-19	TRPH	3.2	mg/l	
A5	MW-15	TRPH	8.9	mg/l	
A5	MW-17	TRPH	14	mg/l	
A4	MW-18	TRPH	8.1	mg/l	
		BTEX			
A2	B6	BENZENE	0.8	µg/l	1
10	DM-7	BENZENE	1	µg/l	1
A2	B4	TOLUENE	0.5	µg/l	1000
A4	MW-12	TOLUENE	4000	µg/l	1000
A2	MW-20	TOLUENE	2	µg/l	1000
A4	H10	TOLUENE	240000	µg/l	1000
A4	MW-13	TOLUENE	630	µg/l	1000
A4	H1	TOLUENE	1200	µg/l	1000
A4	H11	TOLUENE[b]	340000	µg/l	1000
A4	MW-19	TOLUENE	9400	µg/l	1000
A5	MW-15	TOLUENE	99000	µg/l	1000
A5	MW-16	TOLUENE	1100	µg/l	1000
A4	MW-14	TOLUENE	3400	µg/l	1000
A5	MW-17	TOLUENE	120000	µg/l	1000
A4	MW-18	TOLUENE	56000	µg/l	1000
A2	MW-20	XYLENE (TOTAL)	14	µg/l	10000

[a]The RFI action levels for groundwater are as stated in Tables 4-17 and 4-18.

[b]Sample concentrations were calculated based on average of field duplicate samples.

J = Estimated.

B = Below contract-required detection limit.

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Table 4-20A
Summary of LNAPL Analytical Results

Date	Laboratory	Well No.	Results	
10/91	Sound Analytical Services	G5	Petroleum hydrocarbons	15.3%
			Toluene	9.3%
			Diethyl phthalate	0.1%
		H10	Toluene	19.0%
5/93	CH2M HILL Applied Sciences	G5	Peneteck (white mineral oil)	81.6%
			Toluene	11.1%
			Other undifferentiated compounds	7.3%
4/95	Pace—New Orleans	H10	Peneteck oil	48.8%
		MW-18	Peneteck oil	2.96%
4/95	Pace—Mid-Pacific	MW-18	Toluene (Phase 1[a])	92.0%
			Toluene (Phase 2[a])	0.048%

[a]Phases 1 and 2 represent samples of two separate LNAPL layers recovered from well MW-18.

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Table 4-21
LNAPL Monitoring Summary

Day and Time	H10	H1	MW-12	H11	DM-7	H9	H6	DM-2A	DM-2B	DM-8	A9	DM-3A	DM-3B	A2	A4	DM-4	B4	B2	DM-5	B1A	B1B	C1	DM-6	B5	G3	G1	B6	MW-13	MW-14	MW-15	MW-16	MW-17	MW-18	MW-19	MW-20
9/22/93-12:50[14]	---	---	0.063	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/29/93-16:45[14]	---	---	1.17	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
9/30/93-12:00[14]	---	---	1.25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/1/93-11:30[14]	---	---	1.08	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/1/93-18:05[14]	---	---	1.25	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/4/93-14:30[14]	---	---	0.83	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/5/93-16:00[14]	---	---	0.75	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/6/93-09:20[14]	---	---	2.08	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/6/93-19:00[14]	---	---	0.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/7/93-08:20[14]	---	---	2.67	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10/7/93-13:30[14]	---	---	1.17	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
12/93	---	---	0.17	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/9/94	1.42	---	0.0	Sheen	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/10/94-08:40[13]	1.3	---	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/10/94-11:37[13]	1.45	---	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/10/94-17:00[13]	1.15	---	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/11/94-08:50[13]	1.45	---	1.45	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/11/94-11:40[13]	1.65	---	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/11/94-15:00[13]	1.62	---	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/14/94-11:45[13]	1.50[1]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/17/94-08:35[13]	0.62[2]	---	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/17/94-14:38[13]	0.76[2]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/17/94-17:15[13]	0.77[2]	---	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/23/94-08:40[13]	0.87[2]	---	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/23/94-12:00[13]	0.80[2]	---	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/28/94	0.00	---	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/7/94	0.04	---	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
4/25/94	0.01	---	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/4/94	Sheen	---	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
5/18/94	0.0	---	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/7/94	0.0	---	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/8/94	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
6/17/94	Film	0.0	0.007[1]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---	---	---	---	---	---	---	---
8/4/94	Film	Sheen	Sheen	Film	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---	---	---	---	---	---	---	---
9/8/94	Film	0.0	Film	0.010	0.0	Sheen	Sheen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.021	0.005	0.0	0.0	0.010	0.0
10/6/94	0.0	0.0	Film	0.010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---[4]	0.0	0.0	0.0	0.0	0.0	Film	0.0	0.0	0.0	0.021	0.0
11/3/94	0.0	0.0	0.005	0.005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0
12/05/94	0.0	0.0	0.0	Film	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/11/95	0.26[2]	Sheen[7]	Sheen[7]	0.04[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---[4]	0.0	0.0	0.0	0.0	0.0	0.01[7]	0.0	0.0	0.0	Sheen[7]	0.0
2/17/95	2.01	0.0	0.16	Sheen[5]	0.0	0.0	0.0	0.0	0.0	0.0	---[6]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---[6]	0.0	0.0	0.0	0.0	---[4]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Sheen[5]	Sheen[5]	0.0
2/21/95-14:00[13]	0.13	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/22/95-10:00[13]	0.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/22/95-16:40[13]	0.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/23/95-10:30[13]	0.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/24/95-10:30[13]	0.02	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/24/95-12:00[13]	0.03[2]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/27/95-11:15[13]	1.04[1]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/27/95-16:00[13]	0.21[12]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
2/28/95-11:30[13]	0.79[1]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/6/95-11:45[13]	0.61[2]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/6/95-04:45[13]	0.86[2]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/7/95-09:30[13]	0.85[2]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/7/95-03:00[13]	0.41[1]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/8/95-11:00[13]	0.67[2]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/9/95-09:30[13]	0.56[2]	0.0	---	0.0	---	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.0	0.0	---	0.0	---	---
3/9/95-15:30[13]	0.22[2]	---	0.07[2]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/10/95-11:30[13]	0.22[2]	0.0	Sheen	0.0	---	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.0	0.0	---	---	Sheen	---
3/10/95-16:15[13]	0.02	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/13/95-09:30[13]	0.01[12]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/13/95-17:00[13]	Film	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/14/95-09:00[13]	Film	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/14/95-16:00[13]	Film	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/15/95-09:10[13]	Film	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/15/95-16:10[13]	Sheen	0.0	Sheen[12]	0.0	---	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Sheen[12]	0.0	---	---	0.0[12]	---
3/16/95-09:45[13]	0.01	0.0	Sheen	0.0	---	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.0	0.0	---	0.0	0.0	---
3/20/95-09:00[13]	0.18[1]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

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Table 4-21
LNAPL Monitoring Summary

Day and Time	H10	H1	MW-12	H11	DM-7	H9	H6	DM-2A	DM-2B	DM-8	A9	DM-3A	DM-3B	A2	A4	DM-4	B4	B2	DM-5	B1A	B1B	C1	DM-6	B5	G3	G1	B6	MW-13	MW-14	MW-15	MW-16	MW-17	MW-18	MW-19	MW-20
3/20/95-16:10[13]	0.02	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/21/95-10:15[13]	0.01	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/21/95-14:25[13]	0.11[2]	Sheen	Film	Sheen	---	Sheen	Sheen	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.0	Sheen	---	---	Sheen	---
3/22/95-09:10[13]	0.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/23/95-08:10[13]	0.01	0.0	0.0	0.0	---	0.0	0.0	---	---	---	0.0	0.0	0.0	0.0	0.0[9]	---	---	---	---	0.0	0.0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---
3/27/95-10:00[13]	1.58[1]	0.0	Sheen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---	---	---	---	---	---	0.0	0.0	0.0	---	---	---	0.0	---	0.0	0.0	0.0	0.0	0.0	Sheen	0.0	0.0	---	Sheen	0.0
3/27/95-15:25[13]	1.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	Sheen	---	---
3/28/95	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.0	---	---	---	---	---	---	---	---	---	---	---
3/30/9508:00[13]	1.23	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/30/95-04:50[13]	1.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/31/95-09:00[13]	1.08	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3/31/95-16:15[13]	1.46	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.87	---	---
4/3/95-08:30[13]	.667	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.52	---	---
4/3/95-16:40[13]	1.125	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.52	---	---
4/5/95-11:50[13]	.667	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.54	---	---
4/5/95-16:10[13]	.667	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.4	---	---
4/7/95-14:50[13]	.563	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.13	---	---
4/13/95-09:30[13]	.333	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.42	---	---
4/18/95-14:45[13]	.333	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.29	---	---
4/25/95-12:00[13]	.292[1]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.32	---	---
4/26/95-08:20[13]	.198[1]	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	0.31	---	---
4/27/95-12:30[13]	.063	0.0	Film[10]	0.0	---	0.0	---	---	---	0.0	0.0	0.0	0.0	---[6]	0.0	---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---	---	0.0	0.063[11]	Sheen	0.0
4/28/95-13:20[13]	.042	---	---	---	0.0	---	0.0	0.0	0.0	---	---	---	---	---	---	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	0.0	0.0	---	0.29	---	---

Notes:

LNAPL layer thickness shown in feet measured either in the monitoring well or inside a 1-1/2-inch-diameter transparent bailer.
"---" indicates no measurement.
[1]Removed product layer with bailer.
[2]Interface probe.
[3]Inside hydrophobic membrane filter.
[4]Inaccessible due to construction debris.
[5]Sheen noted when measurement device was placed in clean water.
[6]Casing cover/Pvc pipe bent; well could not be accessed.
[7]No sheen noted when measurement device was placed in clean water, but water turned light brown after probing.
[8]Buried under rubble.
[9]Orange/rust colored residue on probe.
[10]Gobules.
[11]Dark phase.
[12]Floating crud layer.
[13]Time for H10 only.
[14]Time for MW-12 only.

Table 4-21A
Metals Exceeding Action Levels in Upper Aquifer Wells in the Background Area

Metal	Action Level (μg/l)	Total (μg/l) (Unfiltered)		Dissolved (μg/l) (Filtered)	
		Well DM-1A	Well E3	Well DM-1A	Well E3
Antimony	6	ND	69.3	ND	ND
Arsenic	0.05	31.6B	131	2B	2.2B
Beryllium	0.02	ND	7.4	ND	ND
Cadmium	2.9	ND	8.1	ND	ND
Chromium	50	-	240	ND	ND
Copper	2.5	52.5	459	ND	ND
Lead	3.2	46.8	84.7	ND	ND
Mercury	0.012	0.21	0.5	ND	ND
Nickel	7.9	67.9	358	ND	ND
Vanadium	112	224	860	ND	-
Zinc	76.6	94.8	487	ND	ND

Note: Only Round 1 data are included.
- = Concentration below action level (See Appendix D for concentration)
ND = Analyte not detected.
B = Reported value is less than the Contract-Required Detection Limit (CRDL), but greater than or equal to the Instrument Detection Limit (IDL)

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VOLUME III
COVER/SPING

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Round 1 Soil Results

Rhone-Poulenc RFI

Round 1

Detected Soil Results

Area	Sample ID	QA/QC	Sample Interval (feet bgs) Top	Bottom	Parameter	Result	Qualifer	Units
BG	ABG-06-05		7	9	Zinc, Total	16.3		mg/kg
Volatiles								
BG	ABG-06-05		7	9	Acetone	0.003	J	mg/kg
BG	ABG-06-05		7	9	Formaldehyde	3.9		mg/kg
BG	ABG-06-05		7	9	Toluene	0.005	J	mg/kg
Inorganics								
BG	ABG-07-01		1	1.5	Aluminum, Total	9330		mg/kg
BG	ABG-07-01		1	1.5	Arsenic, Total	2.2		mg/kg
BG	ABG-07-01		1	1.5	Barium, Total	33.7	B	mg/kg
BG	ABG-07-01		1	1.5	Beryllium, Total	0.43	B	mg/kg
BG	ABG-07-01		1	1.5	Calcium, Total	3620		mg/kg
BG	ABG-07-01		1	1.5	Chromium, Total	13.2		mg/kg
BG	ABG-07-01		1	1.5	Cobalt, Total	7.5	B	mg/kg
BG	ABG-07-01		1	1.5	Iron, Total	14100		mg/kg
BG	ABG-07-01		1	1.5	Lead, Total	2.3	*	mg/kg
BG	ABG-07-01		1	1.5	Magnesium, Total	2900	*	mg/kg
BG	ABG-07-01		1	1.5	Manganese, Total	150		mg/kg
BG	ABG-07-01		1	1.5	Nickel, Total	13.6		mg/kg
BG	ABG-07-01		1	1.5	Sodium, Total	421	B	mg/kg
BG	ABG-07-01		1	1.5	Vanadium, Total	43		mg/kg
BG	ABG-07-01		1	1.5	Zinc, Total	30.1		mg/kg
Semivolatiles								
BG	ABG-07-01		1	1.5	Bis(2-Ethylhexyl)Phthalate	1.1		mg/kg
Volatiles								
BG	ABG-07-01		1	1.5	Formaldehyde	0.45		mg/kg
BG	ABG-07-01		1	1.5	Toluene	0.004	J	mg/kg
Inorganics								
BG	ABG-07-05		7	9	Aluminum, Total	15200		mg/kg
BG	ABG-07-05		7	9	Arsenic, Total	5.9		mg/kg
BG	ABG-07-05		7	9	Barium, Total	48.4		mg/kg
BG	ABG-07-05		7	9	Calcium, Total	2550		mg/kg
BG	ABG-07-05		7	9	Chromium, Total	16.9		mg/kg
BG	ABG-07-05		7	9	Cobalt, Total	5.9	B	mg/kg
BG	ABG-07-05		7	9	Iron, Total	22400		mg/kg
BG	ABG-07-05		7	9	Lead, Total	4.3	*	mg/kg
BG	ABG-07-05		7	9	Magnesium, Total	2250	*	mg/kg
BG	ABG-07-05		7	9	Manganese, Total	142		mg/kg
BG	ABG-07-05		7	9	Nickel, Total	9.3	B	mg/kg
BG	ABG-07-05		7	9	Sodium, Total	845	B	mg/kg
BG	ABG-07-05		7	9	Vanadium, Total	59		mg/kg
BG	ABG-07-05		7	9	Zinc, Total	14.1		mg/kg
Volatiles								
BG	ABG-07-05		7	9	2-Butanone	0.018	J	mg/kg
BG	ABG-07-05		7	9	Acetone	0.087		mg/kg
BG	ABG-07-05		7	9	Formaldehyde	15		mg/kg
BG	ABG-07-05		7	9	Toluene	0.006	J	mg/kg

FD= Field Duplicate
EB= Equipment Blank

Round 2 Soil Results

Rhone-Poulenc RFI

Round 2

Detected Soil Results

Area	Sample ID	QA/QC	Sample Interval (feet bgs) Top	Bottom	Parameter	Result	Qualifer	Units
Conventionals								
04	A04-30-01		4	6	Total Recoverable Petroleum Hydrocarbons	81		mg/kg
Volatiles								
04	A04-30-01		4	6	2-Butanone	0.006	J	mg/kg
04	A04-30-01		4	6	Ethylbenzene	0.009	J	mg/kg
04	A04-30-01		4	6	Toluene	1.9	DJ	mg/kg
04	A04-30-01		4	6	Xylene (Total)	0.019	J	mg/kg
Volatiles								
04	A04-30-02		10	12	Methylene Chloride	0.001	J	mg/kg
04	A04-30-02		10	12	Toluene	0.031		mg/kg
Conventionals								
04	A04-31-01		0	2	Total Recoverable Petroleum Hydrocarbons	380		mg/kg
Volatiles								
04	A04-31-01		0	2	Toluene	0.039		mg/kg
Conventionals								
04	A04-31-02		11	13	Total Recoverable Petroleum Hydrocarbons	43		mg/kg
Volatiles								
04	A04-31-02		11	13	Toluene	0.004	J	mg/kg
Conventionals								
05	A05-10-02		3	5	Total Recoverable Petroleum Hydrocarbons	8200		mg/kg
Volatiles								
05	A05-10-02		3	5	2-Butanone	0.007	J	mg/kg
05	A05-10-02		3	5	Carbon Disulfide	0.007	J	mg/kg
05	A05-10-02		3	5	Ethylbenzene	0.035	J	mg/kg
05	A05-10-02		3	5	Methylene Chloride	0.006	J	mg/kg
05	A05-10-02		3	5	Toluene	29	DJ	mg/kg
05	A05-10-02		3	5	Xylene (Total)	0.14		mg/kg
Volatiles								
05	A05-10-04		7	9	2-Butanone	0.002	J	mg/kg
05	A05-10-04		7	9	Toluene	0.006	J	mg/kg
Volatiles								
05	A05-10-06		11	13	2-Butanone	0.001	J	mg/kg
05	A05-10-06		11	13	Carbon Disulfide	0.0007	J	mg/kg
05	A05-10-06		11	13	Methylene Chloride	0.0009	J	mg/kg
05	A05-10-06		11	13	Toluene	0.028		mg/kg
Volatiles								
05	A05-11-01		0	2	Toluene	0.007	J	mg/kg
Volatiles								
05	A05-11-02		10	12	2-Butanone	0.008	J	mg/kg
05	A05-11-02		10	12	Toluene	0.025		mg/kg
Volatiles								
05	A05-12-01		0	2	Toluene	0.002	J	mg/kg
Volatiles								
05	A05-12-02		10	12	2-Butanone	0.003	J	mg/kg
05	A05-12-02		10	12	Methylene Chloride	0.001	J	mg/kg
Volatiles								
05	A05-12-EB	EB			Chloroform	0.5	J	ug/L
05	A05-12-EB	EB			Toluene	10	J	ug/L
Volatiles								

FD= Field Duplicate
EB= Equipment Blank

Rhone-Poulenc RFI

Round 2

Detected Soil Results

Area	Sample ID	QA/QC	Sample Interval (feet bgs) Top	Bottom	Parameter	Result	Qualifer	Units
05	A05-13-01		2	4	2-Butanone	0.003	J	mg/kg
05	A05-13-01		2	4	Methylene Chloride	0.002	J	mg/kg
05	A05-13-01		2	4	Toluene	0.72	DE	mg/kg
Volatiles								
05	A05-13-02		6	8	2-Butanone	0.003	J	mg/kg
05	A05-13-02		6	8	Carbon Disulfide	0.001	J	mg/kg
05	A05-13-02		6	8	Toluene	0.021		mg/kg
05	A05-13-02		6	8	Xylene (Total)	0.002	J	mg/kg
Volatiles								
05	A05-14-01		1	3	Methylene Chloride	0.001	J	mg/kg
05	A05-14-01		1	3	Toluene	0.007	J	mg/kg
Volatiles								
05	A05-14-06		11	13	2-Butanone	0.003	J	mg/kg
Inorganics								
06	MS-03-01		0	0.5	Mercury, Total	0.13		mg/kg
Inorganics								
06	MS-04-01		0	0.5	Mercury, Total	0.4763		mg/kg
Inorganics								
06	MS-07-01		0	0.5	Mercury, Total	5.5		mg/kg
Inorganics								
06	MS-07-02		1.5	2	Mercury, Total	6.9712	*	mg/kg
Inorganics								
06	MS-08-02		1.5	2	Mercury, Total	4.8	*	mg/kg
Inorganics								
06	MS-09-01		0	0.5	Mercury, Total	0.58		mg/kg
Inorganics								
06	MS-09-02		1.5	2	Mercury, Total	3.2	*	mg/kg
Inorganics								
06	MS-10-02		1.5	2	Mercury, Total	3.1	*	mg/kg
Inorganics								
06	MS-12-01		0	0.5	Mercury, Total	0.4		mg/kg
Inorganics								
06	MS-13-01		0	0.5	Mercury, Total	0.34		mg/kg
Inorganics								
06	MS-14-01		0	0.5	Mercury, Total	6.1		mg/kg
Inorganics								
06	MS-15-01		0	0.5	Mercury, Total	4.4		mg/kg
Inorganics								
06	MS-16-01		0	0.5	Mercury, Total	7		mg/kg
Inorganics								
06	MS-17-01		0	0.5	Mercury, Total	0.89		mg/kg
Inorganics								
06	MS-18-01		0	0.5	Mercury, Total	0.36		mg/kg
Inorganics								
06	MS-19-01		0	0.5	Mercury, Total	1.8		mg/kg
Inorganics								
06	MS-20-01		0	0.5	Mercury, Total	2.9		mg/kg
Inorganics								
06	MS-22-01		0	0.5	Mercury, Total	1.2		mg/kg

FD= Field Duplicate
EB= Equipment Blank

Rhone-Poulenc RFI

Round 2

Detected Soil Results

Area	Sample ID	QA/QC	Sample Interval (feet bgs) Top	Bottom	Parameter	Result	Qualifer	Units
Inorganics								
06	MS-23-01		0	0.5	Mercury, Total	0.27		mg/kg
Inorganics								
06	MS-24-01		0	0.5	Mercury, Total	11.2		mg/kg
Inorganics								
06	MS-25-01		0	0.5	Mercury, Total	0.16		mg/kg
Inorganics								
06	MS-27-01		0	0.5	Mercury, Total	2		mg/kg
Inorganics								
06	MS-28-01		0	0.5	Mercury, Total	1.3		mg/kg
Inorganics								
06	MS-29-01		0	0.5	Mercury, Total	3.2		mg/kg
Inorganics								
06	MS-30-01		0	0.5	Mercury, Total	6.6		mg/kg
Inorganics								
06	MS-31-01		0	0.5	Mercury, Total	1.5		mg/kg
Inorganics								
06	MS-32-01		0	0.5	Mercury, Total	5		mg/kg
Inorganics								
06	MS-33-01		0	0.5	Mercury, Total	0.53		mg/kg
Inorganics								
06	MS-34-01		0	0.5	Mercury, Total	1.5		mg/kg

FD= Field Duplicate
EB= Equipment Blank

Round 1 Groundwater Results

Rhone-Poulenc RFI

Round 1

Detected Groundwater Results

Area	Sample ID	Station ID	QA/QC	Parameter	Result	Qualifer	Units
BG	04-DM9	DM-01B	FD	Lead, Total	2.9	B	ug/L
BG	04-DM9	DM-01B	FD	Magnesium, Dissolved	2290	B	ug/L
BG	04-DM9	DM-01B	FD	Magnesium, Total	2420	B	ug/L
BG	04-DM9	DM-01B	FD	Manganese, Dissolved	28.3		ug/L
BG	04-DM9	DM-01B	FD	Manganese, Total	46.1		ug/L
BG	04-DM9	DM-01B	FD	Potassium, Dissolved	9960		ug/L
BG	04-DM9	DM-01B	FD	Potassium, Total	10300		ug/L
BG	04-DM9	DM-01B	FD	Selenium, Dissolved	3.3	BW	ug/L
BG	04-DM9	DM-01B	FD	Sodium, Dissolved	170000		ug/L
BG	04-DM9	DM-01B	FD	Sodium, Total	169000		ug/L
BG	04-DM9	DM-01B	FD	Vanadium, Dissolved	18	B	ug/L
BG	04-DM9	DM-01B	FD	Vanadium, Total	16.9	B	ug/L
Semivolatiles							
BG	04-DM9	DM-01B	FD	Bis(2-Ethylhexyl)Phthalate	1	J	ug/L
Volatiles							
BG	04-DM9	DM-01B	FD	Formaldehyde	47		ug/L

FD= Field Duplicate
EB= Equipment Blank

Round 2 Groundwater Results

Rhone-Poulenc RFI

Round 2

Detected Groundwater Results

Area	Sample ID	Station ID	QA/QC	Parameter	Result	Qualifer	Units
Conventionals							
01	01-MWA2	MW-A02		Dissolved Oxygen	0.6		mg/L
01	01-MWA2	MW-A02		pH, (field)	7.4		-log+H
01	01-MWA2	MW-A02		Specific Conductance	810		ımhos/cn
01	01-MWA2	MW-A02		Temperature	15.2		°C
Semivolatiles							
01	01-MWA2	MW-A02		Bis(2-Chloroethyl)Ether	5	J	ug/L
01	01-MWA2	MW-A02		Di-n-Butyl Phthalate	1	J	ug/L
01	01-MWA2	MW-A02		n-Nitrosodiphenylamine	1	J	ug/L
Semivolatiles							
01	02-MW21	MW-A02	FD	Bis(2-Chloroethyl)Ether	6	J	ug/L
Conventionals							
01	12-MWA9	MW-A09		Dissolved Oxygen	0.8		mg/L
01	12-MWA9	MW-A09		pH, (field)	6.43		-log+H
01	12-MWA9	MW-A09		Specific Conductance	230		ımhos/cn
01	12-MWA9	MW-A09		Temperature	16		°C
Conventionals							
02	03-MWB6	MW-B06		Dissolved Oxygen	0.4		mg/L
02	03-MWB6	MW-B06		pH, (field)	7		-log+H
02	03-MWB6	MW-B06		Specific Conductance	580		ımhos/cn
02	03-MWB6	MW-B06		Temperature	15.7		°C
Volatiles							
02	03-MWB6	MW-B06		Benzene	0.8		ug/L
Conventionals							
02	11-MW20	MW-20		Dissolved Oxygen	1		mg/L
02	11-MW20	MW-20		pH, (field)	6.4		-log+H
02	11-MW20	MW-20		Specific Conductance	580		ımhos/cn
02	11-MW20	MW-20		Temperature	18.9		°C
Volatiles							
02	11-MW20	MW-20		Toluene	2		ug/L
02	11-MW20	MW-20		Xylene (Total)	14		ug/L
Conventionals							
02	17-MWB4	MW-B04		Dissolved Oxygen	0.8		mg/L
02	17-MWB4	MW-B04		pH, (field)	7.66		-log+H
02	17-MWB4	MW-B04		Specific Conductance	1760		ımhos/cn
02	17-MWB4	MW-B04		Temperature	15.9		°C
Volatiles							
02	18-MW26	MW-B04	FD	Toluene	0.5		ug/L
Conventionals							
04	05-MW12	MW-12		Dissolved Oxygen	1		mg/L
04	05-MW12	MW-12		pH, (field)	6.5		-log+H
04	05-MW12	MW-12		Specific Conductance	900		ımhos/cn
04	05-MW12	MW-12		Temperature	17.6		°C
04	05-MW12	MW-12		Total Recoverable Petroleum Hydrocarbons	24		mg/L
Semivolatiles							
04	05-MW12	MW-12		2-Methylphenol	74		ug/L
04	05-MW12	MW-12		4-Methylphenol	13	J	ug/L
04	05-MW12	MW-12		Bis(2-Ethylhexyl)Phthalate	32		ug/L

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EB= Equipment Blank

Rhone-Poulenc RFI

Round 2

Detected Groundwater Results

Area	Sample ID	Station ID	QA/QC	Parameter	Result	Qualifer	Units
04	05-MW12	MW-12		Di-n-Butyl Phthalate	2	J	ug/L
04	05-MW12	MW-12		Diethyl Phthalate	7	J	ug/L
04	05-MW12	MW-12		Phenol	2	J	ug/L
Volatiles							
04	05-MW12	MW-12		Toluene	4000		ug/L
Conventionals							
04	15-MWH11	MW-H11		Dissolved Oxygen	0.6		mg/L
04	15-MWH11	MW-H11		pH, (field)	6.51		-log+H
04	15-MWH11	MW-H11		Specific Conductance	2500		umhos/cm
04	15-MWH11	MW-H11		Temperature	17.1		°C
04	15-MWH11	MW-H11		Total Recoverable Petroleum Hydrocarbons	54	J	mg/L
Semivolatiles							
04	15-MWH11	MW-H11		2-Methylphenol	1800		ug/L
04	15-MWH11	MW-H11		4-Methylphenol	1100		ug/L
04	15-MWH11	MW-H11		Phenol	910		ug/L
Volatiles							
04	15-MWH11	MW-H11		Toluene	320000	J	ug/L
Semivolatiles							
04	16-MW25	MW-H11	FD	2-Methylphenol	1800		ug/L
04	16-MW25	MW-H11	FD	4-Methylphenol	1100		ug/L
04	16-MW25	MW-H11	FD	Phenol	880		ug/L
Volatiles							
04	16-MW25	MW-H11	FD	Toluene	360000	J	ug/L
Conventionals							
04	19-MWH10	MW-H10		Dissolved Oxygen	1		mg/L
04	19-MWH10	MW-H10		pH, (field)	6.15		-log+H
04	19-MWH10	MW-H10		Specific Conductance	650		umhos/cm
04	19-MWH10	MW-H10		Temperature	16.6		°C
04	19-MWH10	MW-H10		Total Recoverable Petroleum Hydrocarbons	28	J	mg/L
Volatiles							
04	19-MWH10	MW-H10		Toluene	240000		ug/L
Conventionals							
04	20-MW14	MW-14		Dissolved Oxygen	0.2		mg/L
04	20-MW14	MW-14		pH, (field)	6.38		-log+H
04	20-MW14	MW-14		Specific Conductance	1380		umhos/cm
04	20-MW14	MW-14		Temperature	17.9		°C
Volatiles							
04	20-MW14	MW-14		Toluene	3400		ug/L
Conventionals							
04	21-MW18	MW-18		Dissolved Oxygen	1.3		mg/L
04	21-MW18	MW-18		pH, (field)	6		-log+H
04	21-MW18	MW-18		Specific Conductance	610		umhos/cm
04	21-MW18	MW-18		Temperature	17.4		°C
04	21-MW18	MW-18		Total Recoverable Petroleum Hydrocarbons	8.1	J	mg/L
Volatiles							
04	21-MW18	MW-18		Toluene	56000		ug/L
Conventionals							
04	22-MW13	MW-13		Dissolved Oxygen	0.2		mg/L

FD= Field Duplicate
EB= Equipment Blank

Rhone-Poulenc RFI

Round 2

Detected Groundwater Results

Area	Sample ID	Station ID	QA/QC	Parameter	Result	Qualifer	Units
04	22-MW13	MW-13		pH, (field)	7.3		-log+H
04	22-MW13	MW-13		Specific Conductance	2620		imhos/cn
04	22-MW13	MW-13		Temperature	16.4		°C
Volatiles							
04	22-MW13	MW-13		Toluene	630		ug/L
Conventionals							
04	26-MWH1	MW-H01		Dissolved Oxygen	0.1		mg/L
04	26-MWH1	MW-H01		pH, (field)	7.37		-log+H
04	26-MWH1	MW-H01		Specific Conductance	1850		imhos/cn
04	26-MWH1	MW-H01		Temperature	16.2		°C
Volatiles							
04	26-MWH1	MW-H01		Toluene	1200		ug/L
Conventionals							
04	30-MW19	MW-19		Dissolved Oxygen	0.8		mg/L
04	30-MW19	MW-19		pH, (field)	6.42		-log+H
04	30-MW19	MW-19		Specific Conductance	960		imhos/cn
04	30-MW19	MW-19		Temperature	16.9		°C
04	30-MW19	MW-19		Total Recoverable Petroleum Hydrocarbons	3.2		mg/L
Volatiles							
04	30-MW19	MW-19		Toluene	9400		ug/L
Conventionals							
05	06-MW15	MW-15		Dissolved Oxygen	0.8		mg/L
05	06-MW15	MW-15		pH, (field)	7		-log+H
05	06-MW15	MW-15		Specific Conductance	1520		imhos/cn
05	06-MW15	MW-15		Temperature	17.2		°C
05	06-MW15	MW-15		Total Recoverable Petroleum Hydrocarbons	8.9		mg/L
Volatiles							
05	06-MW15	MW-15		Toluene	99000		ug/L
Conventionals							
05	07-MW16	MW-16		Dissolved Oxygen	0.7		mg/L
05	07-MW16	MW-16		pH, (field)	11.2		-log+H
05	07-MW16	MW-16		Specific Conductance	10000		imhos/cn
05	07-MW16	MW-16		Temperature	17.6		°C
Volatiles							
05	07-MW16	MW-16		Toluene	1100		ug/L
Conventionals							
05	28-MW17	MW-17		Dissolved Oxygen	0.2		mg/L
05	28-MW17	MW-17		pH, (field)	6.82		-log+H
05	28-MW17	MW-17		Specific Conductance	2420		imhos/cn
05	28-MW17	MW-17		Temperature	16.7		°C
05	28-MW17	MW-17		Total Recoverable Petroleum Hydrocarbons	14		mg/L
Volatiles							
05	28-MW17	MW-17		Toluene	120000		ug/L
Conventionals							
06	14-DM7	DM-07		Dissolved Oxygen	0.6		mg/L
06	14-DM7	DM-07		pH, (field)	6.62		-log+H
06	14-DM7	DM-07		Specific Conductance	510		imhos/cn
06	14-DM7	DM-07		Temperature	15.8		°C

FD= Field Duplicate
EB= Equipment Blank

Rhone-Poulenc RFI

Round 2

Detected Groundwater Results

Area	Sample ID	Station ID	QA/QC	Parameter	Result	Qualifer	Units
Volatiles							
06	14-DM7	DM-07		Benzene	1		ug/L
Conventionals							
BG	08-DM1B	DM-01B		Dissolved Oxygen	1.4		mg/L
BG	08-DM1B	DM-01B		pH, (field)	9.1		-log+H
BG	08-DM1B	DM-01B		Specific Conductance	610		umhos/cm
BG	08-DM1B	DM-01B		Temperature	13.6		°C
Inorganics							
BG	08-DM1B	DM-01B		Vanadium, Total	19	BJ	ug/L
Inorganics							
BG	09-MW23	DM-01B	FD	Vanadium, Total	19.7	BJ	ug/L
Conventionals							
BG	10-MWE3	MW-E03		Dissolved Oxygen	1		mg/L
BG	10-MWE3	MW-E03		pH, (field)	7		-log+H
BG	10-MWE3	MW-E03		Specific Conductance	405		umhos/cm
BG	10-MWE3	MW-E03		Temperature	15.8		°C
Inorganics							
BG	10-MWE3	MW-E03		Antimony, Total	25.45	BJ	ug/L
BG	10-MWE3	MW-E03		Vanadium, Total	13.3411	BJ	ug/L

FD= Field Duplicate
EB= Equipment Blank

Round 1 Sediment Results

Rhone-Poulenc RFI

Round 1

Detected Sediment Results

Area	Sample ID	QA/QC	Sample Interval (feet bgs) Top	Bottom	Parameter	Result	Qualifer	Units
11	A11-07-01		0	0.5	Indeno(1,2,3-CD)Pyrene	0.085	J	mg/kg
11	A11-07-01		0	0.5	Phenanthrene	0.082	J	mg/kg
11	A11-07-01		0	0.5	Pyrene	0.49	J	mg/kg
Inorganics								
11	A11-08-01	FD	0	0.5	Aluminum, Total	11300		mg/kg
11	A11-08-01	FD	0	0.5	Arsenic, Total	6.8	S	mg/kg
11	A11-08-01	FD	0	0.5	Barium, Total	31.1	B	mg/kg
11	A11-08-01	FD	0	0.5	Beryllium, Total	0.58	B	mg/kg
11	A11-08-01	FD	0	0.5	Calcium, Total	3700		mg/kg
11	A11-08-01	FD	0	0.5	Chromium, Total	16.5	*	mg/kg
11	A11-08-01	FD	0	0.5	Cobalt, Total	9.2	B	mg/kg
11	A11-08-01	FD	0	0.5	Copper, Total	25.8		mg/kg
11	A11-08-01	FD	0	0.5	Iron, Total	16500		mg/kg
11	A11-08-01	FD	0	0.5	Lead, Total	47.5	N*	mg/kg
11	A11-08-01	FD	0	0.5	Magnesium, Total	3890		mg/kg
11	A11-08-01	FD	0	0.5	Manganese, Total	193		mg/kg
11	A11-08-01	FD	0	0.5	Nickel, Total	15.6		mg/kg
11	A11-08-01	FD	0	0.5	Sodium, Total	1970		mg/kg
11	A11-08-01	FD	0	0.5	Vanadium, Total	49		mg/kg
11	A11-08-01	FD	0	0.5	Zinc, Total	93.6	*	mg/kg
Pesticides/PCB's								
11	A11-08-01	FD	0	0.5	4,4'-DDD	0.018	PJ	mg/kg
11	A11-08-01	FD	0	0.5	4,4'-DDE	0.0081	PJ	mg/kg
11	A11-08-01	FD	0	0.5	4,4'-DDT	0.011	PJ	mg/kg
11	A11-08-01	FD	0	0.5	Aroclor-1254	0.2	P	mg/kg
11	A11-08-01	FD	0	0.5	BHC-Delta	0.0067	PJ	mg/kg
11	A11-08-01	FD	0	0.5	Endosulfan I	0.002	P	mg/kg
11	A11-08-01	FD	0	0.5	Endosulfan II	0.0041	P	mg/kg
11	A11-08-01	FD	0	0.5	Endosulfan Sulfate	0.0058		mg/kg
11	A11-08-01	FD	0	0.5	Endrin Aldehyde	0.0058	P	mg/kg
11	A11-08-01	FD	0	0.5	Endrin Ketone	0.0028	JP	mg/kg
11	A11-08-01	FD	0	0.5	Gamma-Chlordane	0.0058	P	mg/kg
Semivolatiles								
11	A11-08-01	FD	0	0.5	Benzo(A)Anthracene	0.21	J	mg/kg
11	A11-08-01	FD	0	0.5	Benzo(A)Pyrene	0.15	J	mg/kg
11	A11-08-01	FD	0	0.5	Benzo(B)Fluoranthene	0.23	J	mg/kg
11	A11-08-01	FD	0	0.5	Benzo(K)Fluoranthene	0.21	J	mg/kg
11	A11-08-01	FD	0	0.5	Bis(2-Ethylhexyl)Phthalate	0.17	J	mg/kg
11	A11-08-01	FD	0	0.5	Chrysene	0.32	J	mg/kg
11	A11-08-01	FD	0	0.5	Fluoranthene	0.56		mg/kg
11	A11-08-01	FD	0	0.5	Indeno(1,2,3-CD)Pyrene	0.077	J	mg/kg
11	A11-08-01	FD	0	0.5	Phenanthrene	0.13	J	mg/kg
11	A11-08-01	FD	0	0.5	Pyrene	0.44	J	mg/kg
Inorganics								
11	A11-EB	EB			Aluminum, Total	26.4	B	ug/L
11	A11-EB	EB			Calcium, Total	262	B	ug/L
11	A11-EB	EB			Sodium, Total	699	B	ug/L

FD= Field Duplicate
EB= Equipment Blank

Round 2 Sediment Results

Rhone-Poulenc RFI

Round 2

Detected Sediment Results

Area	Sample ID	QA/QC	Sample Interval (feet bgs) Top	Bottom	Parameter	Result	Qualifer	Units
Conventionals								
11	A11-01-02		0	0.08	Ammonia	2.83		mg/kg
11	A11-01-02		0	0.08	pH, (lab)	6.69		-log+H
11	A11-01-02		0	0.08	Preserved Total Solids	0.7647		%
11	A11-01-02		0	0.08	Total Organic Carbon	0.0185		%
11	A11-01-02		0	0.08	Total Solids	0.7439		%
11	A11-01-02		0	0.08	Total Volatile Solids	13000		mg/kg
Semivolatiles								
11	A11-01-02		0	0.08	Bis(2-Ethylhexyl)Phthalate	0.029		mg/kg
11	A11-01-02		0	0.08	Chrysene	0.016		mg/kg
11	A11-01-02		0	0.08	Fluoranthene	0.042		mg/kg
11	A11-01-02		0	0.08	Phenanthrene	0.018		mg/kg
11	A11-01-02		0	0.08	Phenol	0.057		mg/kg
11	A11-01-02		0	0.08	Pyrene	0.037		mg/kg
Conventionals								
11	A11-02-02		0	0.08	Ammonia	1.97		mg/kg
11	A11-02-02		0	0.08	pH, (lab)	7.86		-log+H
11	A11-02-02		0	0.08	Preserved Total Solids	0.763		%
11	A11-02-02		0	0.08	Total Organic Carbon	0.0202		%
11	A11-02-02		0	0.08	Total Solids	0.7571		%
11	A11-02-02		0	0.08	Total Volatile Solids	12100		mg/kg
Pesticides/PCB's								
11	A11-02-02		0	0.08	Aldrin	0.00071	YJ	mg/kg
11	A11-02-02		0	0.08	Aroclor-1254	0.024	J	mg/kg
11	A11-02-02		0	0.08	Dieldrin	0.0017	YJ	mg/kg
11	A11-02-02		0	0.08	Gamma-Chlordane	0.0012	YJ	mg/kg
Semivolatiles								
11	A11-02-02		0	0.08	4-Methylphenol	0.019		mg/kg
11	A11-02-02		0	0.08	Anthracene	0.026		mg/kg
11	A11-02-02		0	0.08	Benzo(A)Anthracene	0.13		mg/kg
11	A11-02-02		0	0.08	Benzo(A)Pyrene	0.094		mg/kg
11	A11-02-02		0	0.08	Benzo(B)Fluoranthene	0.13		mg/kg
11	A11-02-02		0	0.08	Benzo(GHI)Perylene	0.031		mg/kg
11	A11-02-02		0	0.08	Benzo(K)Fluoranthene	0.13		mg/kg
11	A11-02-02		0	0.08	Bis(2-Ethylhexyl)Phthalate	0.079		mg/kg
11	A11-02-02		0	0.08	Chrysene	0.2		mg/kg
11	A11-02-02		0	0.08	Di-n-Butyl Phthalate	0.013		mg/kg
11	A11-02-02		0	0.08	Dibenzo(A,H)Anthracene	0.02		mg/kg
11	A11-02-02		0	0.08	Fluoranthene	0.3		mg/kg
11	A11-02-02		0	0.08	Fluorene	0.015		mg/kg
11	A11-02-02		0	0.08	Indeno(1,2,3-CD)Pyrene	0.043		mg/kg
11	A11-02-02		0	0.08	Phenanthrene	0.1		mg/kg
11	A11-02-02		0	0.08	Pyrene	0.22		mg/kg
Conventionals								
11	A11-03-02		0	0.08	Ammonia	1.62		mg/kg
11	A11-03-02		0	0.08	pH, (lab)	7.68		-log+H
11	A11-03-02		0	0.08	Preserved Total Solids	0.739		%
11	A11-03-02		0	0.08	Sulfide As S	9.59		mg/kg
11	A11-03-02		0	0.08	Total Organic Carbon	0.0184		%

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Rhone-Poulenc RFI

Round 2

Detected Sediment Results

Area	Sample ID	QA/QC	Sample Interval (feet bgs) Top	Bottom	Parameter	Result	Qualifer	Units
11	A11-03-02		0	0.08	Total Solids	0.7444		%
11	A11-03-02		0	0.08	Total Volatile Solids	12200		mg/kg
Pesticides/PCB's								
11	A11-03-02		0	0.08	4,4'-DDD	0.0053	J	mg/kg
11	A11-03-02		0	0.08	4,4'-DDE	0.002	YJ	mg/kg
11	A11-03-02		0	0.08	4,4'-DDT	0.0037	J	mg/kg
11	A11-03-02		0	0.08	Aroclor-1254	0.032	J	mg/kg
11	A11-03-02		0	0.08	Gamma-Chlordane	0.00088	YJ	mg/kg
Semivolatiles								
11	A11-03-02		0	0.08	4-Methylphenol	0.016		mg/kg
11	A11-03-02		0	0.08	Anthracene	0.018		mg/kg
11	A11-03-02		0	0.08	Benzo(A)Anthracene	0.095		mg/kg
11	A11-03-02		0	0.08	Benzo(A)Pyrene	0.059		mg/kg
11	A11-03-02		0	0.08	Benzo(B)Fluoranthene	0.12		mg/kg
11	A11-03-02		0	0.08	Benzo(GHI)Perylene	0.019		mg/kg
11	A11-03-02		0	0.08	Benzo(K)Fluoranthene	0.11		mg/kg
11	A11-03-02		0	0.08	Bis(2-Ethylhexyl)Phthalate	0.071		mg/kg
11	A11-03-02		0	0.08	Chrysene	0.18		mg/kg
11	A11-03-02		0	0.08	Fluoranthene	0.23		mg/kg
11	A11-03-02		0	0.08	Indeno(1,2,3-CD)Pyrene	0.027		mg/kg
11	A11-03-02		0	0.08	Phenanthrene	0.029		mg/kg
11	A11-03-02		0	0.08	Pyrene	0.19		mg/kg
Conventionals								
11	A11-04-02		0	0.08	Ammonia	15.3		mg/kg
11	A11-04-02		0	0.08	pH, (lab)	7.14		-log+H
11	A11-04-02		0	0.08	Preserved Total Solids	0.6022		%
11	A11-04-02		0	0.08	Sulfide As S	57.4		mg/kg
11	A11-04-02		0	0.08	Total Organic Carbon	0.0261		%
11	A11-04-02		0	0.08	Total Solids	0.6025		%
11	A11-04-02		0	0.08	Total Volatile Solids	32900		mg/kg
Pesticides/PCB's								
11	A11-04-02		0	0.08	4,4'-DDD	0.0043	J	mg/kg
11	A11-04-02		0	0.08	4,4'-DDE	0.0046	YJ	mg/kg
11	A11-04-02		0	0.08	4,4'-DDT	0.0032	YJ	mg/kg
11	A11-04-02		0	0.08	Aldrin	0.0023	YJ	mg/kg
11	A11-04-02		0	0.08	Aroclor-1254	0.21	J	mg/kg
11	A11-04-02		0	0.08	Aroclor-1260	0.041	YJ	mg/kg
11	A11-04-02		0	0.08	Dieldrin	0.0033	YJ	mg/kg
11	A11-04-02		0	0.08	Gamma-Chlordane	0.0043	YJ	mg/kg
Semivolatiles								
11	A11-04-02		0	0.08	2-Methylnaphthalene	0.017		mg/kg
11	A11-04-02		0	0.08	Benzo(A)Anthracene	0.02		mg/kg
11	A11-04-02		0	0.08	Benzo(A)Pyrene	0.018		mg/kg
11	A11-04-02		0	0.08	Benzo(B)Fluoranthene	0.022		mg/kg
11	A11-04-02		0	0.08	Benzo(K)Fluoranthene	0.031		mg/kg
11	A11-04-02		0	0.08	Bis(2-Ethylhexyl)Phthalate	0.71		mg/kg
11	A11-04-02		0	0.08	Chrysene	0.031		mg/kg
11	A11-04-02		0	0.08	Fluoranthene	0.077		mg/kg
11	A11-04-02		0	0.08	Phenanthrene	0.039		mg/kg

FD= Field Duplicate
EB= Equipment Blank

Rhone-Poulenc RFI

Round 2

Detected Sediment Results

Area	Sample ID	QA/QC	Sample Interval (feet bgs) Top	Bottom	Parameter	Result	Qualifer	Units
11	A11-04-02		0	0.08	Pyrene	0.061		mg/kg
Conventionals								
11	A11-05-02		0	0.08	Ammonia	4.87		mg/kg
11	A11-05-02		0	0.08	pH, (lab)	7.33		-log+H
11	A11-05-02		0	0.08	Preserved Total Solids	0.5956		%
11	A11-05-02		0	0.08	Sulfide As S	51.4		mg/kg
11	A11-05-02		0	0.08	Total Organic Carbon	0.0178		%
11	A11-05-02		0	0.08	Total Solids	0.6177		%
11	A11-05-02		0	0.08	Total Volatile Solids	22600		mg/kg
Inorganics								
11	A11-05-02		0	0.08	Arsenic, Total	6.5		mg/kg
11	A11-05-02		0	0.08	Cadmium, Total	0.4		mg/kg
11	A11-05-02		0	0.08	Chromium, Total	23.1		mg/kg
11	A11-05-02		0	0.08	Copper, Total	32		mg/kg
11	A11-05-02		0	0.08	Lead, Total	26		mg/kg
11	A11-05-02		0	0.08	Mercury, Total	0.081		mg/kg
11	A11-05-02		0	0.08	Nickel, Total	15		mg/kg
11	A11-05-02		0	0.08	Silver, Total	0.19		mg/kg
11	A11-05-02		0	0.08	Zinc, Total	82		mg/kg
Pesticides/PCB's								
11	A11-05-02		0	0.08	4,4'-DDD	0.048		mg/kg
11	A11-05-02		0	0.08	4,4'-DDE	0.0093	J	mg/kg
11	A11-05-02		0	0.08	4,4'-DDT	0.082		mg/kg
11	A11-05-02		0	0.08	Aldrin	0.0012	YJ	mg/kg
11	A11-05-02		0	0.08	Aroclor-1254	0.058	J	mg/kg
11	A11-05-02		0	0.08	Aroclor-1260	0.029	J	mg/kg
11	A11-05-02		0	0.08	Dieldrin	0.0026	YJ	mg/kg
11	A11-05-02		0	0.08	Gamma-Chlordane	0.002	YJ	mg/kg
Semivolatiles								
11	A11-05-02		0	0.08	Benzo(A)Anthracene	0.061		mg/kg
11	A11-05-02		0	0.08	Benzo(A)Pyrene	0.053		mg/kg
11	A11-05-02		0	0.08	Benzo(B)Fluoranthene	0.083		mg/kg
11	A11-05-02		0	0.08	Benzo(GHI)Perylene	0.017		mg/kg
11	A11-05-02		0	0.08	Benzo(K)Fluoranthene	0.092		mg/kg
11	A11-05-02		0	0.08	Bis(2-Ethylhexyl)Phthalate	0.065		mg/kg
11	A11-05-02		0	0.08	Chrysene	0.11		mg/kg
11	A11-05-02		0	0.08	Fluoranthene	0.22		mg/kg
11	A11-05-02		0	0.08	Indeno(1,2,3-CD)Pyrene	0.024		mg/kg
11	A11-05-02		0	0.08	Phenanthrene	0.056		mg/kg
11	A11-05-02		0	0.08	Pyrene	0.18		mg/kg
Conventionals								
11	A11-06-02		0	0.08	Ammonia	14.1		mg/kg
11	A11-06-02		0	0.08	pH, (lab)	7.62		-log+H
11	A11-06-02		0	0.08	Preserved Total Solids	0.5102		%
11	A11-06-02		0	0.08	Sulfide As S	136		mg/kg
11	A11-06-02		0	0.08	Total Organic Carbon	0.0241		%
11	A11-06-02		0	0.08	Total Solids	0.5184		%
11	A11-06-02		0	0.08	Total Volatile Solids	26400		mg/kg
Pesticides/PCB's								

FD= Field Duplicate
EB= Equipment Blank

Rhone-Poulenc RFI

Round 2

Detected Sediment Results

Area	Sample ID	QA/QC	Sample Interval (feet bgs) Top	Bottom	Parameter	Result	Qualifer	Units
11	A11-06-02		0	0.08	4,4'-DDD	0.0047		mg/kg
11	A11-06-02		0	0.08	4,4'-DDT	0.006		mg/kg
11	A11-06-02		0	0.08	Aroclor-1254	0.033		mg/kg
11	A11-06-02		0	0.08	Gamma-Chlordane	0.0011	Y	mg/kg
Semivolatiles								
11	A11-06-02		0	0.08	Anthracene	0.025		mg/kg
11	A11-06-02		0	0.08	Benzo(A)Anthracene	0.15		mg/kg
11	A11-06-02		0	0.08	Benzo(A)Pyrene	0.11		mg/kg
11	A11-06-02		0	0.08	Benzo(B)Fluoranthene	0.24		mg/kg
11	A11-06-02		0	0.08	Benzo(GHI)Perylene	0.039		mg/kg
11	A11-06-02		0	0.08	Benzo(K)Fluoranthene	0.17		mg/kg
11	A11-06-02		0	0.08	Benzyl Butyl Phthalate	0.023		mg/kg
11	A11-06-02		0	0.08	Bis(2-Ethylhexyl)Phthalate	0.23		mg/kg
11	A11-06-02		0	0.08	Chrysene	0.23		mg/kg
11	A11-06-02		0	0.08	Dibenzo(A,H)Anthracene	0.026		mg/kg
11	A11-06-02		0	0.08	Fluoranthene	0.36		mg/kg
11	A11-06-02		0	0.08	Indeno(1,2,3-CD)Pyrene	0.056		mg/kg
11	A11-06-02		0	0.08	Phenanthrene	0.1		mg/kg
11	A11-06-02		0	0.08	Phenol	0.13		mg/kg
11	A11-06-02		0	0.08	Pyrene	0.31		mg/kg
Conventionals								
11	A11-07-02		0	0.08	Ammonia	6.34		mg/kg
11	A11-07-02		0	0.08	pH, (lab)	7.6		-log+H
11	A11-07-02		0	0.08	Preserved Total Solids	0.5546		%
11	A11-07-02		0	0.08	Sulfide As S	26.4		mg/kg
11	A11-07-02		0	0.08	Total Organic Carbon	0.0229		%
11	A11-07-02		0	0.08	Total Solids	0.6053		%
11	A11-07-02		0	0.08	Total Volatile Solids	21300		mg/kg
Pesticides/PCB's								
11	A11-07-02		0	0.08	4,4'-DDD	0.16		mg/kg
11	A11-07-02		0	0.08	4,4'-DDE	0.045		mg/kg
11	A11-07-02		0	0.08	4,4'-DDT	0.18		mg/kg
11	A11-07-02		0	0.08	Aldrin	0.0011	Y	mg/kg
11	A11-07-02		0	0.08	Alpha-Chlordane	0.0013	Y	mg/kg
11	A11-07-02		0	0.08	Aroclor-1254	0.08		mg/kg
11	A11-07-02		0	0.08	Aroclor-1260	0.05		mg/kg
11	A11-07-02		0	0.08	Dieldrin	0.0022	Y	mg/kg
11	A11-07-02		0	0.08	Gamma-Chlordane	0.0022	Y	mg/kg
Semivolatiles								
11	A11-07-02		0	0.08	4-Methylphenol	0.022		mg/kg
11	A11-07-02		0	0.08	Benzo(A)Anthracene	0.11		mg/kg
11	A11-07-02		0	0.08	Benzo(A)Pyrene	0.1		mg/kg
11	A11-07-02		0	0.08	Benzo(B)Fluoranthene	0.19		mg/kg
11	A11-07-02		0	0.08	Benzo(GHI)Perylene	0.04		mg/kg
11	A11-07-02		0	0.08	Benzo(K)Fluoranthene	0.21		mg/kg
11	A11-07-02		0	0.08	Benzyl Butyl Phthalate	0.019		mg/kg
11	A11-07-02		0	0.08	Bis(2-Ethylhexyl)Phthalate	0.18		mg/kg
11	A11-07-02		0	0.08	Chrysene	0.22		mg/kg
11	A11-07-02		0	0.08	Di-n-Octyl Phthalate	0.14		mg/kg

FD= Field Duplicate
EB= Equipment Blank

Rhone-Poulenc RFI

Round 2

Detected Sediment Results

Area	Sample ID	QA/QC	Sample Interval (feet bgs) Top	Bottom	Parameter	Result	Qualifer	Units
11	A11-07-02		0	0.08	Dibenzo(A,H)Anthracene	0.025		mg/kg
11	A11-07-02		0	0.08	Dimethyl Phthalate	0.019		mg/kg
11	A11-07-02		0	0.08	Fluoranthene	0.37		mg/kg
11	A11-07-02		0	0.08	Indeno(1,2,3-CD)Pyrene	0.053		mg/kg
11	A11-07-02		0	0.08	Phenanthrene	0.092		mg/kg
11	A11-07-02		0	0.08	Phenol	0.074		mg/kg
11	A11-07-02		0	0.08	Pyrene	0.27		mg/kg
Conventionals								
11	A11-10-02	FD	0	0.08	Ammonia	4.32		mg/kg
11	A11-10-02	FD	0	0.08	pH, (lab)	7.71		-log+H
11	A11-10-02	FD	0	0.08	Preserved Total Solids	0.5986		%
11	A11-10-02	FD	0	0.08	Sulfide As S	38.6		mg/kg
11	A11-10-02	FD	0	0.08	Total Organic Carbon	0.0157		%
11	A11-10-02	FD	0	0.08	Total Solids	0.61		%
11	A11-10-02	FD	0	0.08	Total Volatile Solids	24300		mg/kg
Inorganics								
11	A11-10-02	FD	0	0.08	Arsenic, Total	7.1		mg/kg
11	A11-10-02	FD	0	0.08	Cadmium, Total	0.38		mg/kg
11	A11-10-02	FD	0	0.08	Chromium, Total	21.6		mg/kg
11	A11-10-02	FD	0	0.08	Copper, Total	32.3		mg/kg
11	A11-10-02	FD	0	0.08	Lead, Total	23		mg/kg
11	A11-10-02	FD	0	0.08	Mercury, Total	0.079		mg/kg
11	A11-10-02	FD	0	0.08	Nickel, Total	16		mg/kg
11	A11-10-02	FD	0	0.08	Silver, Total	0.19		mg/kg
11	A11-10-02	FD	0	0.08	Zinc, Total	81.9		mg/kg
Pesticides/PCB's								
11	A11-10-02	FD	0	0.08	4,4'-DDD	0.058		mg/kg
11	A11-10-02	FD	0	0.08	4,4'-DDE	0.012		mg/kg
11	A11-10-02	FD	0	0.08	4,4'-DDT	0.074		mg/kg
11	A11-10-02	FD	0	0.08	Aldrin	0.0012	Y	mg/kg
11	A11-10-02	FD	0	0.08	Aroclor-1254	0.065		mg/kg
11	A11-10-02	FD	0	0.08	Aroclor-1260	0.065		mg/kg
11	A11-10-02	FD	0	0.08	Dieldrin	0.0028	Y	mg/kg
11	A11-10-02	FD	0	0.08	Gamma-Chlordane	0.0019	Y	mg/kg
Semivolatiles								
11	A11-10-02	FD	0	0.08	4-Methylphenol	0.018		mg/kg
11	A11-10-02	FD	0	0.08	Anthracene	0.018		mg/kg
11	A11-10-02	FD	0	0.08	Benzo(A)Anthracene	0.12		mg/kg
11	A11-10-02	FD	0	0.08	Benzo(A)Pyrene	0.096		mg/kg
11	A11-10-02	FD	0	0.08	Benzo(B)Fluoranthene	0.18		mg/kg
11	A11-10-02	FD	0	0.08	Benzo(GHI)Perylene	0.032		mg/kg
11	A11-10-02	FD	0	0.08	Benzo(K)Fluoranthene	0.16		mg/kg
11	A11-10-02	FD	0	0.08	Bis(2-Ethylhexyl)Phthalate	0.097		mg/kg
11	A11-10-02	FD	0	0.08	Chrysene	0.17		mg/kg
11	A11-10-02	FD	0	0.08	Di-n-Octyl Phthalate	0.027		mg/kg
11	A11-10-02	FD	0	0.08	Dibenzo(A,H)Anthracene	0.018		mg/kg
11	A11-10-02	FD	0	0.08	Fluoranthene	0.38		mg/kg
11	A11-10-02	FD	0	0.08	Indeno(1,2,3-CD)Pyrene	0.041		mg/kg
11	A11-10-02	FD	0	0.08	Phenanthrene	0.072		mg/kg

FD= Field Duplicate
EB= Equipment Blank

Rhone-Poulenc RFI

Round 2

Detected Sediment Results

Area	Sample ID	QA/QC	Sample Interval (feet bgs) Top	Bottom	Parameter	Result	Qualifer	Units
11	A11-10-02	FD	0	0.08	Pyrene	0.3		mg/kg

FD= Field Duplicate
EB= Equipment Blank

Volume III—Replacement Page for Appendix J

Sediments

The Landau study conducted at the RPI Facility (Ref. 1) found no levels of PAH compounds that exceeded any regulatory criteria in sediments. Eight HPAHs (maximum concentration 910 µg/kg, minimum 12 µg/kg) and six LPAHs (maximum concentration 930 µg/kg, minimum 9 µg/kg) were detected. These compounds were found in an average of 66 percent of the samples.

RPI's RCRA Facility Investigation also found no levels of PAH compounds that exceeded the Washington State Marine Sediment Management Standards (Ref. 2). In Round 1, nine HPAHs (maximum concentration 890 µg/kg, minimum 16 µg/kg) and five LPAHs (maximum concentration 1,200 µg/kg, minimum 15 µg/kg) were detected. These compounds were found in 63 percent of the samples. In Round 2 (in the top 1 inch of sediment), the HPAHs ranged in concentration from 13 µg/kg to 400 µg/kg and the LPAHs from 13 µg/kg to 100 µg/kg.

a. PAH compounds have been found in high concentrations in sediments of Elliot Bay, with levels varying from 150 µg/kg to 63,000 µg/kg. NOAA reports that concentrations of the HPAHs benzo(a)pyrene and benz(a)anthracene range from 6 to 4,000 µg/kg and from 10 to 8,400 µg/kg, respectively (Ref. 21). In comparison, sediment samples at the RPI Facility ranged from 12 to 340 µg/kg for benzo(a)pyrene (mean of 110 µg/kg) and 14 to 510 µg/kg for benz(a)anthracene (mean of 138 µg/kg).

b. One study addressing pollutants in Puget Sound found that LPAHs in urban bays were detected in 601 samples out of 612, with a median concentration of 780 µg/kg and a maximum of 630,000 µg/kg. HPAHs were detected in 614 out of 617 samples, with a median of 2,800 µg/kg and a maximum of 3,200,000 µg/kg (Ref. 31).

c. In a data review prepared for the Elliott Bay/Duwamish Restoration Program, it was reported that PAH compounds in sediment samples collected near Slip No. 6 ranged from 500 µg/kg to 15,000 µg/kg (Ref. 32).

d. In an Elliott Bay Action Program study prepared for U.S. EPA in 1988, contaminant sources of the Duwamish Waterway were evaluated. The King County Storm Drain Outfall in Slip No. 6 was one of the locations sampled.

   This drain serves areas to the east of the RPI Facility. Sediment samples collected in 1985, as part of this study, contained eight HPAHs ranging in concentration from 3,300 µg/kg to 16,000 µg/kg (dry weight). Another portion of the same study reported 18,000 µg/kg of total LPAHs and 72,400 µg/kg of total HPAHs in sediments collected from this King County Storm Drain (Ref. 33).

e. Sediment samples were taken in the Duwamish Waterway approximately 0.5 miles upstream from the RPI Facility, near a combined sewer overflow and storm drain outfall site. This study was conducted by King County Department of Metropolitan Services for the Elliott Bay-Duwamish Restoration Program Panel. A 1990 sampling resulted in 44,000 µg/kg total LPAHs (range of individual LPAHs: 900 to 29,000 µg/kg) and 180,000 µg/kg total HPAHs (range: 26,000 to 37,000 µg/kg). A 1992 sampling resulted

in 22,000 and 25,000 μg/kg total LPAHs (range: 900 to 12,000 μg/kg) and 170,000 and 86,000 μg/kg total HPAHs (range: 2,300 to 42,000 μg/kg) (Ref. 34).

The sites where PAH compounds have been detected are shown in Figure J-5.

J.4.2 General Land Use: Possible Sources

Local Industries

The area along the Duwamish River has been an industrial center for at least 90 years. The companies shown in Figure J-2 existed in the past and are no longer in business. They were located and identified from Sanborn Fire Insurance Maps for the years 1904 to 1946 (Ref. 35). Five of these were lumber mills, all within a mile of the RPI site. All burned sawdust in incinerators and boilers; emissions from wood burning are known sources of PAHs. Contributing to this was wood burning in homes, a common source of heat in past years. Many accidental fires occurred in the area, especially in the early years. For example, a racetrack with a large grandstand was located near the site of the present RPI Facility, and burned in 1917 (Ref. 27). Two businesses located just south of the present RPI Facility, Standard Lumber and Manufacturing Company and Associated Packing Company, burned between 1929 and 1946 (Ref. 35).

The Firestone Tire retreading plant was located across East Marginal Way from the RPI Facility for 10 to 15 years. This operation often emitted a dark smoke. Carbon black, which can account for about one third of the weight of tire treads, is a known source of PAHs. The retreading process involves heating the rubber to high temperatures and could be a possible source of PAHs at the nearby RPI Facility.

Malarkey Asphalt Company is located across the Duwamish River from the RPI Facility. According to a 1985 report (Ref. 26), this company had an unlined wastewater disposal pond on the bank of the river, which occasionally overflowed into the river. Asphalt and roofing tar, which the company manufactures, are known sources of PAH compounds. The Mineralized Cell Wood Preserving Company, which was located 0.2 miles north of the Facility in 1945, could very likely have treated wood with creosote as well as with arsenic.

A report prepared for U.S. EPA Region 10 discusses potential PAH sources in the King County Storm Drain Basin, which discharges into Slip No. 6. This report cites possible historical contamination from a petroleum distributor that operated in the Basin in the 1940s, and an aircraft manufacturing site that is on USEPA's CERCLIS (Ref. 33).

Coal and Other Sources

There is a long history of coal mining and coal use in this area (Ref. 36). Coal was mined as early as the mid-1800s in areas to the south and east of the present RPI Facility. As mentioned earlier, a coal mine was even located in Tukwila (Ref. 27). For many years coal was shipped down the Duwamish River, and the overturning of these barges was not uncommon. As early

Volume III—Materials for New Appendix L
(tab divider, section dividers, and text pages)

APPENDIX L

Mineral Oil, Vanillin, and LNAPL Information

Peneteck Oil Information

penreco

106 SOUTH MAIN STREET, BUTLER, PENNSYLVANIA 16001 • TELEX 866-321 • PHONE 412/283-5600

September 20, 1983

Mr. Scott Whittaker
Monsanto Company
9229 East Marginal Way
Seattle, WA 98108

Dear Mr. Whittaker:

At our Bill Vogt's request I am enclosing a copy of our specification folder which includes Peneteck.

You will note that Peneteck meets all the USP requirements for Light Mineral Oil except for the specific gravity requirement. I am enclosing a copy of the USP Monographs.

We measure the viscosity of our products according to ASTM D 445 and we measure specific gravity with a hydrometer according to ASTM D 1298.

As a highly refined petroleum distillate Peneteck is considered to be non-toxic orally but taken internally and vomiting induced it can be hazardous if aspirated into the lungs, hence the instructions not to induce vomiting.

Because the initial boiling point of Peneteck is over 500°F its vapor pressure at normal room temperature is below one millimeter of mercury. The commonly cited value for the Threshold Limit Values - Time Weighted Average for Mineral Oil Mist is 5 mg/m^3 while the TLV - Short-Term Exposure Limit is 10 mg/m^3.

A copy of our Product Health and Safety Data Sheet for Peneteck is enclosed.

Please let me know if you have any questions.

Sincerely,

Charles Steenbergen

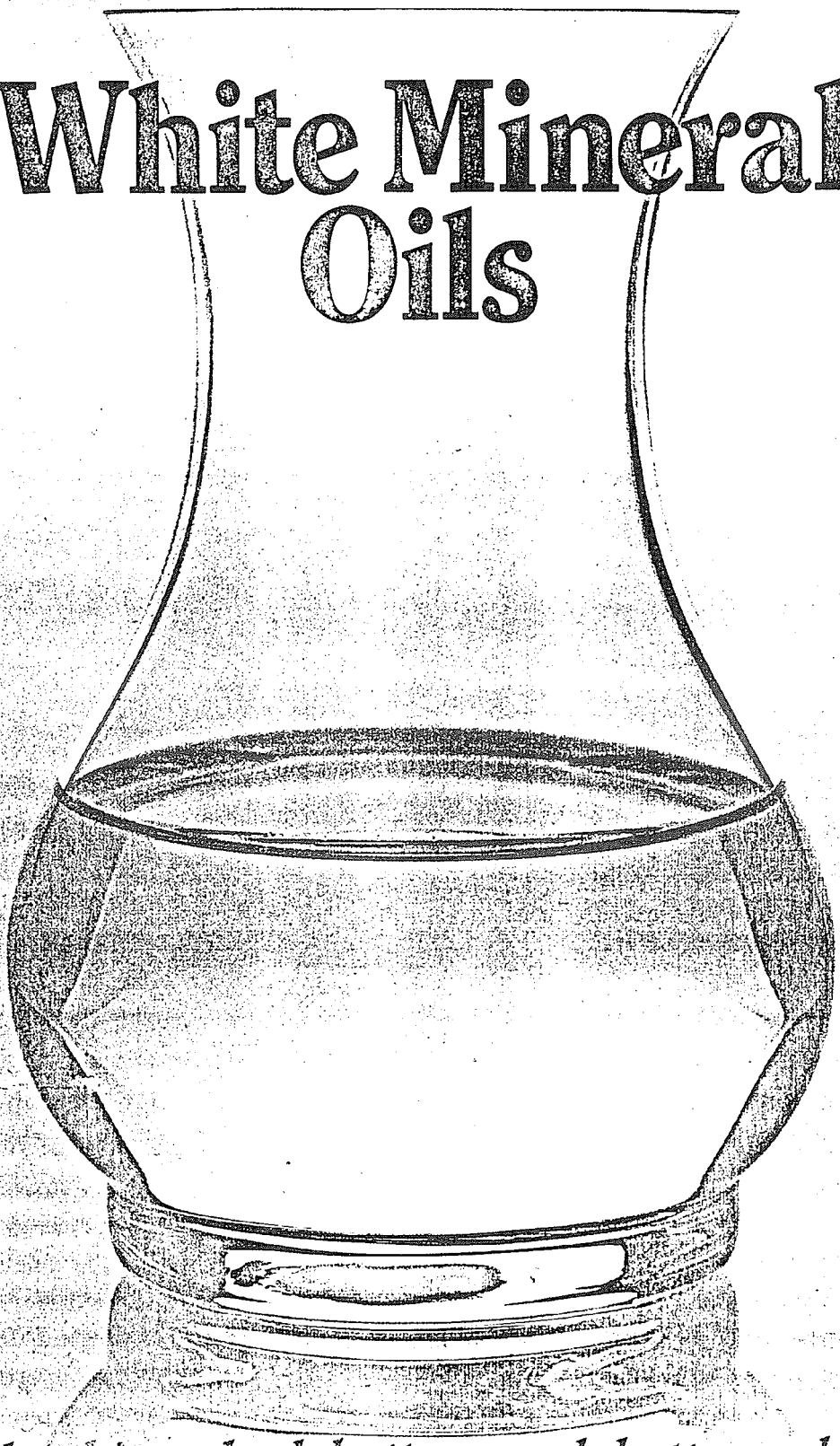
Charles Steenbergen
Technical Representative

cp

cc: B. Vogt

penreco

White Mineral Oils



Make things look better, work better or both

Penreco White Mineral Oils

Penreco White Mineral Oils are painstakingly refined hydrocarbon oils, truly the jewels of the refiner's art. Because of their innocuous and inert characteristics, Penreco White Mineral Oils can be used in a seemingly infinite number of applications.

These carefully refined oils are useful and versatile because they are odorless . . . tasteless . . . non-toxic . . . non-irritating . . . non-hygroscopic . . . transparent . . . fluid at low temperatures . . . highly stable . . . and extremely pure.

Penreco White Mineral Oils are very complex mixtures of paraffin and naphthene hydrocarbons, ranging from approximately 18 to 36 carbon atoms. Due to the multiplicity of isomers made possible by branching and other structural variations, they contain hundreds of thousands of individual hydrocarbons. Therefore, it is not surprising that products with a given viscosity, specific gravity or average molecular weight may show marked differences in other characteristics because of variations in the predominating structures of either hydrocarbon series, or the paraffin/naphthene ratios. In other words, all USP oils of given viscosities are NOT alike. Differences can be important—sometimes vital—to the solution of specific problems.

Standard and Custom Grades

Penreco White Mineral Oils are produced in a number of standard grades covering the viscosity range of 38 to 410 SUS at 100 degrees Fahrenheit. (The complete specifications of these oils are given below.) Additionally, by careful selection of charge stocks and skillful modifications in refining techniques, Penreco is able to vary the finished product composition to effect significant changes desired in compatibility, specific gravity, volatility, and other properties. Thus, we can fulfill the specific needs of individual customers while complying with the most stringent specifications.

Versatility

Only a high degree of technological know-how can produce the extreme purity required by the USP and the F&DA—purity that insures the absence of any significant amounts of sulfur, nitrogen, oxygen, halogen derivatives or unsaturated substances and aromatics. It is this ultimate in refining skill that makes Penreco White Mineral Oils so versatile and useful in a wide range of products and processes.

Penreco White Mineral Oils TSCA Inventory Number 8042-47-5*	Specifications					Typical Properties		
	Viscosity		Specific Gravity			Refractive Index		
	Centistokes @ 40° C	Saybolt Universal Seconds @ 100° F	60/60° F (15.6/15.6° C)	77/77° F (25/25° C)	Pounds Per Gallon 60° F	n_D^{20}	Flash Point °F ASTM D92	Pour Point °F ASTM D97
MINERAL OIL USP								
Drakeol 35	65.3/70.0	340/365	.870/.882	.864/.876	7.25/7.35	1.4800	435	10
Drakeol 34	71.0/78.3	370/410	.864/.878	.858/.872	7.19/7.31	1.4770	475	15
Drakeol 32	59.7/63.3	310/330	.863/.882	.856/.876	7.18/7.35	1.4798	430	10
Drakeol 21	39.7/41.7	205/215	.859/.879	.853/.873	7.15/7.32	1.4759	415	15
Drakeol 19	35.0/37.0	180/190	.858/.877	.852/.871	7.14/7.31	1.4756	410	15
LIGHT MINERAL OIL USP								
Drakeol 15	28.2/30.2	145/155	.856/.876	.850/.870	7.13/7.30	1.4740	390	15
Drakeol 13	24.2/26.3	125/135	.854/.873	.848/.867	7.11/7.27	1.4726	390	15
Drakeol 10	17.9/20.0	95/105	.850/.870	.844/.864	7.08/7.25	1.4694	365	20
Drakeol 9	14.7/16.8	81/90	.845/.860	.838/.854	7.03/7.16	1.4665	365	20
Drakeol 8	12.7/14.5	73/81	.837/.850	.830/.844	6.97/7.08	1.4661	360	20
Drakeol 7	10.8/12.7	65/73	.834/.850	.827/.844	6.94/7.08	1.4634	355	20
Drakeol 6	9.2/10.6	58/64	.834/.843	.827/.836	6.94/7.02	1.4613	320	25
Drakeol 5	7.6/8.7	52/57	.827/.840	.821/.833	6.89/7.00	1.4600	320	25
Draketex 50	6.5/7.8	48/53	.824/.836	.817/.830	6.86/6.96	1.4577	305	30
MINERAL OIL TECHNICAL								
Peneteck[1]	3.4/4.7	38/42	.808/.818	.802/.811	6.73/6.81	1.4517	265	35
Parol 100	17.9/20.0	95/105	.850/.871	.844/.865	7.08/7.25	1.4684	350	20
Parol 80	13.2/15.7	75/85	.837/.863	.830/.857	6.97/7.19	1.4665	340	20
Parol 70	10.8/13.2	65/75	.834/.855	.828/.849	6.94/7.12	1.4642	330	20

Government Regulations

All Drakeols, Draketex 50 and Peneteck meet the following F&DA regulations: 21 CFR 172.878 covering direct use in food, 178.3620 for indirect use in food and 573.680 for use in animal feed. Parols pass 21 CFR 178.3620 for indirect use in food and 573.680 for animal feed use.

Notes:

All regular grade Drakeols, Draketex 50 and Peneteck are inhibited with mixed tocopherols from vitamin E.

To meet USP requirements for "Mineral Oil," the viscosity must be no less than 34.5 centistokes at 40°C (approximately 178 SUS at 100°F) and the specific gravity at 25/25°C must be between 0.845 and 0.905. To meet USP specifications for "Light Mineral Oil", the viscosity at 40°C must not be more than 33.5 centistokes (approximately 173 SUS at 100°F) and the specific gravity at 25/25°C must fall between 0.818 and 0.880. All other requirements for the two grades are the same.

All the oils listed above are odorless, colorless (30+ Saybolt color), tasteless and comply fully with F&DA requirements under the Federal Food, Drug and Cosmetic Act.

[1]Peneteck meets all the USP requirements for "Light Mineral Oil" except that it falls below the minimum requirements for specific gravity.

Drakeol and Penreco are registered trademarks of Penreco, Division of Pennzoil Company.

Typical Property Charts

White Mineral Oils have many physical and chemical properties that are interrelated. Some of these basic relationships are shown on the Typical Property Comparison Charts. The properties of a specific oil depend on the base stock from which it is produced and the refining steps to which it is subjected. Penreco's long experience has shown us how to select feedstocks and alter refining methods to obtain finished White Oils with the characteristics our customers need.

Penreco High Purity Hydrocarbon Solvents

Exceptional purity, rigid specifications and consistent quality set Penreco High Purity Hydrocarbon Solvents apart from ordinary petroleum solvents. These products are ideal for applications that demand both uniformity and purity. Penreco does not compromise quality by resorting to processing short cuts. Each of these solvents has been hydrotreated, fractionated into a narrow distillation range and filtered to obtain purity, clarity and low odor. These are the solvents of choice for cosmetics, pharmaceutical manufacturing, food processing, chemical and other industries where purity is essential.

To achieve the lowest possible odor level, 2251 Oil is produced by a variation of our White Mineral Oil processing sequence. The result is a solvent of brilliant transparency, minimal odor and remarkable quality.

Because of their unique qualities and range of specifications, Penreco High Purity Hydrocarbon Solvents have a wide variety of applications. They have such diverse uses as processing solvents, foam control agents, components of the solvent systems for waterless hand cleaners, agricultural spray carriers, emulsion polish components, fruit and vegetable processing and cleaning oils, metal parts cleaners and for solvent extraction.

Please contact us for experimental samples and technical assistance in matching a Penreco High Purity Hydrocarbon Solvent to your needs.

White Mineral Oil Properties

Chart I

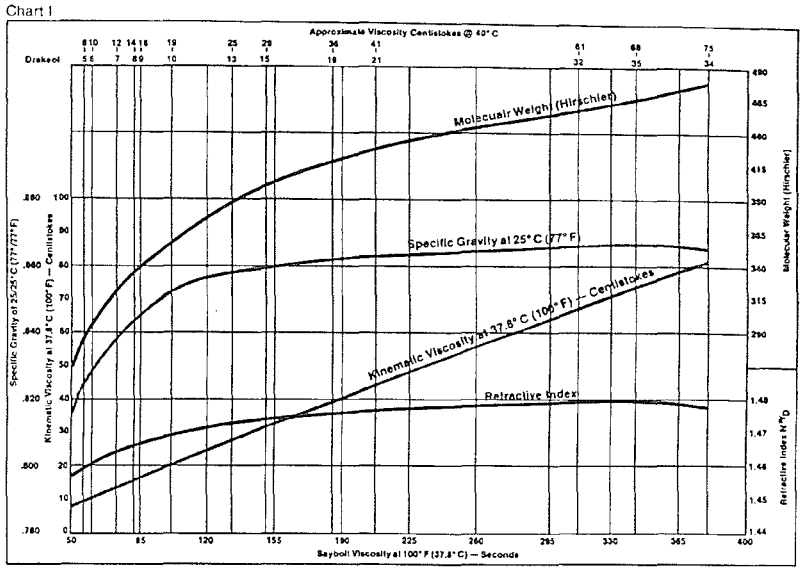
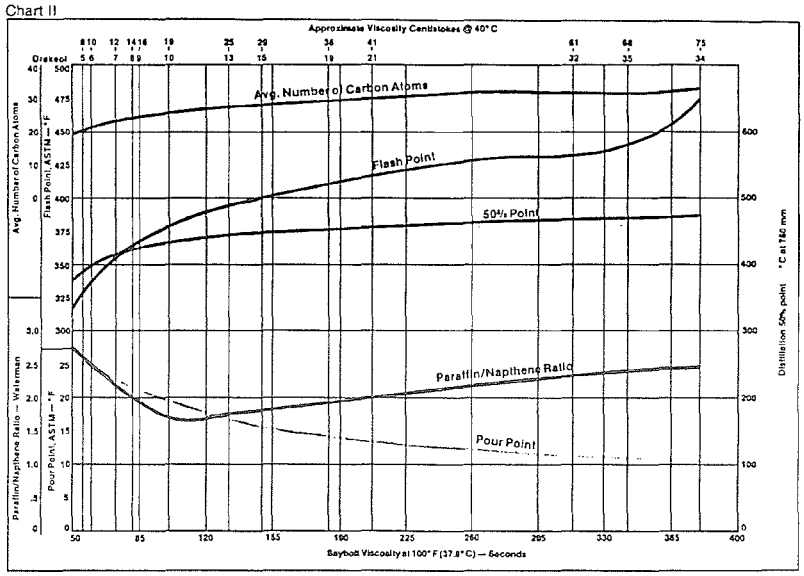


Chart II



Penreco High Purity Hydrocarbon Solvents

Specifications:	2251 Oil	2263 Oil	2257 Oil	2259 Oil	2260 Oil
API Gravity at 60°F	46/50	46/50	44/47	43/47	40/44
Specific Gravity at 60/60°F	.779/.797	.779/.797	.793/.806	.793/.811	.806/.825
Distillation, ASTM D86					
IBP, °F, Min.	375	375	430	445	500
End Point, °F, Max.	500	500	510	535	610
Typical Properties:					
Viscosity at 100°F, SUS	30.5	30.5	33.2	33.6	40.2
Pounds per Gallon at 60°F	6.56	6.56	6.64	6.69	6.79
Flash Point, COC°F	165	165	220	240	280
Pour Point, ASTM D97, °F	-40	-40	-10	-10	25

Government Regulations:

Penreco High Purity Solvents meet the following F&DA Regulations—21 CFR 172.884, 178.3650 and 573.740.

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White Mineral Oils

SPECIFICATIONS / TYPICAL PROPERTIES

		VISCOSITY ASTM D 445 SUS @ 100°F	VISCOSITY ASTM D 445 CST @ 40°C	API ASTM D 1298 @ 60°F	SPECIFIC GRAVITY ASTM D 1298 @ 60°F	SPECIFIC GRAVITY ASTM D 1298 @ 77°F	LBS./GAL. @ 60°F	FLASH POINT ASTM D 92 °F	FLASH POINT ASTM D 92 °C	POUR POINT ASTM D 97 °F	POUR POINT ASTM D 97 °C
MINERAL OIL USP	Drakeol 35	340/365	65.8/71.0	28.0/31.1	.870/.887	.864/.881	7.30	435	224	5	−15
	Drakeol 34	370/410	72.0/79.5	29.7/32.3	.864/.878	.858/.872	7.27	475	246	15	−9
	Drakeol 32	312/330	60.0/63.3	28.9/32.5	.863/.882	.856/.876	7.25	430	221	10	−12
	Drakeol 21	200/215	38.4/41.5	28.9/33.2	.859/.882	.853/.876	7.23	415	213	15	−9
	Drakeol 19	180/190	34.9/37.3	28.9/33.4	.858/.882	.852/.876	7.22	410	210	15	−9
LIGHT MINERAL OIL NF	Drakeol 15	145/155	28.1/30.3	28.9/33.8	.856/.882	.850/.873	7.20	390	199	15	−9
	Drakeol 13	125/135	24.2/26.3	30.6/34.2	.854/.873	.848/.867	7.17	390	199	15	−9
	Drakeol 10	95/105	17.7/20.2	31.1/36.6	.842/.870	.838/.864	7.14	365	185	15	−9
	Drakeol 10B	95/105	17.7/20.2	28.5/30.5	.874/.884	.867/.878	7.30	330	165	−40	−40
	Drakeol 9	80/90	14.2/17.0	33.0/36.0	.845/.860	.838/.854	7.09	360	182	15	−9
	Drakeol 7	65/75	10.8/13.6	35.0/38.2	.834/.850	.828/.843	7.04	355	180	15	−9
	Drakeol 5	52/57	7.6/8.7	36.9/38.7	.831/.842	.825/.835	6.97	320	160	15	−9
	Draketex 50	48/53	6.5/7.8	37.4/40.2	.824/.838	.817/.832	6.96	300	149	20	−7
TECHNICAL MINERAL OI	Peneteck	38/42	3.4/4.7	41.5/43.6	.808/.818	.802/.811	6.77	265	129	30	−1
	Parol 100	95/105	17.7/20.2	31.1/36.6	.842/.870	.838/.864	7.15	360	182	15	−9
	Parol 80	75/90	13.2/17.0	32.5/37.6	.837/.863	.830/.857	7.08	350	177	15	−9
	Parol 70	65/75	10.8/13.6	35.0/38.2	.834/.855	.828/.849	7.05	340	171	15	−9
	4463 Oil	42/59	—	38.0/42.0	.815/.834	—	6.90	315	157	45	7
	6970 Oil	55/65	—	34.0/38.0	.835/.855	—	6.99	325	163	15	−9

GOVERNMENT REGULATIONS

- The products listed above are included in the EPA's TSCA (Toxic Substances Control Act) Inventory.
- The CAS Number for all products listed above is [illegible]7-5.
- None of the products listed above are hazardous by OSHA (Occupational Safety and Health Administration) or DOT (Department of Transportation) standards.
- All Drakeols, Draketex 50, and Peneteck meet the following FDA regulations: 21 CFR 172.878 covering direct use in food, 178.3620 for indirect use in food, and [illegible]80 for use in animal feed. Penreco [illegible]cal mineral oils meet 21 CFR 178.3620 (b) for indirect use in food and 573.680 for animal feed.

NOTES

- All Drakeols, Draketex 50, and Peneteck are inhibited with less than 15 ppm alpha tocopherol (vitamin E).
- Peneteck meets all NF requirements for "Light Mineral Oil" except that it falls below the minimum requirements for specific gravity.
- Colors of all Drakeols, Draketex 50, and Peneteck are +30 Saybolt (ASTM D 156). Colors of all technical oils other than Peneteck are at least +20 Saybolt.
- Some of the most common applications for Penreco White Mineral Oils are shown on the chart on the flipside of this sheet.

To the best of our knowledge, the information contained herein is accurate, but is given without warranty or guarantee. We assume no liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of the suitability of any information or material for the use contemplated, the manner of use, and whether there is any infringement of patents is the sole responsibility of the user.

PURCHASING
DEC 3 1987

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A DIVISION OF PENNZOIL PRODUCTS COMPANY

Regional Sales Offices: Butler, Pennsylvania
Call Toll Free 800/245-3952
In PA Call 412/283-5600
FAX No. 412/283-1630

Dickinson, Texas
713/337-1534
Or Call Toll Free 800/458-5845
FAX No. 713/337-2341

Branches in: Lyndhurst, New Jersey
Los Angeles, California

Penreco White Mineral Oils Application Guide

Penreco White Mineral Oils may be able to help you improve your process or product. Colorless, odorless, tasteless and essentially inert, Penreco White Mineral Oils have been employed in hundreds of applications where less highly refined oils are completely unsuitable. White Mineral Oils can function as carriers, lubricants, plasticizers, base materials, solvents, saturants and coatings. Some of the most common applications for Penreco White Mineral Oils are shown on the attached chart. The oil grades that are recommended for each use are intended only as starting suggestions. We will be glad to furnish experimental samples and provide technical assistance to help you determine which Penreco White Mineral Oil is exactly right for your application.

Application	Use	Recommended Grade
COSMETICS/ PHARMACEUTICALS		
Hair Preparations	Base Materials	Drakeol 6, 9
Ointments, Lotions, Oils		
Body Ointments, Lotions	Therapeutic Agent Carrier, Base Ingredient	Drakeol 7, 9
Baby Oils and Lotions	Principal Ingredient	Drakeol 7, 9
Sun Tan Lotions	Base Material	Drakeol 7
Bath Oils	Principal Ingredient	Drakeol 6, 7, 13
Emulsifiable Baby Oils	Principal Ingredient	Drakeol 6, 7, 13
Creams		
Cleansing, Moisturizing, Hand	Solvent and Emollient	Drakeol 7
Cold Cream	Basic Ingredient	Drakeol 7
Emollient Cream	Base Material	Drakeol 9
Waterless Hand Cleaner	Solvent, Base Material	2251 Oil, Drakeol 7
Make Up	Base Material	Drakeol 7
Eye Make Up	Basic Ingredient	Drakeol 7
Foundation Make Up	Carrier	Drakeol 7
Lipsticks	Basic Ingredient	Drakeol 7
Laxatives	Principal Ingredient	Drakeol 35
Laxative Emulsions	Emulsified Lubricant	Drakeol 9
FOOD/FOOD PROCESSING		
Apples, Pears, Cucumbers, Tomatoes	Protective Coatings, Wraps	Drakeol 7
Peas, Lima Beans, etc.	Froth Flotation Agent	2251 Oil
Bread and Pastries	Divider Oil, Trough Grease	Drakeols
Hard Candy	Slab Dressing	Drakeol 7
Plastics		
Polyethylene	Pigment Dispersant	Drakeol 7, 9
Polyvinyl Chloride and Vinyl Acetate	Plasticizer and Lubricant	Drakeol 7, 9, 10
Polystyrene	Plasticizer	Drakeol 9,35,34
Ethyl Cellulose	Primary Plasticizer	Drakeol 19, 21, 35
Polypropylene	Pigment Dispersant	Drakeol 7, 9
Textiles and Paper		
Wool Worsteds	Production Lubricant	Drakeol 19
Textile and Paper Machinery	Lubricants	Drakeol 9
Paper Saturants	Water Repellent, Moisture Barriers, Transparentizers	Drakeol 35
Paper Newsprint	Foam Control	2251 Oil
Nylon and Rayon	Coning and Finishing Oil Base	Draketex 50
Carbonless Paper	Solvent	2251 Oil, 2263 Oil

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A PENNZOIL DIVISION

106 South Main Street, Butler, Pennsylvania 16001
Call Toll Free (Except in Pennsylvania) 800/245-3952. In Pennsylvania Call 412/283-5600.
Branches in: Lyndhurst, New Jersey; Chicago, Illinois; Los Angeles, California

MATERIAL SAFETY DATA SHEET

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I PRODUCT IDENTIFICATION

Manufacturer's Name	PENRECO	CAS Number: 8042-47-5 MSDS Code: 000203	
Address	106 SOUTH MAIN STREET BUTLER, PENNSYLVANIA 160015958	NFPA Hazard Identification Degree of Hazard	Hazard Ratings
Emergency Telephone No.	(412) 756-0110	Health: 0 Fire: 1 Reactivity: 0	0 - Least 1 - Slight 2 - Moderate 3 - High 4 - Extreme
Trade Name	PENETECK		
Synonyms	MINERAL OIL USP		

II INGREDIENTS

COMPONENT NAME CAS NUMBER	HAZARDOUS IN BLEND	PERCENTAGE MIN	PERCENTAGE MAX	COMPONENT EXPOSURE LIMITS	UNITS
TECHNICAL WHITE MINERAL OIL 8042-47-5	NO		100.00	OSHA PEL ACGIH TLV	NO LIMIT NO LIMIT

BY: ENVIRONMENTAL, SAFETY & HEALTH (713) 546-8512

EFFECTIVE DATE: NOVEMBER 14, 1985

DISCLAIMER OF WARRANTY:

THE INFORMATION CONTAINED HEREIN IS BASED UPON DATA AVAILABLE TO US, AND REFLECTS OUR BEST PROFESSIONAL JUDGEMENT. HOWEVER, NO WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY USE, OR ANY OTHER WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF SUCH DATA, THE RESULTS TO BE OBTAINED FROM THE USE THEROF, OR THAT ANY SUCH USE DOES NOT INFRINGE ANY PATENT. SINCE THE INFORMATION CONTAINED HERIN MAY BE APPLIED UNDER CONDITIONS OF USE BEYOND OUR CONTROL AND WITH WHICH WE MAY BE UNFAMILIAR, WE DO NOT ASSUME ANY RESPONSIBILITY FOR THE RESULTS OF SUCH APPLICATION. THIS INFORMATION IS FURNISHED UPON THE CONDITION THAT THE PERSON RECEIVING IT SHALL MAKE HIS OWN DETERMINATION OF THE SUITABILITY OF THE MATERIAL FOR HIS PARTICULAR PURPOSE.

REQUIRED UNDER USDL SAFETY AND HEALTH REGULATIONS FOR SHIP REPAIRING, SHIPBUILDING, AND SHIPBREAKING (29 CFR 1915, 1916, 1917).

III HEALTH EFFECT INFORMATION

EYE CONTACT	THIS PRODUCT IS NON-IRRITATING TO THE EYES UPON DIRECT CONTACT.
SKIN CONTACT	THIS PRODUCT IS NOT EXPECTED TO CAUSE ANY SKIN IRRITATION UPON DIRECT SINGLE OR REPEATED AND PROLONGED CONTACT; HOWEVER, SIMILAR CHEMICAL COMPOSITION PRODUCTS APPLIED TO THE SKIN OF LABORATORY ANIMALS RESULTED IN MINIMAL TO SLIGHT DERMAL IRRITATION.
INHALATION	THIS PRODUCT HAS A LOW VAPOR PRESSURE AND IS NOT EXPECTED TO PRESENT AN INHALATION HAZARD AT AMBIENT CONDITIONS. CAUTION SHOULD BE TAKEN TO PREVENT AEROSOLIZATION OR MISTING OF THIS PRODUCT. THE THRESHOLD LIMIT VALUE (TLV) FOR THIS PRODUCT AS OIL MIST IS 5 MG/M3. EXPOSURES BELOW 5 MG/M3 APPEAR TO BE WITHOUT SIGNIFICANT HEALTH RISK.
INGESTION	INGESTION IS RELATIVELY NON-TOXIC UNLESS ASPIRATION OCCURS. THIS PRODUCT HAS LAXATIVE PROPERTIES AND MAY RESULT IN ABDOMINAL CRAMPS AND DIARRHEA. SEE HEALTH DATA SECTION BELOW.
HEALTH DATA	ON RARE OCCASIONS, PROLONGED AND REPEATED EXPOSURE TO OIL MIST POSES A RISK OF PULMONARY DISEASE SUCH AS CHRONIC LUNG INFLAMMATION. THIS CONDITION IS USUALLY ASYMPTOMATIC AS A RESULT OF REPEATED SMALL ASPIRATIONS. SHORTNESS OF BREATH AND COUGH ARE THE MOST COMMON SYMPTOMS. ASPIRATION MAY LEAD TO CHEMICAL PNEUMONITIS WHICH IS CHARACTERIZED BY PULMONARY EDEMA AND HEMORRAGE, AND MAY BE FATAL. SIGNS OF LUNG INVOLVEMENT INCLUDE INCREASED RESPIRATION RATE, INCREASED HEART RATE, AND A BLUISH DISCOLORATION OF THE SKIN. COUGHING, CHOKING, AND GAGGING ARE OFTEN NOTED AT THE TIME OF ASPIRATION. GASTROINTESTINAL DISCOMFORT MAY DEVELOP, FOLLOWED BY VOMITTING, WITH A FURTHER RISK OF ASPIRATION.

IV EMERGENCY & FIRST AID PROCEDURES

EYE CONTACT	IMMEDIATELY FLUSH EYES WITH LARGE AMOUNTS OF WATER AND CONTINUE FLUSHING FOR 15 MINUTES. IF MATERIAL IS HOT, TREAT FOR THERMAL BURNS AND TAKE VICTIM TO HOSPITAL IMMEDIATELY.
SKIN CONTACT	REMOVE CONTAMINATED CLOTHING. IF MATERIAL IS HOT, SUBMERGE INJURED AREA IN COLD WATER. IF VICTIM IS SEVERELY BURNED, REMOVE TO A HOSPITAL IMMEDIATELY.
INHALATION	THIS MATERIAL HAS A LOW VAPOR PRESSURE AND IS NOT EXPECTED TO PRESENT AN INHALATION EXPOSURE AT AMBIENT CONDITIONS. IF VAPOR OR MIST IS GENERATED WHEN THE MATERIAL IS HEATED OR HANDLED, REMOVE VICTIM FROM EXPOSURE. IF BREATHING HAS STOPPED OR IS IRREGULAR, ADMINISTER ARTIFICIAL RESPIRATION AND SUPPLY OXYGEN IF IT IS AVAILABLE. IF VICTIM IS UNCONSCIOUS, REMOVE TO FRESH AIR AND SEEK MEDICAL ATTENTION.
INGESTION	MAY ACT AS A LAXATIVE. DO NOT INDUCE VOMITING.

V PERSONAL HEALTH PROTECTION INFORMATION

EYE PROTECTION	EYE PROTECTION IS NOT REQUIRED UNDER CONDITIONS OF NORMAL USE. IF MATERIAL IS HANDLED SUCH THAT IT COULD BE SPLASHED INTO EYES, WEAR PLASTIC FACE SHIELD OR SPLASH-PROOF SAFETY GOGGLES.
SKIN PROTECTION	NO SKIN PROTECTION IS REQUIRED FOR SINGLE, SHORT DURATION EXPOSURES. FOR PROLONGED OR REPEATED EXPOSURES. USE IMPERVIOUS SYNTHETIC RUBBER CLOTHING (BOOTS, GLOVES, APRONS, ETC.) OVER PARTS OF THE BODY SUBJECT TO EXPOSURE. IF HANDLING HOT MATERIAL, USE INSULATED PROTECTIVE CLOTHING (BOOTS, GLOVES, APRONS, ETC.).
RESPIRATORY PROTECTION	RESPIRATORY PROTECTION IS NOT REQUIRED UNDER CONDITIONS OF NORMAL USE. IF VAPOR OR MIST IS GENERATED WHEN THE MATERIAL IS HEATED OR HANDLED, USE AN ORGANIC VAPOR RESPIRATOR WITH A DUST AND MIST FILTER. ALL RESPIRATORS MUST BE NIOSH CERTIFIED. DO NOT USE COMPRESSED OXYGEN IN HYDROCARBON ATMOSPHERES.
VENTILATION	IF VAPOR OR MIST IS GENERATED WHEN THE MATERIAL IS HEATED OR HANDLED, ADEQUATE VENTILATION IN ACCORDANCE WITH GOOD ENGINEERING PRACTICE MUST BE PROVIDED TO MAINTAIN CONCENTRATIONS BELOW THE SPECIFIED EXPOSURE OR FLAMMABLE LIMITS.
OTHER	CONSUMPTION OF FOOD AND BEVERAGE SHOULD BE AVOIDED IN WORK AREAS WHERE HYDROCARBONS ARE PRESENT. ALWAYS WASH HANDS AND FACE WITH SOAP AND WATER BEFORE EATING, DRINKING, OR SMOKING.

VI FIRE PROTECTION INFORMATION

FLASH POINT	265F	TEST METHOD	C.O.C.
AUTOIGNITION TEMPERATURE	>600F	TEST METHOD	NO DATA
FLAMMABLE LIMITS IN AIR % BY VOL	LOWER NO DATA	UPPER NO DATA	

EXTINGUISHING MEDIA	USE DRY CHEMICAL, FOAM, OR CARBON DIOXIDE.
SPECIAL FIRE FIGHTING PROCEDURES	WATER MAY BE INEFFECTIVE BUT CAN BE USED TO COOL CONTAINERS EXPOSED TO HEAT OR FLAME. CAUTION SHOULD BE EXERCISED WHEN USING WATER OR FOAM AS FROTHING MAY OCCUR, ESPECIALLY IF SPRAYED INTO CONTAINERS OF HOT, BURNING LIQUID.
UNUSUAL FIRE AND EXPLOSIVE CONDITIONS	DENSE SMOKE MAY BE GENERATED WHILE BURNING. CARBON MONOXIDE, CARBON DIOXIDE, AND OTHER OXIDES MAY BE GENERATED AS PRODUCTS OF COMBUSTION.

VII REACTIVITY DATA

STABILITY (THERMAL, LIGHT, ETC.)	STABLE	CONDITIONS TO AVOID	NONE
HAZARDOUS POLYMERIZATION	WILL NOT OCCUR	CONDITIONS TO AVOID	NONE

INCOMPATIBILITY MATERIALS TO AVOID	MAY REACT WITH STRONG OXIDIZING AGENTS.
HAZARDOUS DECOMPOSITION PRODUCTS	NONE

VIII ENVIRONMENTAL PRECAUTIONS

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	CONSULT HEALTH EFFECT INFORMATION IN SECTION III, PERSONAL HEALTH PROTECTION INFORMATION IN SECTION V, FIRE PROTECTION INFORMATION IN SECTION VI, AND REACTIVITY DATA IN SECTION VII. NOTIFY APPROPRIATE AUTHORITIES OF SPILL. CONTAIN SPILL IMMEDIATELY. DO NOT ALLOW SPILL TO ENTER SEWERS OR WATERCOURSES. REMOVE ALL SOURCES OF IGNITION. ABSORB WITH APPROPRIATE INERT MATERIAL SUCH AS SAND, CLAY, ETC.. LARGE SPILLS MAY BE PICKED UP US VACUUM PUMPS, SHOVELS, BUCKETS, OR OTHER MEANS AND PLACED IN DRUMS OR OTHER SUITABLE CONTAINERS.
WASTE DISPOSAL METHOD	ALL DISPOSALS MUST COMPLY WITH FEDERAL, STATE, AND LOCAL REGULATIONS. THE MATERIAL, IF SPILLED OR DISCARDED, MAY BE A REGULATED WASTE. REFER TO STATE AND LOCAL REGULATIONS. CAUTION! IF REGULATED SOLVENTS ARE USED TO CLEAN UP SPILLED MATERIAL, THE RESULTING WASTE MIXTURE MAY BE REGULATED. DEPARTMENT OF TRANSPORTATION (DOT) REGULATIONS MAY APPLY FOR TRANSPORTING THIS MATERIAL WHEN SPILLED. WASTE MATERIAL MAY BE LANDFILLED OR INCINERATED AT AN APPROVED FACILITY. MATERIALS SHOULD BE RECYCLED IF POSSIBLE.

IX MISCELLANEOUS

HANDLING AND STORAGE REQUIREMENTS	DO NOT TRANSFER TO UNMARKED CONTAINERS. STORE IN CLOSED CONTAINERS AWAY FROM HEAT, SPARKS, OPEN FLAME, OR OXIDIZING MATERIALS. THIS PRODUCT IS NOT CLASSIFIED AS HAZARDOUS UNDER DOT REGULATIONS. FIRE EXTINGUISHERS SHOULD BE KEPT READILY AVAILABLE. SEE NFPA 30 AND OSHA 1910.106--FLAMMABLE AND COMBUSTIBLE LIQUIDS.
ADDITIONAL INFORMATION	NO ADDITIONAL INFORMATION.

X PHYSICAL PROPERTIES

BOILING POINT	510F	PERCENT VOLATILE	NIL
MELTING POINT	N/A	VAPOR DENSITY (AIR=1)	< 1
APPEARANCE	TRANSPARENT, WHITE LIQUID	EVAPORATION RATE (EE=1)	< 1
ODOR	ODORLESS	SPECIFIC GRAVITY	APPROX 0.80 @ 60/60F
VAPOR PRESSURE	< 1 MM HG @ 70F	MOLECULAR WEIGHT	VARIES
SOLUBILITY	SOLUBLE IN HYDROCARBONS		

HSDB

Topic: MINERAL OIL

ADMINISTRATIVE INFORMATION
Hazardous Substance DataBank Number:
1. 1922
Last Revision Date:
1. 941228
Update History:
1. Field Update on 12/28/94, 1 field added/edited/deleted.
2. Field Update on 11/03/94, 1 field added/edited/deleted.
3. Field Update on 11/02/94, 1 field added/edited/deleted.
4. Field Update on 08/02/94, 1 field added/edited/deleted.
5. Complete Update on 08/07/93, 1 field added/edited/deleted.
6. Complete Update on 05/25/93, 1 field added/edited/deleted.
7. Field update on 12/22/92, 1 field added/edited/deleted.
8. Complete Update on 01/23/92, 1 field added/edited/deleted.
9. Complete Update on 06/04/90, 5 fields added/edited/deleted.
10. Field Update on 05/14/90, 1 field added/edited/deleted.
11. Field Update on 01/15/90, 1 field added/edited/deleted.
12. Complete Update on 01/11/90, 3 fields added/edited/deleted.
13. Complete Update on 01/27/89, 1 field added/edited/deleted.
14. Complete Update on 04/24/87, 37 fields added/edited/deleted.

SUBSTANCE IDENTIFICATION
Name of Substance:
1. MINERAL OIL
CAS Registry Number:
1. 8012-95-1
Synonyms:
1. ADEPSINE OIL **QC REVIEWED**
2. ALBOLINE **QC REVIEWED**
3. BAYOL F **QC REVIEWED**
4. FLEXON 845 **PEER REVIEWED**
5. GLYMOL **QC REVIEWED**
6. HEAVY LIQUID PETROLATUM **QC REVIEWED** [Osol, A. (ed.). Remington's Pharmaceutical Sciences. 16th ed. Easton, Pennsylvania: Mack Publishing Co., 1980. 746
7. HEAVY MINERAL OIL **PEER REVIEWED** [American Hospital Formulary Service. Volumes I and II. Washington, DC: American Society of Hospital Pharmacists, to 1984.,p. 56:12
8. IRGAWAX 361 **PEER REVIEWED**
9. KAYDOL **QC REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 85/8412
10. LIQUID PARAFFIN **QC REVIEWED** [The Merck Index. 10th ed.

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Rahway, New Jersey: Merck Co., Inc., 1983. 1033
11. LIQUID PETROLATUM **QC REVIEWED** [Osol, A. (ed.). Remington's Pharmaceutical Sciences. 16th ed. Easton, Pennsylvania: Mack Publishing Co., 1980. 746
12. LIQUID VASELINE **PEER REVIEWED** [Rossoff, I.S. Handbook of Veterinary Drugs. New York: Springer Publishing Company, 1974. 366
13. NUJOL **QC REVIEWED**
14. PARAFFIN OIL **PEER REVIEWED**
15. PARAFFIN OILS **PEER REVIEWED**
16. PAROLEINE **QC REVIEWED**
17. PETROLATUM, LIQUID **PEER REVIEWED**
18. PRIMOL D **PEER REVIEWED**
19. SAXOL **QC REVIEWED**
20. SHELLFLEX 371N **PEER REVIEWED**
21. SUNPAR 150 **PEER REVIEWED**
22. ULTROL 7 **PEER REVIEWED**
23. UVASOL **PEER REVIEWED**
24. WHITE MINERAL OIL **QC REVIEWED**
25. WHITE OILS **PEER REVIEWED** [Rossoff, I.S. Handbook of Veterinary Drugs. New York: Springer Publishing Company, 1974. 366
26. Balneol **QC REVIEWED**
27. Blandlube **QC REVIEWED**
28. Kondremul **QC REVIEWED**
29. MagieSol 44 **QC REVIEWED**
30. Mineral oils **QC REVIEWED**
31. Neo-Cultol **QC REVIEWED**
32. Paraffins **QC REVIEWED**
33. Petrogalar **QC REVIEWED**
34. Petrolatum, liq **QC REVIEWED**
35. Agoral **QC REVIEWED** [component of
36. Alpha Keri **QC REVIEWED** [component of
37. Keri Lotion **QC REVIEWED** [component of
38. Crystosol **QC REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 85/8412
39. Drakeol **QC REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 85/8412
40. Fonoline **QC REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety

Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 85/8412

41. Bayol 55 **QC REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 85/8412
42. Molol **QC REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 85/8412
43. Parol **QC REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 85/8412
44. Peneteck **QC REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 85/8412
45. Penreco **QC REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 85/8412
46. Perfecta **QC REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 85/8412
47. Primol 355 **QC REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 85/8412
48. Protopet **QC REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances

(RTECS). National Library of Medicine's current MEDLARS file.,p. 85/8412

49. Tech Pet F **QC REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 85/8412

Molecular Formula:

1. UVCB **QC REVIEWED**

RTECS Number:

1. NIOSH/PY8030000

MANUFACTURE/USE INFORMATION

Methods of Manufacturing:

1. ...BY REFINING CRUDER LUBRICATING OILS TO REMOVE UNSATURATED OR VOLATILE COMPOUNDS, AS WELL AS RESINS & COMPOUNDS OF NITROGEN & SULFUR. LIQUID PETROLATUM CONSISTS LARGELY OF SATURATED ALIPHATIC (C14 TO C18) & CYCLIC HYDROCARBONS. **QC REVIEWED** [Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. II-156
2. AN OIL EITHER PRESSED OR DRY-DISTILLED FROM PARAFFIN DISTILLATE. **QC REVIEWED** [Hawley, G.G. The Condensed Chemical Dictionary. 10th ed. New York: Van Nostrand Reinhold Co., 1981. 774
3. AFTER REMOVING THE LIGHTER HYDROCARBONS FROM PETROLEUM...THE RESIDUE IS AGAIN.../DISTILLED/ BETWEEN 330-390 DEG C & THE DISTILLATE TREATED FIRST WITH SULFURIC ACID, THEN SODIUM HYDROXIDE &...DECOLORIZED BY FILTERING... THE PURIFIED PRODUCT IS AGAIN CHILLED, TO REMOVE PARAFFIN, & REDISTILLED @ TEMP ABOVE 330 DEG C. **QC REVIEWED** [Osol, A. (ed.). Remington's Pharmaceutical Sciences. 16th ed. Easton, Pennsylvania: Mack Publishing Co., 1980. 746

Impurities:

1. Polynuclear aromatic compounds have been detected in samples of mineral oil for medicinal and cosmetic uses **QC REVIEWED** [IARC MONOGRAPHS 1972-PRESENT V33 p.94

Formulations/Preparations:

1. MINERAL OIL, USP (LIQUID PETROLATUM), IS AVAILABLE IN NUMEROUS PREPN, OFTEN UNDER VARIOUS TRADE NAMES. **PEER REVIEWED** [Gilman, A. G., L. S. Goodman, and A. Gilman. (eds.). Goodman and Gilman's The Pharmacological Basis of Therapeutics. 6th ed. New York: Macmillan Publishing Co., Inc. 1980. 1009
2. AGORAL, PLAIN (PARKE, DAVIS), FLEET MINERAL OIL ENEMA (FLEET), KONDREMUL PLAIN (FISONS), PETROGALAR, PLAIN (WYETH) (ALL NONPRESCRIPTION). **QC REVIEWED** [American Medical Association, AMA Department of Drugs. AMA Drug

Evaluations. 5th ed. Chicago: American Medical Association, 1983. 1308

3. DOMOL (DOME), LUBATH (WARNER/LAMBERT), SURFOL (STIEFEL). **PEER REVIEWED** [American Medical Association, AMA Department of Drugs. AMA Drug Evaluations. 4th ed. Chicago: American Medical Association, 1980. 1015
4. JELLY, ORAL, 55% WEIGHT/WEIGHT (NEO-CULTOL); OIL (NUJOL); OIL, RECTAL (FLEET MINERAL OIL ENEMA); SUSPENSION, ORAL 1.6 ML/5 ML (AGORAL PLAIN); 2.75 ML/5 ML (KONDREMUL PLAIN EMULSION) & 3.25 ML/5 ML (PETROGALAR PLAIN). /MINERAL OIL, HEAVY/ **PEER REVIEWED** [American Hospital Formulary Service. Volumes I and II. Washington, DC: American Society of Hospital Pharmacists, to 1984.,p. 56:12
5. OIL, RECTAL (SAF-TIP OIL RETENTION ENEMA); OIL (AVAILABLE BY NONPROPRIETARY NAME). /MINERAL OIL, LIGHT/ **PEER REVIEWED** [American Hospital Formulary Service. Volumes I and II. Washington, DC: American Society of Hospital Pharmacists, to 1984.,p. 56:12
6. Britol (RE Carroll); Sontex (Marathon); Drakeol, Parol, Peneteck (Penreco); Semtol, Kaydol, Orzol, Gloria, Protol, Carnation, Klearol, Blandol, Rudol, Ervol, Benol (Witco) **QC REVIEWED** [CHEMCYCLOPEDIA 1986 p.124
7. Medical /and technical/ white oils may contain alpha-tocopherol (Vitamin E) at levels up to 10 mg/kg as an antioxidant **QC REVIEWED** [IARC MONOGRAPHS 1972-PRESENT V33 p.94

Manufacturers:

1. American Oil & Supply Co, An AOSI Co, 238 Wilson Ave, Newark, NJ 07105, (201)589-0250 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
2. ARCO Petroleum Prod Co, Div of Atlantic Richfield Co, 400 E Sibley Blvd, Harvey, IL 60426, (312)210-3544 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.43
3. Avatar Corp, 7728 W 99 St, Hickory Hills, IL 60457, (312)430-4200 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
4. BP Oil Inc, PO Box 5155, Cleveland, OH 44101, (216)271-8207 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
5. Exxon Co USA, PO Box 2180, Houston, TX 77252-2180, (713)656-3636 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
6. E H Kellogg & Co, Inc, 63 First St, Mt Vernon, NY 10550, (914)664-3045 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
7. Magie Bros Oil, Div Pennzoil, 9101 Fullerton Ave, Franklin Park, IL 60131, (312)625-2600 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
8. Marathon Marco Co, 539 S Main St, Findlay, OH 45840,

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(419)422-2121 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437

9. Mobil Oil Corp, Special Products Div, 5151 Beltline Rd, Dallas, TX 75240, (214)851-5250 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
10. Non-Fluid Oil Corp, 298 Delancy St, Newark, NJ 07105, (201)344-3451 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
11. Penreco, 106 S Main St, Butler, PA 16001, (412)283-5600 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
12. Sea Land Chemical Co, 14820 Detroit Ave, Cleveland, OH 44107, (216)221-5106 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
13. Shell Chem Co, Chemical Sales, 1 Shell Plaza, Houston, TX 77002, (713)241-6161 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
14. Standard Oil Co, (Ohio), PO Box 5155, Cleveland, OH 44101, (216)271-8207 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
15. Stevenson Bro & Co, Inc, 1039 W Venango St, Philadelphia, PA 19140, (215)223-2600 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
16. Total Petroleum Inc, East Superior St, Alma, MI 48801, (517)463-1161 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
17. US Petrochem Co, Inc, 63 E St, Mt. Vernon, NY 10550, (914)664-3045 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
18. Vescosity Oil Co, 3200 S Western Avenue, Chicago, IL 60608, (312)847-0224 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
19. Witco Golden Bear Div, 10100 Santa Monica Blvd, Suite 1470, Los Angeles, CA 90067, (213)277-4511 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
20. Witco Chemical, Kendall/Amalie Div, 77 N Kendall Ave, Bradford, PA 16701, (814)368-6111 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
21. Witco Chemical Corp, Sonneborn Div, 520 Madison Ave, New York, NY 10022, (212)605-3908 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437
22. Witco Chemical Corp, Southwest Petrochem Div, 8400 W 110 St, Bldg 25, Overland Park, KS 66210, (913)383-5000 **QC REVIEWED** [CHEMICALWEEK BUYERS' GUIDE '86 p.437

Other Manufacturing Information:

1. A MIXTURE OF LIQUID HYDROCARBONS FROM PETROLEUM. **QC REVIEWED** [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 1033
2. LIGHT MINERAL OIL IS SIMILAR TO MINERAL OIL BUT LOWER MOLECULAR WEIGHT HYDROCARBONS PREDOMINATE, RESULTING IN

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LOWER VISCOSITY & SPECIFIC GRAVITY. /LIGHT MINERAL OIL/ **QC REVIEWED** [American Hospital Formulary Service. Volumes I and II. Washington, DC: American Society of Hospital Pharmacists, to 1984.,p. 56:12

3. GRADES: BY VISCOSITY & COLOR. **QC REVIEWED** [Hawley, G.G. The Condensed Chemical Dictionary. 10th ed. New York: Van Nostrand Reinhold Co., 1981. 774
4. OILS MAY CONTAIN TOCOPHEROL OR BUTYLATED HYDROXYTOLUENES TO INHIBIT OXIDATION. /HEAVY & LIGHT/ **PEER REVIEWED** [American Hospital Formulary Service. Volumes I and II. Washington, DC: American Society of Hospital Pharmacists, to 1984.,p. 56:12
5. /LIQUID PETROLATUM IS/ THE OFFICIAL USP NAME FOR A MIXTURE OF REFINED LIQ HYDROCARBONS OF HIGH VISCOSITY. **QC REVIEWED** [Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. II-156
6. ...IT HAS BEEN DIFFICULT FOR MANY TO ACCEPT WHEN THE UNITED STATES PERMITS ITS USE IN ANIMAL FEEDS TO REDUCE DUSTINESS OF FEEDS OR MINERAL SUPPLEMENTS; AS A LUBRICANT IN PRODUCING PELLETS, CUBES, BLOCKS; & TO PREVENT SEGREGATION OF TRACE MINERALS IN MINERALIZED SALT... US REGULATIONS SET A MAXIMUM OF 3.0% FOR...USE IN MINERAL SUPPLEMENTS & 0.06% OF THE TOTAL RATION WHEN USED IN FEED OR FEED CONCENTRATES. **QC REVIEWED** [Rossoff, I.S. Handbook of Veterinary Drugs. New York: Springer Publishing Company, 1974. 367
7. ...AIRBORNE MIST OF PETROLEUM-BASE CUTTING OILS OR WHITE MINERAL PETROLEUM OIL. /OIL MIST (MINERAL)/ **PEER REVIEWED** [American Conference of Governmental Industrial Hygienists, Inc. Documentation of the Threshold Limit Values, 4th ed., 1980. Cincinnati, Ohio: American Conference ofGovernmmental Industrial Hygienists, Inc., 1980. 314
8. VET: TOPICALLY, IT HAS BEEN USED AS A VEHICLE IN OINTMENTS (INCL OPHTHALMIC), WOUND DRESSINGS, & INTRAMAMMARY PRODUCTS. ARGUMENTS AGAINST ITS USE IN THE LATTER HAVE BEEN BASED ON THE POTENTIAL CARCINOGENICITY OF CERTAIN GRADES (FOR THE CONSUMER OF MILK) OR DIFFICULTY OF ELIMINATING LAST FEW DROPLETS FROM MAN'S FOOD SUPPLY. **PEER REVIEWED** [Rossoff, I.S. Handbook of Veterinary Drugs. New York: Springer Publishing Company, 1974. 367
9. IN REFINEMENT FOR HUMAN USE, AROMATIC AMINES & UNSATURATED HYDROCARBONS ARE REMOVED FROM PETROLEUM, LEAVING A VARIETY OF SATURATED HYDROCARBONS. PALATABILITY...IS IMPROVED WHEN IT IS EMULSIFIED WITH ACACIA. **QC REVIEWED** [American Hospital Formulary Service. Volumes I and II. Washington, DC: American Society of Hospital Pharmacists, to 1984.,p. 56:12

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10. PESTICIDE TOLERANCES & EXEMPTIONS FOR POSTHARVEST USE ON GRAIN CROPS: PESTICIDE TOLERANCES IN PPM: MINERAL OIL: 200 PPM ON CORN & GRAIN SORGHUM. /FROM TABLE/ **PEER REVIEWED** [White-Stevens, R. (ed.). Pesticides in the Environment: Volume 3. New York: Marcel Dekker, Inc., 1977. 304
11. MINERAL OIL IS COMBINED WITH PHENOLPHTHALEIN IN SOME MULTIPLE INGREDIENT /PRC: LAXATIVE/ PREPN. **PEER REVIEWED** [Miller, R. R., and D. J. Greenblatt. Handbook of Drug Therapy. New York: Elsevier North Holland, 1979. 1057
12. IT IS USED AS "FOOD-SAFE" LUBRICANT ON PANS, ROLLERS, BELTS, & MACHINERY IN CLOSE PROXIMITY TO MANY FOODS, & AS A DEFOAMING AGENT IN FOODS. IT IS A COMMON OR MAIN INGREDIENT IN "BABY OILS" OR AGENTS USED TO IMPROVE SHEEN OF LIVESTOCK HAIR FOR SHOWS. APPARENTLY SUCCESSFUL AS THE MAIN INGREDIENT IN VIGOROUSLY APPLIED TOPICAL OILS FOR NON-SPECIFIC DERMATITIS OR SEBORRHEAS IN DOGS. TOPICALLY, AS A MITICIDE FOR SNAKES (BY IMMERSION), & AS AN INSECTICIDE ADJUVANT ON MANY CLASSES OF LIVESTOCK. IT HAS BEEN USED AGAINST EAR MITES. APPLIED TOPICALLY WITHIN THE CLOACA IT HAS BEEN OF VALUE IN EGG BOUND CAGED BIRDS. MORTALITY AND HYPERKERATOSIS ASSOCIATED WITH TOPICAL APPLICATION IN YOUNG CHICKS APPEARS TO BE SECONDARY TO MICROBIAL INFECTION. HAS BEEN USED AS A CAPILLARY SEAL FOR EGGS IN COLD STORAGE. **QC REVIEWED** [Rossoff, I.S. Handbook of Veterinary Drugs. New York: Springer Publishing Company, 1974. 367

Major Uses:

1. INGREDIENT IN VARIOUS PHARMACEUTICAL PREPARATIONS **PEER REVIEWED** [Gilman, A. G., L. S. Goodman, and A. Gilman. (eds.). Goodman and Gilman's The Pharmacological Basis of Therapeutics. 6th ed. New York: Macmillan Publishing Co., Inc. 1980. 952
2. FORMERLY AS A VEHICLE FOR DRUGS TO BE APPLIED TO NASAL MUCOUS MEMBRANES /LIGHT/ **PEER REVIEWED** [Gilman, A. G., L. S. Goodman, and A. Gilman. (eds.). Goodman and Gilman's The Pharmacological Basis of Therapeutics. 6th ed. New York: Macmillan Publishing Co., Inc. 1980. 952
3. CATHARTIC; VET: LAXATIVE, EXTERNALLY AS A PROTECTANT, LUBRICANT **QC REVIEWED** [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 1033
4. FLOOR TREATMENT **QC REVIEWED** [Hawley, G.G. The Condensed Chemical Dictionary. 10th ed. New York: Van Nostrand Reinhold Co., 1981. 774
5. LUBRICANT IN MFR OF FOOD PRODUCTS **PEER REVIEWED** [Furia, T.E. (ed.). CRC Handbook of Food Additives. 2nd ed. Cleveland: The Chemical Rubber Co., 1972. 402
6. AS A VEHICLE TO DISSOLVE OR SUSPEND MEDICINAL AGENTS

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PEER REVIEWED [American Hospital Formulary Service. Volumes I and II. Washington, DC: American Society of Hospital Pharmacists, to 1984.,p. 84:2408

7. AS DETERGENT FOR REMOVAL OF DERMATOLOGICAL PREPN /LIGHT/ **PEER REVIEWED** [American Hospital Formulary Service. Volumes I and II. Washington, DC: American Society of Hospital Pharmacists, to 1984.,p. 84:2408
8. IN CRACKING-FLOTATION METHOD OF GRAIN PRESERVATION **PEER REVIEWED** [White-Stevens, R. (ed.). Pesticides in the Environment: Volume 3. New York: Marcel Dekker, Inc., 1977. 269
9. IN FUNGICIDES **PEER REVIEWED** [White-Stevens, R. (ed.). Pesticides in the Environment: Volume 2. New York: Marcel Dekker, Inc., 1976. 90
10. SEE PETROLEUM OILS. IN INSECTICIDES; HERBICIDES /PETROLEUM OILS/ **QC REVIEWED** [Farm Chemicals Handbook 1984. Willoughby, Ohio: Meister Publishing Co., 1984.,p. A-15
11. Superfatting agent in soaps **QC REVIEWED** [KIRK-OTHMER ENCYC CHEM TECH 3RD ED 1978-PRESENT V21 p.177
12. Liquid defoamer in papermaking **QC REVIEWED** [KIRK-OTHMER ENCYC CHEM TECH 3RD ED 1978-PRESENT V16 p.807
13. Used in clear gel hair dressings **QC REVIEWED** [KIRK-OTHMER ENCYC CHEM TECH 3RD ED 1978-PRESENT V12 p.95
14. Pharmaceutical preparations (procesing aids, intestinal lubricants); cosmetics (cold creams, hair preparations); food applicants (release agents, binders, flotation sealants, defoamants, protective coatings); food packaging and processing; chemical and plastics industry (processing medium, extenders, plasticizers); and animal feed products /medical white oils/ **QC REVIEWED** [IARC MONOGRAPHS 1972-PRESENT V33 p.112
15. Cosmetics (hair oils, creams); textile-machine lubricants; horticultural sprays; wrapping paper; corrosion protection in meat-packing industry; and lubricants for watches, bicycles and spindles /technical white oils/ **QC REVIEWED** [IARC MONOGRAPHS 1972-PRESENT V33 p.112

U.S. Production:

1. (1986) ND **QC REVIEWED**

U.S. Imports:

1. (1984) 1.69X10+7 g **QC REVIEWED** [BUREAU OF THE CENSUS. U.S. IMPORTS FOR CONSUMPTION AND GENERAL IMPORTS 1984 p.1-386

U.S. Exports:

1. (1984) 7.49X10+7 g /medicinal and non-medicinal/ **QC REVIEWED** [BUREAU OF THE CENSUS. U.S. EXPORTS, SCHEDULE E, 1984 p.2-63 and 2-65

CHEMICAL & PHYSICAL PROPERTIES

Color/Form:

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Topic: MINERAL OIL

1. COLORLESS, OILY LIQ **QC REVIEWED** [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 1033

Boiling Point:

1. 360 DEG C **PEER REVIEWED** [National Fire Protection Association. Fire Protection Guide on Hazardous Materials. 7th ed. Boston, Mass.: National Fire Protection Association, 1978.,p. 325M-146

Density/Specific Gravity:

1. 0.875-0.905 **QC REVIEWED** [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 1033

Solubilities:

1. INSOL IN WATER, ALCOHOL; SOL IN BENZENE, CHLOROFORM, ETHER, CARBON DISULFIDE, PETROLEUM ETHER **QC REVIEWED** [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 1033
2. MISCIBLE WITH MOST FIXED OILS; NOT MISCIBLE WITH CASTOR OIL; SOL IN VOLATILE OILS **QC REVIEWED** [Osol, A. (ed.). Remington's Pharmaceutical Sciences. 16th ed. Easton, Pennsylvania: Mack Publishing Co., 1980. 746

Surface Tension:

1. @ 25 DEG C SLIGHTLY BELOW 35 DYNES/CM **QC REVIEWED** [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 1033

Viscosity:

1. KINEMATIC VISCOSITY NOT LESS THAN 38.1 CENTISTOKES @ 37.8 DEG C **QC REVIEWED** [Osol, A. (ed.). Remington's Pharmaceutical Sciences. 16th ed. Easton, Pennsylvania: Mack Publishing Co., 1980. 746

Other Chemical/Physical Properties:

1. DEVELOPS NOT MORE THAN A FAINT ODOR OF PETROLEUM WHEN HEATED; FREE OR NEARLY FREE FROM FLUORESCENCE **QC REVIEWED** [Osol, A. (ed.). Remington's Pharmaceutical Sciences. 16th ed. Easton, Pennsylvania: Mack Publishing Co., 1980. 746
2. BURNED LUBE OIL ODOR /OIL MIST (MINERAL)/ **PEER REVIEWED** [American Conference of Governmental Industrial Hygienists, Inc. Documentation of the Threshold Limit Values, 4th ed., 1980. Cincinnati, Ohio: American Conference ofGovernmmental Industrial Hygienists, Inc., 1980. 314

SAFETY & HANDLING

Flammable Properties

NFPA Hazard Classification:

1. Health 0. 0= Materials which on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material. **QC REVIEWED** [National Fire Protection Association. Fire Protection Guide on Hazardous Materials. 7th ed. Boston, Mass.: National Fire Protection Association, 1978.,p. 325M-146

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2. Flammability 1. 1= Materials that must be preheated before ignition can occur. Water may cause frothing if it gets below the surface of the liquid and turns to steam. However, water fog gently applied to the surface will cause frothing which will extinguish the fire. **QC REVIEWED** [National Fire Protection Association. Fire Protection Guide on Hazardous Materials. 7th ed. Boston, Mass.: National Fire Protection Association, 1978.,p. 325M-146
3. Reactivity 0. 0= Materials which (in themselves) are normally stable even under fire exposure conditions and which are not reactive with water. Normal fire fighting procedures may be used. **QC REVIEWED** [National Fire Protection Association. Fire Protection Guide on Hazardous Materials. 7th ed. Boston, Mass.: National Fire Protection Association, 1978.,p. 325M-146

Flash Point:

1. 193 DEG C OC **PEER REVIEWED** [National Fire Protection Association. Fire Protection Guide on Hazardous Materials. 7th ed. Boston, Mass.: National Fire Protection Association, 1978.,p. 325M-146
2. 229 DEG C CC /PARAFFIN OIL/ **QC REVIEWED** [National Fire Protection Association. Fire Protection Guide on Hazardous Materials. 7th ed. Boston, Mass.: National Fire Protection Association, 1978.,p. 325M-154

Fire Fighting Information

Fire Fighting Procedures:

1. WATER OR FOAM MAY CAUSE FROTHING. **PEER REVIEWED** [National Fire Protection Association. Fire Protection Guide on Hazardous Materials. 7th ed. Boston, Mass.: National Fire Protection Association, 1978.,p. 325M-146

Other Safety & Handling

Stability/Shelf Life:

1. OXIDATION & PEROXIDATION WHEN IT OCCURS IN MINERAL OILS CONTINUES ALMOST @ LOGARITHMIC RATE **PEER REVIEWED** [Rossoff, I.S. Handbook of Veterinary Drugs. New York: Springer Publishing Company, 1974. 366

Shipment Methods and Regulations:

1. CONTAINERS: UP TO TANK CARS. **QC REVIEWED** [Hawley, G.G. The Condensed Chemical Dictionary. 10th ed. New York: Van Nostrand Reinhold Co., 1981. 774

Disposal Methods:

1. SRP: At the time of review, criteria for land treatment or burial (sanitary landfill) disposal practices are subject to significant revision. Prior to implementing land disposal of waste residue (including waste sludge), consult with environmental regulatory agencies for guidance on acceptable disposal practices. **PEER REVIEWED**

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2. Incineration & landfill: Contaminated mineral oil can be disposed of by controlled incineration. An alternative can be the use of oily sand and debris for landfill at sites carefully chosen to avoid any risk of the oil causing contamination of water supplies. **QC REVIEWED** [United Nations. Treatment and Disposal Methods for Waste Chemicals (IRPTC File). Data Profile Series No. 5. Geneva, Switzerland: United Nations Environmental Programme, Dec. 1985. 211
3. Recycling & incineration: There are several stages of treatment. The final wastewater will probably require treatment, usually biological degradation, or perhaps carbon adsorption. The separated oil may be recycled, burnt for its heat content, incinerated if it is a difficult waste, or dumped. There are several ways of handling special wastes where the oil is relatively valuable and/or easily recoverable, and these include solvent extraction into an immiscible solvent, steam distillation, and air stripping of more volatile cmpd. It is always worth considering whether the recovery or reuse is technically and economically viable. **QC REVIEWED** [United Nations. Treatment and Disposal Methods for Waste Chemicals (IRPTC File). Data Profile Series No. 5. Geneva, Switzerland: United Nations Environmental Programme, Dec. 1985. 211
4. Adsorbed oil can be buried in an approved landfill. Scrap oil can be disposed of by proper incineration or via licensed waste disposal company. Recommendable methods: Incineration, open burning, solidification & landfill. Peer-review: Residual oil can be solidified by mixing with calcium oxide. Small amt of heavy oils can be landfilled. (Peer-review conclusions of an IRPTC expert consultation (May 1985)) **QC REVIEWED** [United Nations. Treatment and Disposal Methods for Waste Chemicals (IRPTC File). Data Profile Series No. 5. Geneva, Switzerland: United Nations Environmental Programme, Dec. 1985. 211

TOXICITY/BIOMEDICAL EFFECTS

Summary

Antidote and Emergency Treatment:

1. ALTHOUGH CONTROVERSIAL, EMESIS IS INDICATED IN SOME HYDROCARBON INGESTIONS, ESPECIALLY WHEN ABSORPTION MAY PRODUCE SYSTEMIC EFFECTS. ...MINERAL OIL /IS/...CONSIDERED TO BE RELATIVELY NONTOXIC & /DOES NOT/...REQUIRE VOMITING. **PEER REVIEWED** [Doull, J., C.D. Klaassen, and M. D. Amdur (eds.). Casarett and Doull's Toxicology. 2nd ed. New York: Macmillan Publishing Co., 1980. 687
2. IN A CASE OF CHRONIC MINERAL OIL PNEUMONIA (CAUSED BY LAXATIVE ADMIN), EXPTL TREATMENT WITH SCHEDULED COUGHING SPELLS & EXPECTORATION CAN IMPROVE PT PROGNOSIS. **QC

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REVIEWED** [HECKERS H ET AL; LONG-TERM COURSE OF MINERAL OIL PNEUMONIA; LUNG 155 (2): 101-10 (1978)

Toxicity Excerpts

Human Toxicity Excerpts:

1. IF IT GAINS ACCESS TO LUNGS MINERAL OIL PRODUCES LIPID PNEUMONITIS. ALTHOUGH MORE FREQUENTLY OBSERVED WHEN OIL WAS USED AS VEHICLE FOR APPLICATION OF DRUGS TO NASAL MUCOUS MEMBRANES, LIPID PNEUMONITIS CAN ALSO OCCUR FOLLOWING ORAL INGESTION OF OIL, PARTICULARLY IF...TAKEN @ BEDTIME. ... LEAKAGE OF OIL PAST ANAL SPHINCTER IS AN ANNOYING SIDE EFFECT AND AN OCCASIONAL CAUSE OF PRURITUS ANI. IT IS ALSO CLAIMED THAT OIL INTERFERES WITH HEALING OF POSTOPERATIVE WOUNDS IN ANORECTAL REGION AND THAT CONTINUOUS PRESENCE OF OIL IN RECTUM DISTURBS NORMAL DEFECATORY REFLEXES. **QC REVIEWED** [Gilman, A. G., L. S. Goodman, and A. Gilman. (eds.). Goodman and Gilman's The Pharmacological Basis of Therapeutics. 6th ed. New York: Macmillan Publishing Co., Inc. 1980. 1009
2. MINERAL OIL ACTS AS A LIPID SOLVENT; ADMIN WITH MEALS, IT MAY INTERFERE WITH ABSORPTION OF ESSENTIAL FAT-SOLUBLE SUBSTANCES. REGULAR INGESTION OF MINERAL OIL DURING PREGNANCY MAY REDUCE ABSORPTION OF VITAMIN K & PRODUCE HYPOPROTHROMBINEMIA. /IN INTESTINAL TRACT/...ELICITS TYPICAL FOREIGN-BODY REACTION IN INTESTINAL MUCOSA, MESENTERIC LYMPH NODES, LIVER, AND SPLEEN. ALTHOUGH NO PHYSIOLOGICAL DISTURBANCES HAVE BEEN RELATED TO PRESENCE OF OIL AT THESE SITES, IT MUST BE QUESTIONED WHETHER /OIL/...CAN BE USED SAFELY OVER LONG PERIODS OF TIME. **QC REVIEWED** [Gilman, A. G., L. S. Goodman, and A. Gilman. (eds.). Goodman and Gilman's The Pharmacological Basis of Therapeutics. 6th ed. New York: Macmillan Publishing Co., Inc. 1980. 1009
3. ...IF TAKEN CONTINUOUSLY IN LARGE AMT IT MAY IMPAIR APPETITE... **QC REVIEWED** [Osol, A. (ed.). Remington's Pharmaceutical Sciences. 16th ed. Easton, Pennsylvania: Mack Publishing Co., 1980. 746
4. /IN NASAL DROPS & SPRAYS/...OIL GRAVITATES TO LOWER LOBES OF LUNGS, WHERE IT SETS UP A GRANULOMATOUS REACTION, FOLLOWED BY MARKED FIBROSIS & ENCYSTMENT. DAILY ORAL DOSES OF 30-90 ML FOR MANY MONTHS HAS PRODUCED THE SAME EFFECT. THE FATALITY OF THIS COMPLICATION IS HIGH. **PEER REVIEWED** [Thienes, C., and T.J. Haley. Clinical Toxicology. 5th ed. Philadelphia: Lea and Febiger, 1972. 192
5. IN AN INSTANCE OF POSSIBLE EMBOLISM FROM AN OIL INJECTION, ONE PT HAD RAPID LOSS OF VISION, SEVERE HEADACHE, CONVULSIONS, & COMA IMMEDIATELY AFTER INJECTION OF...MINERAL OIL PREPN, GRANUGENOL, INTO PLEURAL CAVITY IN TREATMENT OF EMPYEMA. RECOVERING GRADUALLY...WITHIN 3 WK

VISION HAD RETURNED ESSENTIALLY TO NORMAL. **PEER REVIEWED** [Grant, W. M. Toxicology of the Eye. 2nd ed. Springfield, Illinois: Charles C. Thomas, 1974. 803

6. LIQ PETROLATUM...CAN BE APPLIED TO HUMAN EYES WITHOUT CAUSING DISCOMFORT OR SIGNS OF IRRITATION. **PEER REVIEWED** [Grant, W. M. Toxicology of the Eye. 2nd ed. Springfield, Illinois: Charles C. Thomas, 1974. 801
7. MASSIVE VISCERAL LIPID DEPOSITION FOLLOWING THE PROLONGED ORAL USE OF MINERAL OIL IS REPORTED. **QC REVIEWED** [NOCHOMOVITZ LE, UYS CJ; MASSIVE VISCERAL LIPID DEPOSITION FOLLOWING PROLONGED MINERAL OIL INGESTION; S AFR J LAB CLIN MED 20 (2): 1226 (1974)

Non-Human Toxicity Excerpts:

1. /PARENTERALLY IN VACCINES/...GRANULOMATOUS REACTIONS AT INJECTION SITES ARE NOT UNCOMMON. SIMILAR REACTIONS CAN OCCUR FROM ITS USE AS A LUBRICANT ON EXPLORATORY INSTRUMENTS... **PEER REVIEWED** [Rossoff, I.S. Handbook of Veterinary Drugs. New York: Springer Publishing Company, 1974. 367
2. REGULAR ORAL USE MAY INTERFERE WITH ABSORPTION OF FAT SOLUBLE VITAMINS...150 ML DAILY TO COWS CAUSED MARKED DECR IN CAROTENE & TOCOPHEROL BLOOD LEVELS AS WELL AS ACCELERATING POSTPARTURIENT DECR IN CAROTENE, VITAMIN A ESTER, TOCOPHEROL, & XANTHOPHYLL IN MILK...IT MAY ALSO PREVENT GROWTH OF INTESTINAL MICROORGANISMS AS FEEDING IT TO RATS PRODUCES VITAMIN K DEFICIENCY. **QC REVIEWED** [Rossoff, I.S. Handbook of Veterinary Drugs. New York: Springer Publishing Company, 1974. 366
3. EXPTL ANIMAL EXPOSURE STUDIES TO WHITE MINERAL OIL MIST (UNTREATED, & WITH NO ADDITIONS) FOR REPEATED DAILY 6-HR EXPOSURES FOR 1 YR @ 5 MG/CU M WERE ENTIRELY NEGATIVE IN ALL CRITERIA USED FOR MEASURING RESPONSE. ...100 MG/CU M RESULTED IN SOME SLIGHT CHANGES IN SOME BUT NOT ALL SPECIES EXPOSED; NO HISTOLOGIC CHANGES OF SIGNIFICANCE WERE NOTED; RESPIRATORY FUNCTION WAS NORMAL IN.../RABBITS/. ... EXPOSURE TO OIL MIST DID NOT APPEAR TO ACCELERATE PRODN OF LUNG TUMORS IN A LUNG-TUMOR SUSCEPTIBLE STRAIN OF MICE. /OIL MIST (MINERAL)/ **QC REVIEWED** [American Conference of Governmental Industrial Hygienists, Inc. Documentation of the Threshold Limit Values, 4th ed., 1980. Cincinnati, Ohio: American Conference ofGovernmmental Industrial Hygienists, Inc., 1980. 314
4. INJECTION OF MINERAL OIL...INTO ANTERIOR CHAMBER OF RABBITS, REPLACING THE AQUEOUS HUMOR, HAS BEEN USED TO OBSTRUCT AQUEOUS OUTFLOW & TO INDUCE GLAUCOMA EXPTL. THIS PRESUMABLY IS A MECHANICAL EFFECT RATHER THAN TOXIC REACTION. **PEER REVIEWED** [Grant, W. M. Toxicology of the Eye. 2nd ed. Springfield, Illinois: Charles C. Thomas,

1974. 803

5. RABBITS INJECTED IP WITH 30 CC PARAFFIN OIL SCORED AN UNUSUALLY HIGH FREQUENCY (2.8%) OF WELL-SPREAD METAPHASES IN THE PERITONEAL CAVITY. **QC REVIEWED** [PLASSARA M ET AL; RES J RETICULOENDOTHEL SOC 12: 340-2 (1972)
6. PLASMACYTOMAS WERE FOUND IN 58% OF 373 BALB/CANN (C) MICE GIVEN 3 0.5-ML DOSES OF MINERAL OIL. **QC REVIEWED** [POTTER M ET AL; J NATL CANCER INST 54 (6): 1413-8 (1975)
7. DOGS, RATS, MICE, & GERBILS WERE EXPOSED FOR 6 HR, 5 DAYS/WK UP TO 2 YR TO AN ATMOSPHERE CONTAINING A MINERAL OIL-BASE MIST @ CONCN OF 5 & 100 MG/CU M. ONLY @ 100 MG/CU M IN DOGS & RATS, BUT NOT IN MICE & GERBILS, DID MICROGRANULOMAS DEVELOP. **QC REVIEWED** [STULA EF, KWON BK; AM IND HYG ASSOC J 39 (5): 393-9 (1978)
8. Forty-seven mineral oils were tested for their ability to induce sebaceous gland suppression in female C3H/HeN or CF1 mice. Six groups of 5 mice were treated with 0, 1, 2, 3, 4 or 6 epidermal applications of one or more of 3 vol (0.2, 0.1 or 0.05 ml) of the test substance. The sebaceous gland suppression indices were calculated from the total numbers of sebaceous glands and hair follicles in 9 sections of treated skin from each mouse. Suppression curves were drawn by plotting the mean suppression indices against the number of applications of each oil sample. The suppression curves were compared with the cutaneous carcinogenic potentials of these mineral oils, assessed by long-term skin bioassays. All the carcinogenic oil samples induced suppression of sebaceous glands. The non-carcinogenic samples had no significant suppressant activity. There was a correlation between cutaneous carcinogenic activity and suppressant potential for all tested samples. Results of the suppression tests considered, together with the kinematic viscosities of the test substances, enabled accurate prediction of their cutaneous carcinogenic potential. **QC REVIEWED** [Peristianis GC; J Appl Toxicol 9 (4): 245-54 (1989)
9. Groups of 25 9-day-old chicken embryos were exposed to 10 or 20 ul pharmaceutical mineral oil on the eggshell. There were no mortalities or embryos with edema, ascites or liver lesions in either treated group. No histological changes were observed in the livers or kidneys, however embryos exposed to 20 ul mineral oil had slight dilation of the heart. Body wt, liver wt, crown-rump length, and body wt/crown-rump length ratio of the embryos exposed to mineral oil did not differ from those of controls. **QC REVIEWED** [Couillard CM, Leighton FA; Fundam Appl Toxicol 13 (1): 165-73 (1989)

Toxicity Values

Minimum Fatal Dose Level:

HSDB

Topic: MINERAL OIL

1. 1= PRACTICALLY NON-TOXIC: PROBABLE ORAL LETHAL DOSE (HUMAN) ABOVE 15 G/KG, MORE THAN 1 QUART (2.2 LB) FOR 70 KG PERSON (150 LB). **PEER REVIEWED** [Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984.,p. II-156

Pharmacokinetics

Absorption, Distribution and Excretion:

1. MINERAL OIL IS ABSORBED TO A LIMITED EXTENT FROM THE INTESTINAL TRACT... STABLE EMULSIONS OF OIL PENETRATE & SOFTEN STOOL MORE EFFECTIVELY THAN DOES NON-EMULSIFIED OIL... EMULSIFICATION ENHANCES ABSORPTION OF THE OIL. **QC REVIEWED** [Gilman, A. G., L. S. Goodman, and A. Gilman. (eds.). Goodman and Gilman's The Pharmacological Basis of Therapeutics. 6th ed. New York: Macmillan Publishing Co., Inc. 1980. 1009
2. VET: ...PARENTERALLY, IN...VACCINES TO PROLONG ANTIGEN EFFECT. HISTOLOGICAL STUDIES INDICATE THAT GREAT DEAL OF...OIL REMAINS AT INJECTION SITE FOR LONG TIME, WITH MACROPHAGES PICKING UP SMALL AMT & TRANSPORTING IT THROUGH LYMPHATIC SYSTEM. ITS ULTIMATE FATE IS STILL UNKNOWN. **PEER REVIEWED** [Rossoff, I.S. Handbook of Veterinary Drugs. New York: Springer Publishing Company, 1974. 367
3. ABSORPTION...IS REPORTEDLY MINIMAL FOLLOWING ORAL OR RECTAL ADMIN. /HEAVY & LIGHT MINERAL OIL/ **QC REVIEWED** [American Hospital Formulary Service. Volumes I and II. Washington, DC: American Society of Hospital Pharmacists, to 1984.,p. 56:12
4. ALTHOUGH 30-60% OF ORALLY ADMIN...EMULSION REPORTEDLY IS ABSORBED FROM INTESTINE, SOME CLINICIANS BELIEVE THAT THERE IS NO EVIDENCE THAT EMULSION IS ABSORBED TO A GREATER EXTENT THAN IS NONEMULSIFIED MINERAL OIL. **PEER REVIEWED** [American Hospital Formulary Service. Volumes I and II. Washington, DC: American Society of Hospital Pharmacists, to 1984.,p. 56:12
5. ON THE BASIS OF (14)C MEASUREMENTS IN RATS & SQUIRREL MONKEYS GIVEN MINERAL OIL EMULSIONS INCORPORATING N-[(14)C]HEXADECANE, SC OR IM, IT WAS CONCLUDED THAT MINERAL OIL WAS RETAINED FOR A LONG TIME @ THE INJECTION SITE. AFTER 1 MONTH, GREATER THAN 60% WAS STILL PRESENT THERE, & AFTER 10 MONTHS, GREATER THAN 25%. **PEER REVIEWED** [The Chemical Society. Foreign Compound Metabolism in Mammals. Volume 2: A Review of the Literature Published Between 1970 and 1971. London: The Chemical Society, 1972. 112

Mechanism of Action:

1. IT PENETRATES & SOFTENS THE STOOL; IT MAY ALSO INTERFERE WITH ABSORPTION OF WATER. **PEER REVIEWED** [Gilman, A. G., L. S. Goodman, and A. Gilman. (eds.). Goodman and

Topic: MINERAL OIL

Gilman's The Pharmacological Basis of Therapeutics. 6th ed. New York: Macmillan Publishing Co., Inc. 1980. 1009

2. ...PROMOTES BOWEL MOVEMENT BY RETARDING WATER REABSORPTION; THERE IS NO STIMULATION OF PERISTALSIS. **PEER REVIEWED** [Miller, R. R., and D. J. Greenblatt. Handbook of Drug Therapy. New York: Elsevier North Holland, 1979. 1057
3. Forty-seven mineral oils were tested for their ability to induce sebaceous gland suppression in female C3H/HeN or CF1 mice. Six groups of 5 mice were treated with 0, 1, 2, 3, 4 or 6 epidermal applications of one or more of 3 vol (0.2, 0.1 or 0.05 ml) of the test substance. The sebaceous gland suppression indices were calculated from the total numbers of sebaceous glands and hair follicles in 9 sections of treated skin from each mouse. Suppression curves were drawn by plotting the mean suppression indices against the number of applications of each oil sample. The suppression curves were compared with the cutaneous carcinogenic potentials of these mineral oils, assessed by long-term skin bioassays. All the carcinogenic oil samples induced suppression of sebaceous glands. The non-carcinogenic samples had no significant suppressant activity. There was a correlation between cutaneous carcinogenic activity and suppressant potential for all tested samples. Results of the suppression tests considered, together with the kinematic viscosities of the test substances, enabled accurate prediction of their cutaneous carcinogenic potential. **UNREVIEWED** [Peristianis GC; J Appl Toxicol 9 (4): 245-54 (1989)

Interactions:

1. DECREASED ABSORPTION OF VITAMIN A MAY OCCUR WITH CONCOMITANT ADMIN OF MINERAL OIL. **PEER REVIEWED** [Evaluations of Drug Interactions. 2nd ed. and supplements. Washington, DC: American Pharmaceutical Assn., 1976, 1978. 450
2. THE EFFECT OF WARFARIN MAY BE POTENTIATED DUE TO INTERFERENCE WITH VITAMIN K ABSORPTION. **PEER REVIEWED** [Miller, R. R., and D. J. Greenblatt. Handbook of Drug Therapy. New York: Elsevier North Holland, 1979. 1057

PHARMACOLOGY

Therapeutic Uses:

1. /ORALLY/ THE DOSE IS 15-45 ML, USUALLY TAKEN @ NIGHT BEFORE RETIRING. MINERAL OIL IS SOMEWHAT MORE PALATABLE IF...TAKEN WITH FRUIT JUICE OR AS MINERAL OIL EMULSION, USP. STABLE EMULSIONS...PENETRATE AND SOFTEN THE STOOL MORE EFFECTIVELY THAN DOES NONEMULSIFIED OIL, THEY CAUSE LESS DIFFICULTY WITH LEAKAGE...THROUGH ANAL SPHINCTER. MINERAL OIL IS ALSO AVAILABLE FOR RECTAL ADMIN AS MINERAL OIL ENEMA. **QC REVIEWED** [Gilman, A. G., L. S. Goodman,

and A. Gilman. (eds.). Goodman and Gilman's The Pharmacological Basis of Therapeutics. 6th ed. New York: Macmillan Publishing Co., Inc. 1980. 1009

2. IT HAS BEEN USED ORALLY TO LESSEN THE STRAIN OF EVACUATION OF INSPISSATED STOOL (...IN PT WITH HERNIA OR CARDIOVASCULAR DISEASE) OR RECTALLY TO EASE PASSAGE OF IMPACTED OR DRIED FECAL MATERIAL. **QC REVIEWED** [Osol, A. (ed.). Remington's Pharmaceutical Sciences. 16th ed. Easton, Pennsylvania: Mack Publishing Co., 1980. 1307
3. DOSAGE: ORAL: ...CHILDREN OVER 6 YEARS, 10-15 ML OF PLAIN MINERAL OIL @ BEDTIME OR 0.25-5 ML OF EMULSION TWO TIMES DAILY. RECTAL: ADULTS, 120 ML; CHILDREN OVER 6 YEARS, 60 ML. **QC REVIEWED** [Osol, A. (ed.). Remington's Pharmaceutical Sciences. 16th ed. Easton, Pennsylvania: Mack Publishing Co., 1980. 1308
4. /USED AS EMOLLIENTS IN BATH OIL/...HELPFUL IN ICHTHYOSIS OR PRURITIC & CHRONIC ECZEMATOUS DERMATOSIS. **PEER REVIEWED** [American Medical Association, AMA Department of Drugs. AMA Drug Evaluations. 4th ed. Chicago: American Medical Association, 1980. 1015
5. WHEN ADMIN ORALLY, MINERAL OIL & MINERAL OIL EMULSION PRODUCE LAXATION AFTER 6-8 HR. **PEER REVIEWED** [American Hospital Formulary Service. Volumes I and II. Washington, DC: American Society of Hospital Pharmacists, to 1984.,p. 56:12
6. ALTHOUGH MINERAL OIL EMULSIONS PENETRATE & SOFTEN FECAL MATERIAL MORE EFFECTIVELY & ARE MORE PALATABLE THAN PLAIN MINERAL OIL, THERE APPEARS TO BE LITTLE DIFFERENCE IN LAXATIVE EFFECTIVENESS BETWEEN THESE TWO PREPARATIONS. ...MAY ALSO BE ADMIN RECTALLY AS AN ENEMA. PLAIN (NONEMULSIFIED) MINERAL OIL SHOULD BE ADMIN ONLY @ BEDTIME ON AN EMPTY STOMACH. ...EMULSION MAY BE ADMIN WITH MEALS. DOSAGE OF...EMULSION IS EXPRESSED IN TERMS OF ITS MINERAL OIL CONTENT. CONTAINERS OF MINERAL OIL EMULSIONS SHOULD BE SHAKEN BEFORE USING. **QC REVIEWED** [American Hospital Formulary Service. Volumes I and II. Washington, DC: American Society of Hospital Pharmacists, to 1984.,p. 56:12
7. VET: ORALLY, AS A LAXATIVE WITH LIGHT GRADES (LOW VISCOSITY) EVEN HAVING SOME ADVANTAGE IN ANIMALS OVER HEAVY GRADES (HIGH VISCOSITY). **PEER REVIEWED** [Rossoff, I.S. Handbook of Veterinary Drugs. New York: Springer Publishing Company, 1974. 366
8. Vet: A preparation that contains 0.5% neomycin, 1% carbaryl, 9% sulfacetamide, 0.5% tetracaine, and 88.1% mineral oil is used in treatment of ear infections and ear mite infestations of small animals, including rabbits... **QC REVIEWED** [Booth, N.H., L.E. McDonald (eds.). Veterinary Pharmacology and Therapeutics. 5th ed. Ames,

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Iowa: Iowa State University Press, 1982. 668

Drug Warning:

1. ...CAN CAUSE VARIETY OF UNTOWARD EFFECTS, & ITS USE AS A LAXATIVE REQUIRES APPRECIATION OF ITS POTENTIAL HAZARDS... HABITUAL USE OF MINERAL OIL MUST BE AVOIDED. ... INDISCRIMINATE USE...BY ELDERLY, DEBILITATED, OR DYSPHAGIC INDIVIDUALS SHOULD BE DISCOURAGED. **QC REVIEWED** [Gilman, A. G., L. S. Goodman, and A. Gilman. (eds.). Goodman and Gilman's The Pharmacological Basis of Therapeutics. 6th ed. New York: Macmillan Publishing Co., Inc. 1980. 1009
2. ORAL USE FOR MORE THAN TWO WEEKS COATS THE MUCOSA OF THE SMALL INTESTINE AND REDUCES THE ADSORPTION OF VITAMINS, ESPECIALLY THE FAT-SOLUBLE VITAMINS (A, D, E, AND K). THE PATIENT SHOULD BE WARNED THAT LIPID PNEUMONIA MAY OCCUR IF MINERAL OIL IS ASPIRATED AND THAT UNTOWARD EFFECTS, SUCH AS HEPATIC INFILTRATION, CAN RESULT FROM ITS ABSORPTION. BECAUSE OF THE THEORETICAL POSSIBILITY THAT CONCURRENT USE OF THE VARIOUS DETERGENT DOCUSATE SALTS MAY FURTHER ENHANCE THE ABSORPTION OF MINERAL OIL, THEIR CONCOMITANT ADMINISTRATION IS NOT RECOMMENDED. **QC REVIEWED** [Osol, A. (ed.). Remington's Pharmaceutical Sciences. 16th ed. Easton, Pennsylvania: Mack Publishing Co., 1980. 1307
3. MINERAL OIL STILL PRESCRIBED BY SOME SURGEONS AFTER ANORECTAL SURGERY DESPITE THE FACT THAT IT SOMETIMES CAUSES PRURITUS ANI, & LACERATION OF THE AREA FROM SCRATCHING OR RUBBING INTERFERES WITH HEALING. **QC REVIEWED** [Osol, A. (ed.). Remington's Pharmaceutical Sciences. 16th ed. Easton, Pennsylvania: Mack Publishing Co., 1980. 1308

EXPOSURE STANDARDS & REGULATIONS

Occupational Permissible Levels

Threshold Limit Values:

1. 8-Hr Time Weighted Avg (TWA) 5 mg/cu m; Short Term Exposure Limit (STEL) 10 mg/cu m; as sampled by method that does not collect vapor (1976) /Oil mist, mineral/ **QC REVIEWED** [American Conference of Governmental Industrial Hygienists. Threshold Limit Values for Chemical Substances and Physical Agents and Biological ExposureIndices for 1993-1994. Cincinnati, OH: ACGIH, 1993. 28

Other Standards and Regulations

FDA Requirements:

1. FDA NUMBER: 121.1099; LIMITATIONS: IN DEFOAMING AGENTS LIMITED TO USE IN PROCESSING BEET SUGAR & YEAST; UP TO 150 PPM IN YEAST, MEASURED AS HYDROCARBONS. **PEER REVIEWED** [Furia, T.E. (ed.). CRC Handbook of Food Additives. 2nd ed. Cleveland: The Chemical Rubber Co., 1972. 899

MONITORING AND ANALYSIS METHODS

HSDB

Topic: MINERAL OIL

Analytic Laboratory Methods:

1. COLUMN CHROMATOGRAPHY OF MINERAL OIL IN BAKED PRODUCTS. **PEER REVIEWED** [Association of Official Analytical Chemists. Official Methods of Analysis. 10th ed. and supplements. Washington, DC: Association of Official Analytical Chemists, 1965. New editions through13th ed. plus supplements, 1982.,p. 13/226 14.117
2. DETERMINATION OF MINERAL OIL IN FATS. **PEER REVIEWED** [Association of Official Analytical Chemists. Official Methods of Analysis. 10th ed. and supplements. Washington, DC: Association of Official Analytical Chemists, 1965. New editions through13th ed. plus supplements, 1982.,p. 13/458 28.122
3. USE OF 1,1,2-TRICHLOROTRIFLUOROETHANE FOR THE QUANTITATIVE DETERMINATION OF MINERAL OIL AIR SAMPLE BY UV ABSORPTION. **QC REVIEWED** [WALDRON T; USE OF 1,1,2-TRICHLOROTRIFLUOROETHANE FOR THE QUANTITATIVE DETERMINATION OF MINERAL OIL AIR SAMPLE CONCN BY UV ABSORPTION; ANN OCCUP HYG 21 (2): 229-32 (1978)
4. TECHNIQUES FOR ANALYZING AQUATIC MINERAL OIL POLLUTION ARE PRESENTED. **QC REVIEWED** [CARLBERG SR; ANALYSIS OF AQUATIC MINERAL OIL POLLUTION A PRESENTATION OF ALTERNATIVE ANALYTICAL TECHNIQUES; FAO FISH TECH PAP 137: 85-97 (1975)

The United States Pharmacopeia, Twentieth Revision, Rockville, MD., September 1980

cells relative to the blank, at the wavelength of maximum absorbance at about 450 nm, with a suitable spectrophotometer. Calculate the quantity, in mg, of $C_{14}H_{14}N_2O$ in the portion of Tablets taken by the formula $250C(A_U/A_S)$, in which C is the concentration, in mg per ml, of USP Metyrapone RS in the *Standard preparation*, and A_U and A_S are the absorbances of the solutions from the *Assay preparation* and the *Standard preparation*, respectively.

Metyrapone Tartrate Injection

$C_{14}H_{14}N_2O.2C_4H_6O_6$ 526.45

1-Propanone, 2-methyl-1,2-di-3-pyridinyl-, [*R*-(*R**,*R**)]-2,3-dihydroxybutanedioate (1:2).

2-Methyl-1,2-di-3-pyridyl-1-propanone tartrate (1:2) [*908-35-0*].

» Metyrapone Tartrate Injection is a sterile solution of Metyrapone Tartrate in Water for Injection, prepared from Metyrapone with the aid of Tartaric Acid. It contains not less than 93.0 percent and not more than 107.0 percent of the labeled amount of $C_{14}H_{14}N_2O.2C_4H_6O_6$.

Packaging and storage—Preserve in single-dose or in multiple-dose containers, preferably of Type I glass, protected from light and excessive heat.

Reference standard—*USP Metyrapone Reference Standard*—Dry in vacuum at room temperature for 6 hours before using.

Identification—

A: Mix a volume of Injection, containing about 1 g of metyrapone tartrate (equivalent to about 430 mg of metyrapone), with 10 ml of 1 *N* sodium hydroxide in a separator. Extract with 10 ml of chloroform, centrifuge, and filter the chloroform extract. The infrared absorption spectrum of this solution, determined in a 0.5-mm cell, exhibits maxima only at the same wavelengths as that of a 1 in 20 solution of USP Metyrapone RS in chloroform, treated and measured in the same manner.

B: Prepare a 1 in 50,000 solution of metyrapone tartrate by the stepwise dilution of Injection with 1 *N* sulfuric acid. The ultraviolet absorption spectrum of this solution exhibits maxima and minima at the same wavelengths as that of a 1 in 100,000 solution of USP Metyrapone RS in the same medium, concomitantly measured.

Pyrogen—It meets the requirements of the *Pyrogen Test* ⟨151⟩, the test dose being 1.0 ml of a solution containing 100 mg of metyrapone tartrate per ml.

pH ⟨791⟩: between 3.0 and 3.5.

Other requirements—It meets the requirements under *Injections* ⟨1⟩.

Assay—

2,4-Dinitrophenylhydrazine hydrochloride in methanol—Shake by mechanical means about 1 g of 2,4-dinitrophenylhydrazine with 75 ml of methanol in a 100-ml flask for 15 minutes, and filter through paper. Mix 23 ml of this solution with 2 ml of hydrochloric acid. Prepare on the day of use.

Potassium hydroxide in methanol—Dissolve 5 g of potassium hydroxide in 100 ml of methanol, mix, and filter.

Standard preparation—Prepare as directed in the *Assay* under *Metyrapone Tablets*.

Assay preparation—Transfer an accurately measured volume of Metyrapone Tartrate Injection, equivalent to about 200 mg of metyrapone tartrate, to a separator. Add 8 ml of 1 *N* sodium hydroxide, shake gently, and extract with five 10-ml portions of chloroform. Filter each extract through a pledget of cotton into a 100-ml volumetric flask, dilute with chloroform to volume, and mix. Transfer 10.0 ml of this solution to a second 100-ml volumetric flask, dilute with chloroform to volume, and mix.

Procedure—Transfer 3.0 ml each of the *Standard preparation*, the *Assay preparation*, and chloroform to provide the blank, to separate 50-ml volumetric flasks. To each flask add 1 ml of *2,4-Dinitrophenylhydrazine hydrochloride in methanol*, and shake gently. Evaporate the solutions on a steam bath almost to dryness, wash down the sides of the flasks with 1-ml portions of a mixture of equal volumes of chloroform and methanol, and again evaporate the solutions on the steam bath almost to dryness. Heat the flasks in an oven maintained at 110° to 120° for 30 minutes, cool, add 10 ml of *Potassium hydroxide in methanol* to each flask, and heat the mixtures on the steam bath for 1 minute. Allow to cool, insert the stoppers, shake by mechanical means for 5 minutes, dilute with methanol to volume, and mix. Concomitantly determine the absorbances of the solutions in 1-cm cells at the wavelength of maximum absorbance at about 450 nm, with a suitable spectrophotometer, against the blank. Calculate the quantity, in mg, of $C_{14}H_{14}N_2O.2C_4H_6O_6$ in each ml of Injection taken by the formula $(526.45/226.28)(C/V)(A_U/A_S)$, in which 526.45 and 226.28 are the molecular weights of metyrapone tartrate and metyrapone, respectively, C is the concentration, in μg per ml, of USP Metyrapone RS in the *Standard preparation*, V is the volume, in ml, of Injection taken, and A_U and A_S are the absorbances of the solutions from the *Assay preparation* and the *Standard preparation*, respectively.

Microcrystalline Cellulose—*see* Cellulose, Microcrystalline NF

Microcrystalline Wax—*see* Wax, Microcrystalline NF

Milk of Bismuth—*see* Bismuth, Milk of

Milk of Magnesia—*see* Magnesia, Milk of

Mineral Oil

» Mineral Oil is a mixture of liquid hydrocarbons obtained from petroleum. It may contain a suitable stabilizer.

Packaging and storage—Preserve in tight containers.

Labeling—Label it to indicate the name of any substance added as a stabilizer.

Specific gravity ⟨841⟩: between 0.845 and 0.905.

Viscosity ⟨911⟩—It has a kinematic viscosity of not less than 34.5 centistokes at 40.0°.

Neutrality—Boil 10 ml with an equal volume of alcohol: the alcohol remains neutral to moistened litmus paper.

Readily carbonizable substances—Place 5 ml in a glass-stoppered test tube that previously has been rinsed with chromic acid cleansing mixture (see ⟨1051⟩), then rinsed with water, and dried. Add 5 ml of sulfuric acid containing from 94.5% to 94.9% of H_2SO_4, and heat in a boiling water bath for 10 minutes. After the test tube has been in the bath for 30 seconds, remove it quickly, and, while holding the stopper in place, give three vigorous, vertical shakes over an amplitude of about 5 inches. Repeat every 30 seconds. Do not keep the test tube out of the bath longer than 3 seconds for each shaking period. At the end of 10 minutes from the time when first placed in the water bath, remove the test tube: the Oil may turn hazy, but it remains colorless, or shows a slight pink or yellow color, and the acid does not become darker than the standard color produced by mixing in a similar test tube 3 ml of ferric chloride CS, 1.5 ml of cobaltous chloride CS, and 0.5 ml of cupric sulfate CS, this mixture being overlaid with 5 ml of Mineral Oil (see ⟨271⟩).

Limit of polynuclear compounds—

Standard solution—Dissolve a suitable quantity of naphthalene, accurately weighed, in isooctane, and dilute quantitatively and stepwise with isooctane to obtain a solution having a concentration of 7.0 μg per ml. Determine the absorbance of this solution in a 1-cm cell at the maximum at about 275 nm, with a suitable spectrophotometer, using isooctane as the blank.

Procedure—Transfer 25.0 ml of Mineral Oil and 25 ml of *n*-hexane to a 125-ml separator, and mix. [NOTE—Use only *n*-hexane that previously has been washed by being shaken twice with one-fifth its volume of methyl sulfoxide. Use no lubricants other than water on the stopcock, or use a separator equipped with a suitable polymeric stopcock.] Add 5.0 ml of methyl sulfoxide, and shake the mixture vigorously for 1 minute. Allow to stand until the lower layer is clear, transfer the lower layer to another 125-ml separator, add 2 ml of *n*-hexane, and shake vigorously. Separate the lower layer, and determine its absorbance in a 1-cm cell, in the

The United States Pharmacopeia,
Twentieth Revision, Rockville, MD.,
September 1980

range of 260 nm to 350 nm, with a suitable spectrophotometer, using as the blank methyl sulfoxide that previously has been shaken vigorously for 1 minute with *n*-hexane in the ratio of 5 ml of methyl sulfoxide and 25 ml of *n*-hexane. The absorbance at any wavelength in the specified range is not greater than one-third of the absorbance, at 275 nm, of the *Standard solution*.

Solid paraffin—Fill a tall, cylindrical, standard oil-sample bottle of colorless glass of about 120-ml capacity with Mineral Oil that has been dried previously in a beaker at 105° for 2 hours and cooled to room temperature in a desiccator over silica gel. Insert the stopper, and immerse the bottle in a mixture of ice and water for 4 hours: the Oil is sufficiently clear that a black line 0.5 mm in width, on a white background, held vertically behind the bottle, is clearly visible.

Mineral Oil Emulsion

» Prepare Mineral Oil Emulsion as follows:

Mineral Oil	500 ml
Acacia, in very fine powder	125 g
Syrup	100 ml
Vanillin	40 mg
Alcohol	60 ml
Purified Water, a sufficient quantity, to make	1000 ml

Mix the Mineral Oil with the Powdered Acacia in a dry mortar, add 250 ml of Purified Water all at once, and emulsify the mixture. Then add, in divided portions, triturating after each addition, a mixture of the Syrup, 50 ml of Purified Water, and the Vanillin dissolved in the alcohol. Finally add Purified Water to make the product measure 1000 ml, and mix.

The Vanillin may be replaced by not more than 1 percent of any other official flavoring substance or any mixture of official flavoring substances. Sixty ml of sweet orange peel tincture or 2 g of benzoic acid may be used as a preservative in place of the Alcohol.

For other permissible modifications, see *Emulsions* ⟨1151⟩.

Packaging and storage—Preserve in tight containers.

Alcohol content, *Method I* ⟨611⟩: between 4.0% and 6.0% of C_2H_5OH.

Light Mineral Oil

» Light Mineral Oil is a mixture of liquid hydrocarbons obtained from petroleum. It may contain a suitable stabilizer.

Packaging and storage—Preserve in tight containers.

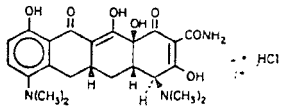
Labeling—Label it to indicate the name of any substance added as a stabilizer.

Specific gravity ⟨841⟩: between 0.818 and 0.880.

Viscosity ⟨911⟩—It has a kinematic viscosity of not more than 33.5 centistokes at 40°.

Neutrality, Readily carbonizable substances, Limit of polynuclear compounds, and **Solid paraffin**—It meets the requirements of the tests for *Neutrality*, *Readily carbonizable substances*, *Limit of polynuclear compounds*, and *Solid paraffin* under *Mineral Oil*.

Minocycline Hydrochloride



$C_{23}H_{27}N_3O_7 \cdot HCl$ 493.94

2-Naphthacenecarboxamide, 4,7-bis(dimethylamino)-1,4,4a,5,5a,6,11,12a-octahydro-3,10,12,12a-tetrahydroxy-1,11-dioxo-, monohydrochloride, [4*S*-(4α,4aα,5aα,12aα)]-.

4,7-Bis(dimethylamino)-1,4,4a,5,5a,6,11,12a-octahydro-3,10,12,12a-tetrahydroxy-1,11-dioxo-2-naphthacenecarboxamide monohydrochloride [*13614-98-7*].

» Minocycline Hydrochloride conforms to the regulations of the federal Food and Drug Administration concerning antibiotic drugs (446.60) (see *Antibiotics* ⟨1011⟩). It has a potency equivalent to not less than 785 μg of minocycline ($C_{23}H_{27}N_3O_7$) per mg.

Packaging and storage—Preserve in tight containers, protected from light.

Reference standard—*U. S. Minocycline Hydrochloride Reference Standard*.

pH: between 3.5 and 4.5, in a solution containing 10 mg of minocycline per ml.

Water: between 4.3% and 8.0%.

Minocycline content: between 78.5% and 88.5%.

Other requirements—It complies with the tests for identification, safety, and crystallinity.

Minocycline Hydrochloride Capsules

» Minocycline Hydrochloride Capsules conform to the regulations of the federal Food and Drug Administration concerning antibiotic drugs (446.160b) (see *Antibiotics* ⟨1011⟩). Capsules contain the equivalent of not less than 90.0 percent and not more than 115.0 percent of the labeled amount of minocycline ($C_{23}H_{27}N_3O_7$), the labeled amount being 50 or 100 mg in each Capsule.

Packaging and storage—Preserve in tight, light-resistant containers.

Water: not more than 12%.

Minocycline Hydrochloride Oral Suspension

» Minocycline Hydrochloride Oral Suspension conforms to the regulations of the federal Food and Drug Administration concerning antibiotic drugs (446.160c) (see *Antibiotics* ⟨1011⟩). It contains the equivalent of not less than 90.0 percent and not more than 130.0 percent of the labeled amount of minocycline ($C_{23}H_{27}N_3O_7$), the labeled amount being 10 mg per ml, and one or more suitable diluents, flavors, preservatives, and wetting agents in an aqueous vehicle.

Packaging and storage—Preserve in tight, light-resistant containers.

pH: between 7.0 and 9.0.

Vanillin Information

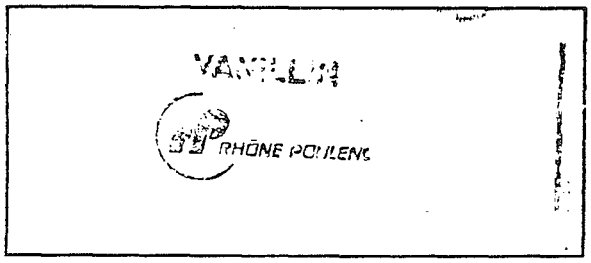
REC'D CH$_2$M SEA MAY 1 1995

EXPANDING THE LIMITS OF NATURE...

...WITH VANILLIN AND
FROM RHONE

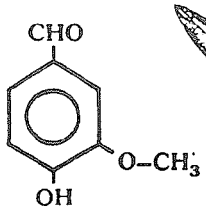
Rhone-Poulenc offers Vanillin and Ethyl Vanillin with the same inherent aroma and flavor characteristics of natural vanilla beans plus the advantage of a dependable supply not related to seasonality and crop yield.

Our vertically integrated plant in St. Fons, France, provides a unique Vanillin, inventoried and readily available in the U.S. Produced in a continuous manufacturing process, you are assured of uniform quality no matter the size of your order. We are proud of our Vanillin which is derived from guaiacol not lignin as are most other Vanillins. This means that we can now offer consistent purity while keeping our environment cleaner. Yet it is completely interchangeable with lignin derived Vanillins.



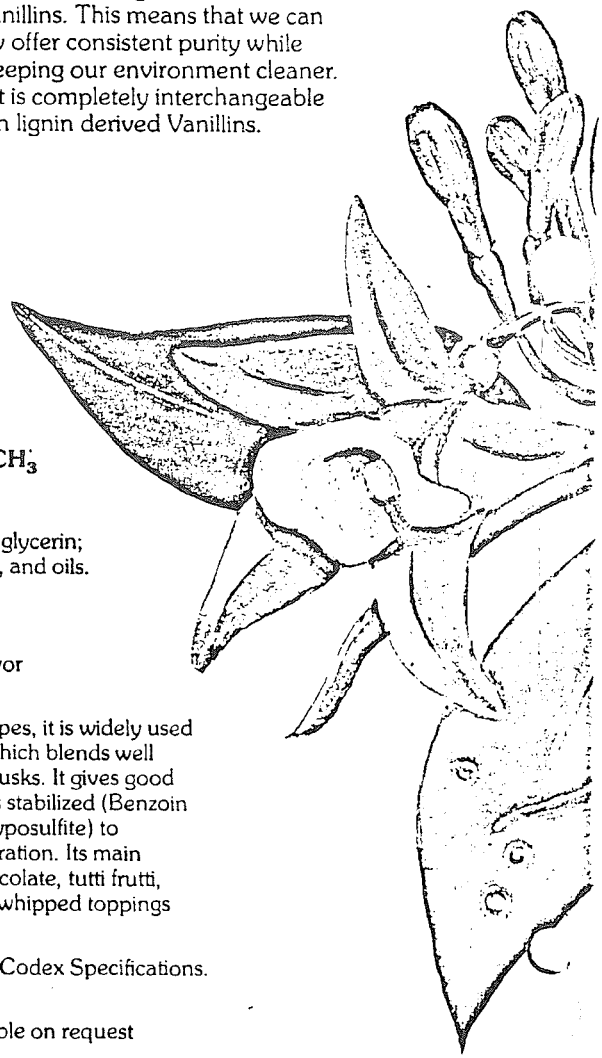
VANILLIN

APPEARANCE:	White to creamy white crystalline powder
ASSAY:	99.6% min.
MELTING RANGE °C:	81.0-83.0
FLASH POINT °C:	153
HEAVY METALS: (ppm)	10 maximum
ARSENIC: (ppm)	3 maximum
SOLUBILITY:	1% soluble in water, 5% soluble in glycerin; soluble in prolylene glycol, alcohol, and oils.
STORAGE & HANDLING PRECAUTIONS:	Store away from moist air and light, avoid contact with iron.
RECOMMENDED USES:	One of the purest perfume and flavor chemicals with a tenacious odor.



In perfumery, especially oriental types, it is widely used for its warm, powdery basic note which blends well with Heliotropin, Coumarin and Musks. It gives good results in soap pastes, provided it is stabilized (Benzoin resinoid and 2% dose of sodium hyposulfite) to prevent undesirable brown discoloration. Its main application is in flavors such as chocolate, tutti frutti, beverages, ice cream, margarines, whipped toppings and a variety of baked goods.

- Meets USP and Food Chemical Codex Specifications.
- TSCA Listed
- Material safety data sheet available on request
- RIFM Monograph available

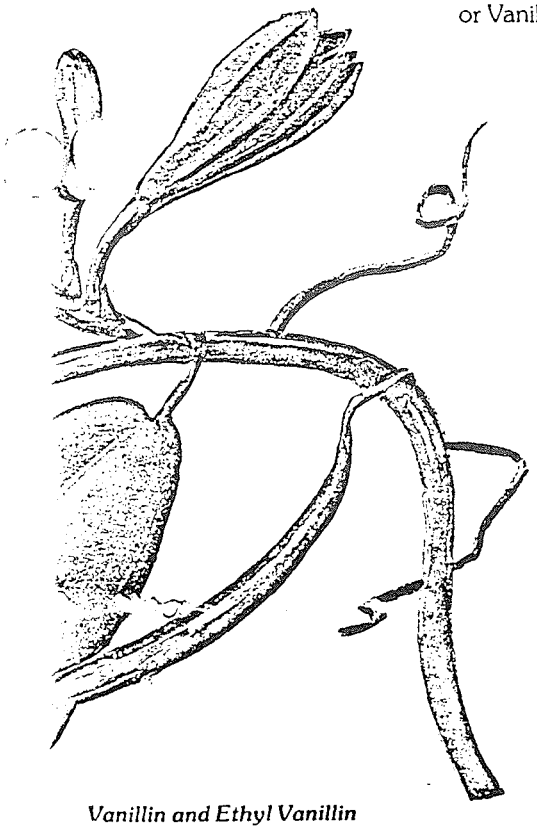


ETHYL VANILLIN
POULENC INC.

Our Ethyl Vanillin, derived from guethol, is 2–3 times stronger than Vanillin, and has consistent high purity. It is manufactured in Freeport, Texas, as well as in St. Fons, France. The two manufacturing facilities make Rhone-Poulenc a leading supplier of Ethyl Vanillin and reaffirm the scope of Rhone-Poulenc's commitment to the aroma chemicals industry and our capability to supply all your needs.

ETHYL VANILLIN
RHÔNE-POULENC

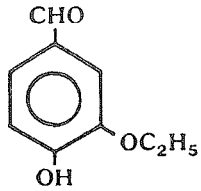
Consider Rhone-Poulenc as your preferred source for high purity, worldwide consistent quality and competitively priced Vanillin and Ethyl Vanillin. Note: While the sample packets are actual representations of the products, they are not intended for evaluation purposes. For evaluation samples of Ethyl Vanillin or Vanillin, call or write us today.



Vanillin and Ethyl Vanillin ich, sweet aromas as the deliciously fragrant vanilla plant

ETHYL VANILLIN

APPEARANCE:	White to slightly yellow crystalline powder
ASSAY:	98.0% min.
MELTING RANGE °C:	76.0-78.0
FLASH POINT °C:	146
HEAVY METALS: (ppm)	10 maximum
ARSENIC: (ppm)	3 maximum
SOLUBILITY:	Soluble in alcohol and most conventional perfume and flavor oils
STORAGE & HANDLING PRECAUTIONS:	Store away from moist air and light, avoid contact with iron
RECOMMENDED USES:	Widely used in fragrance compositions to promote a sweet, floral scent. Outstanding odor intensity and excellent tenacity. The flavor description is similar to vanillin, only 2-3 times stronger.



- Meets Food Chemical Codex Specifications
- TSCA Listed.
- Material safety data sheet available on request.
- RIFM Monograph available

THIS IS RHONE-POULENC INC.

Rhone-Poulenc Inc. is the United States subsidiary of Rhone-Poulenc S.A. of France. With sales in the 6 to 7 billion-dollar range, Rhone-Poulenc S.A. is among the largest chemical companies in the world, operating in 60 countries and employing 81,000 people.

Rhone-Poulenc Inc. is engaged in the manufacturing and marketing of fine and specialty chemicals, agricultural chemicals, animal health products, pharmaceuticals and products for the communications industry.

As a diversified company serving various industries, Rhone-Poulenc also has a number of products manufactured by its Specialty Chemicals, Basic Chemicals and Health Products Divisions which are widely used as food ingredients. It is a major supplier to many international food, flavors and fragrance companies.

OTHER PRODUCTS FOR THE FOOD INDUSTRY...

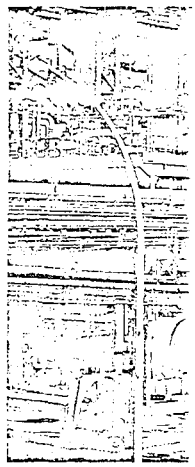
- METHYL SALICYLATE
- AMMONIUM BICARBONATE
- PHOSPHATES
- VITAMINS A, B-12, E

For more information about Rhone-Poulenc products for the food industry write to:

RHÔNE-POULENC INC.
ORGANIC CHEMICALS DIVISION
Monmouth Junction, New Jersey 08852 - Telephone: (201) 297-0100

RHÔNE-POULENC

FLAVORS: INDUSTRY HAS A TASTE FOR VANILLIN



Vanillin plant in Saint-Fons (Rhône "99.99% pure"

How many people are aware that vanillin, synthetic vanilla, is both a flavoring and used in pharmaceuticals? The world uses nearly 8,000 tons per year and with its purchase of the Monsanto plant in Seattle (U.S.A.), Rhône-Poulenc now meets one ho[illegible] se needs.

[illegible]orld food industry's demand is more than one hundred times greater than the quantities that Nature and the vanilla plant can supply and there is no hope of correcting this situation. Not only are 1,000 tons of beans required to obtain 30 tons of vanilla powder, but the species can really only be cultivated within a restricted geographic region. Madagascar, the Comoro Islands and Reunion Island supply 80% of the world's vanilla production. As a result of the insufficient supply – 150 tons per year – vanilla prices now soar at an average of $70 per kilo. At this price, vanilla is becoming a luxury product.

Chemists have known how to offset the vanilla tree's limitations for a long time. Rhône-Poulenc was already producing vanillin in 1894. Eclipsed from the market for [illegible]me due to lack of [illegible]titive processes, the Group regained its strength in 1978 with a new process and a modern plant in Saint-Fons near Lyons. And, since the leading position worldwide through its second plant in the United States.

With the same molecular structure and the same flavor, vanillin is the exact replica of vanilla. The white powder obtained is completely pure. "Distillation and crystallization allow us to reach 99.99% purity which is the standard of the pharmaceutical industry," emphasizes Pierre Gilles, sales manager of the organic intermediates department. The Americans consume one third of world production. The Group also produces a second version of synthetic vanilla: ethylvanillin. Classified as artificial vanilla – it has a different molecular structure – this substance's flavor is three times stronger than vanillin's. In addition to being 40% less expensive to use than the latter, candy and chocolate manufacturers sometimes prefer it for the subtlety of its flavor. It is used in the perfume industry to add a powdery note to heady fragrances.

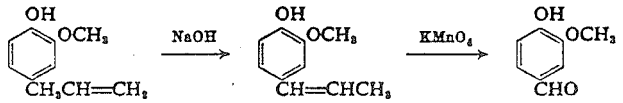
Vanillin's use in the pharmaceutical industry is less well-known. This industry alone demands several thousand tons per year and not just to flavor syrups. Vanillin is used to synthesize medicines such as methyl-dopa, a cardiovascular medication, or trimethoxy-benzaldehyde, an antibacterial agent. In addition, vanillin is the only raw material in levo-dopa, the number one medication in the treatment of Parkinson's disease.

Vanilla creeper. The food industry's demand greatly surpasses Nature's ability to supply.

Vanillin is the principal odorous constituent of vanilla beans, the long podlike capsules of a tropical climbing orchid, *Vanilla planifolia*. It probably is the most widely used flavoring material with the exception of salt, pepper, and vinegar. Annual production of the synthetic product in the United States is over half a million pounds. Besides being used to produce a desired odor or flavor of vanilla, it has a pronounced effect in masking undesirable odors. For example, one part in 2000 will mask the undesirable odor of fresh paint. The masking and neutralizing of the odors of articles manufactured from rubber, textiles, and plastics is an important phase of the perfumer's art.

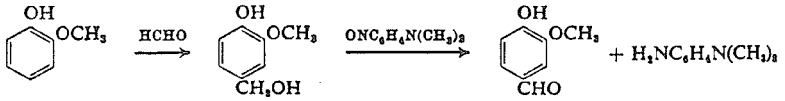
The price of vanilla beans has fluctuated greatly whereas that of synthetic vanillin has continuously decreased. Since one pound of vanillin is equivalent in flavoring power to about 100 pounds of a good grade of vanilla beans, the first synthetic vanillin placed on the market in 1875 at $80 per pound could compete with vanilla beans at $2.50 per pound. The price of synthetic vanillin was $8 per pound in 1925 when that of vanilla beans was $9 per pound, the natural product competing only by virtue of the sales appeal of the phrase "pure vanilla extract" over "imitation" or "artificial vanilla flavor." In the depression year, 1932, the price of vanilla beans dropped to $0.50 per pound. The price of synthetic vanillin has been in the neighborhood of $2 per pound since 1940.

Numerous processes have been developed for the synthesis of vanillin. For many years the cheapest synthetic method started with eugenol from natural oil of cloves. The eugenol was isomerized to isoeugenol, in which the double bond is conjugated with the benzene ring, and the side chain then was oxidized with permanganate under controlled conditions.



Eugenol Isoeugenol Vanillin

Guaiacol reacts readily with formaldehyde, and the resulting vanillyl alcohol can be oxidized to vanillin by one of several mild oxidizing agents such as *p*-nitrosodimethylaniline (p. 489).



Guaiacol Vanillyl alcohol Vanillin

Currently vanillin is being obtained by heating the lignin sulfonates from waste sulfite liquors (pp. 400, 527) with alkali. **Ethavan** is the trade name of a synthetic product containing an ethoxy group in place of the methoxy group. It has 3.5 times the flavoring power of vanillin.

Methylation of vanillin with methyl sulfate and alkali yields **veratral** (3,4-dimethoxybenzaldehyde), a material useful in organic synthesis. **Piperonal** (*heliotropin*) is 3,4-methylenedioxybenzaldehyde and is made from safrole (p. 516) by a process analogous to the production of vanillin from eugenol.

Author: Carl R. Noller
Second Edition
W.B. Saunders Co., Publishers

als. Sensitive to air. ec 60-70° in a nitrog

ride. F_5V; mol wt 145.95. V d from vanadium tetrafluoride at 650° in N_2 current accord- VF_3: Ruff, Lickfett, *Ber.* **44**, *idbook of Preparative Inorganic* r, Ed. (Academic Press, New rom the elements: Trevorrow, 5167 (1957); Clark, Emeleus, *J.* ew of transition metal pentaflu- *orine Chem.* **7**, 113-145 (1973). . $d_4^{19.5}$ 2.502. Heat of vaporiza- eciable vapor pressure at room , dil alkali. Soly in anhydrous in alcohol, chloroform, acetone, ulfide. Dec toluene and ether. temp; more rapidly in presence of yellow color. May be stored iron, nickel, copper, platinum.

de. Vanadic anhydride. O_5V_2; 56.02%. V_2O_5. Prepd by heat- te, NH_4VO_3. horhombic crystals; d 3.35; mp ly in the region 700-1125°. One 5 ml water; sol in concd acids, s; sol in alkalies, forming vana- s acid solutions are reduced by aporation with HCl. ed to be a respiratory irritant and nish-black tongue, chest pain, , lung changes. When ingested, May also cause a papular skin *nviron. Health* **5**, 542 (1962); E. *istrial Metals* (Appleton-Century- ., 1969) pp 340-347. xidation of SO_2 to SO_3, alcohol to manuf of yellow glass; inhibiting on in glass; depolarizer; as devel- form of ammonium vanadate as nting fabrics and in manuf of ani-

fluoride. F_4V; mol wt 126.95. V Prepd from VCl_4 and HF or from fett, *Ber.* **44**, 2539 (1911); Cavell, 2, 2692; Kwasnik in *Handbook of mistry*, vol. 1, G. Brauer, Ed. (Aca- 2nd ed., 1963) pp 252-253. der; very hygroscopic; hydrolyzes nd eventually a blue paste. d 3.15. a vacuum. Also disproportionates -120° in a vacuum. Freely sol in acetone deep green, in glacial acetic gly sol in alc, chloroform, SO_2Cl_2. iron or copper vessels.

luoride. F_3V; mol wt 107.95. V . Prepd from VCl_3 and HF: Ruff, 911); from VCl_2 and HF: Emeleus, 1949, 2979; by thermal decompn in F_5: Sturm, Sheridan, *Inorg. Syn.* **7**,

der. d 3.363. mp approx 1406°. eat. Almost insol in water, alcohol, acetic anhydride, glacial acetic acid, loride, chloroform, carbon disulfide. l soln. Aq solns have strong reduc-

en rhombohedral crystals, obtained um trioxide dissolved in hydrofluoric reduction of a soln of vanadium pent- . one molecule of water at 100°. Dis- e extent, forming autocomplexes.

... vanadium trioxide; vana-

Black powder. On exposure to air it is gradually convert- ed into indigo-blue crystals of V_2O_4. d 4.87; mp 1940°. Insol in water; difficultly sol in acids.

USE: Catalyst, e.g., in making ethanol from ethylene.

9582. Vanadium Trisulfate. $O_{12}S_3V_2$; mol wt 390.10. O 49.22%, S 24.66%, V 26.12%. $V_2(SO_4)_3$. Prepd by the reduc- tion of V_2O_5 in sulfuric acid with elemental sulfur: Auger, *Compt. Rend.* **173**, 306 (1921); Riveng, *Bull. Soc. Chim. France* **4**, 1697 (1937); Claunch, Jones, *Inorg. Syn.* **7**, 92 (1963).

Lemon-yellow powder. When heated in vacuum at or slightly below 410°, it dec into $VOSO_4$ and SO_2. Stable in dry air. Upon exposure to moist air for several weeks, a green hydrate forms. Very slowly sol in water at room temp, somewhat faster in boiling water; practically insol in concd sulfuric acid; sol in dil and concd nitric acid. Power- ful reducing agent.

9583. Vanadium Trisulfide. Vanadium sesquisulfide. S_3V_2; mol wt 198.10. V 51.44%, S 48.56%. V_2S_3.

Greenish-black powder; d 4.7. Dec when heated. Insol in water, cold HCl, dil H_2SO_4; sol in hot HCl, hot dil H_2SO_4, HNO_3.

9584. Vanadyl Dichloride. Vanadium oxydichloride. Cl_2OV; mol wt 137.86. V 36.96%, O 11.61%, Cl 51.44%. $VOCl_2$. Usually contains some water. Prepd according to the eq $V_2O_5 + 3VCl_3 + VOCl_3 \rightarrow 6VOCl_2$: Funk, Weiss, *Z. Anorg. Allgem. Chem.* **295**, 327 (1958); Oppermann, *ibid.* **351**, 113 (1967).

Green, very deliquesc tabular crystals. d 2.88. Dispro- portionates at 384° to VOCl and $VOCl_3$. Slowly dec by water. Sol in abs alcohol, glacial acetic acid. *Keep tightly closed.*

USE: Has been used as mordant in printing fabrics.

9585. Vanadyl Sulfate. Vanadium oxysulfate. O_5SV; mol wt 163.00. O 49.08%, S 19.67%, V 31.25%. $VOSO_4$.

Dihydrate, blue, cryst powder. Sol in water.

USE: Dihydrate as mordant in dyeing and printing textiles; manuf colored glass; for blue and green glazes on pottery.

9586. Vanadyl Trichloride. Vanadium oxytrichloride. Cl_3OV; mol wt 173.32. Cl 61.37%, O 9.23%, V 29.40%. $VOCl_3$. Prepd by the action of dry Cl_2 on V_2O_3 or V_2O_5: Brown, Griffitts, *Inorg. Syn.* **1**, 106 (1939); **4**, 80 (1953); Oppermann, *Z. Anorg. Allgem. Chem.* **351**, 113 (1967).

Yellow liquid, emitting red fumes on exposure to moist air. d 1.84; bp 126-127°; solidif −77°. Dec in presence of moisture into vanadic acid and HCl. When a small quantity of water is added, it becomes thick and almost blood-red because of formation of vanadic acid. *Keep tightly closed.* LD_{50} in rats: 0.14 g/kg orally: Smyth *et al.*, *Am. Ind. Hyg. Assoc. J.* **30**, 470 (1969).

9587. Vanaspati. Manuf by hydrogenation of vegetable oils, peanut, cottonseed and sesame in the presence of acti- vated-Ni catalyst: Gupta, *Indian Chem. Eng.* **3**, 163 (1961), *C.A.* **56**, 15895h (1962). Product mp 31-37°; max free fatty acid (as oleic) 0.25%.

USE: Hydrogenated shortening. Used in the Orient.

9588. Vancomycin. Vancocin. Mol wt about 3300 (Analyses show about 7% nitrogen and 16-17% carbohy- drate.) Antibiotic substance produced by *Streptomyces orientalis* from Indonesian and Indian soil: McCormick *et al.*, *Antibiot. Ann.* 1955-56 (New York, 1956) p 606; U.S. pat. 3,067,099 (1962 to Lilly). Structure studies: Marshall, *J. Med. Chem.* **8**, 18 (1965). Assignment of structure to the branched-chain amino-sugar *vancosamine* obtained upon acid hydrolysis of vancomycin: Weringa *et al.*, *J. Chem. Soc. Perkin Trans. I* **1972**, 443; Smith *et al.*, *Chem. Commun.* **1972**, 361. *See also* Roberts *et al.*, *ibid.* **1973**, 772. Nature of the aromatic rings: Smith *et al.*, *J. Chem. Soc. Perkin Trans. I* **1974**, 2369. *Review:* Jordan, Reynolds, in *Antibiotics* vol. 3, J. W. Corcoran, F. E. Hahn, Eds. (Springer-Verlag, New York, 1975) pp 704-718.

Hydrochloride, a white solid; uv max (H_2O) 282 nm ... sol in

...nium sulfate ar... from acidic soln... ably stable in ... temp (5°). LD_{50}...

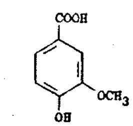
THERAP CAT: ...ibiotic ...eason- ... at low

9589. Vanilla. Cured, full-grown, unripe fruit of *Vanilla planifolia* Andr., *Orchidaceae*. *Habit.* Mexico, West Indies, Reunion, Mauritius, Seychelles. *Constit.* 2-2.75% vanillin, about 4% resin; vanillic acid, about 10% sugar.

USE: In manuf of confectionery and in various bakery products; perfumery; flavor for beverages; galenicals, etc.

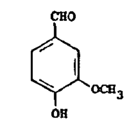
THERAP CAT: Pharmaceutic aid (flavor).

9590. Vanillic Acid. *4-Hydroxy-3-methoxybenzoic acid.* $C_8H_8O_4$; mol wt 168.14. C 57.14%, H 4.80%, O 38.06%. Obtained from vanillin by oxidation with silver oxide or by controlled caustic fusion: Pearl, *Org. Syn.* **30**, 101 (1950).



White, odorless needles. mp 210°. Sublimes undecomp. ... very sol in alc; sol in ether. Not colored by $FeCl_3$. Its salts are freely sol in water.

9591. Vanillin. *4-Hydroxy-3-methoxybenzaldehyde;* methylprotocatechuic aldehyde; vanillic aldehyde; 3-meth- oxy-4-hydroxybenzaldehyde. $C_8H_8O_3$; mol wt 152.14. C 63.15%, H 5.30%, O 31.55%. Occurs naturally in vanilla, in potato parings, in Siam benzoin, etc.; made synthetically from eugenol or guaiacol; also from the waste (lignin) of the wood pulp industry: Sörensen, Mehlum, U.S. pat. 2,752,394 (1956). Production from lignosulfonic acid compds: Craig, Logan, U.S. pats. **3,054,659** and **3,054,825** (both 1962 to Ontario Paper Co.).

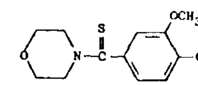


White or very slightly yellow needles; pleasant aromatic vanilla odor and taste. Slowly oxidizes somewhat on expo- sure to moist air. Affected by light. d 1.056; mp 80-81° (81-83°); bp 285°; bp_{15} 170°. One gram dissolves in 100 ml water, 16 ml water at 80°, about 20 ml glycerol; freely sol in alc, chloroform, ether, carbon disulfide, glacial acetic acid, pyridine; also sol in oils and aq solns of alkali hydroxides. Solns are acid to litmus. MLD orally in rats: 3.0 g/kg. *Preserve in tight, light-resistant containers.*

USE: As a flavoring agent in confectionery, beverages, foods, galenicals; in perfumery. One part vanillin equals 400 parts vanilla pods; in manuf liqueurs. 2.5-3 parts vanillin replace 500 parts tincture vanilla; also as reagent in analyti- cal chemistry.

THERAP CAT: Pharmaceutic aid (flavor).

9592. Vanitiolide. *4-[(4-Hydroxy-3-methoxyphenyl)thio- methyl]morpholine; 4-(thiovanilloyl)morpholine;* ... morpholide thione; 2-hydroxy-5- (morpholinothiocarbonyl)anisole; 4-[4-hydroxy(thio-m- anisoyl)]morpholine; 2-methoxy-4-(morpholinothiocarbon- yl)phenol; 4-(morpholinothiocarbonyl)guaiacol; Bildux. $C_{12}H_{15}NO_3S$; mol wt 253.33. C 56.89%, H 5.97%, N 5.53%, O 18.95%, S 12.66%. Prepn of similar compds, 4-[o- and ...methoxy(thiobenzoyl)]morpholine and 4-(thiosalicyloyl)-



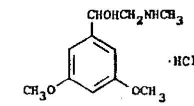
THERAP CAT: Choleretic.

9593. Varidase®. A combination of streptokinase and streptodornase. Proposed for enzymolytic removal of ne- crotic tissue. *Ref:* *J. Am. Med. Assoc.* **145**, 1173 (1951). Method of production: Christensen, *C.A.* **41**, 7428 (1947); Pakula, *C.A.* **49**, 568 (1955).

THERAP CAT: Fibrinolytic.

THERAP CAT (VET): Aids in resolution of exudates contain- ing pus and fibrin.

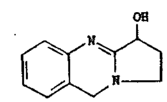
9594. Varon. *3,5-Dimethoxy-α-[(methylamino)methyl]- benzenemethanol hydrochloride; 3,5-dimethoxy-α-(methyl- aminomethyl)benzyl alcohol hydrochloride;* α-(3,5-dimeth- oxyphenyl)-β-methylaminoethanol hydrochloride; α-(3,5- dimethoxyphenyl)-α-hydroxy-β-(methylamino)ethane hy- drochloride. $C_{11}H_{18}ClNO_3$; mol wt 247.73. C 53.33%, H 7.32%, Cl 14.31%, N 5.65%, O 19.38%. Prepn: Abe *et al.*, *J. Pharm. Soc. Japan* **76**, 1058, 1094 (1956); Abe and Abe; Sei- chiro, Japan. pats. **9681('58)**; **3774('59)** (both to Tanabe).



Crystals from alc, mp 131-133°. Soluble in water.

THERAP CAT: Oxytocic.

9595. Vasicine. *1,2,3,9-Tetrahydropyrrolo[2,1-b]quin- azolin-3-ol;* peganine. $C_{11}H_{12}N_2O$; mol wt 188.22. C 70.19%, H 6.43%, N 14.88%, O 8.50%. Isoln from *Adhatoda vasica* Nees, *Acanthaceae*: Hooper, *Pharm. J.* **18**, 841 (1888); Sen, Ghose, *J. Indian Chem. Soc.* **1**, 315 (1924); Mehta *et al.*, *J. Org. Chem.* **28**, 445 (1963). Isoln from *Peganum harmala* L., *Zygophyllaceae*: Späth, Nikawitz, *Ber.* **67**, 45 (1934); Späth, Kuffner, *ibid.* **67**, 868 (1934). Structure and synthe- sis: Späth *et al.*, *ibid.* **68**, 699 (1935); Späth, Platzer, *ibid.* **69**, 255 (1936). Synthesis of *dl*-vasicine: Southwick, Casanova, *J. Am. Chem. Soc.* **80**, 1168 (1958). *Reviews:* Späth, *Mo- natsh.* **72**, 115 (1938); H. T. Openshaw, "The Quinazoline Alkaloids" in *The Alkaloids* vol. III, R. H. F. Manske, H. L. Holmes, Eds. (Academic Press, New York, 1953) pp 101- 118; Ray, *J. Indian Chem. Soc.* **35**, 697 (1958).



dl-Form, needles from alc. mp 210°. Sublimes in high vacuum. Sol in acetone, alcohol, chloroform; slightly sol water, ether, benzene.

l-Form, needles from alc, mp 212°. $[\alpha]_D^{14}$ −254° (c = in $CHCl_3$); $[\alpha]_D^{14}$ −62° (c = 2.4 in alc). In dil HCl this al- loid is dextrorotatory.

Hydrochloride dihydrate, needles, mp 208° (dry).

Hydriodide dihydrate, needles, mp 195° (dry).

Methiodide, needles from methanol, mp 187°.

Acetylvasicine, $C_{11}H_{11}N_2OCOCH_3$, crystals, mp 1... $p_{0.01}$ 230-240°.

9596. Vasopressin. Antidiuretic hormone; beta-hyp- phamine; β-hypophamine; Leiormone; Pitressin; Tonephin; Vasophysin. The water-soluble, pressor principle prepd synthesis or obtained from the posterior lobe of the pituitary of healthy domestic animals used for food by man: U.S. XVIII, 770. Separation from oxytocin: Kamm *et al.*, *J. Am. Chem. Soc.* **50**, 573 (1928). Purification: Turner *et al.*, *J. Biol. Chem.* **191**, 21 (1951). Two vasopressins, differing only in the amino acid at position 8, have been isolated: arginine

Monsanto Company 104(e) Response

The Merck Index
9th Edition, Page 9596

Monsanto 2A002221

Monsanto

MONSANTO COMPANY
DEPARTMENT OF MEDICINE & ENVIRONMENTAL HEALTH

TOXICITY INFORMATION

TOXICITY INFORMATION ON: VANILLIN

TOXICITY

The rat acute oral LD_{50} of vanillin is 3.30 grams/kilogram, administered as a 10% suspension in corn oil. When applied as a 40% suspension in corn oil and held in continuous 24-hour contact with rabbit skin, the dermal LD_{50} was estimated to be greater than 5.01 grams/kilogram. Thus, vanillin is considered to be slightly toxic by ingestion in single doses and practically non-toxic by single dermal applications.

When 0.1 milliliter of finely powdered vanillin was placed into the conjunctival sac of the rabbit eye, a mild degree of irritation resulted. The average score of the 24-, 48- and 72-hour readings was 18.8 on a scale of 110.0. All eyes had regained a normal appearance by the end of the 168-hour observation period.

No irritation resulted after 0.5 gram finely ground vanillin, moistened with water, was held in continuous 24-hour contact with intact and abraded rabbit skin.

HANDLING PRECAUTIONS

In case of eye contact, flush immediately with large volumes of water. If irritation persists, consult a physician.

Vanillin appears to possess no other acute toxicologic properties which would require special handling other than the good hygienic practices employed with any industrial chemical.

12/23/76
Y-76-261

The above information is based upon studies conducted for Monsanto Company. It is believed to be correct, and it is supplied to others upon the co that the persons receiving it shall make their own determination of its suitability for their purposes. No warranty is expressed or implied regard accuracy of this information or the results to be obtained from its use.

Inquiries regarding this information are to be referred to the Department of Medicine & Environmental Health, 800 N. Lindbergh, St. Louis, Mo. 63166, (314) 694-1000.

MATERIAL SAFETY DATA SHEET

RHONE-POULENC PRODUCT NAME(S)
VANILLIN NF (ALL GRADES)

PRODUCT CODE(S)
2831050, 2484768, 2484769
2484770, 2484771, 2484772
2484773

RHONE-POULENC INC.
CN 5266
Princeton, N.J. 08543-5266
(201) 297-0100

Emergency Phone Number (24 Hours)
CHEMTREC 800-424-9300

Date Prepared
10/19/89

Supercedes
3/3/89

MSDS Number
00001-01.ORG

Section 1. PRODUCT IDENTIFICATION

Synonym(s): Benzaldehyde, 4-hydroxy-3-methoxy-; 4-hydroxy-3-methoxybenzaldehyde; 3-methoxy-4-hydroxybenzaldehyde

Chemical Name(s) of Primary Component(s)	CAS Number(s)	Chemical Formula
Benzaldehyde, 4-hydroxy-3-methoxy-	121-33-5	$C_8H_8O_3$

Section 2. INGREDIENTS/SUMMARY OF HAZARDS

Ingredient(s)	CAS Number(s)	OSHA Hazardous (H)/ Non-Hazardous (NH)	Percent
Benzaldehyde, 4-hydroxy-3-methoxy-	121-33-5	NH	100

SARA Title III Hazard Classification:

( ) Immediate (Acute) Health Hazard
( ) Delayed (Chronic) Health Hazard
( ) Fire Hazard
( ) Sudden Release of Pressure Hazard
( ) Reactive Hazard
(X) Non-hazardous

WARNING STATEMENTS:

Based on currently available data, this product does not meet the OSHA definition of a hazardous substance. However, good industrial hygiene practices should be used in handling it.

Section 3. PHYSICAL DATA

Melting Point (°F):	176-181
Boiling Point (°F):	545 (slow decomposition begins about 320°F)
Vapor Pressure (mmHg):	0.0022 @ 25°C (1) 0.13 @ 65°C (4) 1 @ 107 °C (1) 7.3 @ 140 °C (4)
Saturated Vapor Concentration:	2.9 ppm in air @ 25°C (760 mmHg) (1)
Vapor Density (air = 1):	5.3
Solubility in Water:	Slightly soluble (1 g/100 ml @ 25°C)
Specific Gravity:	1.056
Evaporation Rate (butyl acetate = 1):	Not available
% Volatile by Volume:	Not available
Appearance/Odor:	Fine, white needle crystals/characteristic vanilla odor

Section 4. FIRE AND EXPLOSION HAZARD DATA

Flash Point (°F)/Method: 307/CC

Flammable Limits: LFL Not applicable UFL Not applicable

Extinguishing Media: (x) Water Fog (x) Foam
(x) Dry Chemical (x) CO_2
(x) Other (specify): Any Class B extinguishing agent

Special Fire Fighting Procedures:
Wear a NIOSH/MSHA approved self-contained breathing apparatus and full protective clothing. Cool containers exposed to fire with water.

Unusual Fire and Explosion Hazards:
Powder cloud could ignite. Auto-ignition temperature: 400-500°C (752-932°F).

RHONE-POULENC PRODUCT NAME(S)
VANILLIN NF (ALL GRADES)

Section 5. REACTIVITY DATA

Stability: ( ) Unstable (x) Stable

Conditions to avoid: Avoid prolonged exposure to direct sunlight and other light sources.

Incompatibility (materials to avoid):

( ) Water	(x) Strong acids	(x) Strong bases
( ) Reducing agents	(x) Strong oxidizing materials	( ) Combustible materials
(x) Other (specify):	Iron; moist air (oxidizes slowly); sodium hydroxide (reacts exothermally).	

Hazardous Decomposition Products or Byproducts:
On combustion, oxides of carbon are emitted.

Hazardous polymerization: ( ) May occur (X) Will not occur

Conditions to avoid: Not applicable

Section 6. HEALTH HAZARD DATA/FIRST AID PROCEDURES

EXPOSURE LIMITS IN AIR (TLV or suggested control figure)

No TLV established for this product.

EFFECTS OF SINGLE OVEREXPOSURE

Swallowing: LOW ORAL TOXICITY. Oral/rat LD50: 3330 mg/kg (3); 1580 mg/kg (2).

Skin Absorption: LOW TOXICITY BY SKIN ABSORPTION. Dermal/rabbit LD50: greater than 5010 mg/kg (3).

Inhalation: No data found.

Skin Contact: Non-irritating. (3)

Eye Contact: Mildly irritating. (3)

RHONE-POULENC PRODUCT NAME(S)
VANILLIN NF (ALL GRADES)

Section 6. HEALTH HAZARD DATA/FIRST AID PROCEDURES (Continued)

EFFECTS OF REPEATED OVEREXPOSURE:
Vanillin is not expected to produce significant adverse human health effects when recommended safety precautions are followed.

Vanillin is considered to be Generally Recognized As Safe (GRAS) by the Flavor and Extract Manufacturers Association and is approved by the FDA for food use (GRAS).

CARCINOGENICITY:
This product does not contain any ingredient designated by IARC, NTP, ACGIH or OSHA as a probable human carcinogen.

SIGNIFICANT LABORATORY DATA WITH POSSIBLE RELEVANCE TO MAN:
In a subchronic rat feeding study (91 days), growth depression and increased organ weights (liver, kidney, spleen) were observed at the highest dietary concentrations tested (50,000 ppm). No adverse effects were noted in a chronic rat study at a dietary concentration of 20,000 ppm. (3)

In human patch tests, vanillin was reported to produce no primary irritation when tested at concentrations of 2.0 and 20.0% on 29 normal subjects and at 0.4% on 35 subjects with dermatoses.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE:
Vanillin is known to cause reactions in people previously sensitized to Balsam of Peru, benzoin, rosin, benzoic acid, orange peel, cinnamon, and clove. (1)

FIRST AID PROCEDURES

EYES: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes using an eyewash fountain. Lift upper and lower lids and rinse well under them. Get medical attention if irritation develops or persists.

SKIN: In case of contact, immediately wash with soap and plenty of water for at least 5 minutes. Remove contaminated clothing and shoes. Thoroughly clean contaminated clothing and shoes before reuse. Get medical attention if irritation develops or persists.

INHALATION:
Remove from area of exposure. Get medical attention as needed.

INGESTION:
If swallowed and victim is fully conscious, induce vomiting immediately by giving two glasses of water and sticking finger down throat. GET IMMEDIATE MEDICAL ATTENTION.

RHONE-POULENC PRODUCT NAME(S)
VANILLIN NF (ALL GRADES)

Section 6. HEALTH HAZARD DATA/FIRST AID PROCEDURES (Continued)

NOTE TO PHYSICIAN:
All treatments should be based on observed signs and symptoms of distress in the patient. Consideration should be given to the possibility that overexposure to materials other than this product may have occurred.

Treat symptomatically. No specific information found.

Section 7. PRECAUTIONS FOR SAFE HANDLING AND USE

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:
Sweep, scoop or vacuum up all spilled material, contaminated soil and other contaminated material and place in clean, dry container for disposal. Complete cleanup on a dry basis.

WASTE DISPOSAL METHOD:
Dispose of in accordance with local, state and federal regulations.

HANDLING AND STORAGE:
This is a fragrance/flavor material. Store in tight, light-resistant containers in a cool, dry place. Do not use iron or steel containers. Avoid contamination by other aromatic products. Use adequate ventilation. Avoid contact with eyes. Avoid direct or prolonged contact with skin. Avoid breathing dust. Wash hands and work clothes frequently. Do not eat, drink or smoke in the work area. Emptied containers retain vapor and product residue. Observe all product safeguards until container is cleaned, reconditioned or destroyed.

OTHER PRECAUTIONS: None found.

Section 8. CONTROL MEASURES AND WORKER PROTECTION INFORMATION

Respiratory Protection (specify type):
None normally needed. Under dusting conditions, use a NIOSH/MSHA approved air purifying respirator.

Ventilation:
Provide adequate ventilation. Use local exhaust as needed.

Protective Clothing:
Work uniform, gloves.

RHONE-POULENC PRODUCT NAME(S)
VANILLIN NF (ALL GRADES)

Section 8. CONTROL MEASURES AND WORKER PROTECTION INFORMATION (Continued)

Eye Protection:
(X) Safety Glasses with Side Shields
(X) Chemical Workers Goggles (under significant potential of eye contact)
( ) Gas-tight Goggles or Equivalent
( ) Other (specify):

Other Protective Equipment:
Maintain a safety shower and eyewash fountain in the work area.

Section 9. REGULATORY STATUS

TSCA Inventory Status:
(X) Product is TSCA certified.
( ) Product is exempt from TSCA because it is FDA regulated.
( ) Product is exempt from TSCA because it is FIFRA regulated.
( ) Product is restricted to research and development use.

Transportation Status: Not regulated.

Reportable Quantity (RQ), under U.S. EPA CERCLA: Not listed

Specifically Listed under SARA Title III:
( ) Section 302 Extremely Hazardous Substances
( ) Section 313 Toxic Chemicals
(X) Not listed

Section 10. REFERENCES

(1) Patty's Industrial Hygiene and Toxicology (3 ed) Vol. II, 2502 (1981).
(2) Food & Cosmet. Tox. 15:633 (1977).
(3) Unpublished toxicity studies.
(4) Rhone-Poulenc data.

The information herein is given in good faith
but no warranty, expressed or implied, is made.

HSDB

Topic: VANILLIN

ADMINISTRATIVE INFORMATION
Hazardous Substance DataBank Number:
1. 1027
Last Revision Date:
1. 941222
Update History:
1. Complete Update on 12/22/94, 1 field added/edited/deleted.
2. Complete Update on 10/27/94, 2 fields added/edited/deleted.
3. Complete Update on 03/25/94, 1 field added/edited/deleted.
4. Field update on 12/17/92, 1 field added/edited/deleted.
5. Complete Update on 10/10/90, 1 field added/edited/deleted.
6. Complete Update on 04/16/90, 1 field added/edited/deleted.
7. Field update on 03/06/90, 1 field added/edited/deleted.
8. Complete Update on 11/20/89, 4 fields added/edited/deleted.
9. Complete Update on 10/14/86

SUBSTANCE IDENTIFICATION
Name of Substance:
1. VANILLIN
CAS Registry Number:
1. 121-33-5
Synonyms:
1. 2-METHOXY-4-FORMYLPHENOL **PEER REVIEWED**
2. 3-METHOXY-4-HYDROXYBENZALDEHYDE **PEER REVIEWED**
3. 4-FORMYL-2-METHOXYPHENOL **PEER REVIEWED**
4. 4-HYDROXY-3-METHOXY BENZALDEHYDE **PEER REVIEWED** [Furia, T.E. (ed.). CRC Handbook of Food Additives. 2nd ed. Volume 2. Boca Raton, Florida: CRC Press, Inc., 1980. 306
5. 4-HYDROXY-3-METHOXYBENZALDEHYDE **PEER REVIEWED**
6. 4-HYDROXY-5-METHOXYBENZALDEHYDE **PEER REVIEWED**
7. 4-HYDROXY-M-ANISALDEHYDE **PEER REVIEWED**
8. BENZALDEHYDE, 4-HYDROXY-3-METHOXY- **PEER REVIEWED**
9. LIOXIN **PEER REVIEWED**
10. M-ANISALDEHYDE, 4-HYDROXY- **PEER REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 82/8103
11. METHYLPROTOCATECHUIC ALDEHYDE **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275
12. P-HYDROXY-M-METHOXYBENZALDEHYDE **PEER REVIEWED**
13. P-VANILLIN **PEER REVIEWED**
14. PROTOCATECHUALDEHYDE 3-METHYL ETHER **PEER REVIEWED** [Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co.,

Topic: VANILLIN

1975. 560

15. PROTOCATECHUALDEHYDE, METHYL- **PEER REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 82/8103
16. VANILLA **PEER REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 82/8103
17. VANILLALDEHYDE **PEER REVIEWED**
18. VANILLIC ALDEHYDE **PEER REVIEWED**

Molecular Formula:

1. C8-H8-O3 **PEER REVIEWED**

Wiswessar Line Notation:

1. VHR DQ CO1 **PEER REVIEWED** [U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, National Institute for Occupational Safety Health. Registry ofToxic Effects of Chemical Substances (RTECS). National Library of Medicine's current MEDLARS file.,p. 82/8103

RTECS Number:

1. NIOSH/YW5775000

MANUFACTURE/USE INFORMATION

Methods of Manufacturing:

1. RECOVERED FROM WASTE SULFITE LIQUOR FROM PAPER MANUFACTURE **PEER REVIEWED** [SRI
2. ...SYNTHETICALLY FROM EUGENOL OR GUAIACOL; ALSO FROM THE WASTE (LIGNIN) OF THE WOOD PULP INDUSTRY: SORENSEN, MEHLUM, US PATENT 2,752,394 (1956). PRODN FROM LIGNOSULFONIC ACID COMPD: CRAIG, LOGAN, US PATENTS, 3,054,659 & 3,054,825 (BOTH 1962 TO ONTARIO PAPER CO). **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275
3. FROM SAFROLE OBTAINED FROM CAMPHOR OR SASSAFRAS OIL BY CONVERTING TO ISOSAFROLE; BY...METHYLATION & OXIDATION OF ISOSAFROLE, A MIXTURE OF VANILLIN & ISOVANILLIN IS OBTAINED... **PEER REVIEWED** [Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975. 560
4. ...BY EXTRACTION OF THE VANILLA BEAN...METHOD OF PURIFICATION: CRYSTALLIZATION. /PRC: INDIVIDUAL VANILLA BEANS ARE BRANDED BY THE GROWER/ **PEER REVIEWED** [Hawley, G.G. The Condensed Chemical Dictionary. 9th ed. New York: Van Nostrand Reinhold Co., 1977. 911

HSDB

Topic: VANILLIN

5. SYNTHESIS OF VANILLIN. **PEER REVIEWED** [DELPLACE A; SYNTHESIS OF VANILLIN; RIV ITAL ESSENZE, PROFUMI, PIANTE OFF, AROMI, SAPONI, COSMET, AEROSOL 62(MAY) 170 (1980)

Formulations/Preparations:

1. GRADES: TECHNICAL, USP, FCC **PEER REVIEWED** [Hawley, G.G. The Condensed Chemical Dictionary. 9th ed. New York: Van Nostrand Reinhold Co., 1977. 911
2. NF/FCC crystal grades **QC REVIEWED** [CHEMCYCLOPEDIA 1986 p.119

Manufacturers:

1. International Telephone & Telegraph Corporation, Hq, 320 Park Ave, New York, NY 10022, (212) 752-6000; Subsidiary: ITT Rayonier Inc, 1177 Summer St, Stamford, CT 06904, (203) 348-7000; Grays Harbor Division; Production site: Hoquiam, WA 98550 **UNREVIEWED** [SRI. 1989 Directory of Chemical Producers - United States of America. Menlo Park, CA: SRI International, 1989. 668
2. Rhone-Poulenc, Inc, Hq, 52 Vanderbilt Avenue, New York NY 10017, (201) 297-0100; Specialty Group, CN 5266, Princeton, NJ 08543; Production site: 9229 East Marginal Way, Seattle, WA 98108 **UNREVIEWED** [SRI. 1989 Directory of Chemical Producers - United States of America. Menlo Park, CA: SRI International, 1989. 668

Other Manufacturing Information:

1. INCOMPATIBILITIES: ...COMBINES WITH GLYCERIN, FORMING A COMPOUND WHICH IS ALMOST INSOLUBLE IN ALCOHOL. **PEER REVIEWED** [Osol, A. and J.E. Hoover, et al. (eds.). Remington's Pharmaceutical Sciences. 15th ed. Easton, Pennsylvania: Mack Publishing Co., 1975. 1236
2. NON-ALCOHOLIC BEVERAGES, 63 PPM; ICE CREAM, ICES, ETC, 95 PPM; CANDY, 200 PPM; BAKED GOODS, 220 PPM; GELATINS & PUDDINGS, 120 PPM; CHEWING GUM, 270 PPM; SYRUPS, 330-20,000 PPM; CHOCOLATE, 970 PPM; TOPPINGS, 150 PPM; MARGARINE, 0.20 PPM. **PEER REVIEWED** [Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975. 560
3. SOLN...SOLD AS SYNTHETIC SUBSTITUTE FOR VANILLA...BUT IT IS INFERIOR IN FLAVOR TO REAL VANILLA EXTRACT. **PEER REVIEWED** [Osol, A. and J.E. Hoover, et al. (eds.). Remington's Pharmaceutical Sciences. 15th ed. Easton, Pennsylvania: Mack Publishing Co., 1975. 1236
4. USED IN FORMULATING INSECT ATTRACTANTS; ESP EFFECTIVE IN ATTRACTING ROACHES & CRICKETS. **PEER REVIEWED** [MIYACHI H ET AL; INSECT ATTRACTANT COMPOSITION; JAPAN KOKAI PATENT 77 82729 (SAPPORO BREWERIES, LTD 7/11/77)
5. USED AS ATTRACTANT IN ADHESIVE STRIP FOR CONTROLLING FLYING INSECTS. **PEER REVIEWED** [KYDONIEUS AF; METHOD & COMPOSITION FOR CONTROLLING FLYING INSECTS; GERMAN OFFEN

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Topic: VANILLIN

PATENT 2715683 10/20/77 (HERCULITE PROTECTIVE FABRICS CORP)

6. VANILLAN (I) IS USED AS FLY ATTRACTANT IN TRICHLORPHON BAIT FORMULATIONS. **PEER REVIEWED** [WEIGAND N ET AL; ATTRACTANT FOR TRICHLORPHON FORMULATIONS; GERMAN OFFEN PATENT 2510450 09/16/76 (SCHUELKE UND MAYR GMBH)
7. EFFECT OF VANILLIN ON GROWTH & DEVELOPMENT PROCESSES IN THE COTTON PLANT. **PEER REVIEWED** [PALESIKO NB ET AL; EFFECT OF CINNAMIC ACID & VANILLIN ON GROWTH & DEVELOPMENT PROCESSES IN THE COTTON PLANT; FIZIOL RAST (MOSCOW) 13(5) 842 (1966)
8. ACTION OF SOME PHENOLIC COMPD AS PLANT-GROWTH REGULATORS. **PEER REVIEWED** [PASHKAR SI ET AL; ACTION OF SOME PHENOLIC COMPD AS PLANT-GROWTH REGULATORS; AGROKHIMIYA 1, 90 (1969)
9. FLAVORS USEFUL IN ROOT BEER, BUTTER. **PEER REVIEWED** [Furia, T.E. (ed.). CRC Handbook of Food Additives. 2nd ed. Volume 2. Boca Raton, Florida: CRC Press, Inc., 1980. 306
10. ONE PART VANILLIN EQUALS 400 PARTS VANILLA PODS; IN MFR LIQUEURS, 2.5-3 PARTS VANILLIN REPLACE 500 PARTS TINCTURE VANILLA. **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275
11. VANILLIN...IS DIFFICULT TO DISPERSE UNIFORMLY IN FOOD PRODUCTS & THERE IS A HIGH RISK OF OVERFLAVORING. **PEER REVIEWED** [Furia, T.E. (ed.). CRC Handbook of Food Additives. 2nd ed. Volume 2. Boca Raton, Florida: CRC Press, Inc., 1980. 310
12. FEMA NUMBER 3107 **PEER REVIEWED** [Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975. 560

Major Uses:

1. FLAVORING AGENT IN GALENICALS; IN PERFUMERY; REAGENT IN ANALYTICAL CHEMISTRY; PHARMACEUTIC AID (FLAVOR) **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275
2. FLAVORING AGENT FOR BAKED GOODS & OTHER FOOD PRODUCTS; ELECTROPLATING AGENT; CHEM INT FOR L-DOPA, STEROIDS, & ANTIDEPRESSANT DRUGS **PEER REVIEWED** [SRI
3. USED IN FORMULATING INSECT ATTRACTANTS **PEER REVIEWED** [MIYACHI H ET AL; INSECT ATTRACTANT COMPOSITION; JAPAN KOKAI PATENT 77 82729 (SAPPORO BREWERIES, LTD 7/11/77)

U.S. Production:

1. (1975) 1.5X10+9 GRAMS (EST) **PEER REVIEWED** [SRI
2. (1972) OVER 1.14X10+9 GRAMS (DEMAND) **PEER REVIEWED** [SRI

U.S. Imports:

1. (1975) 1.33X10+9 GRAMS **PEER REVIEWED** [SRI

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2. (1972) 7.17X10+8 GRAMS **PEER REVIEWED** [SRI
3. (1984) 1.57X10+9 g **QC REVIEWED** [BUREAU OF THE CENSUS. U.S. IMPORTS FOR CONSUMPTION AND GENERAL IMPORTS 1984 p.1-345

U.S. Exports:
1. (1975) ND **PEER REVIEWED** [SRI
2. (1972) ND **PEER REVIEWED** [SRI
3. (1984) 1.37X10+9 g /Vanillin and Ethyl Vanillin/ **QC REVIEWED** [BUREAU OF THE CENSUS. U.S. EXPORTS, SCHEDULE E, 1984 p.2-83

CHEMICAL & PHYSICAL PROPERTIES

Color/Form:
1. NEEDLES FROM WATER, PETROLEUM ETHER, TETRAHEDRONS FROM WATER, PETROLEUM ETHER **PEER REVIEWED** [Weast, R.C. (ed.). Handbook of Chemistry and Physics. 60th ed. Boca Raton, Florida: CRC Press Inc., 1979.,p. C-143
2. WHITE TO YELLOWISH CRYSTALLINE POWDER **PEER REVIEWED** [Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975. 560
3. WHITE OR VERY SLIGHTLY YELLOW NEEDLES **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275

Odor:
1. PLEASANT AROMATIC VANILLA ODOR **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275

Taste:
1. PLEASANT VANILLA TASTE **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275

Boiling Point:
1. 170 DEG C @ 15 MM HG **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275

Melting Point:
1. 80-81 DEG C **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275

Molecular Weight:
1. 152.14 **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275

Density/Specific Gravity:
1. 1.056 **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275

Heat of Combustion:
1. 914.1 KGCAL @ 20 DEG C **PEER REVIEWED** [Weast, R.C. (ed.). Handbook of Chemistry and Physics. 60th ed. Boca Raton, Florida: CRC Press Inc., 1979.,p. D-288

pH:
1. SOLN ARE ACID TO LITMUS **PEER REVIEWED** [The Merck

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Topic: VANILLIN

Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275

Solubilities:

1. VERY SOL IN ACETONE, HOT BENZENE & PETROLEUM ETHER **PEER REVIEWED** [Weast, R.C. (ed.). Handbook of Chemistry and Physics. 60th ed. Boca Raton, Florida: CRC Press Inc., 1979.,p. C-143
2. 1 G DISSOLVES IN: 100 ML WATER, 16 ML WATER @ 80 DEG C, ABOUT 20 ML GLYCEROL; FREELY SOL IN CHLOROFORM, ETHER, CARBON DISULFIDE, GLACIAL ACETIC ACID, PYRIDINE; SOL IN OILS & IN AQ SOLN OF ALKALI HYDROXIDES **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275
3. 1:2 IN 95% ALCOHOL, 1:3 IN 70% ALCOHOL **PEER REVIEWED** [Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975. 560

Spectral Properties:

1. MAX ABSORPTION (ALCOHOL): 279 NM (LOG E= 4.01); 309 NM (LOG E= 4.02) **PEER REVIEWED** [Weast, R.C. (ed.). Handbook of Chemistry and Physics. 60th ed. Boca Raton, Florida: CRC Press Inc., 1979.,p. C-143
2. SADTLER REFERENCE NUMBER: 8703 (IR, PRISM) **QC REVIEWED** [Weast, R.C. (ed.). Handbook of Chemistry and Physics. 60th ed. Boca Raton, Florida: CRC Press Inc., 1979.,p. C-667
3. MAX ABSORPTION (0.1 N HYDROCHLORIC ACID): 247 NM, 309 NM **PEER REVIEWED** [Sunshine, I. (ed.). CRC Handbook of Analytical Toxicology. Cleveland: The Chemical Rubber Co., 1969. 821
4. IR: 2530 (Coblentz Society Spectral Collection) **QC REVIEWED** [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985.,p. V1 143
5. UV: 3-153 (Organic Electronic Spectral Data, Phillips et al, John Wiley & Sons, New York) **QC REVIEWED** [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985.,p. V1 143
6. NMR: 197 (Varian Associates NMR Spectra Catalogue) **QC REVIEWED** [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985.,p. V1 143
7. MASS: 905 (Atlas of Mass Spectral Data, John Wiley & Sons, New York) **QC REVIEWED** [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985.,p. V1 143
8. NMR: 107 (Varian Associates NMR Spectra Catalogue) **QC

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REVIEWED** [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985.,p. V2 430

Vapor Density:

1. 5.2 (AIR= 1) **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2662

Vapor Pressure:

1. 2.2X10-3 MM HG @ 25 DEG C **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2499

Other Chemical/Physical Properties:

1. PERCENT IN "SATURATED" AIR: 0.00029 @ 25 DEG C, 760 MM HG **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2499
2. RELATIVE HUMIDITY: 0.5% MAX (WEIGHT LOSS %) **PEER REVIEWED** [Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975. 560
3. DECOMPOSED BY ALKALIES **PEER REVIEWED** [Osol, A. and J.E. Hoover, et al. (eds.). Remington's Pharmaceutical Sciences. 15th ed. Easton, Pennsylvania: Mack Publishing Co., 1975. 1236
4. CONVERSION FACTORS: 1 MG/L= 161 PPM, 1 PPM= 6.2 MG/CU M **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2662
5. ODOR DETECTION: RECOGNITION IN WATER: 4.00 PPM; DETECTION IN WATER: 2.00X10-1 PPM; DETECTION IN AIR: 1.10X10-6 PPB; DETECTION IN AIR: 2.00X10-4 PPB. /FROM TABLE/ **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2502

SAFETY & HANDLING

Flammable Properties

Fire Potential:

1. FLAMMABILITY PROPERTIES OF SOME SYNTHETIC FRAGRANT SUBSTANCES & INTERMEDIATE PRODUCTS. **PEER REVIEWED** [KURAVSKAYA IM, BOROVIK VN; FLAMMABILITY PROPERTIES OF SOME SYNTHETIC FRAGRANT SUBSTANCES & INTERMEDIATE PRODUCTS; MASLO-ZHIR PROM-ST 2, 19 (1975)

Hazardous Reactions

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Topic: VANILLIN

Reactivities and Incompatibilities:
1. A VIOLENT REACTION OCCURRED WHEN SMALL AMT OF VANILLIN WAS ADDED TO THALLIUM TRINITRATE TRIHYDRATE (UP TO 50%) IN 90% FORMIC ACID. **PEER REVIEWED** [National Fire Protection Association. Fire Protection Guide on Hazardous Materials. 7th ed. Boston, Mass.: National Fire Protection Association, 1978.,p. 491M-438

Other Safety & Handling

Stability/Shelf Life:
1. SLOWLY OXIDIZES SOMEWHAT ON EXPOSURE TO MOIST AIR; AFFECTED BY LIGHT **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275

Shipment Methods and Regulations:
1. CONTAINERS: CARTONS, BOTTLES, CANS, DRUMS. **PEER REVIEWED** [Hawley, G.G. The Condensed Chemical Dictionary. 9th ed. New York: Van Nostrand Reinhold Co., 1977. 911

Storage Conditions:
1. PRESERVE IN TIGHT, LIGHT-RESISTANT CONTAINERS. **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275

Cleanup Methods:
1. SORPTION OCCURRED ON DISSOCIATED MG IONS, FORMING INSOL CHEMISORB PRODUCTS. SORPTION OF VANILLIN & VANILLIC ALC DIFFER DUE TO DIFFERENCE IN ELECTRON TRANSFERENCE. **PEER REVIEWED** [ASANO A; REMOVAL OF ORGANIC COMPONENTS FROM WASTEWATER WITH SYNTHETIC INORGANIC SORBENTS; EHIME-KEN KOGYO SHIKENJO KENKYU HOKOKU 16: 82 (1978)

TOXICITY/BIOMEDICAL EFFECTS

Toxicity Excerpts

Human Toxicity Excerpts:
1. .../VANILLIN IS/ PHARMACOLOGICALLY ACTIVE, CAUSING DEPRESSED BLOOD PRESSURE, INCREASED RESPIRATORY RATE, & DEATH DUE TO CARDIOVASCULAR COLLAPSE. **PEER REVIEWED** [Patty, F. (ed.). Industrial Hygiene and Toxicology: Volume II: Toxicology. 2nd ed. New York: Interscience Publishers, 1963. 1696
2. IN CLOSED-PATCH TESTS ON HUMAN SKIN VANILLIN CAUSED NO PRIMARY IRRITATION WHEN TESTED @ CONCN OF 20% ON 29 NORMAL SUBJECTS, @ 2% ON 30 NORMAL SUBJECTS, & @ 0.4% ON 35 SUBJECTS WITH DERMATOSES. MAXIMIZATION TESTS WERE CONDUCTED ON GROUPS OF 25 VOLUNTEERS...@ CONCN OF 2-5% IN PETROLATUM & PRODUCED NO SENSITIZATION REACTIONS. **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2539
3. VANILLIN APPLIED UNDILUTED FOR 48 HR IN THE STANDARD OCCLUDED ALUMINUM-PATCH TEST USED BY THE NORTH AMERICAN

DERMATITIS RESEARCH GROUP DID NOT PRODUCE ANY IRRITATION OR SENSITIZATION IN A 62-YR-OLD SUBJECT WITH A PERFUME DERMATITIS. **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2539

4. POSITIVE REACTIONS TO VANILLIN WERE REPORTED IN 8/142 PT WHO WERE ALREADY SENSITIZED TO BALSAM OF PERU. IN STUDIES OF SENSITIZATION TO BALSAM OF PERU & ITS COMPONENTS, VANILLIN, PURE OR 10% IN VASELINE, PRODUCED POSITIVE PATCH-TEST REACTIONS IN 21/164 PT SENSITIVE TO BALSAM. VANILLIN WAS CONSIDERED...SECONDARY ALLERGEN... **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2539
5. The ability of vanillin, to induce the number of sister chromatid exchanges was studied lymphocytes at dose levels of 1, 2, and 4 mM. Two studies on the induction of chromosome aberrations in human lymphocytes by vanillin are reported. In both experiments, chromatid aberrations did not differ significantly from the ethanol solvent controls at any of the concentrations (1, 2 and 4 mM) tested. Chromosome aberrations were also not significant at these three doses if chromosome gaps were excluded from the analysis. With gaps, a significant increase was observed only at the 4 mM concentration. No exogenous metabolic activation system was used in the SCE or the chromosome aberration study. **QC REVIEWED** [Jansson T and Zech L; Mutat Res 190:221-224 (1987)
6. ...IRRITATION...& SENSITIZATION POTENTIAL. **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2539

Non-Human Toxicity Excerpts:

1. /IN/ RABBITS ANESTHETIZED WITH SODIUM BARBITAL...LETHAL DOSES OF VANILLIN ADMINISTERED IP CAUSED A SUDDEN DROP IN BLOOD PRESSURE ACCOMPANIED BY A SUDDEN DOUBLING OF THE RESPIRATION RATE. RESPIRATION...RETURNED TO NORMAL, WHEREAS THE BLOOD PRESSURE CONTINUED TO FALL, FINALLY CAUSING DEATH. **PEER REVIEWED** [Patty, F. (ed.). Industrial Hygiene and Toxicology: Volume II: Toxicology. 2nd ed. New York: Interscience Publishers, 1963. 1698
2. INTRAGASTRIC ADMIN OF 300 MG OF VANILLIN/KG TO RATS, TWICE WEEKLY, FOR 14 WK PRODUCED NO ADVERSE EFFECTS. **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons,

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3. GROUPS OF 16 RATS WERE FED DIETS CONTAINING VANILLIN @ LEVELS TO PROVIDE 20 MG/KG BODY WEIGHT/DAY FOR 18 WK WITHOUT ANY ADVERSE EFFECTS, BUT 64 MG/KG/DAY FOR 10 WK CAUSED GROWTH DEPRESSION & DAMAGE TO MYOCARDIUM, LIVER, KIDNEY, LUNG, SPLEEN, & STOMACH. **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2540
4. /NO ADVERSE EFFECTS NOTED IN/...10 MALE & 10 FEMALE RATS, 4-6 WK OLD...ON DIET /MAINTAINED FOR 91 DAYS/ CONTAINING...3000 PPM VANILLIN, EQUIVALENT TO...150 MG/KG/DAY. MILD ADVERSE EFFECTS FOLLOWED INGESTION OF 10,000 PPM DIET, & @ 50,000 PPM GROWTH WAS DEPRESSED & LIVER, KIDNEYS, & SPLEEN WERE ENLARGED. **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2540
5. ...SINGLE DOSES OF VANILLIN...AS 4 OR 5% SOLUTIONS IN MILK /WERE ADMIN TO RABBITS BY INTUBATION/. ...DOSES OF 3.0 G/KG OR MORE...WERE LIKELY TO BE LETHAL. TYPICAL SIGNS OF INTOXICATION...WERE INCREASED RESPIRATION, LACHRYMATION, DYSPNEA, COLLAPSE, & DEATH IN COMA. NO CONVULSIONS WERE OBSERVED. **PEER REVIEWED** [Patty, F. (ed.). Industrial Hygiene and Toxicology: Volume II: Toxicology. 2nd ed. New York: Interscience Publishers, 1963. 1697
6. VANILLIN INJECTED IP INTO STRAIN A MICE IN TOTAL DOSES OF 3.6-18.0 G/KG OVER A PERIOD OF 24 WK PRODUCED NO EXCESSES OF LUNG TUMORS & WAS NOT CONSIDERED TO BE CARCINOGENIC. **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2540
7. VANILLIN (200 UG/CULTURE) WAS FOUND TO DIRECTLY SUPPRESS THE IN VITRO ANTI-SHEEP RBC ANTIBODY RESPONSE AT NONCYTOTOXIC DOSES. **PEER REVIEWED** [KUTZ ET AL; EVALUATION OF CHEMICALS FOR IMMUNOMODULATORY EFFECTS USING AN IN VITRO ANTIBODY-PRODUCING ASSAY; ENVIRON RES 22(2) 368 (1980)

Toxicity Values

Minimum Fatal Dose Level:

1. 3. 3= MODERATELY TOXIC: PROBABLE ORAL LETHAL DOSE (HUMAN) 500 MG/KG-5 G/KG, BETWEEN 1 OUNCE & 1 PINT (OR 1 LB) FOR 70 KG PERSON (150 LB). **PEER REVIEWED** [Gosselin, R.E., H.C. Hodge, R.P. Smith, and M.N. Gleason. Clinical Toxicology of Commercial Products. 4th ed. Baltimore: Williams and Wilkins, 1976.,p. II-169

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Topic: VANILLIN

Pharmacokinetics

Absorption, Distribution and Excretion:

1. ...WHEN VANILLIN WAS FED TO RATS @...100 MG/KG MOST METABOLITES WERE EXCRETED IN THE URINE WITHIN 24 HR... **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2540

Metabolism/Metabolites:

1. ...VANILLIN...FED TO RABBITS IN 2 G DOSES WAS EXCRETED AS GLUCUROVANILLIN (14%) AND VANILLIC ACID (70%), OF WHICH ONE THIRD WAS CONJUGATED WITH GLUCURONIC AND SULFURIC ACIDS. **PEER REVIEWED** [Patty, F. (ed.). Industrial Hygiene and Toxicology: Volume II: Toxicology. 2nd ed. New York: Interscience Publishers, 1963. 1698
2. ...VANILLIN ADMIN IP TO RATS GAVE RISE TO A NUMBER OF URINARY PRODUCTS; CHIEF AMONG THESE WAS VANILLIC ACID IN BOTH FREE & CONJUGATED FORMS. OTHER METABOLITES WERE CONJUGATED VANILLIN, CONJUGATED VANILLYL ALCOHOL, & CATECHOL. **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2540
3. YIELDS PROTOCATECHUALDEHYDE PROBABLY BY MICROORGANISMS, RR SCHELINE, XENOBIOTICA 2, 227 (1972); VANILLIN-4-BETA-D-GLUCOSIDE IN BEAN & JAPONICA, MIWA ET AL, KOSO KAGAKU SHINPOJIUMU 12, 48 (1957); VANILLIN-4-BETA-D-GLUCURONIDE IN RABBITS, SANMONS, HG & RT WILLIAMS, BIOCHEM J 35, 1175 (1941). /FROM TABLE/ **PEER REVIEWED** [Goodwin, B.L. Handbook of Intermediary Metabolism of Aromatic Compounds. New York: Wiley, 1976.,p. V-2
4. ...WHEN VANILLIN WAS FED TO RATS @...100 MG/KG MOST METABOLITES WERE EXCRETED IN URINE WITHIN 24 HR, CHIEFLY AS GLUCURONIDE &/OR SULFATE CONJUGATES, ALTHOUGH THE ACIDS FORMED WERE ALSO EXCRETED FREE & AS THEIR GLYCINE CONJUGATES. **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2540
5. /VANILLIN WAS FED TO RATS @ 100 MG/KG/...IN 48 HR 94% OF DOSE WAS ACCOUNTED FOR, 7% AS VANILLIN, 19% AS VANILLYL ALCOHOL, 47% AS VANILLIC ACID, 10% AS VANILLOYLGLYCINE, 8% AS CATECHOL, 2% AS 4-METHYLCATECHOL, 0.5% AS GUAIACOL, & 0.6% AS 4-METHYLGUAIACOL. **PEER REVIEWED** [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 2541
6. YIELDS VANILLIC ACID IN MAN, THOMAS, H & W DIRSCHERL, ACTA

ENDOCR 47, 69 (1964); DIRSCHERL ET AL, HOPPE-SEYLER'S Z PHYSIOL CHEM 346, 385 (1962). /FROM TABLE/ **PEER REVIEWED** [Goodwin, B.L. Handbook of Intermediary Metabolism of Aromatic Compounds. New York: Wiley, 1976.,p. V-2

PHARMACOLOGY

Therapeutic Uses:

1. EXPTL USE: THE CHOLERETIC PROPERTIES & MECHANISM OF COUMARIN COMPD & PHENOLIC COMPD WERE STUDIED BY EXAMINING THEIR EFFECTS ON PARAMETERS SUCH AS BILE FLOW, BILE ACIDS, ELECTROLYTES, & BILIARY METABOLITES. VANILLIN ACCELERATED BILE SECRETION. **PEER REVIEWED** [TAKEDA ET AL; J PHARMACOBIO-DYN 4(9) 724 (1981)
2. ...AS AN AEROSOLED AID IN GETTING EWES TO SUCKLE ORPHAN LAMBS. **PEER REVIEWED** [Rossoff, I.S. Handbook of Veterinary Drugs. New York: Springer Publishing Company, 1974. 634

ENVIRONMENTAL FATE/EXPOSURE POTENTIAL

Pollution Sources

Natural Occurring Sources:

1. /IT/ OCCURS NATURALLY IN VANILLA, IN POTATO PARINGS, IN SIAM BENZOIN... **PEER REVIEWED** [The Merck Index. 9th ed. Rahway, New Jersey: Merck & Co., Inc., 1976. 1275
2. ...VANILLIN OCCURS IN...BALSAMS, & IS A CONSTITUENT OF LIGNINS. **PEER REVIEWED** [Parke, D. V. The Biochemistry of Foreign Compounds. Oxford: Pergamon Press, 1968. 141
3. IT IS...FOUND IN MANY...SUBSTANCES, INCLUDING TISSUES OF CERTAIN PLANTS, CRUDE BEET SUGAR, ASPARAGUS, &...ASAFETIDA. **PEER REVIEWED** [Osol, A. and J.E. Hoover, et al. (eds.). Remington's Pharmaceutical Sciences. 15th ed. Easton, Pennsylvania: Mack Publishing Co., 1975. 1236
4. ...IT HAS BEEN REPORTED IN THE ESSENTIAL OIL OF JAVA CITRONELLA (CYMBOPOGON NARDUS RENDL)..../AND IN/ CLOVE BUD OIL... **PEER REVIEWED** [Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975. 560
5. VEGETABLE SOURCES THAT CONTAIN VANILLIN ARE LISTED & DISCUSSED. **PEER REVIEWED** [PEYRON L; RIV ITAL ESSENZE, PROFUMI, PIANTE OFF, AROMI, SAPONI, COSMET, AEROSOL 62(MAY) 167 (1980)

Environmental Transformations

Biodegredation:

1. DECOMPOSITION UNDER STRICT ANAEROBIC CONDITIONS WAS OBSERVED FOR VANILLIN. **PEER REVIEWED** [HEALY ET AL; METHANOGENIC BIODEGRADATION OF AROMATIC COMPOUNDS; US ENVIRON PROT AGENCY, OFF RES DEV, (REP) EPA; ISS EPA-600/9-79-012, PROC WORKSHOP: MICROB DEGRADATION POLLUT

HSDB

Topic: VANILLIN

MAR ENVIRON: 348 (1978), 408 (1979)

Human Exposure

Probable Exposures:

1. VANILLIN AND ETHYL VANILLIN ARE BOTH SUFFICIENTLY LOW IN SYSTEMIC TOXICITY TO PRESENT NO SIGNIFICANT HAZARDS FROM INDUSTRIAL OPERATION. **PEER REVIEWED** [Patty, F. (ed.). Industrial Hygiene and Toxicology: Volume II: Toxicology. 2nd ed. New York: Interscience Publishers, 1963. 1696

EXPOSURE STANDARDS & REGULATIONS

Other Standards and Regulations

FDA Requirements:

1. FDA GRAS **PEER REVIEWED** [Fenaroli's Handbook of Flavor Ingredients. Volume 2. Edited, translated, and revised by T.E. Furia and N. Bellanca. 2nd ed. Cleveland: The Chemical Rubber Co., 1975. 560
2. SYNTHETIC FLAVOR REGULATION NUMBER: 182.60 **PEER REVIEWED** [Furia, T.E. (ed.). CRC Handbook of Food Additives. 2nd ed. Volume 2. Boca Raton, Florida: CRC Press, Inc., 1980. 306

MONITORING AND ANALYSIS METHODS

Analytic Laboratory Methods:

1. DETERMINATION OF VANILLIN IN VANILLA EXTRACTS & SUBSTITUTES BY UV SPECTROPHOTOMETRY & COLUMN CHROMATOGRAPHY. **PEER REVIEWED** [Association of Official Analytical Chemists. Official Methods of Analysis. 10th ed. and supplements. Washington, DC: Association of Official Analytical Chemists, 1965. New editions through13th ed. plus supplements, 1982.,p. 13/307 19.010
2. GAS CHROMATOGRAPHY IN COMBINATION WITH MASS SPECTROSCOPY WAS USED TO DETECT THE FRAGRANCE OF VANILLA BEAN EXTRACTS. THIRTY COMPD INCLUDING VANILLIN WERE ISOLATED & IDENTIFIED. **PEER REVIEWED** [SHIODA H; NATURAL FLAVOR. III. FRAGRANCE OF VANILLA BEAN; SHIONO KORYO SHOHO 203: 8 (1979)

LNAPL Data

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: Rhone-Poulenc

Date: October 22, 1991

Report On: Analysis of Waste Liquid

Lab No.: 20717-1
Page 1 of 6

IDENTIFICATION:
Sample Received on 10-18-91
Client ID: **RUSH MWG-5**

ANALYSIS:

Sample was analyzed in accordance with Test Methods for Evaluating Solid Waste, (SW-846), U.S.E.P.A., 1986 Method 8270 (ABN Semivolatiles)

CAS No.	Compounds	Concentration ug/l	PQL
108-95-2	Phenol	ND	1,000,000
111-44-4	bis(2-Chloroethyl) ether	ND	1,000,000
95-57-8	2-Chlorophenol	ND	1,000,000
541-73-1	1,3-Dichlorobenzene	ND	1,000,000
106-46-7	1,4-Dichlorobenzene	ND	1,000,000
100-51-6	Benzyl Alcohol	ND	2,000,000
95-50-1	1,2-Dichlorobenzene	ND	1,000,000
95-48-7	2-Methylphenol	ND	1,000,000
39638-32-9	bis(2-Chloroisopropyl)ether	ND	1,000,000
106-44-5	4-Methylphenol	ND	1,000,000
621-64-7	N-Nitroso-Di-N-propylamine	ND	1,000,000
67-72-1	Hexachloroethane	ND	1,000,000
98-95-3	Nitrobenzene	ND	1,000,000
78-59-1	Isophorone	ND	1,000,000
88-75-5	2-Nitrophenol	ND	1,000,000
105-67-9	2,4-Dimethylphenol	ND	1,000,000
65-85-0	Benzoic Acid	ND	5,000,000
111-91-1	bis(2-Chloroethoxy)methane	ND	1,000,000
120-83-2	2,4-Dichlorophenol	ND	1,000,000
120-82-1	1,2,4-Trichlorobenzene	ND	1,000,000
91-20-3	Naphthalene	ND	1,000,000
106-47-8	4-Chloroaniline	ND	2,000,000
87-68-3	Hexachlorobutadiene	ND	1,000,000
59-50-7	4-Chloro-3-methylphenol	ND	2,000,000

ND = Not Detected

Continued . . . . .

This report is issued solely for the use of the person or company to whom it is addressed. This laboratory accepts responsibility only for the due performance of analysis in accordance with industry acceptable practice. In no event shall Sound Analytical Services, Inc. or its employees be responsible for consequential or special damages in any kind or in any amount.

SOUND ANALYTICAL SERVICES, INC.

Rhone-Poulenc
Page 2 of 6
Lab No. 20717-1
October 22, 1991

Client ID: RUSH MWG-5

EPA Method 8270 Continued

CAS No.	Compounds	Concentration ug/l	PQL
91-57-6	2-Methylnaphthalene	ND	1,000,000
77-47-4	Hexachlorocyclopentadiene	ND	1,000,000
88-06-2	2,4,6-Trichlorophenol	ND	1,000,000
95-95-4	2,4,5-Trichlorophenol	ND	1,000,000
91-58-7	2-Chloronaphthalene	ND	1,000,000
88-74-4	2-Nitroaniline	ND	5,000,000
131-11-3	Dimethyl phthalate	ND	1,000,000
208-96-8	Acenaphthylene	ND	1,000,000
99-09-2	3-Nitroaniline	ND	5,000,000
83-32-9	Acenaphthene	ND	1,000,000
51-28-5	2,4-Dinitrophenol	ND	5,000,000
100-02-7	4-Nitrophenol	ND	5,000,000
132-64-9	Dibenzofuran	ND	1,000,000
121-14-2	2,4-Dinitrotoluene	ND	1,000,000
606-20-2	2,6-Dinitrotoluene	ND	1,000,000
84-66-2	Diethylphthalate	1,000,000	1,000,000
7005-72-3	4-Chlorphenyl phenyl ether	ND	1,000,000
86-73-7	Fluorene	ND	1,000,000
100-01-6	4-Nitroaniline	ND	5,000,000
534-52-1	4,6-Dinitro-2-methylphenol	ND	5,000,000
86-30-6	N-Nitrosodiphenylamine	ND	1,000,000
101-55-3	4-Bromophenyl phenyl ether	ND	1,000,000
118-74-1	Hexachlorobenzene	ND	1,000,000
87-86-5	Pentachlorophenol	ND	5,000,000
85-01-8	Phenanthrene	ND	1,000,000
120-12-7	Anthracene	ND	1,000,000
84-74-2	Di-n-butylphthalate	ND	1,000,000

ND = Not Detected

Continued . . . . .

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SOUND ANALYTICAL SERVICES, INC.

Phone-Poulenc
Page 3 of 6
Lab No. 20717-1
October 22, 1991

Client ID: RUSH MWG-5

EPA Method 8270 Continued

CAS No.	Compounds	Concentration ug/l	PQL
206-44-0	Fluoranthene	ND	1,000,000
129-00-0	Pyrene	ND	1,000,000
85-68-7	Butyl benzyl phthalate	ND	1,000,000
91-94-1	3,3'-Dichlorobenzidine	ND	2,000,000
56-55-3	Benzo(a)anthracene	ND	1,000,000
117-81-7	bis(2-ethylhexyl)phthalate	ND	1,000,000
218-01-9	Chrysene	ND	1,000,000
117-84-0	Di-n-octyl phthalate	ND	1,000,000
205-99-2	Benzo(b)fluoranthene	ND	1,000,000
207-08-9	Benzo(k)fluoranthene	ND	1,000,000
50-32-8	Benzo(a)pyrene	ND	1,000,000
193-39-5	Indeno(1,2,3-cd)pyrene	ND	1,000,000
53-70-3	Dibenz(a,h)anthracene	ND	1,000,000
191-24-2	Benzo(g,h,i)perylene	ND	1,000,000

ND = Not Detected
PQL - Practical Quantitation Limit - These are the quantitation limits for this sample. This number is based on sample size, matrix and dilution required.
Note: All soil samples are reported on a dry weight basis.

Semi-Volatile Surrogates

Surrogate Compound	Percent Recovery	Control Limits Water	Control Limits Soil
Nitrobenzene - d_5		35 - 114	23 - 120
2-Fluorobiphenyl	Diluted	43 - 116	30 - 115
p-Terphenyl-d_{14}		33 - 141	18 - 137
Phenol-d_6	Out	10 - 94	24 - 113
2-Fluorophenol		21 - 100	25 - 121
2,4,6-Tribromophenol		10 - 123	19 - 122

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SOUND ANALYTICAL SERVICES, INC.

Rhone-Poulenc
Page 4 of 6
Lab No. 20717-1
October 22, 1991

Client ID: RUSH MWG-5

METHOD 8270
TENTATIVELY IDENTIFIED COMPOUNDS

Sample was analyzed in accordance with Test Methods for Evaluating Solid Waste, (SW-846), U.S.E.P.A., 1986 Method 8270 (ABN Semivolatiles)

No.	Scan No.	CAS No.	Compound Name	Estimated Concentration ug/l
1.	1377		unknown branched alkene	8,200,0
2.	1393	74645-98-0	dodecane, 2,7,10-trimethyl-	9,800,000
3.	1398	31295-56-4	dodecane, 2,6,11-trimethyl-	7,600,000
4.	1405		unknown alkane	5,200,000
5.	1447	17301-32-5	undecane, 4,7-dimethyl-	15,000,000
6.	1498	17301-28-9	undecane, 3,6-dimethyl-	6,000,000
7.	1504		unknown alkane	8,900,000
8.	1509	55045-12-0	tetradecane, 4,11-dimethyl-	5,200,000
9.	1517	544-76-3	hexadecane	8,600,000
10.	1525	2882-96-4	pentadecane, 3-methyl-	6,200,000

Continued . . . . .

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SOUND ANALYTICAL SERVICES, INC.

Rhone-Poulenc
Page 5 of 6
Lab No. 20717-1
October 22, 1991

Client ID: RUSH MWG-5

METHOD 8270
TENTATIVELY IDENTIFIED COMPOUNDS
Continued

Sample was analyzed in accordance with Test Methods for Evaluating Solid Waste, (SW-846), U.S.E.P.A., 1986 Method 8270 (ABN Semivolatiles)

No.	Scan No.	CAS No.	Compound Name	Estimated Concentration ug/l
11.	1545		unknown alkene	2,600,000
12.	1565		unknown alkane	14,000,000
13.	1589		unknown	1,500,000
14.	1613		unknown alkane	10,000,000
15.	1622		unknown fatty acid diester	5,400,000
16.	1629	25117-26-4	hexadecane, 4-methyl-	5,200,000
17.	1637	6418-43-5	hexadecane, 3-methyl-	4,200,000
18.	1674		unknown alkane	12,000,000
19.	1713		heptadecane	4,300,000
20.	1774	54105-67-8	heptadecane, 2,6-dimethyl-	12,000,000

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SOUND ANALYTICAL SERVICES, INC.

Rhone-Poulenc
Page 6 of 6
Lab No. 20717-1
October 22, 1991

Client ID: **RUSH MWG-5**

	Concentration, mg/l
BTEX by EPA SW-846 Method 8020	
Benzene	< 50
Toluene	93,000
Ethyl Benzene	< 50
Xylenes	< 50
SURROGATE RECOVERY	
BTEX-Trifluorotoluene	150
Total Metals:	
Antimony	17
Arsenic (GFAA)	< 0.54
Beryllium	< 0.27
Cadmium	< 0.27
Chromium	< 0.54
Copper	< 1.4
Lead (GFAA)	< 0.27
Mercury (CVAA)	< 0.1
Nickel	< 2.2
Selenium (GFAA)	< 0.27
Silver	< 1.1
Thallium (GFAA)	< 0.54
Zinc	< 1.1
Total Sulfide	< 20

SOUND ANALYTICAL SERVICES

DENNIS L. BEAN

This report is issued solely for the use of the person or company to whom it is addressed. This laboratory accepts responsibility only for the due performance of analysis in accordance with industry acceptable practice. In no event shall Sound Analytical Services, Inc. or its employees be responsible for consequential or special damages in any kind or in any amount.

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS
4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: Rhone-Poulenc Date: October 22, 1991

Report On: Analysis of Waste Liquid Lab No.: 20717-2

IDENTIFICATION:
Sample Received on 10-18-91
Client ID: **RUSH MWH-10**

ANALYSIS:

	Concentration, mg/l
BTEX by EPA SW-846 Method 8020	
Benzene	< 50
Toluene	190,000
Ethyl Benzene	< 50
Xylenes	< 50
SURROGATE RECOVERY	
BTEX-Trifluorotoluene	175
Total Metals:	
Antimony	7.9
Arsenic (GFAA)	< 0.54
Beryllium	< 0.27
Cadmium	< 0.27
Chromium	< 0.54
Copper	< 1.4
Lead (GFAA)	< 0.27
Mercury (CVAA)	< 0.1
Nickel	< 2.2
Selenium (GFAA)	< 0.27
Silver	< 1.1
Thallium (GFAA)	< 0.54
Zinc	< 1.1

SOUND ANALYTICAL SERVICES

STAN P. PALMQUIST

This report is issued solely for the use of the person or company to whom it is addressed. This laboratory accepts responsibility only for the due performance of analysis in accordance with

CH2M HILL LNAPL Characterization Report, August 25, 1993

CH2M HILL

Engineers
Planners
Economists
Scientists

August 25, 1993

Mr. George S Goodridge
Senior Environmental attorney
Rhone-Poulenc, Inc.
CN 5266
Princeton, NJ 08543-5266

Dear Mr. Goodridge,

On May 26, 1993, the CH2M HILL Corvallis Applied Sciences Laboratory received one sample with a request for evaluation of chemical composition.

The analytical results are enclosed. Associated data included to Sue Hays and Pat O'Flaherty only. Any unusual difficulties encountered during the analysis of this sample are discussed in the case narrative.

Under CH2M HILL policy, your samples will be stored for up to 30 days after results are reported. If prior instructions have not been given for disposal, your organization will be contacted at that time for instructions.

CH2M HILL appreciates your business and look forward to serving your analytical needs again. If you should have any questions concerning the data, of if you need additional information, please call me directly, at (503) 752-4271.

Sincerely,

Kelly E. Cook
Environmental Scientist

cc: Sue Hays/Rhone-Poulenc
Edwin Liu/Rhone-Poulenc
Pat O'Flaherty/CH2M HILL/SEA

Enclosures

Corvallis Office
2300 N.W. Walnut Blvd., Corvallis, OR 97330
P.O. Box 428, Corvallis, OR 97339-0428
503.752.4271
FAX 503.752.0276

Corvallis Applied Sciences Laboratory

Client Information		Lab Information	
Project Name:	Rhone-Poulenc	Date Rec'd:	5/26/93
Project Manager:	Pat O'Flaherty	Batch ID:	528704
Sampled By:	Tim O'Conner	Dilution Factor:	1
Client Sample ID:	RPGW5	Report Revision No.:	1
Sampling Date:	5/25/93	Reported By:	K. Cook
Sampling Time:	14:30	Reviewed By:	K. Sanders
Type:	Grab		
Matrix	LNAPL		
Basis:	As Rec'd.		

Analyte	Reporting Limit	Sample Result	Qualifier	Units	Method	Date Analyzed
Palatinol DOP	500	86	J	mg/l	GC/FID	7/26/93
Palatinol 711	500	460.0	JN	mg/l	GC/FID	7/26/93
Santicizer 148	500	ND	U	mg/l	GC/FID	7/26/93
Toluene	500	90,090		mg/l	GC/FID	7/26/93
White Mineral Oil (Peneteck)	500	665,000		mg/l	GC/FID	7/26/93
Specific Gravity	0.005	0.815		g/cc	Gravimeteric	8/18/93

Density Corrected Values

Toluene	11.1%
Peneteck	81.6%
Total	92.7%

N=Unconfirmed Identity
ND=Not Detected
U=Not detected at specified detection limits
J=Estimated value
T=Exceeded holding time

Corvallis Applied Sciences Laboratory

Client Information		Lab Information	
Project Name:	Rhone-Poulenc	Date Rec'd:	5/26/93
Project Manager:	Pat O'Flarity	Batch ID:	528704
Sampled By:	Tim O'Conner	Dilution Factor:	1
Client Sample ID:	RPGW5	Report Revision No.:	0
Sampling Date:	5/25/93	Reported By:	K. Cook
Sampling Time:	14:30	Reviewed By:	K. Sanders
Type:	Grab		
Matrix	LNAPL		
Basis:	As Rec'd.		

Analyte	Reporting Limit	Sample Result	Qualifier	Units	Method	Date Analyzed
Palatinol DOP	500	86	J	mg/l	GC/FID	7/26/93
Palatinol 711	500	460.0	J N	mg/l	GC/FID	7/26/93
Santicizer 148	500	~~500.0~~ ND	U	mg/l	GC/FID	7/26/93
Toluene	500	90,090		mg/l	GC/FID	7/26/93
White Mineral Oil (Peneteck)	500	665,000		mg/l	GC/FID	7/26/93
Specific Gravity	0.005	0.815		g/cc	Gravimeteric	8/18/93

Density Corrected Values

Toluene	11.1%
Peneteck	81.6%
Total	92.7%

N = Unconfirmed identity
ND = Not Detected

U=Not detected at specified detection limits
J=Estimated value
T=Exceeded holding time

ORGANIC DATA QUALIFIERS

U Indicates the compound was analyzed for, but not detected. The number adjacent to the "U" qualifier indicates the reporting limit for that compound. The reporting limit can vary from sample to sample depending on dilution factors or percent moisture adjustments when indicated.

J Indicates an estimated value. It is used when the data indicates the presence of a compound below the stated reporting limit.

C This flag applies to GC analytes only. The "C" flag indicates the presence of this compound has been confirmed by GC/MS analysis.

B This flag is used when the analyte is found in the associated blank, as well as the sample. This notation indicates possible blank contamination and suggests the data user evaluate these compounds and their amounts carefully.

E This qualifier indicates that the value reported exceeds the linear calibration range for that compound. Therefore, the sample should be re-nalyzed at an appropriate dilution. The "E" qualified amount is an estimated concentration, and the results of the ilution will be reported on a separate form.

D This qualifier indicates compounds which have been identified during a diluted re-nalysis. "D" qualifiers are used for samples that have been analyzed initially at a lesser dilution than required for accurate quantification.

NARRATIVE

Preliminary Evaluation

The sample received and assigned reference no. 528704 was initially designated as LNAPL (light, non-aqueous petroleum liquid), and subsequently identified as RPGW5 (product) on the sample chain of custody. Three other samples were received with this sample as reference materials for possible use as analytical standards for quantification.

Initial evaluation of the sample was to determine a method of analysis for the presence and possible quantitation of specific organic compounds. The method chosen for evaluation of the sample is capillary gas chromatography using a flame ionization detector. The capillary column gives excellent separation of complex mixtures and the flame ionization detector is considered to be almost universal for the detection of hydrocarbon mixtures. The method of analysis was found to be very effective for this sample, and initial screening revealed a complex mixture of hydrocarbons with a very distinctive fingerprint. The initial chromatograms are included in the appendix under "PRELIMINARY DATA".

This preliminary information showed the presence of toluene at approximately 10% of the total sample. The three chemicals accompanying the sample were also chromatographed and eliminated as major components. Several other compounds were named as possible components (gasoline, diesel, and stoddard solvent) and were also chromatographed. None of the characteristic fingerprints matched the sample and all were eliminated as major components.

Qualitative and Quantitative Analysis

The preliminary evaluation showed the method to be adequate for the quantitative analysis of the sample. The analysis proceeded to quantify toluene and the three other chemicals initially sent with the sample. A sample of white mineral oil (Peneteck) was also evaluated at this time as a possible constituent. The chromatograms are included in the appendix under "QUANTITATIVE DATA". The diluted sample was also sent to our Redding California laboratory for qualitative analysis using gas chromatography/mass spectroscopy for identification of compounds present. The results of the analysis is included as a separate report following this document in the appendix under "QUALITATIVE DATA". The report verifies toluene as a major component and identifies the remainder as a mix of complex hydrocarbons, typical of mineral oil components. The compound bis(2-Ethylhexyl)phthalate is also identified as being present at an estimated level of 50 mg/l. This is the same as Palatinol DOP, reported at 86 mg/l in the quantitative report.

The fingerprint of the mineral oil sample was a very close match to the sample and was quantified with the other compounds during the analysis as a major constituent of the sample. Small amounts of two of the three initially suspected chemicals were found at levels below the lowest standard used and can only be reported as estimates.

The total percentage accounted for does not add up to 100 percent. This is not unusual when dealing with samples of this nature since this is a complex mixture which has been subjected to environmental influences of change. Many of the peaks seen in the sample are possibly degradation products and were not identified or quantified as part of this analysis and probably makeup the remaining percentage.

Results are reported on an as received basis unless otherwise noted in the reports.

CLIENT SAMPLE CROSS-REFERENCE

CH2M HILL APPLIED SCIENCES LABORATORY

Client Sample ID	CVO Lab Sample ID
5/25 Palatino1-711	528701
5/25 Saniticizer-148	528702
5/25 Palatino1-DOP	538703
5/25 RPGW5	538704

CH2M HILL

QUALITY ANALYTICAL LABORATORIES

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M HILL Project #: SEA35051.GP

Purchase Order #:

Project Name: RHONE - Poulenc

Company Name/CH2M HILL Office: CH2M HILL / SEA

Project Manager & Phone #: Mr. / Ms. PAT O'FLAHERTY

Report Copy to:

Requested Completion Date:

Sampling Requirements: SDWA ☐ NPDES ☐ RCRA ☐ OTHER ___

Sample Disposal: Dispose ☒ Return ☐

LAB TEST CODES

ANALYSES REQUESTED

SHADED AREA -- FOR LAB USE ONLY

Lab 1 #: 578C1-4

Lab 2 #:

Quote #:

Kit Request #:

Project #:

No. of Samples: 4

Page: 1 of 2

COC Rev | Login | LIMS Ver | Ack Gen

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	REMARKS	LAB 1 ID	LAB 2 ID
5/25/93	14:30		X	X		PALATINOL 711	1	PLASTICIZER	1	
5/25/93	14:30		X	X		SANITICIZER 148	1	"	2	
5/25/93	14:30		X	X		PALATINOL DOP	1	"	3	

Sampled By & Title (Please sign and print name): Tim O'Connor / HYDROLOGIST — Date/Time: 5/25/93 14:30

Relinquished By (Please sign and print name): Tim O'Connor — Date/Time: 5/25/93 15:00

Received By (Please sign and print name): Jim McNick — Date/Time: 5/26/93 [illegible]

Relinquished By (Please sign and print name): — Date/Time:

Received By (Please sign and print name): — Date/Time:

Relinquished By (Please sign and print name): — Date/Time:

Received By (Please sign and print name): — Date/Time:

Shipped Via: UPS BUS Fed-Ex Hand Other ___ — Shipping #: 1701815.50

Work Authorized By (Please sign and print name):

Remarks:

HAZWRAP/NESSA: Y N

QC Level: (1) 2 3 Other:

COC Rec ✓ | ICE ✓ | Ana Req ✓ | TEMP ✓ | Cust Seal ✓ | Ph ___

Instructions — Agreement Provisions on Reverse Side

DISTRIBUTION: ORIGINAL - LAB Yellow - LAB [illegible]

Monsanto Company 104(e) Response

Monsanto 2A002257

CH2M HILL
QUALITY ANALYTICAL LABORATORIES

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M HILL Project #: SEA35951.GD
Purchase Order #:
Project Name: RHONE Poulenc
Company Name/CH2M HILL Office:
Project Manager & Phone #: Mr. [ ] Ms. [X] PAT O'FLARITY
Report Copy to:
Requested Completion Date:
Sampling Requirements: SDWA [ ] NPDES [ ] RCRA [ ] OTHER ____
Sample Disposal: Dispose [X] Return [ ]

LAB TEST CODES

ANALYSES REQUESTED

SHADED AREA -- FOR LAB USE ONLY
Lab 1 #: 528761-74
Lab 2 #:
Quote #:
Kit Request #:
Project #:
No. of Samples: 4
Page: 2 of 2
COC Rev | Login | LIMS Ver | Ack Gen

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	REMARKS	LAB 1 ID	LAB 2 ID
5/25/13	14:00		X	X		RPGW5	2	PRODUCT	4	

Sampled By & Title (Please sign and print name): Tim O'Connor
Date/Time: 5/25/13 14:45
Relinquished By (Please sign and print name): Tim O'Connor
Date/Time: 5/25/13 15:00
Received By (Please sign and print name): Vivi Mistick
Date/Time: 5/26/13 [illegible]
Relinquished By (Please sign and print name):
Date/Time:
Received By (Please sign and print name):
Date/Time:
Relinquished By (Please sign and print name):
Date/Time:
Received By (Please sign and print name):
Date/Time:
Shipped Via: UPS BUS Fed-Ex Hand Other ____
Shipping #: 1570181550
Work Authorized By (Please sign and print name):
Remarks: WASTE

HAZWRAP/NESSA: Y N
QC Level: 1 2 3 Other:
COC Rec [ ] ICE [ ]
Ana Req [ ] TEMP [ ]
Cust Seal [ ] Ph [ ]

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: ORIGINAL - LAB, Yellow - LAB, Pink - Client

Monsanto Company 104(e) Response

Monsanto 2A002258

RHÔNE-POULENC INC.
ORGANIC CHEMICALS DIVISION

9229 E. Marginal Way South - P.O. Box 80963 - Seattle, Washington 98108 - Telephone: (206) 764-4450

May 14, 1993

Mr. Rod Gravley
CH2M Hill
2300 N.W. Walnut Blvd.
Corvallis, OR 97339

Dear Mr. Gravley:

Rhone-Poulenc Inc. is requesting bids for quantitatively analyzing one or more samples of nonaqueous liquid for toluene and three specific plasticizers. None or all of the following plasticizers may be present:

1. Palatinol DOP (BASF trade name); DEHP; dioctyl phthalate; bis (2-ethylhexyl) phthalate; 1, 2-benzenedicarboxylic acid bis (2-ethylhexyl) ester.

2. Palatinol 711 (BASF trade name); di ($C_{7,9,11}$ alkyl) phthalate; 1,2 - benzenedicarboxylic acid di ($C_{7,9,11}$ alkyl) esters

3. Santicizer 148 (Monsanto trade name); isodecyl diphenyl phosphate (87 - 91%) and triphenyl phosphate (4 - 6%)

Samples of these plasticizers and MSDS's will be provided at the time that the unknown sample is sent. Toluene known to be present in the sample to be analyzed, and other components such as straight chain and branched hydrocarbons may also be present.

If you are interested in submitting a bid, please include proposed methodology, estimated time required for performing the work, and the quantities of plasticizers and unknown liquid needed for the analyses.

In requesting this bid I am acting under instructions of an attorney rendering legal advice in anticipation of potential litigation. Because of this, I am asking that all work related to this project remain privileged and confidential and be labeled as such. Only one report on the analysis of the sample (s) is to be generated and it, along with the bid currently being solicited, are to be submitted to Mr. George S. Goodridge, Senior Environmental Attorney, Rhone-Poulenc Inc. CN 5266, Princeton, NJ 08543-5266.

If you have any questions or need additional information, please call me at (206) 764-4450 or, alternatively, Patt O'Flaherty of CH2M Hill at (206) 453-5000.

FAX 206/764-4498

Sincerely,

Sue E. Hays

FAX - 908/821-2787

Sue E. Hays
Consultant

cc: G.S. Goodridge
E. Liu
P. O'Flaherty

RHÔNE-POULENC

RHÔNE-POULENC INC.
ORGANIC CHEMICALS DIVISION

9229 E. Marginal Way South Seattle, Washington 98108 - Telephone: (206) 764-4450

July 21, 1993

Kathy McKinley
CH2M-HILL, Corvallis Office
2300 NW Walnut Boulevard
Corvallis, OR 97330-3538

Dear Kathy:

Confirming our telephone conversation yesterday, I would like CH2M-HILL to perform the analyses requested in my letter of May 14, 1993, and the additional analyses discussed in my later telephone conversation with Kelly Cook. The project, therefore, consists of analyzing the liquid sample sent to you for the three plasticizers, toluene, and the other nonaqueous constitutients according to the proposed methodology and pricing as stated in Kelly's June 28, 1993, letter. I am sending, under separate cover, a sample of Peneteck Oil (white mineral oil), a possible component of the nonaqueous sample.

I would like to add TCLP for all eight metals and flash point to the requested analyses. Let me know if additional sample will be needed for these analyses.

Please send the report to George Goodridge, as requested in my original letter. As we discussed today, you will be able to have the results ready within 21 days. If it is possible to have them in less time, it would be appreciated. I will be out of town until August 16, but any questions can be addressed to Patt O'Flaherty at (206) 453-5000.

Sincerely,

Sue E. Hays

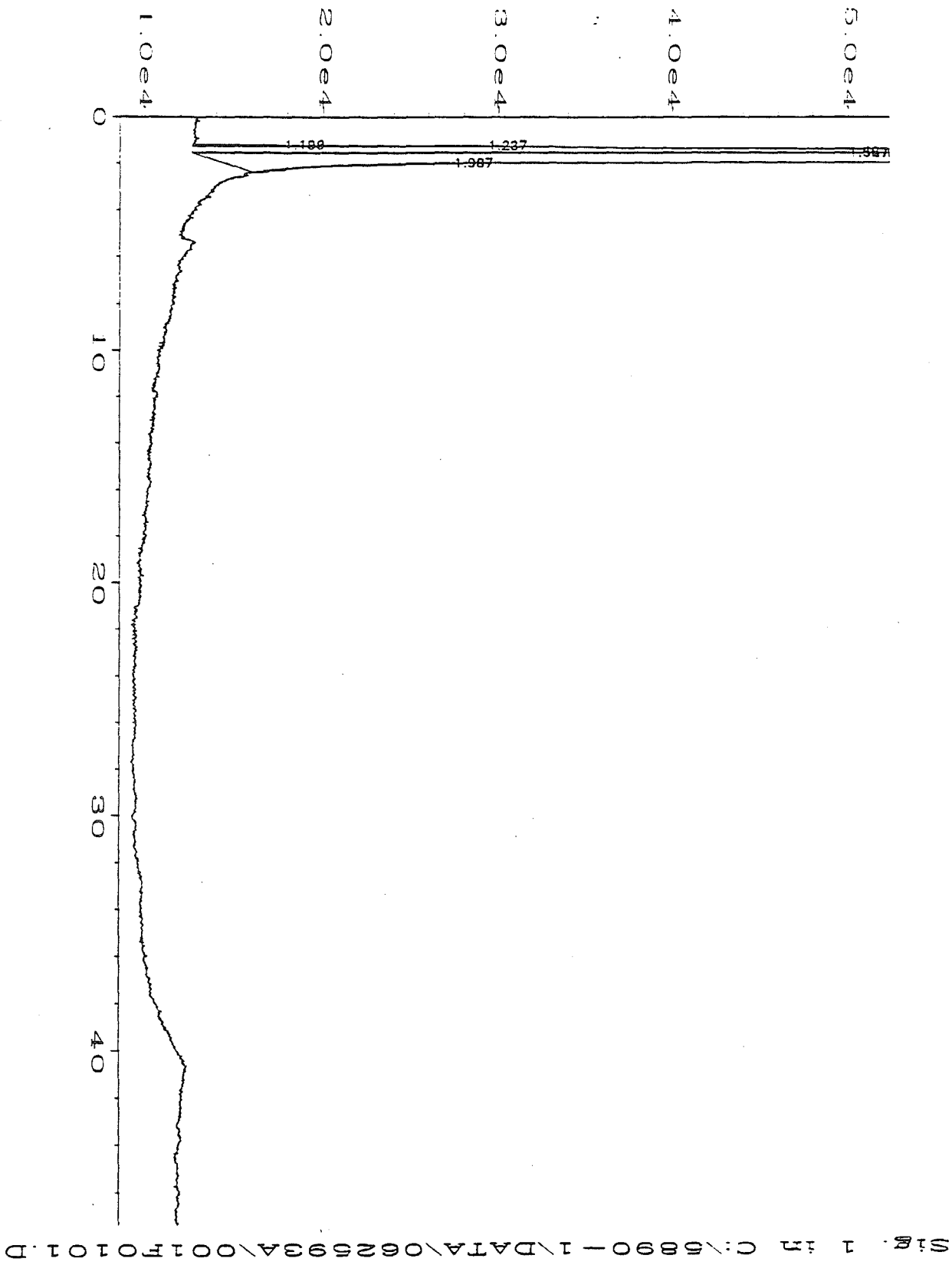
Sue E. Hays, Consultant

cc: Kelly Cook
George Goodridge
Edwin Liu
Patt O'Flaherty

RHÔNE-POULENC

TOTAL P.02

PRELIMINARY DATA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1.237
1.987
0
10
20
30
40
Sig. 1 in C:\5890-1\DATA\062593A\001FO101.D

External Standard Report

Data File Name : C:\5890-1\DATA\062593A\001F0101.D
Operator : K. Cook
Instrument : 5890-1
Sample Name : MeCl Blank
Run Time Bar Code:
Acquired on : 25 Jun 93 03:30 PM
Report Created on: 25 Jun 93 04:20 PM
Last Recalib on : 28 APR 93 04:03 PM
Multiplier : 1

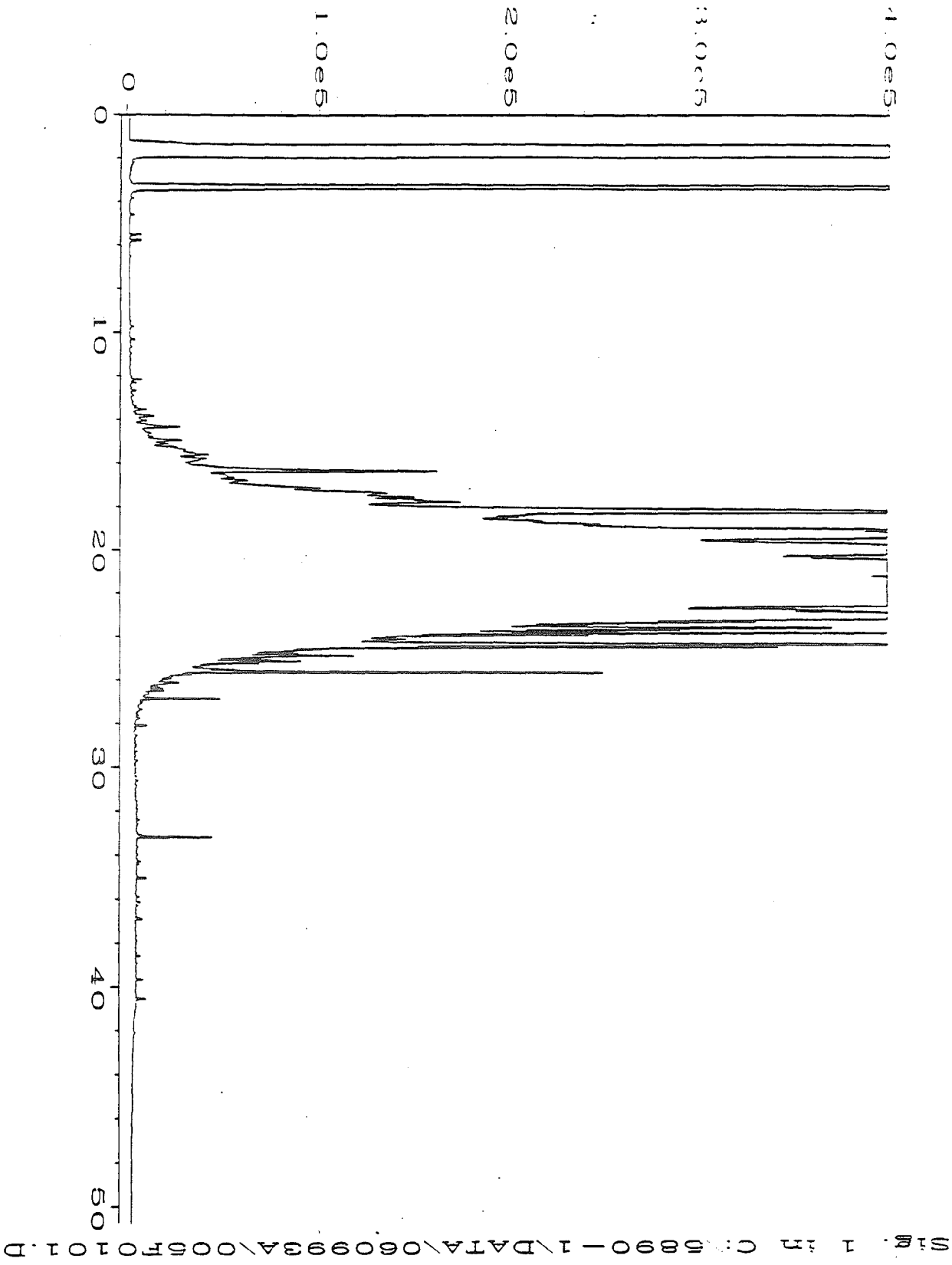
Page Number : 1
Vial Number : 1
Injection Number : 1
Sequence Line : 1
Instrument Method: 060993A.MTH
Analysis Method : 060993A.MTH
Sample Amount : 0
ISTD Amount :

Sig. 1 in C:\5890-1\DATA\062593A\001F0101.D

Ret Time	Area	Type	Width	Ref#	UG/ML	Name
7.000	* not found *			1		GAS (C8-C10)
23.250	* not found *			1		DIESEL (C10-C28)
40.000	* not found *			1		OIL (C28-C36)
1.199	5078	BV	0.015		5077.709	* uncalibrated *
1.237	23607	VV	0.024		23606.96	* uncalibrated *
1.491	6.37983E+008	HH S	0.102		6.4E+008	* uncalibrated *
1.527	1.84018E+008	HH S	0.033		1.8E+008	* uncalibrated *
1.557	5.9126E+008	HB S	0.104		5.9E+008	* uncalibrated *
1.987	716	BB T	0.008		716.455	* uncalibrated *

Calibration table contains at least one peak with amt = 0

Not all calibrated peaks were found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3.0e5
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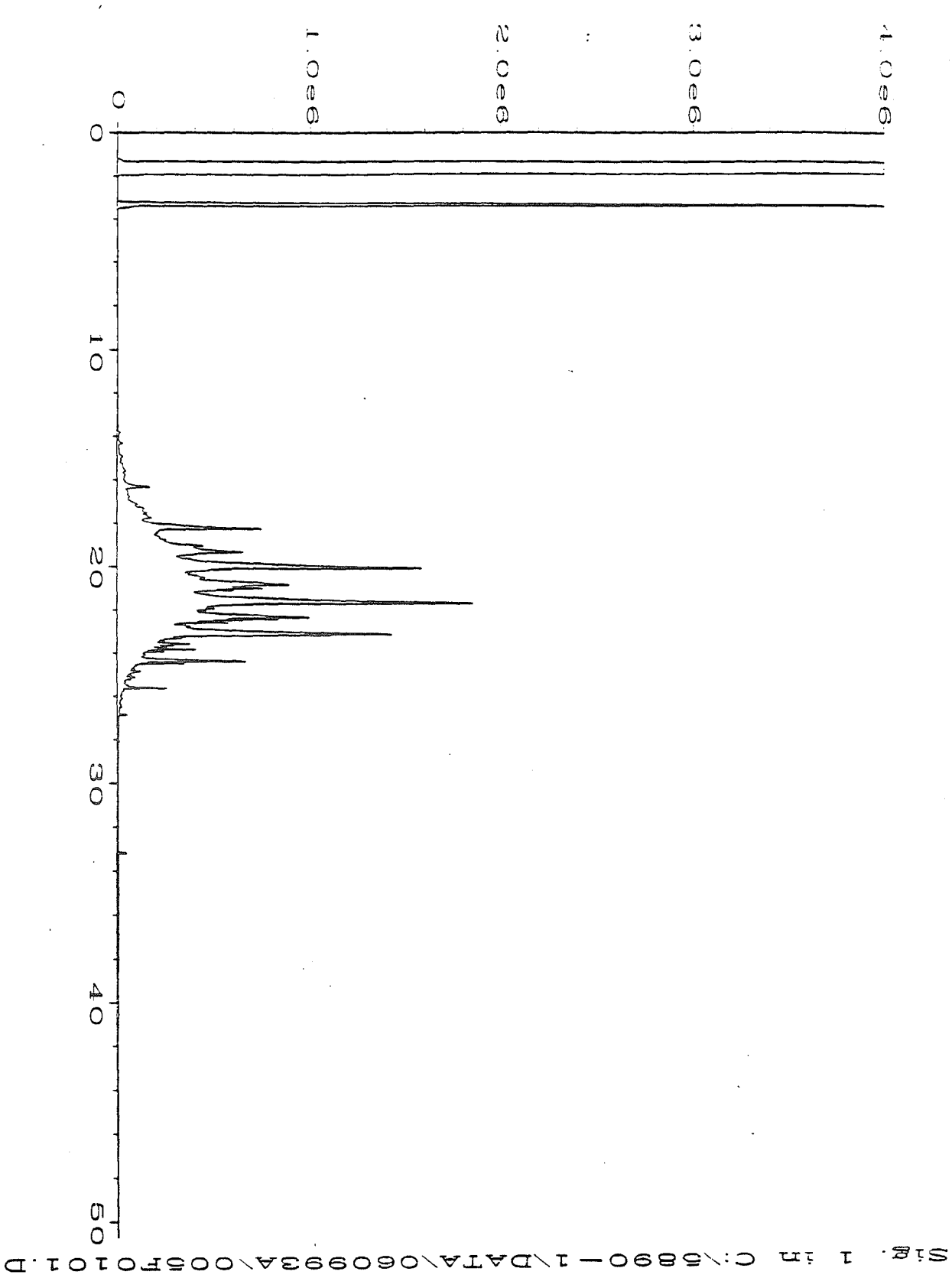
1.0e5
0
0
10
20
30
40
50
Sig. 1 in C:\5890-1\DATA\060993A\005F0101.D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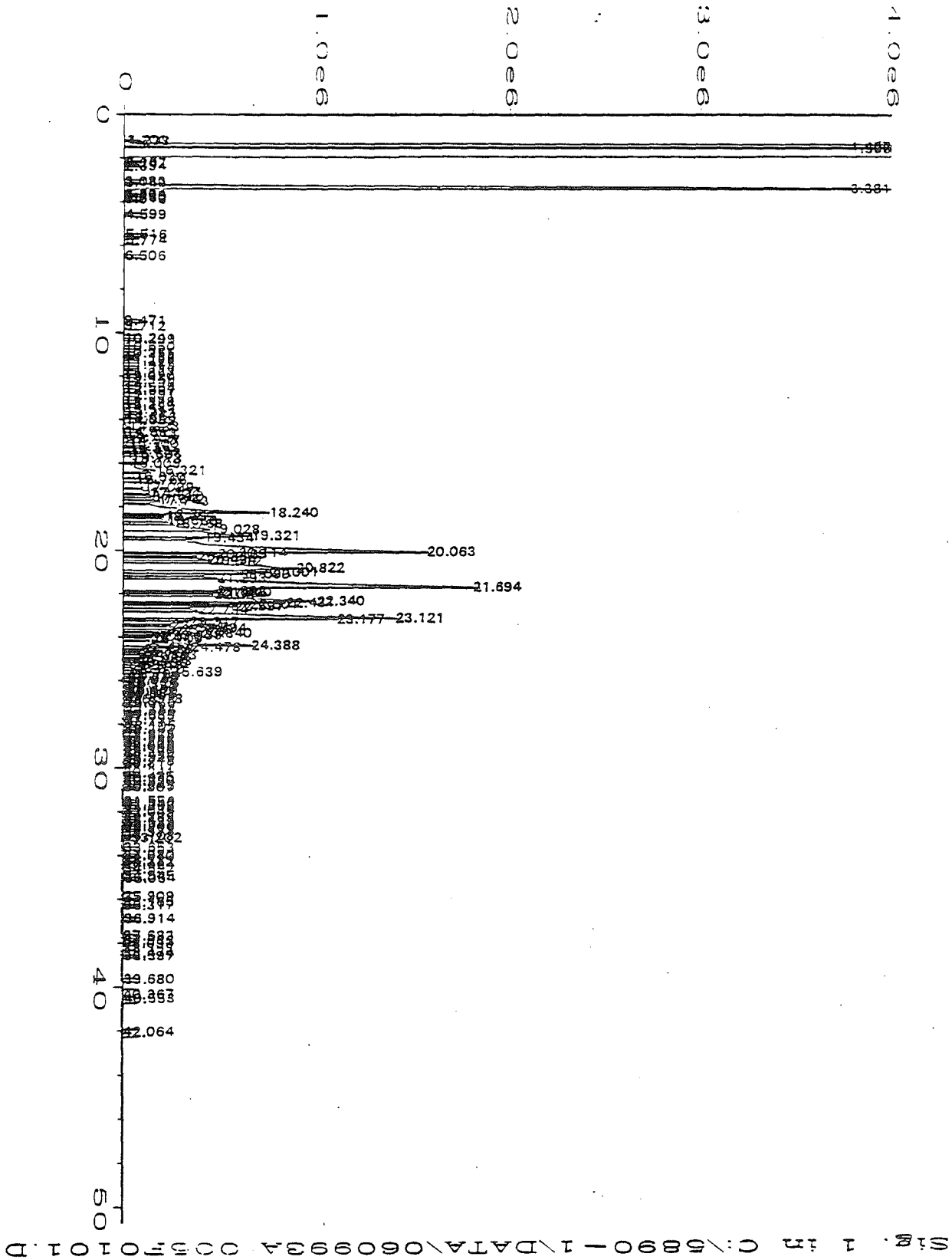
3.0e6
4.0e6



Sig. 1 in C:\5890-1\DATA\060993A.005FO101.D

Calibrated report not possible because no calibration table exists

Area Percent Report

Data File Name : C:\5890-1\DATA\060993A\005F0101.D
Operator : K. Cook
Instrument : 5890-1
Sample Name : LNAPL 1:50 Dilution in MECl
Run Time Bar Code:
Acquired on : 07 Jun 93 08:18 PM
Report Created on: 08 Jun 93 04:00 PM

Page Number : 1
Vial Number : 5
Injection Number : 1
Sequence Line : 1
Instrument Method: 060993A.MTH
Analysis Method : 060993A.MTH

Sig. 1 in C:\5890-1\DATA\060993A\005F0101.D

Pk#	Ret Time	Area	Height	Type	Width	Area %
1	1.200	5213	5295	BV	0.015	0.0003
2	1.238	23447	17194	VV	0.023	0.0014
3	1.457	4.88981E+008	7.47581E+007	HH S	0.080	29.6528
4	1.497	1.63412E+008	7.56911E+007	HH S	0.030	9.9096
5	1.536	1.89068E+008	7.65541E+007	HH S	0.031	11.4654
6	1.563	5.75552E+008	7.70165E+007	HB S	0.093	34.9026
7	2.161	1116	1257	BV T	0.013	0.0001
8	2.267	1252	974	BB T	0.018	0.0001
9	2.394	602	558	PV T	0.016	0.0000
10	3.083	1608	748	PV T	0.030	0.0001
11	3.169	2163	1677	VV T	0.019	0.0001
12	3.381	2.38342E+007	4297949	VV T	0.067	1.4453
13	3.634	2873	806	VV T	0.048	0.0002
14	3.708	971	403	VV T	0.032	0.0001
15	3.758	1391	585	VV T	0.034	0.0001
16	3.830	4693	1982	VV T	0.034	0.0003
17	3.915	1353	674	VV T	0.030	0.0001
18	4.599	5993	2385	BV	0.038	0.0004
19	5.516	14910	5861	BV	0.038	0.0009
20	5.774	17920	5705	BB	0.047	0.0011
21	6.506	1834	714	BB	0.039	0.0001
22	9.471	2326	713	BV	0.047	0.0001
23	9.712	9023	1937	VB	0.063	0.0005
24	10.241	1754	637	BV	0.040	0.0001
25	10.299	6424	2625	VV	0.037	0.0004
26	10.650	3508	1048	VV	0.047	0.0002
27	10.955	2439	823	BB	0.044	0.0001
28	11.165	1544	606	BV	0.039	0.0001
29	11.235	1748	668	VV	0.040	0.0001
30	11.327	2195	694	VV	0.045	0.0001
31	11.475	2145	641	VB	0.047	0.0001
32	11.739	1035	513	BV	0.033	0.0001
33	11.867	1485	236	VV	0.088	0.0001
34	12.020	2058	655	BV	0.049	0.0001
35	12.169	18745	5784	VV	0.047	0.0011
36	12.298	8359	2858	VB	0.043	0.0005
37	12.554	3282	685	BV	0.073	0.0002
38	12.667	9487	2843	VV	0.048	0.0006
39	12.891	9630	1978	VV	0.066	0.0006
40	13.178	7811	1521	VV	0.077	0.0005
41	13.281	6585	1567	VV	0.060	0.0004
42	13.395	17688	3295	VV	0.080	0.0011
43	13.547	48931	8169	VV	0.087	0.0030
44	13.712	14221	2996	VV	0.066	0.0009
45	13.853	75762	11886	VV	0.085	0.0046
46	13.956	13702	4695	VV	0.042	0.0008

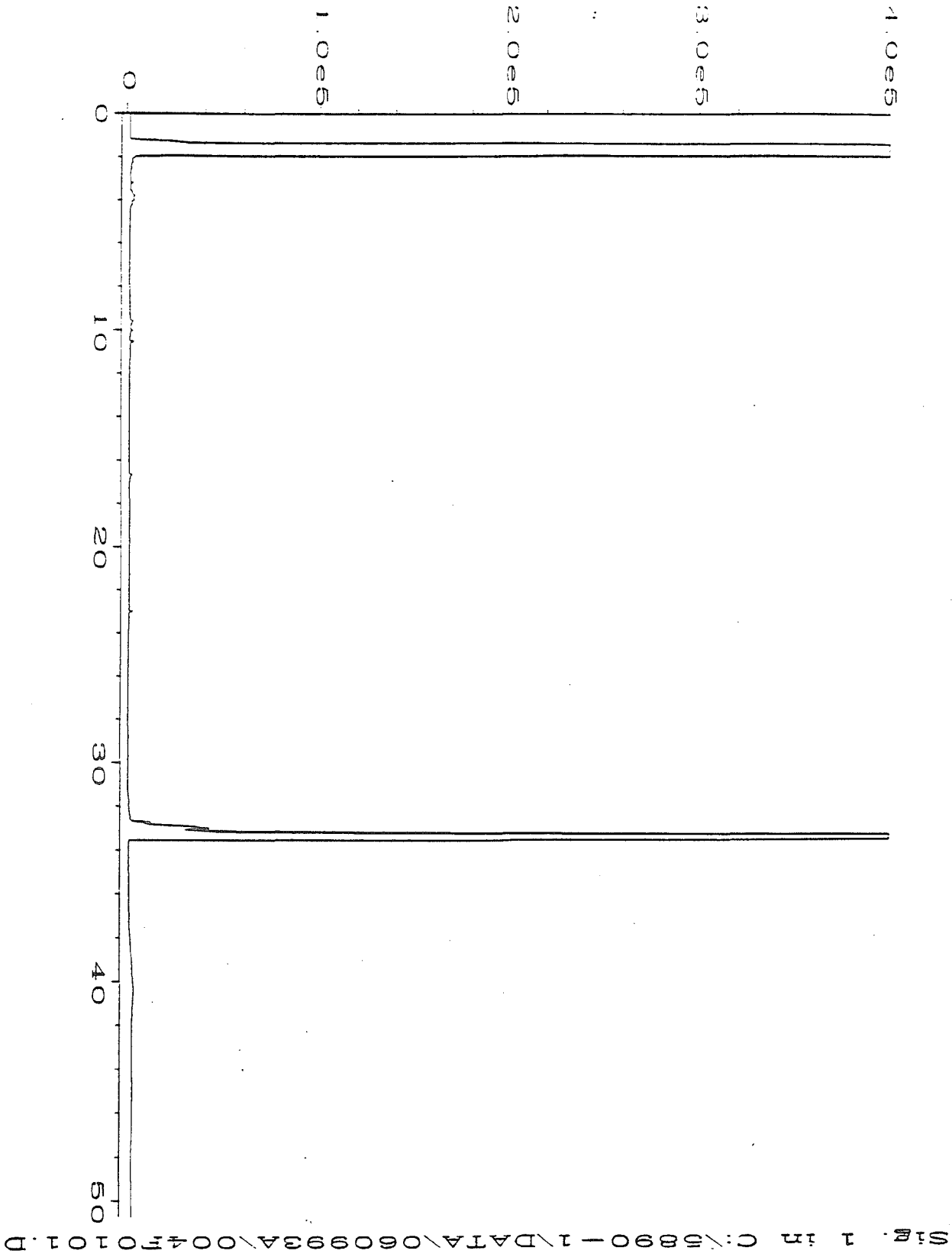
47	14.052	52902	8018	VV	0.087	0.0032
48	14.333	202160	25441	VV	0.108	0.0123
49	14.551	52477	7854	VV	0.087	0.0032
50	14.618	91399	10584	VV	0.112	0.0055
51	14.794	59740	11326	VV	0.075	0.0036
52	14.947	212394	25882	VV	0.108	0.0129
53	15.100	135998	19182	VV	0.097	0.0082
54	15.262	125738	23688	VV	0.078	0.0076
55	15.391	238449	28168	VV	0.111	0.0145
56	15.528	177041	33338	VV	0.089	0.0107
57	15.601	277498	39857	VV	0.097	0.0168
58	15.778	544130	38768	VV	0.180	0.0330
59	16.009	127690	30249	VV	0.063	0.0077
60	16.321	1684263	160045	VV	0.141	0.1021
61	16.630	747201	52812	VV	0.179	0.0453
62	16.766	574793	59804	VV	0.125	0.0349
63	17.099	1292931	98056	VV	0.170	0.0784
64	17.327	1488353	133582	VV	0.145	0.0903
65	17.404	466390	126440	VV	0.054	0.0283
66	17.510	1015093	147398	VV	0.097	0.0616
67	17.642	938161	153155	VV	0.086	0.0569
68	17.743	1658414	172209	VV	0.130	0.1006
69	18.240	8773295	740741	VV	0.150	0.5320
70	18.341	1180657	210999	VV	0.078	0.0716
71	18.455	1161987	202633	VV	0.081	0.0705
72	18.638	2116496	215876	VV	0.120	0.1283
73	18.768	1784001	246242	VV	0.101	0.1082
74	19.028	5588653	434092	VV	0.172	0.3389
75	19.321	8925821	645965	VV	0.184	0.5413
76	19.434	2337868	402864	VV	0.082	0.1418
77	20.063	2.41892E+007	1572281	VV	0.187	1.4669
78	20.114	1889520	576921	VV	0.046	0.1146
79	20.169	2719544	470309	VV	0.096	0.1649
80	20.296	1810590	369025	VV	0.071	0.1098
81	20.434	2821790	417147	VV	0.113	0.1711
82	20.512	2831900	445103	VV	0.085	0.1717
83	20.822	1.39255E+007	878746	VV	0.198	0.8445
84	21.001	4768391	741355	VV	0.092	0.2892
85	21.099	3949540	593124	VV	0.087	0.2395
86	21.293	3164380	467362	VV	0.091	0.1919
87	21.694	2.90617E+007	1816281	VV	0.193	1.7624
88	21.882	1497839	468492	VV	0.053	0.0908
89	21.940	1576529	494964	VV	0.045	0.0956
90	21.985	1378142	471572	VV	0.049	0.0836
91	22.064	2179285	452923	VV	0.070	0.1322
92	22.340	1.13892E+007	985123	VV	0.146	0.6907
93	22.431	3197753	825455	VV	0.053	0.1939
94	22.501	2449226	639089	VV	0.052	0.1485
95	22.597	2972560	566079	VV	0.069	0.1803
96	22.784	3319581	372912	VV	0.116	0.2013
97	23.121	1.43624E+007	1408970	VV	0.126	0.8710
98	23.177	4590276	1099915	VV	0.070	0.2784
99	23.317	2426379	326612	VV	0.099	0.1471
100	23.452	1201213	238953	VV	0.069	0.0728
101	23.594	2499924	367591	VV	0.094	0.1516
102	23.695	1119054	287258	VV	0.056	0.0679
103	23.773	758015	254799	VV	0.042	0.0460
104	23.840	1482177	398013	VV	0.052	0.0899
105	23.939	979349	238787	VV	0.056	0.0594
106	24.016	463941	135964	VV	0.047	0.0281
107	24.100	827617	142351	VV	0.088	0.0502
108	24.167	378515	131228	VV	0.048	0.0230

109	24.388	4126478	647405	VV	0.085	0.2502
110	24.478	1492272	337426	VV	0.064	0.0905
111	24.588	492149	97697	VV	0.067	0.0298
112	24.674	317465	83114	VV	0.054	0.0193
113	24.767	414055	85466	VV	0.067	0.0251
114	24.863	699141	114663	VV	0.081	0.0424
115	24.977	201806	66176	VV	0.043	0.0122
116	25.059	266255	71483	VV	0.052	0.0161
117	25.133	263571	86887	VV	0.043	0.0160
118	25.180	163845	65222	VV	0.042	0.0099
119	25.236	270751	65102	VV	0.056	0.0164
120	25.346	213054	39360	VV	0.071	0.0129
121	25.510	322937	52013	VV	0.082	0.0196
122	25.639	860860	242183	VV	0.050	0.0522
123	25.704	78713	27488	VV	0.042	0.0048
124	25.764	127227	30202	VV	0.058	0.0077
125	25.845	107683	20209	VV	0.069	0.0065
126	25.948	93682	19435	VV	0.066	0.0057
127	26.043	54249	15377	VV	0.050	0.0033
128	26.126	153023	23481	VV	0.086	0.0093
129	26.255	46589	12889	VV	0.050	0.0028
130	26.340	47396	13895	VV	0.048	0.0029
131	26.407	65544	15349	VV	0.058	0.0040
132	26.510	49828	15824	VV	0.046	0.0030
133	26.583	27552	7813	VV	0.051	0.0017
134	26.656	43192	7952	VV	0.080	0.0026
135	26.878	133125	44191	VV	0.044	0.0081
136	26.975	21840	4883	VV	0.064	0.0013
137	27.065	30520	4252	VV	0.093	0.0019
138	27.364	32306	4202	VV	0.100	0.0020
139	27.444	6763	2639	VV	0.043	0.0004
140	27.586	8043	2375	VV	0.049	0.0005
141	27.653	7656	2505	VV	0.044	0.0005
142	27.797	21408	3036	VV	0.103	0.0013
143	28.105	15978	6640	VV	0.037	0.0010
144	28.247	6286	1305	VV	0.064	0.0004
145	28.515	3989	1014	VV	0.066	0.0002
146	28.569	6099	1617	VV	0.053	0.0004
147	28.795	2315	869	VV	0.039	0.0001
148	28.855	2367	948	VV	0.037	0.0001
149	28.966	4118	1404	VV	0.044	0.0002
150	29.046	4375	1218	VV	0.051	0.0003
151	29.290	4419	1505	PV	0.043	0.0003
152	29.454	2627	792	VV	0.052	0.0002
153	29.525	2320	712	VV	0.047	0.0001
154	29.718	7718	1737	PV	0.064	0.0005
155	29.811	785	421	VV	0.029	0.0000
156	30.241	1589	629	VV	0.039	0.0001
157	30.435	1991	845	PV	0.036	0.0001
158	30.560	2392	523	VV	0.076	0.0001
159	30.634	7170	1513	VV	0.072	0.0004
160	30.845	3383	1050	VV	0.049	0.0002
161	30.907	3609	843	VV	0.057	0.0002
162	31.556	2917	837	PV	0.053	0.0002
163	31.642	3074	824	VV	0.055	0.0002
164	31.712	1942	740	VV	0.039	0.0001
165	31.765	3799	846	VV	0.063	0.0002
166	31.934	4034	970	VV	0.061	0.0002
167	32.043	3112	792	VV	0.055	0.0002
168	32.289	3036	782	VV	0.054	0.0002
169	32.421	6087	1941	VV	0.047	0.0004
170	32.528	1696	601	VV	0.047	0.0001

171	32.616	4552	1175	VV	0.057	0.0003
172	32.706	3219	815	VV	0.056	0.0002
173	32.977	3354	853	PV	0.056	0.0002
174	33.108	6731	2846	VV	0.036	0.0004
175	33.202	88811	38384	VV	0.036	0.0054
176	33.653	4018	886	VV	0.064	0.0002
177	33.982	3270	1001	VV	0.048	0.0002
178	34.040	2852	770	VV	0.053	0.0002
179	34.221	4776	953	PV	0.074	0.0003
180	34.312	6000	2234	VV	0.041	0.0004
181	34.424	5755	1607	VV	0.050	0.0003
182	34.627	2310	548	PV	0.064	0.0001
183	34.945	4771	820	BV	0.076	0.0003
184	35.064	11634	5052	VV	0.036	0.0007
185	35.909	6835	1637	PV	0.059	0.0004
186	36.165	7206	2192	BV	0.049	0.0004
187	36.317	2842	1109	VV	0.040	0.0002
188	36.914	11882	3191	VB	0.052	0.0007
189	37.683	3510	849	VV	0.071	0.0002
190	37.882	2347	893	PV	0.039	0.0001
191	37.933	2050	892	VV	0.036	0.0001
192	38.033	2199	493	PV	0.066	0.0001
193	38.474	2615	888	BV	0.047	0.0002
194	38.597	4914	2143	PV	0.036	0.0003
195	39.680	9506	3269	VV	0.046	0.0006
196	40.367	2967	574	BB	0.073	0.0002
197	40.553	15627	4769	BB	0.051	0.0009
198	42.064	3483	649	BB	0.077	0.0002

Total area = 1.64902E+009

==========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2.0e5
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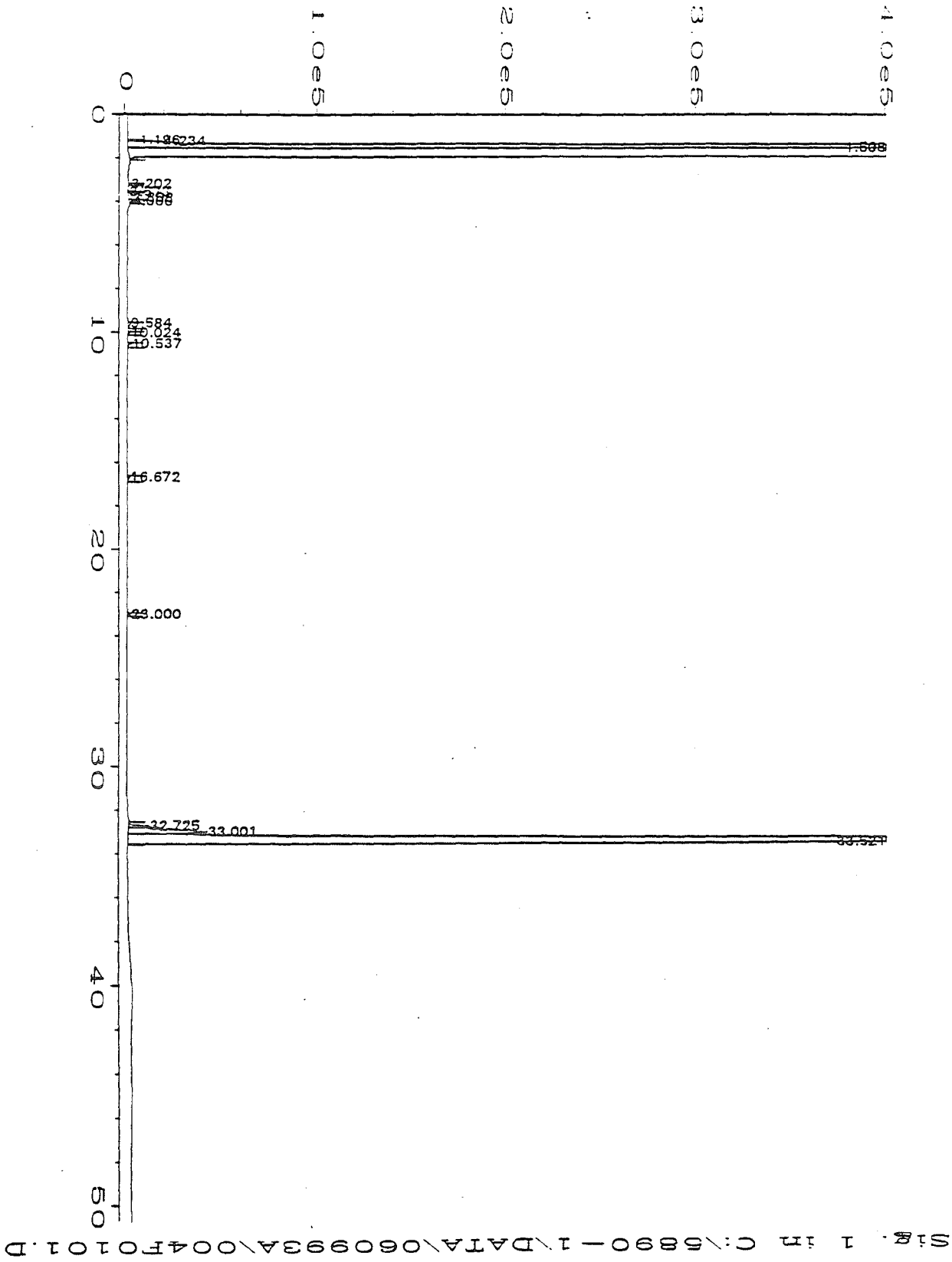
0
0
10
20
30
40
50
Sig. 1 in C:\5890-1\DATA\060993A\004FO101.D


Sig. 1 in C:\5890-1\DATA\060993A\004F0101.D
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4.0e5
0
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20
30
40
50
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1.608
3.202
9.584
10.024
10.537
16.672
23.000
32.725
33.001
33.527

Calibrated report not possible because no calibration table exists

Area Percent Report

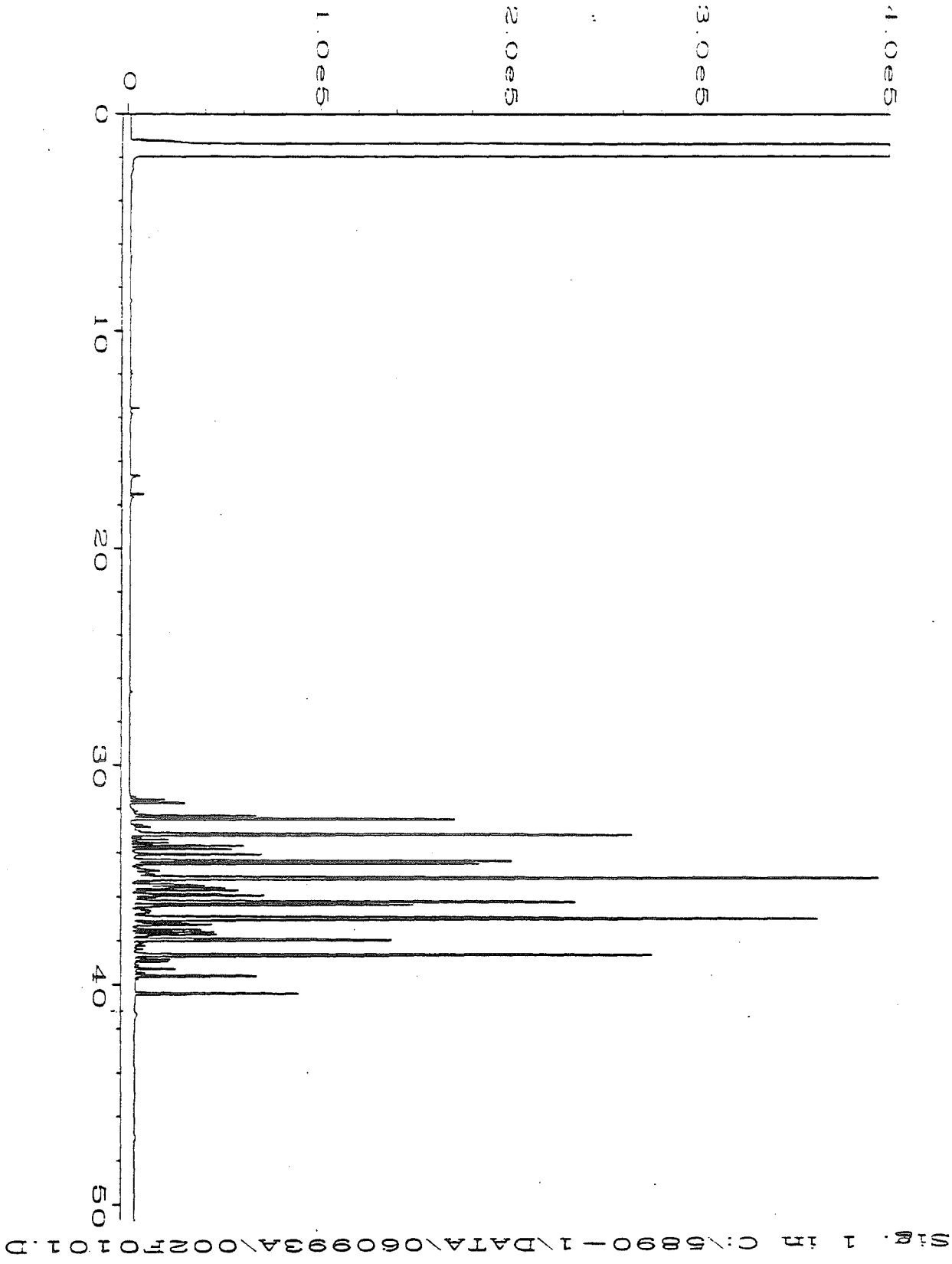
Data File Name : C:\5890-1\DATA\060993A\004F0101.D
Operator : K. Cook
Instrument : 5890-1
Sample Name : Palatinol DOP
Run Time Bar Code:
Acquired on : 07 Jun 93 07:18 PM
Report Created on: 08 Jun 93 03:55 PM

Page Number : 1
Vial Number : 4
Injection Number : 1
Sequence Line : 1
Instrument Method: 060993A.MTH
Analysis Method : 060993A.MTH

Sig. 1 in C:\5890-1\DATA\060993A\004F0101.D

Pk#	Ret Time	Area	Height	Type	Width	Area %
1	1.196	5817	5968	BV	0.015	0.0004
2	1.234	27167	18986	VV	0.020	0.0020
3	1.508	7.4124E+008	7.61028E+007	HH S	0.162	54.8840
4	1.535	5.95059E+008	7.65562E+007	HB S	0.101	44.0602
5	3.202	1455	1052	BB	0.021	0.0001
6	3.573	1102	624	BV	0.026	0.0001
7	3.808	21209	1801	VV	0.144	0.0016
8	4.000	10192	1322	VV	0.094	0.0008
9	9.584	11452	1400	VB	0.109	0.0008
10	10.024	4728	1293	BB	0.055	0.0004
11	10.537	8426	1892	BB	0.066	0.0006
12	16.672	8497	1304	BB	0.089	0.0006
13	23.000	4244	1793	BB	0.036	0.0003
14	32.725	50199	10545	BV	0.067	0.0037
15	33.001	450840	40684	VV	0.134	0.0334
16	33.521	1.36533E+007	1205115	VV	0.139	1.0109

Total area = 1.35056E+009


Sig. 1 in C:\5890-1\DATA\060993A\002F0101.D
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10
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4.0e5

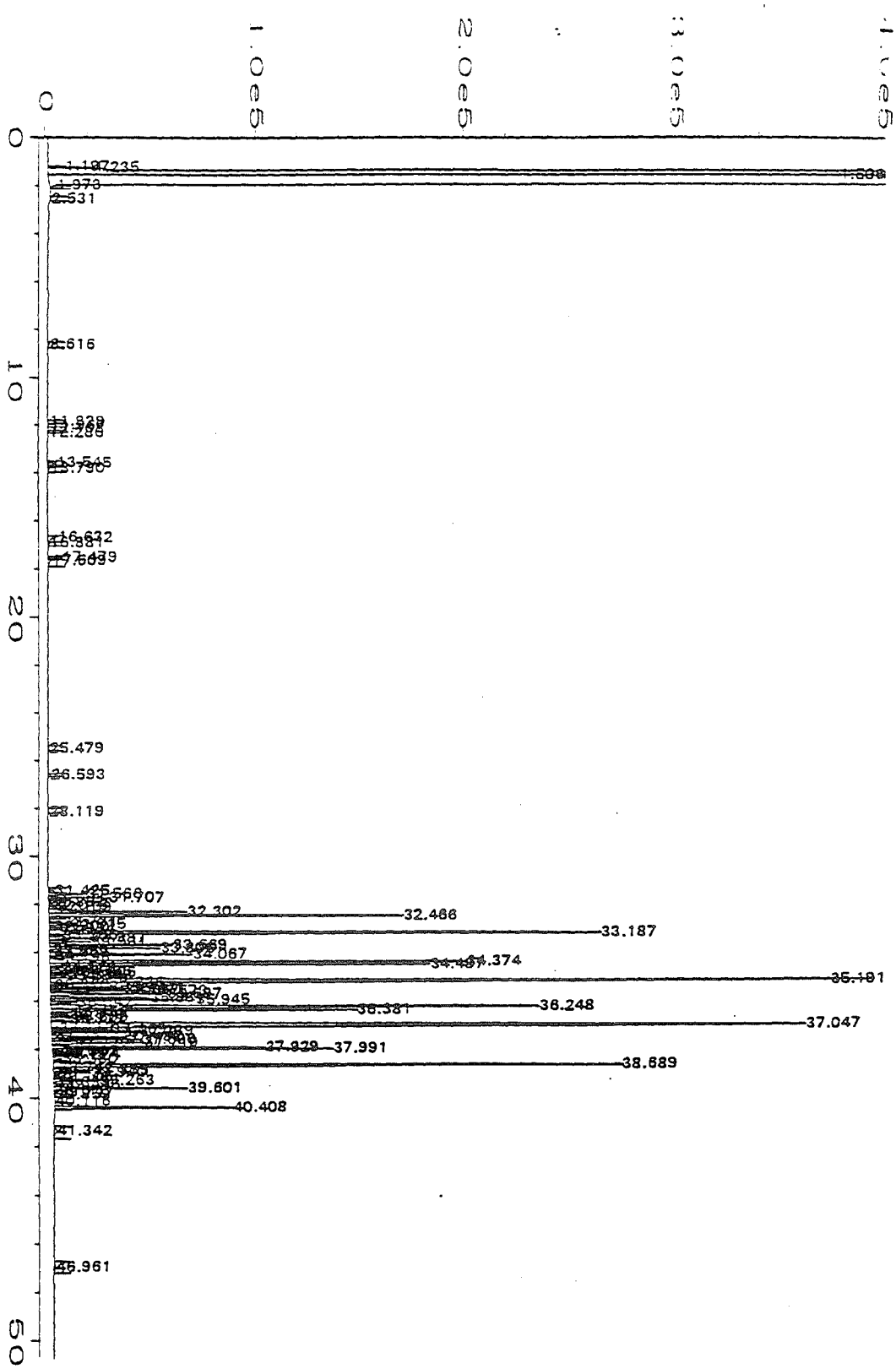

Fig. 1 in C:\5890-1\DATA\060993A\002F0101.D

Calibrated report not possible because no calibration table exists

Area Percent Report

Data File Name : C:\5890-1\DATA\060993A\002F0101.D
Operator : K. Cook
Instrument : 5890-1
Sample Name : Palantinol 7||
Run Time Bar Code:
Acquired on : 07 Jun 93 05:17 PM
Report Created on: 08 Jun 93 03:46 PM

Page Number : 1
Vial Number : 2
Injection Number : 1
Sequence Line : 1
Instrument Method: 060993A.MTH
Analysis Method : 060993A.MTH

Sig. 1 in C:\5890-1\DATA\060993A\002F0101.D

Pk#	Ret Time	Area	Height	Type	Width	Area %
1	1.197	8362	8020	BV	0.016	0.0006
2	1.235	34166	21928	VV	0.022	0.0025
3	1.506	7.40336E+008	7.66974E+007	HH S	0.118	54.4200
4	1.537	6.06634E+008	7.70634E+007	HB S	0.099	44.5919
5	1.973	539	1036	BV T	0.008	0.0000
6	2.531	3577	639	VB	0.071	0.0003
7	8.616	6396	1017	BB	0.078	0.0005
8	11.828	2782	995	BB	0.042	0.0002
9	11.967	4635	1468	BV	0.046	0.0003
10	12.108	2828	838	VB	0.048	0.0002
11	12.286	1202	529	BB	0.037	0.0001
12	13.545	9912	4394	BB	0.035	0.0007
13	13.790	5704	1197	BB	0.066	0.0004
14	16.632	27298	4811	BV	0.078	0.0020
15	16.881	3089	644	VB	0.066	0.0002
16	17.479	13573	6836	BV	0.031	0.0010
17	17.609	10649	1739	PB	0.085	0.0008
18	25.479	1518	527	BB	0.043	0.0001
19	26.593	2741	1208	BB	0.035	0.0002
20	28.119	1616	608	BB	0.040	0.0001
21	31.425	7222	2923	BV	0.038	0.0005
22	31.566	41377	17972	VV	0.036	0.0030
23	31.707	64171	28248	VB	0.035	0.0047
24	31.882	1525	566	BV	0.041	0.0001
25	32.015	9718	2196	VV	0.060	0.0007
26	32.109	13987	3787	VV	0.053	0.0010
27	32.302	178160	65029	VV	0.041	0.0131
28	32.466	505337	169322	VV	0.042	0.0371
29	32.731	17411	6394	VV	0.040	0.0013
30	32.815	29893	10138	VV	0.044	0.0022
31	32.900	10649	2375	VV	0.063	0.0008
32	32.994	19513	5294	VV	0.054	0.0014
33	33.187	1006288	262940	VV	0.051	0.0740
34	33.266	13303	6203	VV	0.033	0.0010
35	33.387	44641	19193	VV	0.036	0.0033
36	33.531	45636	19601	VV	0.036	0.0034
37	33.669	139037	58000	VV	0.037	0.0102
38	33.806	121413	52005	VV	0.036	0.0089
39	33.895	3599	1557	VV	0.035	0.0003
40	33.959	4696	2025	VV	0.034	0.0003
41	34.067	172779	67285	VV	0.039	0.0127
42	34.148	9547	2575	VV	0.052	0.0007
43	34.374	696333	199180	VV	0.049	0.0512
44	34.487	497464	181647	VV	0.039	0.0366
45	34.561	12550	5872	VV	0.033	0.0009
46	34.672	16933	4581	VV	0.050	0.0012

47	34.766	43714	12488	VV	0.048	0.0032
48	34.806	36560	14491	VV	0.037	0.0027
49	34.889	24045	8623	VV	0.040	0.0018
50	34.946	50064	12149	VV	0.060	0.0037
51	35.191	1905646	390706	VV	0.063	0.1401
52	35.236	71277	27338	VV	0.043	0.0052
53	35.320	4208	1931	VV	0.033	0.0003
54	35.417	85597	33384	VV	0.039	0.0063
55	35.471	95600	37903	VV	0.037	0.0070
56	35.537	80509	34719	VV	0.035	0.0059
57	35.573	100620	47992	VV	0.032	0.0074
58	35.697	130947	54795	VV	0.037	0.0096
59	35.861	118559	46392	VV	0.040	0.0087
60	35.945	164859	68153	VV	0.037	0.0121
61	36.042	42041	12601	VV	0.048	0.0031
62	36.248	980284	232706	VV	0.056	0.0721
63	36.381	395841	146006	VV	0.041	0.0291
64	36.452	22773	10507	VV	0.033	0.0017
65	36.570	22061	8907	VV	0.037	0.0016
66	36.638	30262	10131	VV	0.045	0.0022
67	36.722	45602	8972	VV	0.071	0.0034
68	37.047	2242050	359756	VV	0.079	0.1648
69	37.113	7321	3547	VV	0.032	0.0005
70	37.169	63742	28031	VV	0.036	0.0047
71	37.239	90360	40901	VV	0.034	0.0066
72	37.279	63973	33125	VV	0.029	0.0047
73	37.382	4136	1665	VV	0.038	0.0003
74	37.482	86972	35275	VV	0.038	0.0064
75	37.596	92202	41695	PV	0.034	0.0068
76	37.719	102520	42950	VV	0.037	0.0075
77	37.772	24282	10504	VV	0.035	0.0018
78	37.929	311706	100833	VV	0.048	0.0229
79	37.991	311126	133935	VV	0.036	0.0229
80	38.061	9181	4610	VV	0.031	0.0007
81	38.107	11522	5196	VV	0.034	0.0008
82	38.157	8235	3940	VV	0.032	0.0006
83	38.224	13540	5736	VV	0.037	0.0010
84	38.380	13186	4335	VB	0.045	0.0010
85	38.689	1056790	270499	BV	0.055	0.0777
86	38.742	5233	2424	VV	0.033	0.0004
87	38.835	61737	18713	VV	0.047	0.0045
88	38.940	38489	17504	VV	0.034	0.0028
89	39.105	5572	2269	VB	0.039	0.0004
90	39.263	52982	21397	BV	0.038	0.0039
91	39.339	2356	749	VV	0.044	0.0002
92	39.446	14025	5302	VV	0.040	0.0010
93	39.601	168569	62744	VV	0.041	0.0124
94	39.747	5671	2105	VV	0.041	0.0004
95	39.859	1583	559	VB	0.044	0.0001
96	40.116	1583	448	BB	0.053	0.0001
97	40.408	266400	84072	BV	0.047	0.0196
98	41.342	18197	1429	BB	0.158	0.0013
99	46.961	11410	884	BB	0.160	0.0008

Total area = 1.36041E+009

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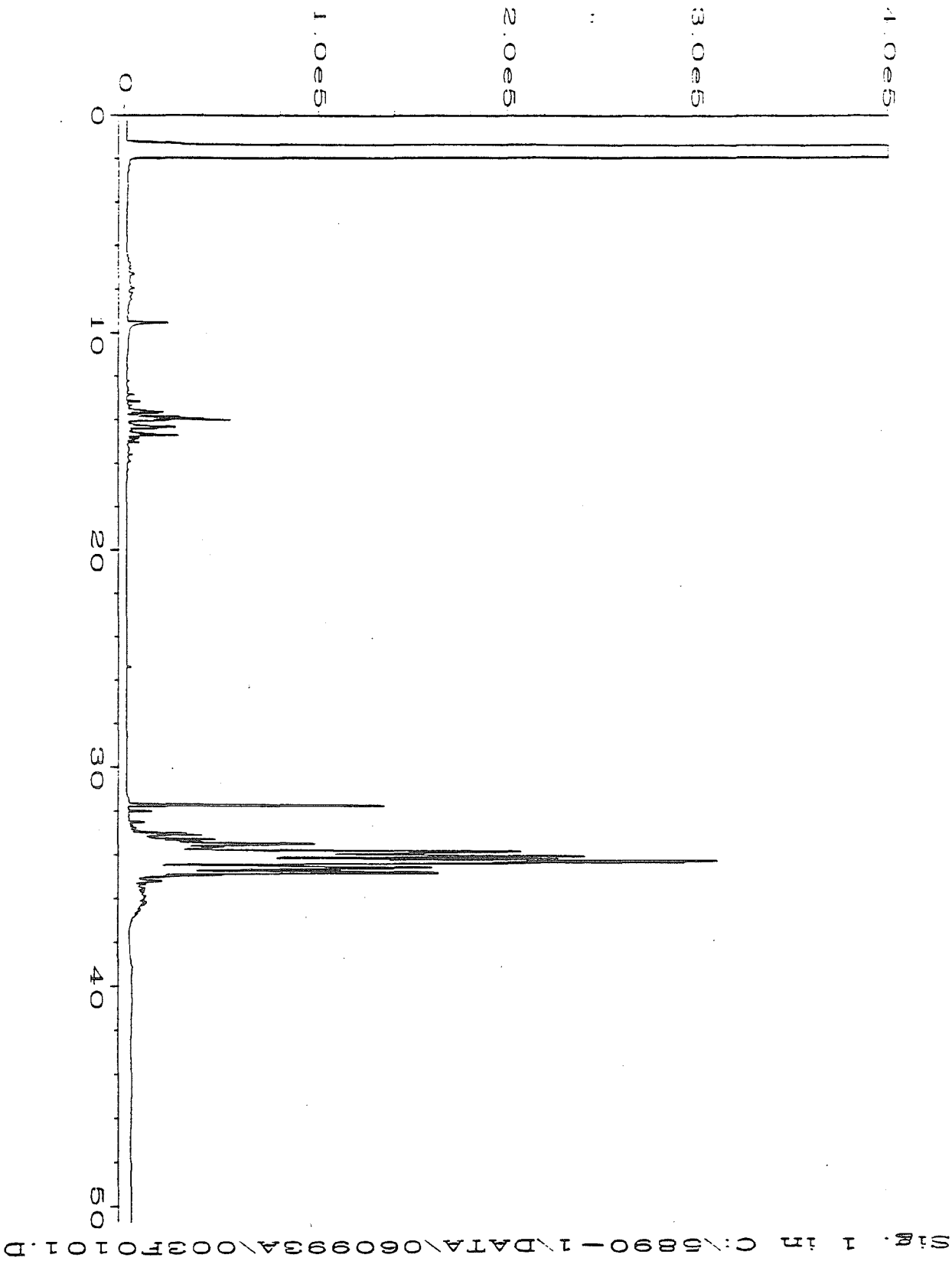
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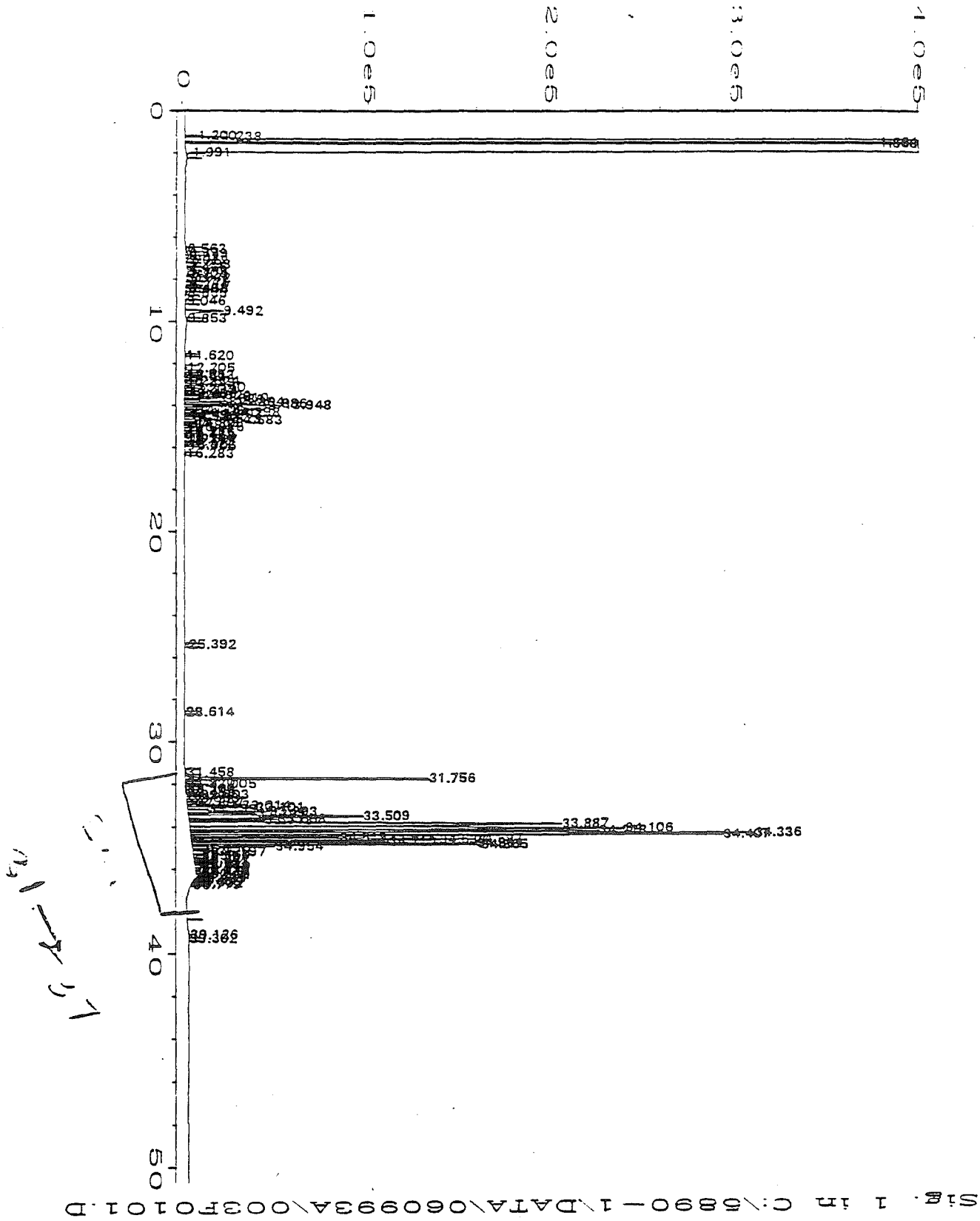
20
30
40
50
Sig. 1 in C:\5890-1\DATA\060993A\003FO101.D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11.620
25.392
28.614
31.756
33.509
33.887
34.336
34.954
39.362

Calibrated report not possible because no calibration table exists

Area Percent Report

Data File Name : C:\5890-1\DATA\060993A\003F0101.D
Operator : K. Cook
Instrument : 5890-1
Sample Name : Santicizer 148
Run Time Bar Code:
Acquired on : 07 Jun 93 06:18 PM
Report Created on: 08 Jun 93 03:49 PM

Page Number : 1
Vial Number : 3
Injection Number : 1
Sequence Line : 1
Instrument Method: 060993A.MTH
Analysis Method : 060993A.MTH

Sig. 1 in C:\5890-1\DATA\060993A\003F0101.D

Pk#	Ret Time	Area	Height	Type	Width	Area %
1	1.200	6448	6520	BV	0.015	0.0005
2	1.238	27152	19911	VV	0.023	0.0019
3	1.464	4.99822E+008	7.48863E+007	HH S	0.111	34.9790
4	1.533	3.4033E+008	7.67662E+007	HH S	0.054	23.8173
5	1.563	5.75762E+008	7.70859E+007	HB S	0.096	40.2935
6	1.991	623	1149	BV T	0.009	0.0000
7	6.563	3170	666	BV	0.065	0.0002
8	6.779	7735	1552	VV	0.067	0.0005
9	6.923	10994	1674	VV	0.084	0.0008
10	7.072	6750	1599	VV	0.058	0.0005
11	7.293	16645	2838	PV	0.081	0.0012
12	7.415	1001	458	VV	0.036	0.0001
13	7.466	2713	661	VB	0.061	0.0002
14	7.708	2040	798	BV	0.041	0.0001
15	7.779	3753	1198	VV	0.052	0.0003
16	7.821	4852	1292	VV	0.054	0.0003
17	7.932	14323	2781	VV	0.070	0.0010
18	8.176	12856	2170	PV	0.086	0.0009
19	8.284	6144	1582	VV	0.058	0.0004
20	8.408	4635	1379	VV	0.056	0.0003
21	8.456	11677	2051	VV	0.082	0.0008
22	8.655	5865	1087	VV	0.081	0.0004
23	9.046	3532	688	PB	0.071	0.0002
24	9.492	123818	20566	PV	0.084	0.0087
25	9.853	5430	825	VV	0.087	0.0004
26	11.620	883	403	BV	0.033	0.0001
27	12.205	3658	1298	BB	0.042	0.0003
28	12.512	2817	877	VV	0.045	0.0002
29	12.553	2597	795	VV	0.044	0.0002
30	12.634	3407	1296	VV	0.040	0.0002
31	12.824	9649	3784	VV	0.038	0.0007
32	12.898	2600	1067	VV	0.037	0.0002
33	13.140	14362	6944	VV	0.032	0.0010
34	13.208	2533	1004	VV	0.037	0.0002
35	13.314	6983	2749	VV	0.040	0.0005
36	13.387	5572	1877	VV	0.043	0.0004
37	13.466	4060	1846	VV	0.033	0.0003
38	13.529	20649	9895	VV	0.032	0.0014
39	13.610	68865	18829	VV	0.050	0.0048
40	13.686	34865	16487	VV	0.033	0.0024
41	13.804	59098	27075	VV	0.034	0.0041
42	13.886	103080	39405	VV	0.040	0.0072
43	13.948	121686	52507	VV	0.036	0.0085
44	14.003	71921	22533	VV	0.043	0.0050
45	14.178	7585	3641	VV	0.031	0.0005
46	14.220	14309	6641	VV	0.032	0.0010

47	14.298	87539	24852	VV	0.056	0.0061
48	14.340	22595	14030	VV	0.027	0.0016
49	14.408	30909	15656	VV	0.031	0.0022
50	14.456	3374	2180	VV	0.026	0.0002
51	14.488	4560	2346	VV	0.029	0.0003
52	14.540	6514	3326	VV	0.029	0.0005
53	14.628	52252	15234	VV	0.046	0.0037
54	14.683	74887	26082	VV	0.041	0.0052
55	14.803	12668	6170	VV	0.031	0.0009
56	14.876	12376	5761	VV	0.033	0.0009
57	14.924	8770	4026	VV	0.033	0.0006
58	15.016	14449	6087	VV	0.035	0.0010
59	15.217	2235	792	VV	0.043	0.0002
60	15.276	4036	1537	VV	0.038	0.0003
61	15.325	2568	1124	VV	0.033	0.0002
62	15.388	4684	1224	VV	0.053	0.0003
63	15.458	3333	1129	VV	0.045	0.0002
64	15.597	10616	2629	VV	0.055	0.0007
65	15.712	1784	763	VV	0.035	0.0001
66	15.822	4359	1577	VV	0.040	0.0003
67	15.906	6490	1903	VV	0.049	0.0005
68	16.283	3327	848	VB	0.058	0.0002
69	25.392	5438	2121	BB	0.039	0.0004
70	28.614	1560	629	BB	0.038	0.0001
71	31.458	8833	871	BV	0.141	0.0006
72	31.756	426972	132086	VV	0.045	0.0299
73	31.920	2481	984	VV	0.038	0.0002
74	32.005	29119	12155	VV	0.037	0.0020
75	32.203	2621	764	VV	0.051	0.0002
76	32.346	2153	821	PV	0.043	0.0002
77	32.418	731	393	VV	0.031	0.0001
78	32.503	24251	7917	VV	0.045	0.0017
79	32.656	7611	2082	VV	0.054	0.0005
80	32.772	14476	3550	VV	0.063	0.0010
81	32.897	18669	4515	VV	0.064	0.0013
82	33.014	106715	29055	VV	0.054	0.0075
83	33.101	127084	36231	VV	0.051	0.0089
84	33.189	26818	10843	VV	0.036	0.0019
85	33.293	170864	42948	VV	0.057	0.0120
86	33.395	176552	36488	VV	0.066	0.0124
87	33.509	598722	93732	VV	0.088	0.0419
88	33.658	215855	46878	VV	0.061	0.0151
89	33.713	134637	39901	VV	0.049	0.0094
90	33.887	1708574	202224	VV	0.118	0.1196
91	34.106	1596655	236395	VV	0.090	0.1117
92	34.218	1016926	222391	VV	0.066	0.0712
93	34.336	1564621	306049	VV	0.070	0.1095
94	34.407	1012363	288990	VV	0.048	0.0708
95	34.519	246623	79417	VV	0.047	0.0173
96	34.597	582088	154430	VV	0.053	0.0407
97	34.638	311700	134466	VV	0.033	0.0218
98	34.710	297848	106508	VV	0.041	0.0208
99	34.811	520751	154992	VV	0.049	0.0364
100	34.865	412116	157211	VV	0.039	0.0288
101	34.954	159865	43734	VV	0.051	0.0112
102	35.050	9560	4570	VV	0.031	0.0007
103	35.110	10532	4760	VV	0.033	0.0007
104	35.197	70762	12992	VV	0.071	0.0050
105	35.360	17164	4465	PV	0.057	0.0012
106	35.501	11089	3903	VV	0.042	0.0008
107	35.572	11781	4040	VV	0.045	0.0008
108	35.653	8534	3384	VV	0.039	0.0006

109	35.734	11056	3294	VV	0.048	0.0008
110	35.783	5830	2426	VV	0.034	0.0004
111	35.879	17028	3885	VV	0.060	0.0012
112	35.943	8264	3331	VV	0.041	0.0006
113	35.993	10024	3284	VV	0.046	0.0007
114	36.070	8471	2693	VV	0.046	0.0006
115	36.151	11129	3636	VV	0.047	0.0008
116	36.229	7363	2969	VV	0.040	0.0005
117	36.292	4526	2296	VV	0.032	0.0003
118	36.434	1835	1234	BV	0.026	0.0001
119	36.495	4227	2042	PV	0.033	0.0003
120	36.551	7692	2227	VV	0.048	0.0005
121	36.639	2388	1302	VV	0.030	0.0002
122	36.702	5041	1683	PV	0.044	0.0004
123	36.779	1733	864	VV	0.031	0.0001
124	39.126	8432	699	BV	0.150	0.0006
125	39.302	1417	256	VB	0.080	0.0001

Total area = 1.42892E+009

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QUANTITATIVE DATA

Method: C:\HPCHEM\1\METHODS\RHONE727.MTH

Method Information

Quantitative Runs - LNAPL

Run Time Checklist

Pre-Run Program:	none
Name:	
Parameter:	
Data Acquisition:	On
Data Analysis:	On
Sig. 2 Mth:	none
Post-Run Program:	none
Name:	
Parameter:	

Sequence Recalibration Table

Cal. Line	Cal. Level	Update Response Factor	Update Retention Times	Recalib Interval

Integration Events

Events:	Value:	Time:
Initial Area Reject	0	INITIAL
Initial Peak Width	0.040	INITIAL
Shoulder Detection	OFF	INITIAL
Initial Threshold	2	INITIAL
hreshold	2	3.000

Method: C:\HPCHEM\1\METHODS\RHONE727.MTH

Baseline Now	3.100
Baseline Now	3.600
Baseline Now	14.000
Area Sum ON	14.000
Baseline Now	30.000
Area Sum OFF	30.000

Report Specification

Destination:	File: Auto naming selected
	Printer
Based on:	Area
Calculations:	ESTD
Output:	Chromatogram
	Report
Report Header:	On Chromatogram
	On Each Report Page

Graphics Print Options

Layout:	Full Size
Title:	Vertical
Include:	
Axes Units:	On
Retention Times:	On
Baselines:	On
Retention Times Font:	Times New Roman 8

Calibration Table

Pk#	RT	Lvl	UG/ML	Amt/Area	Ref Istd	I#	Name
1	3.300	1	1098.0	8.6652e-005		1	Toluene
		2	109.8	9.0086e-005			
		3	10.98	8.8522e-005			
2	22.003	1	119.0	7.419e-005		1	WMO
3	33.288	1	12.7	9.5447e-005		1	Palatinol DOP

Calibration Settings

Title:

Reference window:	0.200 minutes
Non-reference window:	0.200 minutes
Units of amount:	UG/ML
Multiplier:	1.0
RF uncal peaks:	1.0
Sample Amount:	0.0

Sample ISTD Information

No Sample ISTD Amounts

Multilevel Information

Fit: Linear
Origin: Include

Sequence: C:\HPCHEM\1\SEQUENCE\RHONE727.SEQ

Operator: Kelly Cook

Sequence preparation date: 31 Jul 93 10:56 AM

Data File Subdirectory: rhone727

Part of methods to run: full method

On a barcode mismatch: inject anyway

Comment:

Sequence Table

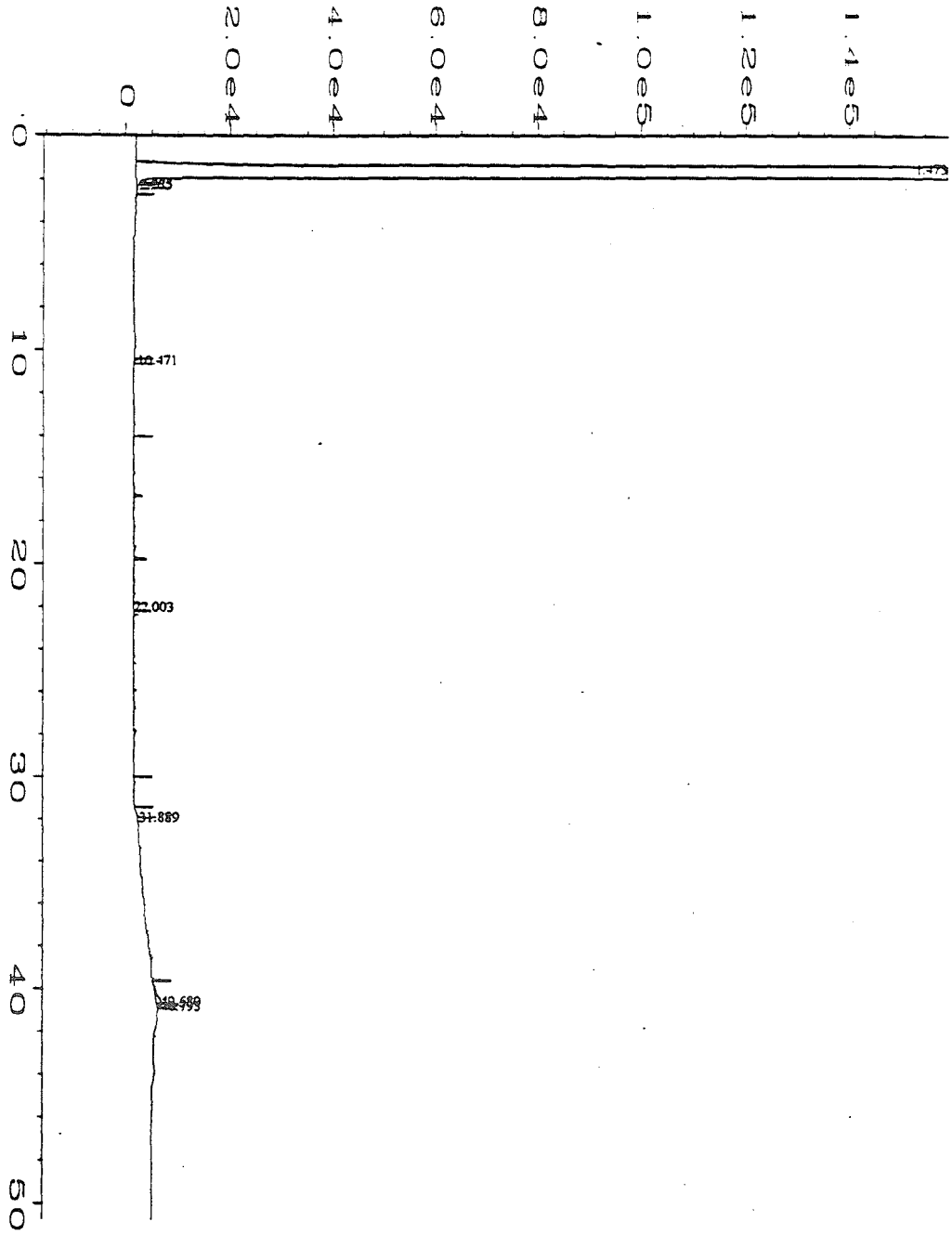
Inj.	Seq. Line	Cal. Line	Method Name	From Vial	To Vial	Inj/ Vial
FRONT						
	1		RHONE727	16	27	1
REAR						
	1					

Sample Table

Vial Num.	Sample Name	Sample Amount	Multiplier	ISTD Amount
16	MECL BLANK			
17	LNAPL 1:50			
18	LNAPL 1:5000			
19	WMO 1000			
20	WMO 100			
21	WMO 10			
22	PALATINOL 711			
23	SANTICIZER 148			
24	PALATINOL DOP			
25	TOLUENE 1000			
26	TOLUENE 100			
27	TOLUENE 10			

Sample Log Table

Seq. Line	Vial Num.	Sample Name	Sample Amount	Multiplier	ISTD Amount	Cal. Line	Method Name	Inj Via
FRONT								
1	16	MECL BLANK					RHONE727	
1	17	LNAPL 1:50					RHONE727	
1	18	LNAPL 1:5000					RHONE727	
1	19	WMO 1000					RHONE727	
1	20	WMO 100					RHONE727	
1	21	WMO 10					RHONE727	
1	22	PALATINOL 711					RHONE727	
1	23	SANTICIZER 148					RHONE727	
1	24	PALATINOL DOP					RHONE727	
1	25	TOLUENE 1000					RHONE727	
1	26	TOLUENE 100					RHONE727	
1	27	TOLUENE 10					RHONE727	
REAR								
1								



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\016F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 16
Sample Name	: MECL BLANK	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 11:07 AM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 02:42 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 AUG 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

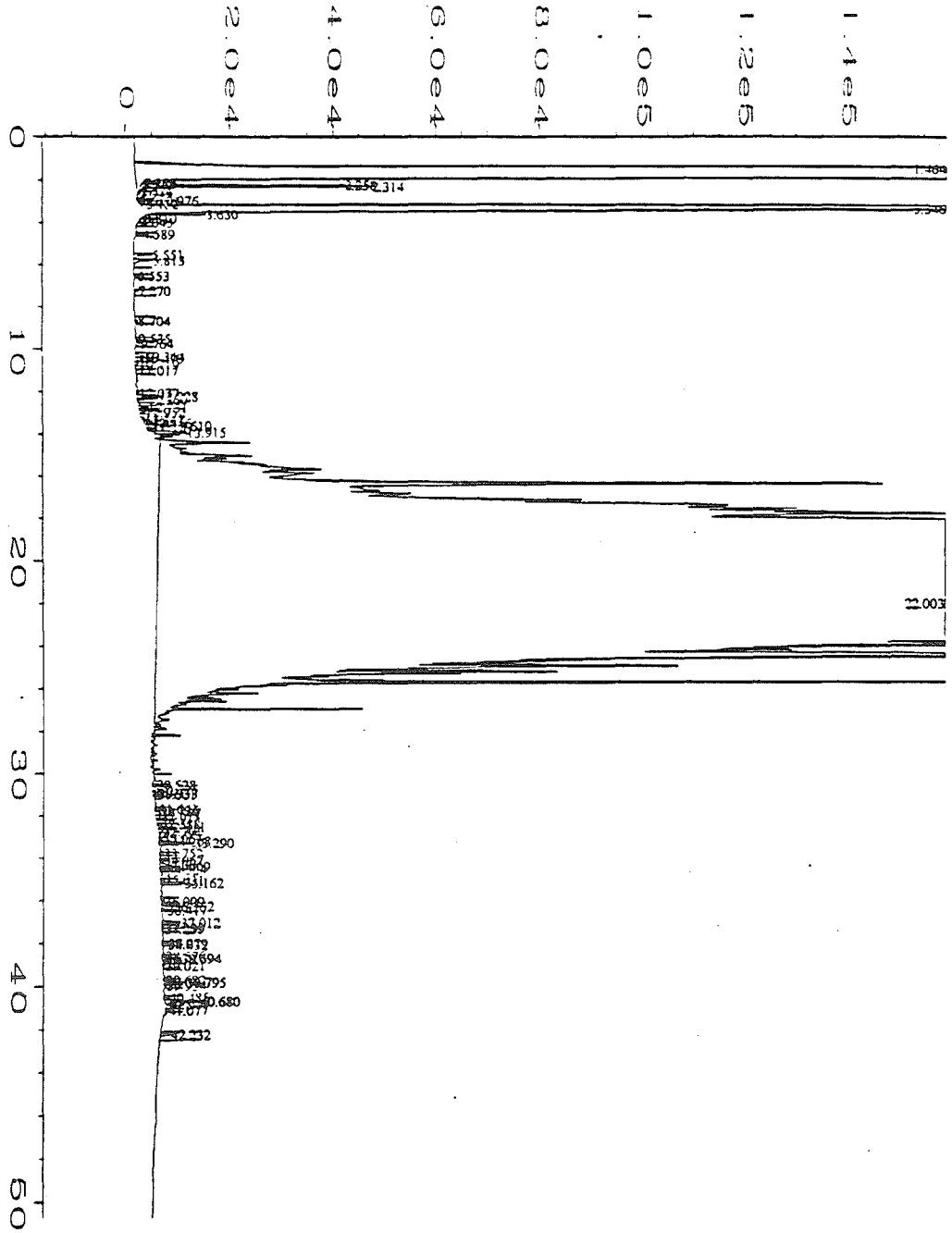
External Standard Report

Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\016F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 16
Sample Name	: MECL BLANK	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 11:07 AM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 02:42 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 AUG 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

Sig. 1 in C:\HPCHEM\1\DATA\RHONE-P\016F0101.D

Ret Time	Area	Type	Width	Ref#	UG/ML	Name
3.300	* not found *			1		Toluene
22.003	17698	BB +	0.000	1	1.313	WMO
33.288	* not found *			1		Palatinol DOP
1.473	1.12795E+009	BB S	0.198		1.1E+009	* uncalibrated *
2.223	325	BV T	0.024		325.372	* uncalibrated *
2.265	174	VB T	0.031		173.630	* uncalibrated *
10.471	3648	BB	0.073		3648.130	* uncalibrated *
31.889	196	BB	0.016		195.849	* uncalibrated *
40.580	23157	BV	0.335		23157.11	* uncalibrated *
40.795	4722	VB	0.092		4722.165	* uncalibrated *

Not all calibrated peaks were found



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\017F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 17
Sample Name	: LNAPL 1:50	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 12:05 PM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 01:59 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

External Standard Report

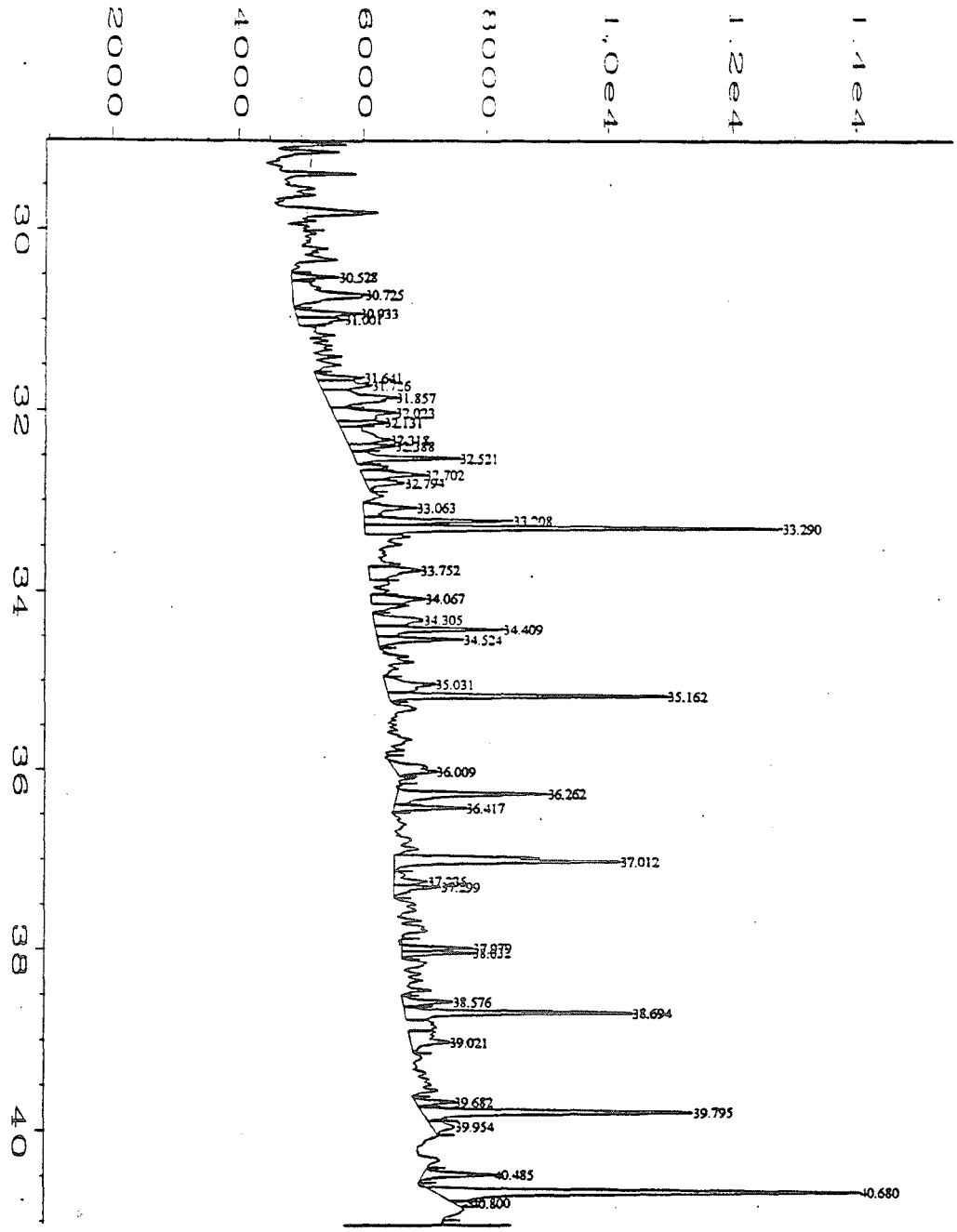
Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\017F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 17
Sample Name	: LNAPL 1:50	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 12:05 PM	Instrument Method:	RHONE727.M
Report Created on:	20 Aug 93 02:00 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

Sig. 1 in C:\HPCHEM\1\DATA\RHONE-P\017F0101.D

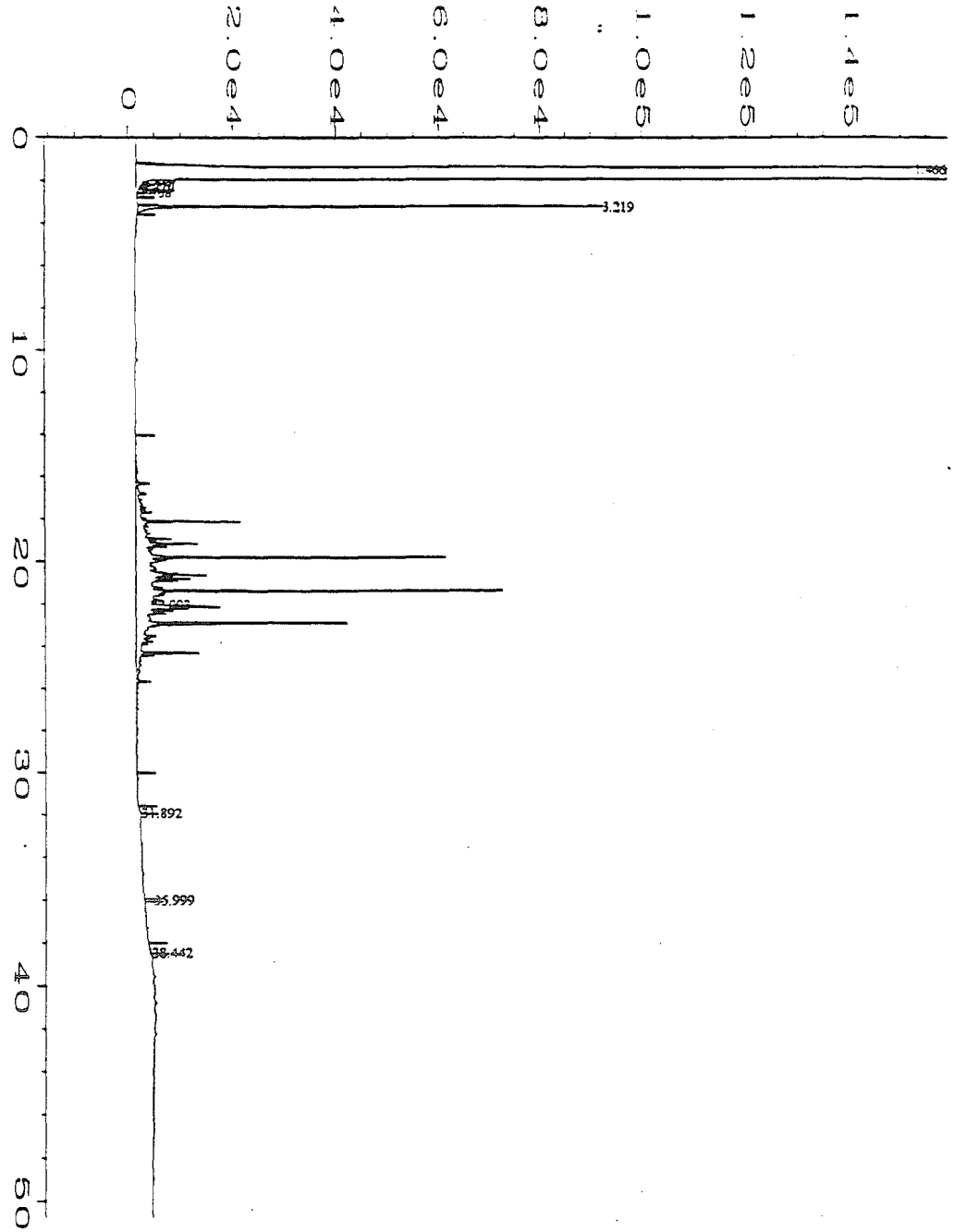
Ret Time	Area	Type	Width	Ref#	UG/ML	Name
3.346	2.03906E+007	VBA	0.072	1	1766.465	Toluene x50 = 8.83%
22.003	1.80419E+008	BB +	0.000	1	13385.26	WMO x50 = 66.9%
33.290	18020	VV	0.041	1	1.720	Palatinol DOP x50 = 86 ppm
1.464	1.11006E+009	BBAS	0.195		1.1E+009	* uncalibrated *
2.126	614	BV T	0.025		614.421	* uncalibrated *
2.149	281	VV T	0.016		280.515	* uncalibrated *
2.181	616	PV T	0.017		616.486	* uncalibrated *
2.212	139	VV T	0.020		139.161	* uncalibrated *
2.258	47718	PV T	0.019		47717.65	* uncalibrated *
2.314	80267	VV T	0.026		80266.85	* uncalibrated *
2.521	845	VV T	0.028		845.241	* uncalibrated *
2.576	1077	VV T	0.039		1077.223	* uncalibrated *
2.645	124	PB T	0.022		123.589	* uncalibrated *
2.976	8949	PV T	0.024		8949.000	* uncalibrated *
3.056	3525	VB T	0.035		3525.389	* uncalibrated *
3.152	1949	BV	0.023		1948.986	* uncalibrated *
3.630	22383	BV	0.030		22383.04	* uncalibrated *
3.810	1459	PV	0.032		1458.986	* uncalibrated *
4.045	1660	PV	0.038		1660.435	* uncalibrated *
4.589	3867	PV	0.052		3867.133	* uncalibrated *
5.551	15582	BV	0.067		15581.66	* uncalibrated *
5.813	19370	VB	0.076		19369.71	* uncalibrated *
6.553	2287	BB	0.065		2286.590	* uncalibrated *
7.270	3846	BB	0.079		3845.914	* uncalibrated *
8.704	2514	BV	0.078		2514.169	* uncalibrated *
9.535	1603	BB	0.049		1602.920	* uncalibrated *
9.764	3562	BV	0.056		3561.968	* uncalibrated *
10.364	8532	BV	0.064		8532.203	* uncalibrated *
10.470	9973	VV	0.099		9972.590	* uncalibrated *
10.719	3965	VB	0.076		3965.380	* uncalibrated *
11.017	3372	BV	0.078		3372.291	* uncalibrated *
12.077	2993	VV	0.107		2992.590	* uncalibrated *
12.228	16451	VV	0.056		16451.15	* uncalibrated *
12.360	8008	VV	0.059		8007.849	* uncalibrated *
12.731	6415	VV	0.053		6415.362	* uncalibrated *
12.952	4797	VV	0.061		4796.595	* uncalibrated *
13.241	882	PV	0.039		881.719	* uncalibrated *
13.347	892	PV	0.046		892.378	* uncalibrated *
13.456	6991	VV	0.071		6991.170	* uncalibrated *
13.610	25272	VV	0.075		25272.31	* uncalibrated *
13.770	1641	PV	0.033		1641.164	* uncalibrated *
13.915	33944	PBA	0.075		33943.86	* uncalibrated *
30.528	1753	BV	0.036		1752.736	* uncalibrated *
30.725	8724	VV	0.106		8724.037	* uncalibrated *
30.933	3219	PV	0.051		3219.235	* uncalibrated *

Operator	: Kelly Cooki	Page Number	: 2
Instrument	: 5890-1	Vial Number	: 17
Sample Name	: LNAPL 1:50	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 12:05 PM	Instrument Method	: RHONE72
Report Created on	: 20 Aug 93 02:00 PM	Analysis Method	: RHONE7
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

31.001	3156	VV	0.056	3155.707	* uncalibrated *	
31.641	1951	PV	0.044	1950.824	* uncalibrated *	
31.726	3998	VV	0.067	3998.422	* uncalibrated *	
31.857	7466	VV	0.092	7466.422	* uncalibrated *	
32.023	5780	VV	0.078	5779.878	* uncalibrated *	
32.131	2195	VV	0.042	2195.151	* uncalibrated *	
32.318	5305	VV	0.096	5305.158	* uncalibrated *	
32.388	2208	VV	0.042	2208.164	* uncalibrated *	
32.521	5121	VV	0.045	5120.549	* uncalibrated *	
32.702	3865	VV	0.058	3865.118	* uncalibrated *	
32.794	2192	VB	0.055	2191.530	* uncalibrated *	
33.063	3624	PV	0.059	3624.015	* uncalibrated *	
33.208	6770	VV	0.042	6770.202	* uncalibrated *	
33.752	4694	VV	0.079	4694.096	* uncalibrated *	
34.067	3684	VV	0.075	3684.378	* uncalibrated *	
34.305	4247	PV	0.077	4247.008	* uncalibrated *	
34.409	6266	VV	0.045	6266.455	* uncalibrated *	
34.524	4076	VV	0.044	4076.316	* uncalibrated *	
35.031	4452	BV	0.082	4451.854	* uncalibrated *	
35.162	10826	VV	0.038	10826.04	* uncalibrated *	7.4 x 50 = 370
36.009	3832	BV	0.078	3831.915	* uncalibrated *	
36.262	8154	BV	0.050	8154.344	* uncalibrated *	10.3 x 50 = 515
36.417	2849	VV	0.039	2848.747	* uncalibrated *	
37.012	14205	VV	0.054	14204.95	* uncalibrated *	
37.235	2153	VV	0.057	2152.781	* uncalibrated *	
37.299	2497	VB	0.055	2496.751	* uncalibrated *	
37.979	2496	BV	0.034	2496.382	* uncalibrated *	
38.032	2572	VV	0.034	2572.499	* uncalibrated *	
38.576	2584	PV	0.049	2583.880	* uncalibrated *	
38.694	10351	VV	0.042	10351.14	* uncalibrated *	9.76 x 50 = 488
39.021	4369	VB	0.095	4369.492	* uncalibrated *	
39.682	1676	PV	0.042	1676.075	* uncalibrated *	Ave 466
39.795	14000	VV	0.050	13999.83	* uncalibrated *	
39.954	1938	VB	0.076	1938.080	* uncalibrated *	
40.485	3598	BV	0.047	3597.603	* uncalibrated *	
40.680	23094	PV	0.052	23094.07	* uncalibrated *	
40.800	694	VV	0.042	693.645	* uncalibrated *	
41.077	2151	BV	0.053	2151.003	* uncalibrated *	
42.232	10531	BB	0.079	10530.55	* uncalibrated *	



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\017F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 17
Sample Name	: LNAPL 1:50	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 12:05 PM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 02:01 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\018F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 18
Sample Name	: LNAPL 1:5000	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 01:06 PM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 01:46 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

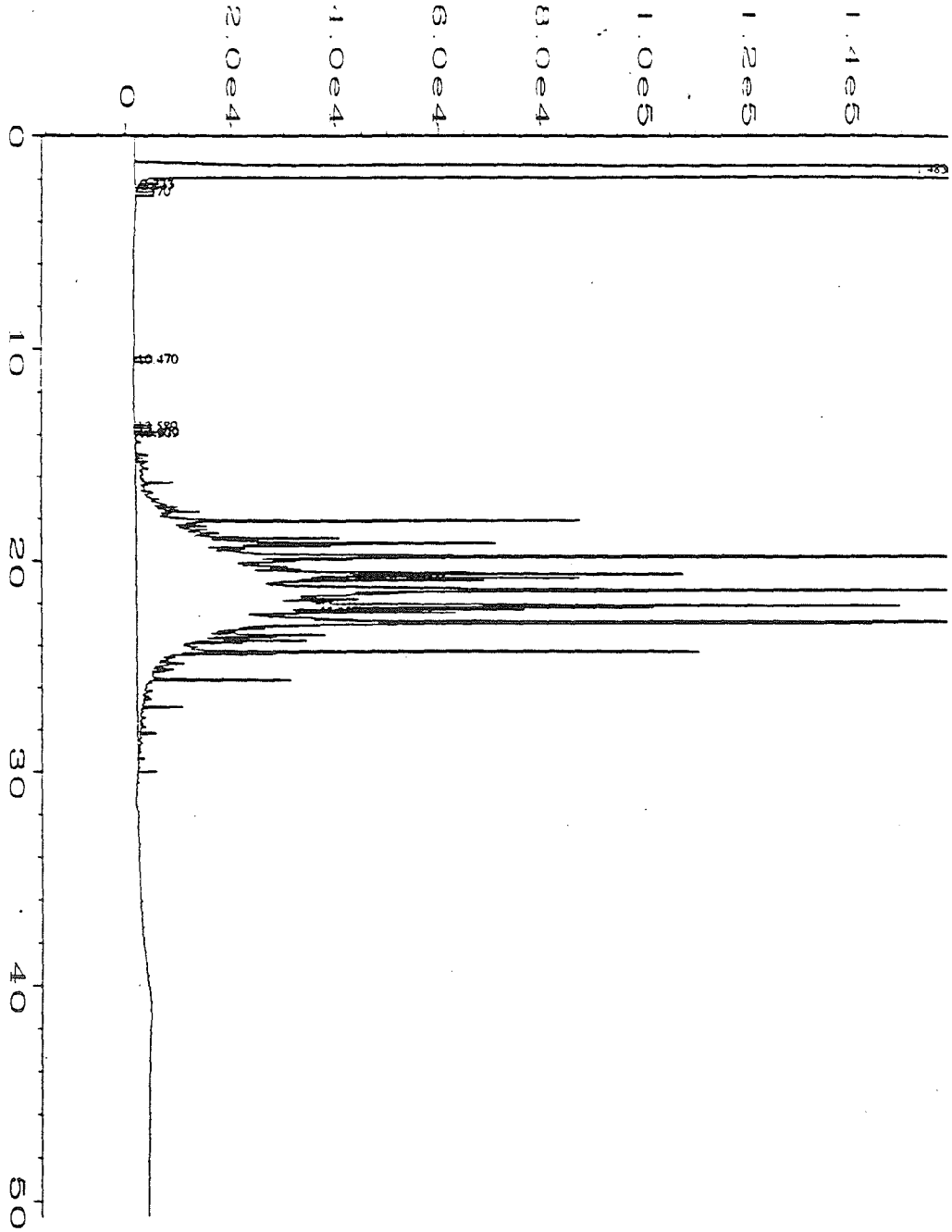
External Standard Report

Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\018F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 18
Sample Name	: LNAPL 1:5000	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 01:06 PM	Instrument Method:	RHONE727.M
Report Created on:	20 Aug 93 01:47 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

Sig. 1 in C:\HPCHEM\1\DATA\RHONE-P\018F0101.D

Ret Time	Area	Type	Width	Ref#	UG/ML	Name
3.219	191740	BBA	0.031	1	18.018	Toluene x5000 = 90,090 = 9.01 %
22.003	1791912	BB +	0.000	1	132.942	WMO x500 = 66.47%
1.466	1.1112E+009	BB S	0.193		1.1E+009	* uncalibrated *
2.217	747	BV T	0.031		747.377	* uncalibrated *
2.261	1695	VV T	0.030		1694.728	* uncalibrated *
2.320	616	VV T	0.030		615.958	* uncalibrated *
2.397	51	PB T	0.022		51.462	* uncalibrated *
2.568	952	BB T	0.073		951.946	* uncalibrated *
31.892	1122	BB	0.052		1122.497	* uncalibrated *
35.999	3817	BV	0.036		3817.461	* uncalibrated *
38.442	817	BB	0.039		816.508	* uncalibrated *

9.01%/0.815 = 11.1%
66.47%/0.815 = 81.6%
92.7%



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\019F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 19
Sample Name	: WMO 1000	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 02:06 PM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 02:39 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 AUG 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

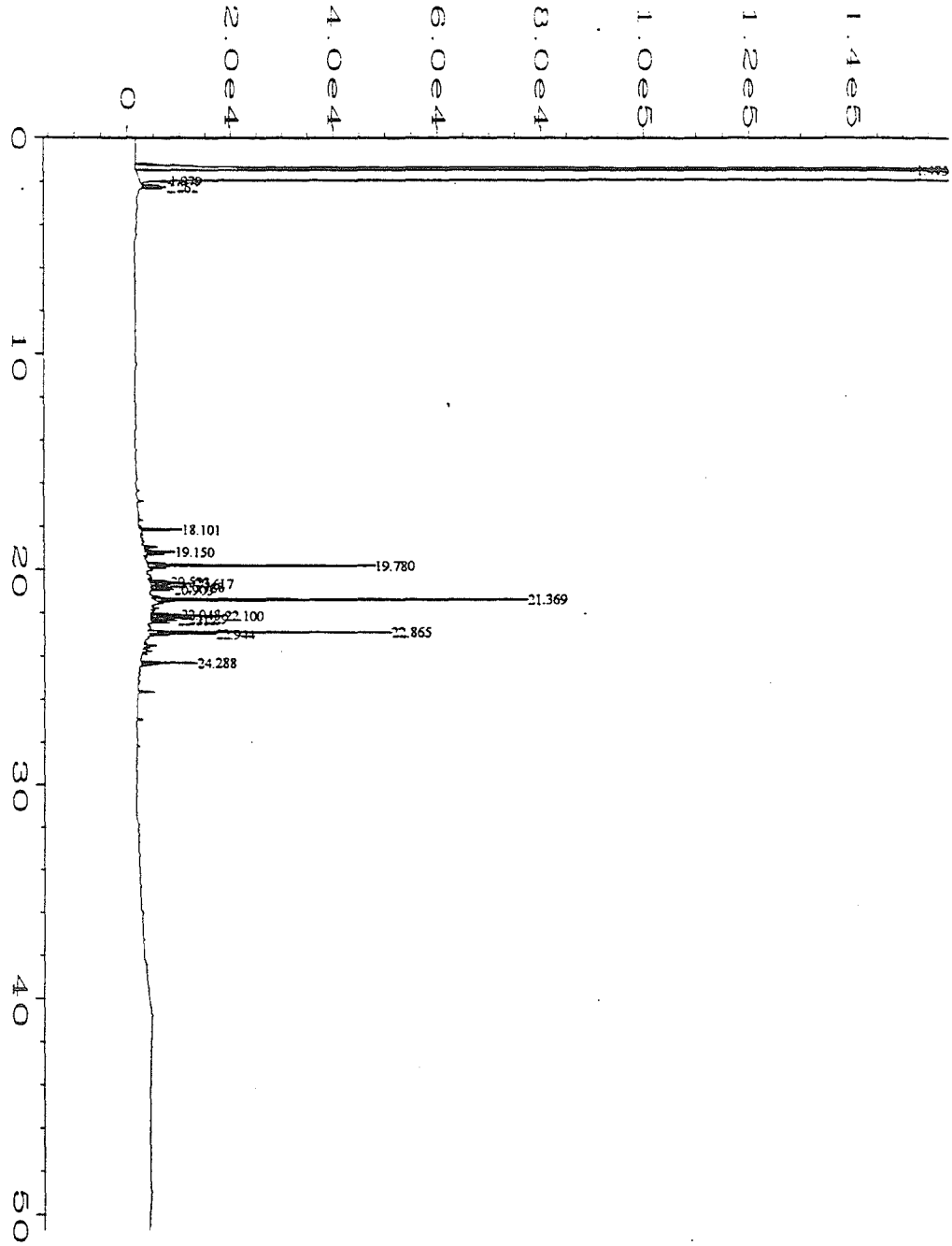
External Standard Report

Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\019F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 19
Sample Name	: WMO 1000	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 02:06 PM	Instrument Method:	RHONE727.M
Report Created on:	20 Aug 93 02:40 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 AUG 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

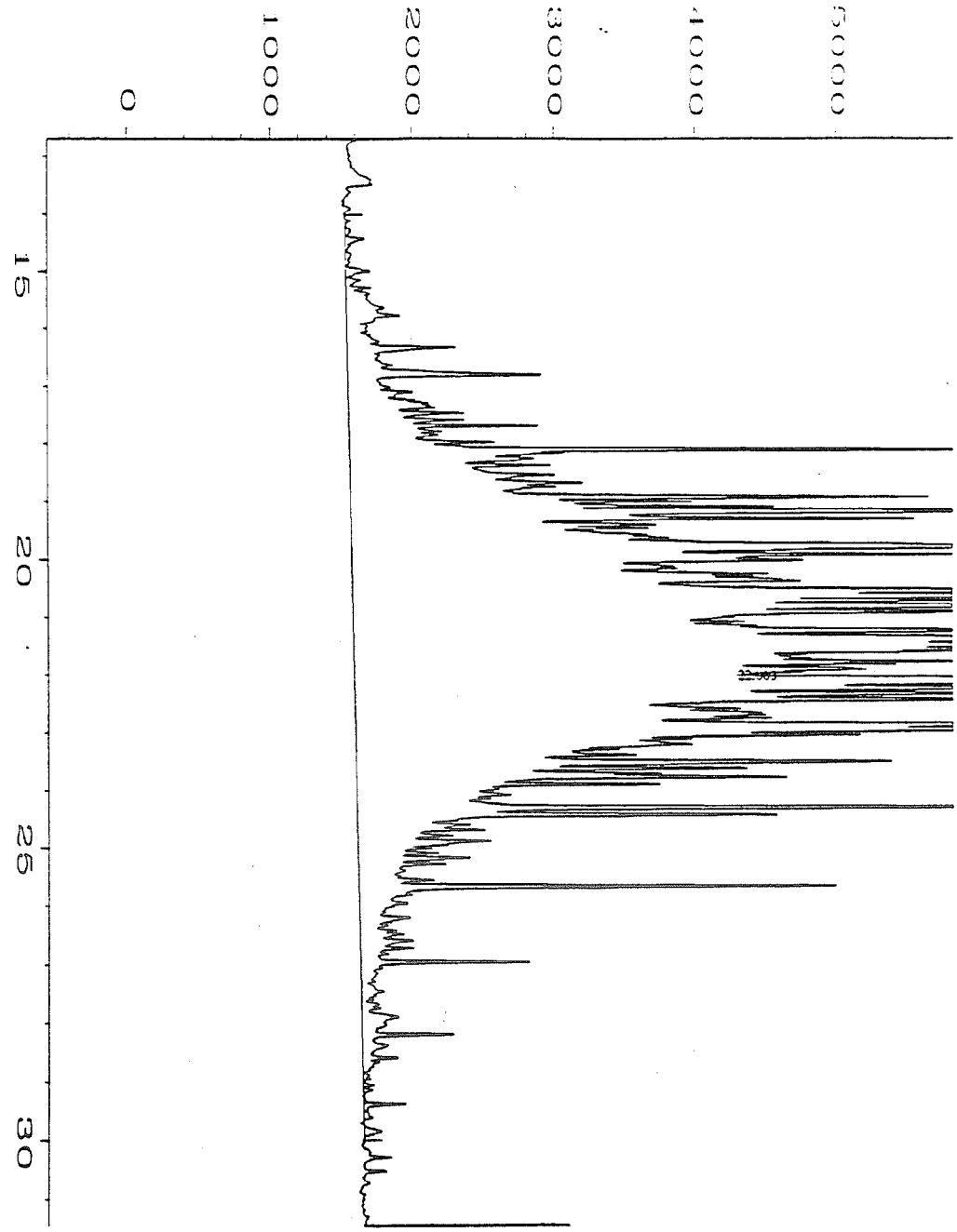
Sig. 1 in C:\HPCHEM\1\DATA\RHONE-P\019F0101.D

Ret Time	Area	Type	Width	Ref#	UG/ML	Name
3.300	* not found *			1		Toluene
22.003	1.55361E+007	BB +	0.000	1	1152.626	WMO
33.288	* not found *			1		Palatinol DOP
1.483	1.16156E+009	BB S	0.202		1.2E+009	* uncalibrated *
2.233	714	BV T	0.029		713.755	* uncalibrated *
2.273	857	VB T	0.036		856.663	* uncalibrated *
2.570	1100	BB T	0.074		1100.200	* uncalibrated *
10.470	3214	BB	0.066		3213.839	* uncalibrated *
13.589	1944	VV	0.042		1944.227	* uncalibrated *
13.870	2455	BV	0.041		2455.012	* uncalibrated *
13.909	1780	VV	0.032		1780.286	* uncalibrated *

Not all calibrated peaks were found



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\020F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 20
Sample Name	: WMO 100	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 03:06 PM	Instrument Method	: RHONE727.M
Report Created on	: 03 Aug 93 08:31 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 28 APR 93 04:03 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\020F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 20
Sample Name	: WMO 100	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 03:06 PM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 01:16 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

External Standard Report

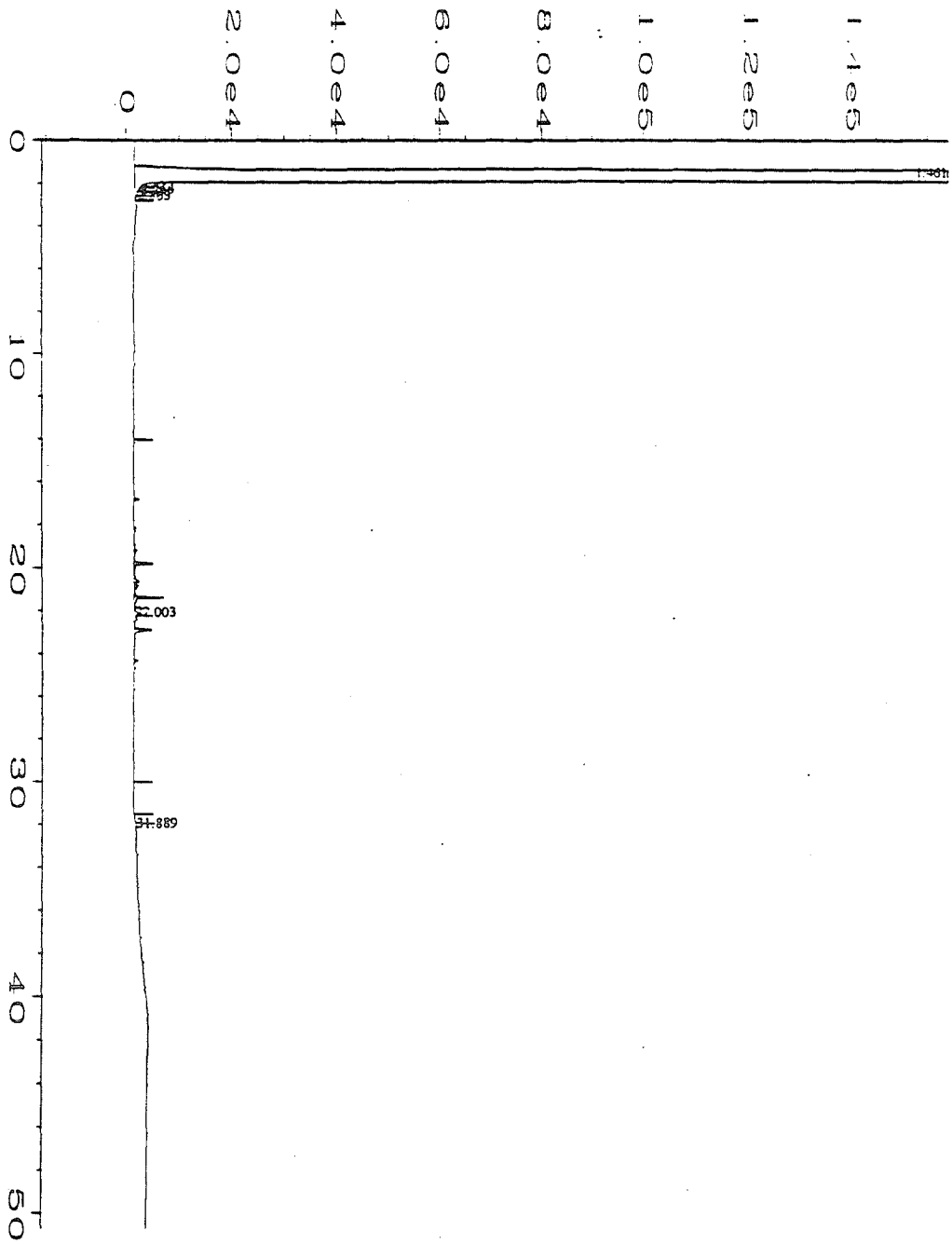
Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\020F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 20
Sample Name	: WMO 100	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 03:06 PM	Instrument Method:	RHONE727.M
Report Created on:	20 Aug 93 01:16 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

Sig. 1 in C:\HPCHEM\1\DATA\RHONE-P\020F0101.D

Ret Time	Area	Type	Width	Ref#	UG/ML	Name
3.348	* not found *			1		Toluene
22.003	1603990	BB +	0.000	1	119.000	WMO
1.474	1.13898E+009	BB S	0.194		1.1E+009	* uncalibrated *
2.181	1400	BV T	0.017		1400.209	* uncalibrated *
2.224	551	VV T	0.022		550.597	* uncalibrated *
2.262	5547	VV T	0.019		5546.873	* uncalibrated *
2.320	4953	VB T	0.020		4952.796	* uncalibrated *
2.566	487	BV T	0.050		486.579	* uncalibrated *

Not all calibrated peaks were found

AMT/AREA = 7.41899×10^{-5}



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\021F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 21
Sample Name	: WMO 10	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 04:07 PM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 02:37 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 AUG 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

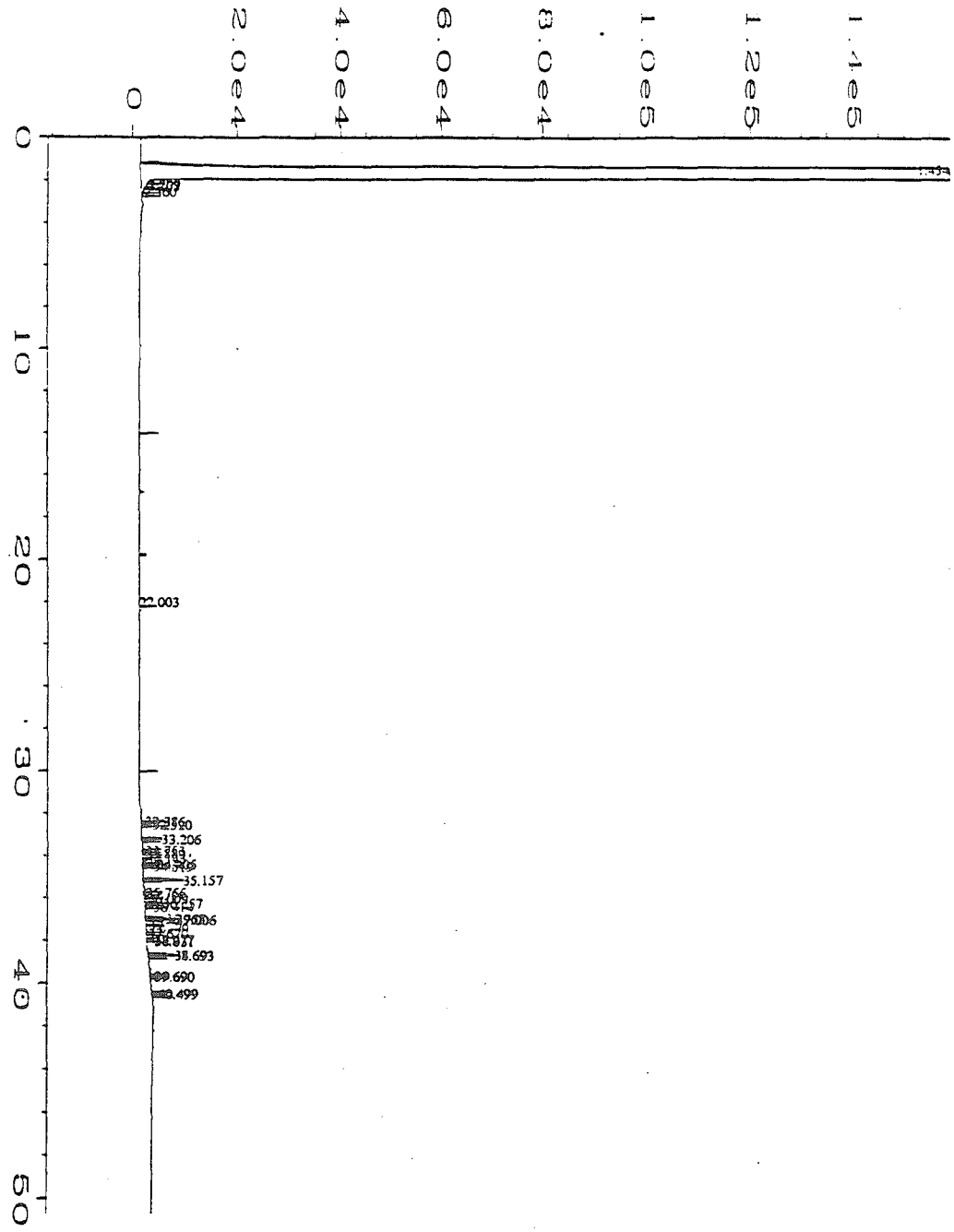
External Standard Report

Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\021F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 21
Sample Name	: WMO 10	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 04:07 PM	Instrument Method:	RHONE727.M
Report Created on:	20 Aug 93 02:37 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 AUG 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

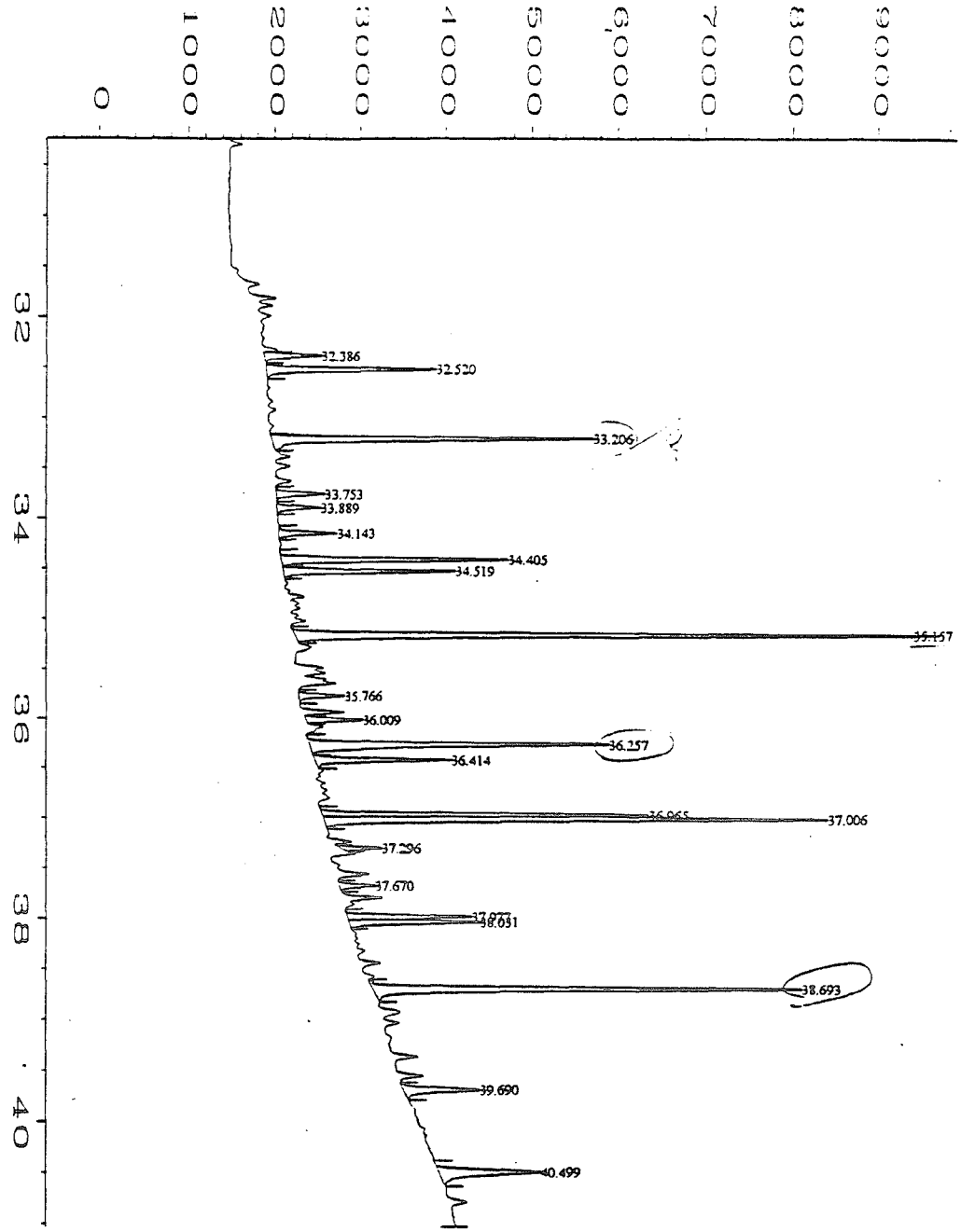
Sig. 1 in C:\HPCHEM\1\DATA\RHONE-P\021F0101.D

Ret Time	Area	Type	Width	Ref#	UG/ML	Name
3.300	* not found *			1		Toluene
22.003	163593	BB +	0.000	1	12.137	WMO
33.288	* not found *			1		Palatinol DOP
1.461	1.11272E+009	BB S	0.196		1.1E+009	* uncalibrated *
2.214	825	BV T	0.034		825.234	* uncalibrated *
2.266	1259	VB T	0.045		1259.326	* uncalibrated *
2.398	70	BV T	0.023		69.826	* uncalibrated *
2.563	57	PB T	0.023		57.195	* uncalibrated *
31.889	1230	BB	0.076		1230.487	* uncalibrated *

Not all calibrated peaks were found



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\022F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 22
Sample Name	: PALATINOL 711	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 05:07 PM	Instrument Method:	RHONE727.M
Report Created on:	20 Aug 93 02:07 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\022F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 22
Sample Name	: PALATINOL 711	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 05:07 PM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 02:08 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

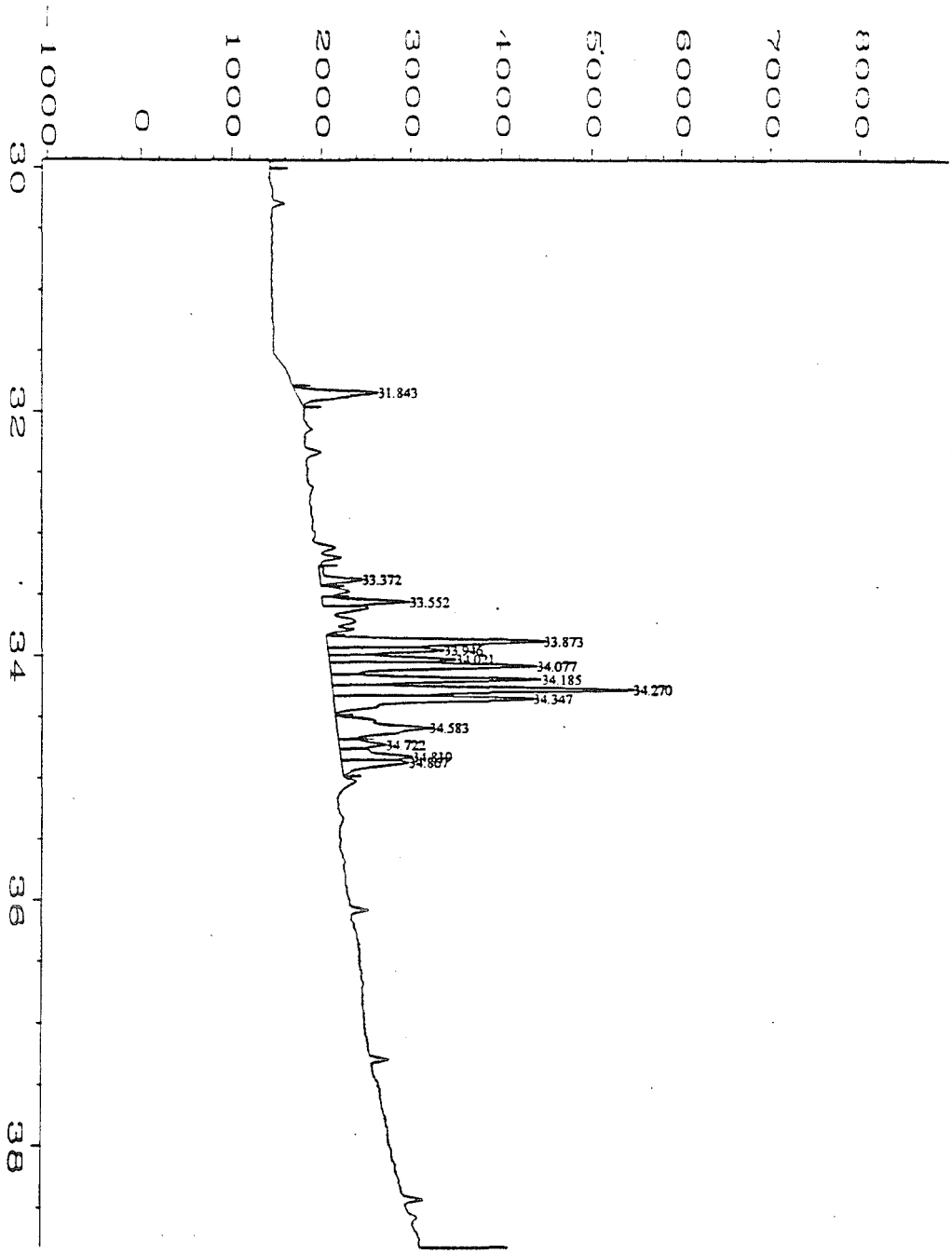
External Standard Report

Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\022F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 22
Sample Name	: PALATINOL 711 12.6ppm	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 05:07 PM	Instrument Method:	RHONE727.M
Report Created on:	20 Aug 93 02:07 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

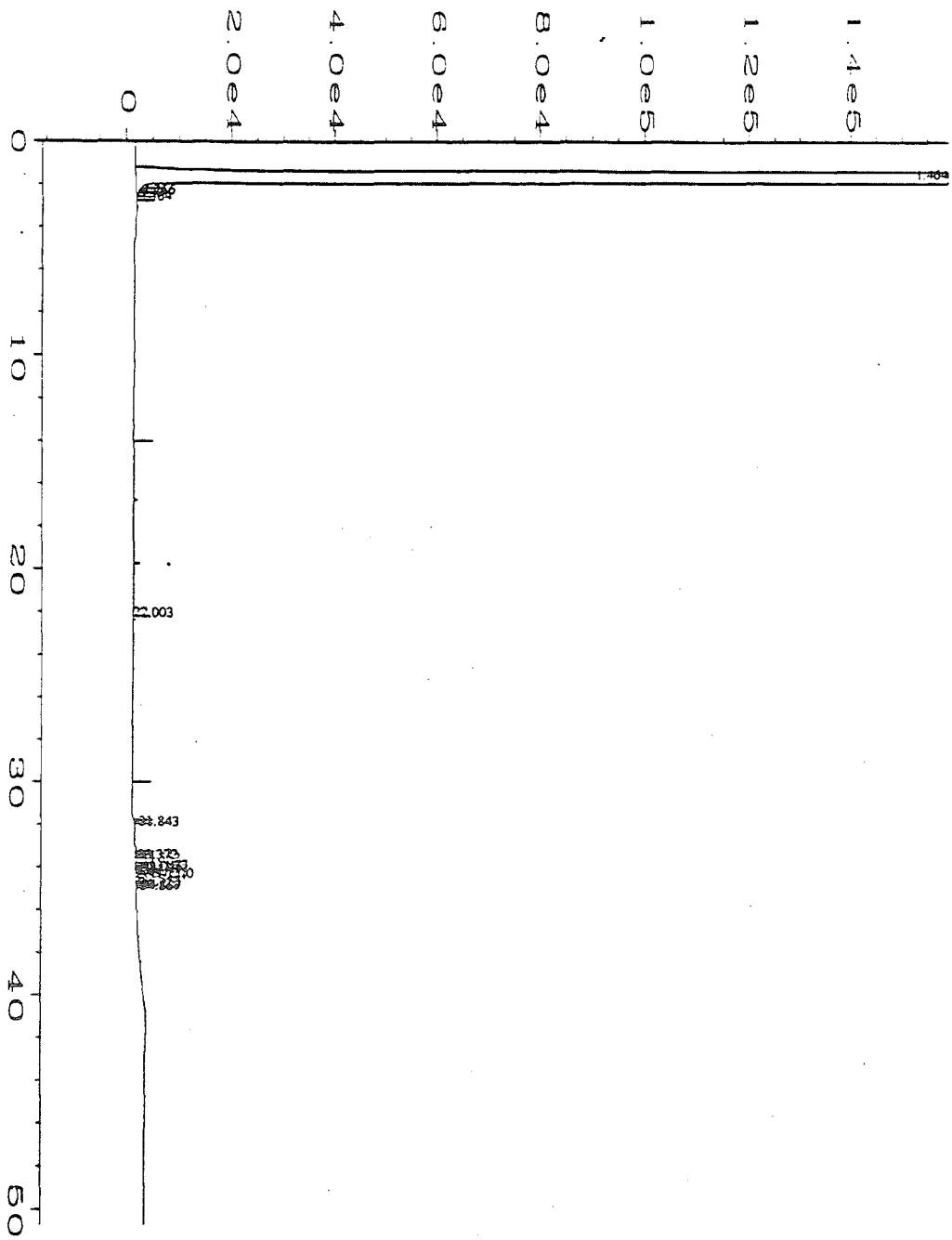
Sig. 1 in C:\HPCHEM\1\DATA\RHONE-P\022F0101.D

Ret Time	Area	Type	Width	Ref#	UG/ML	Name	
3.300	* not found *			1		Toluene	
22.003	12869	BB +	0.000	1	0.955	WMO	
33.206	9778	BV	0.040	1	0.933	Palatinol DOP	
1.454	1.09999E+009	BB S	0.193		1.1E+009	* uncalibrated *	
2.209	716	BV T	0.028		715.832	* uncalibrated *	
2.263	1164	VB T	0.042		1164.137	* uncalibrated *	
2.560	1310	BB T	0.079		1310.469	* uncalibrated *	
32.386	1640	VB	0.037		1639.588	* uncalibrated *	
32.520	4895	BB	0.039		4894.618	* uncalibrated *	AMT/AREA
33.753	1400	BB	0.038		1399.805	* uncalibrated *	
33.889	1172	BB	0.035		1172.026	* uncalibrated *	
34.143	1550	BB	0.036		1549.711	* uncalibrated *	
34.405	6709	BV	0.040		6708.547	* uncalibrated *	
34.519	4887	VB	0.038		4886.715	* uncalibrated *	0.000683
35.157	18440	BV	0.039		18440.24	* uncalibrated *	
35.766	1260	BB	0.037		1259.651	* uncalibrated *	
36.009	1473	VV	0.035		1472.901	* uncalibrated *	
36.257	9982	BV	0.043		9982.418	* uncalibrated *	0.001262
36.414	3806	PB	0.037		3806.384	* uncalibrated *	
36.965	7718	BV	0.032		7717.624	* uncalibrated *	
37.006	15950	VB	0.041		15949.94	* uncalibrated *	
37.296	889	PV	0.029		888.909	* uncalibrated *	
37.670	1008	VB	0.035		1008.157	* uncalibrated *	
37.977	3355	BV	0.035		3354.887	* uncalibrated *	
38.031	3846	VV	0.038		3845.953	* uncalibrated *	
38.693	13364	VB	0.041		13364.49	* uncalibrated *	0.000943
39.690	2647	BB	0.047		2646.824	* uncalibrated *	
40.499	4532	BB	0.056		4532.034	* uncalibrated *	

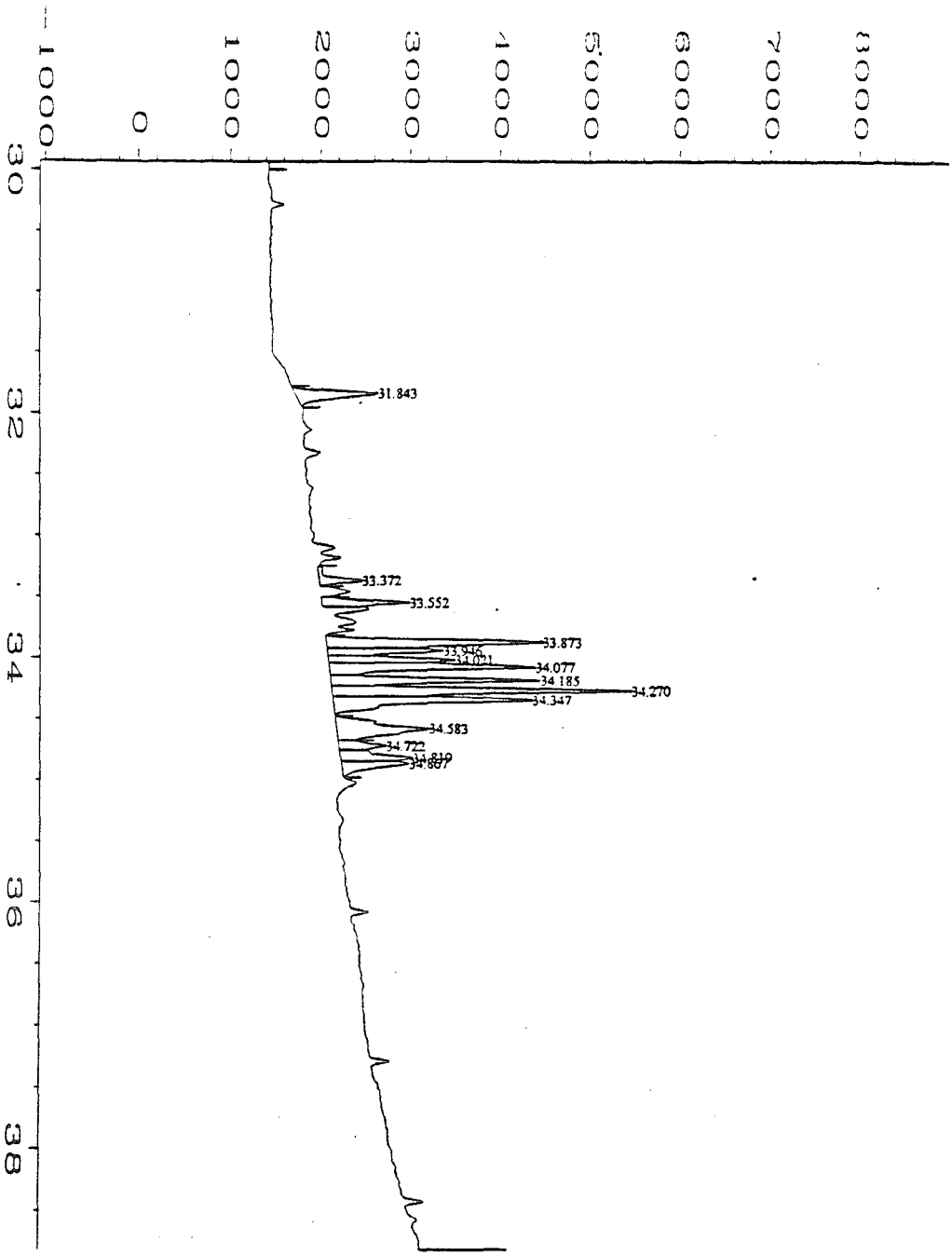
Not all calibrated peaks were found



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\023F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 23
Sample Name	: SANTICIZER 148	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 06:07 PM	Instrument Method:	RHONE727.M
Report Created on:	20 Aug 93 02:05 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:



a File Name	: C:\HPCHEM\1\DATA\RHONE-P\023F0101.D		
rator	: Kelly Cooki	Page Number	: 1
trument	: 5890-1	Vial Number	: 23
ple Name	: SANTICIZER 148	Injection Number	: 1
Time Bar Code:		Sequence Line	: 1
uired on	: 26 Jul 93 06:07 PM	Instrument Method	: RHONE727.M
ort Created on	: 20 Aug 93 02:03 PM	Analysis Method	: RHONE727.M
t Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
iplier	: 1	ISTD Amount	:



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\023F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 23
Sample Name	: SANTICIZER 148	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 06:07 PM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 02:05 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

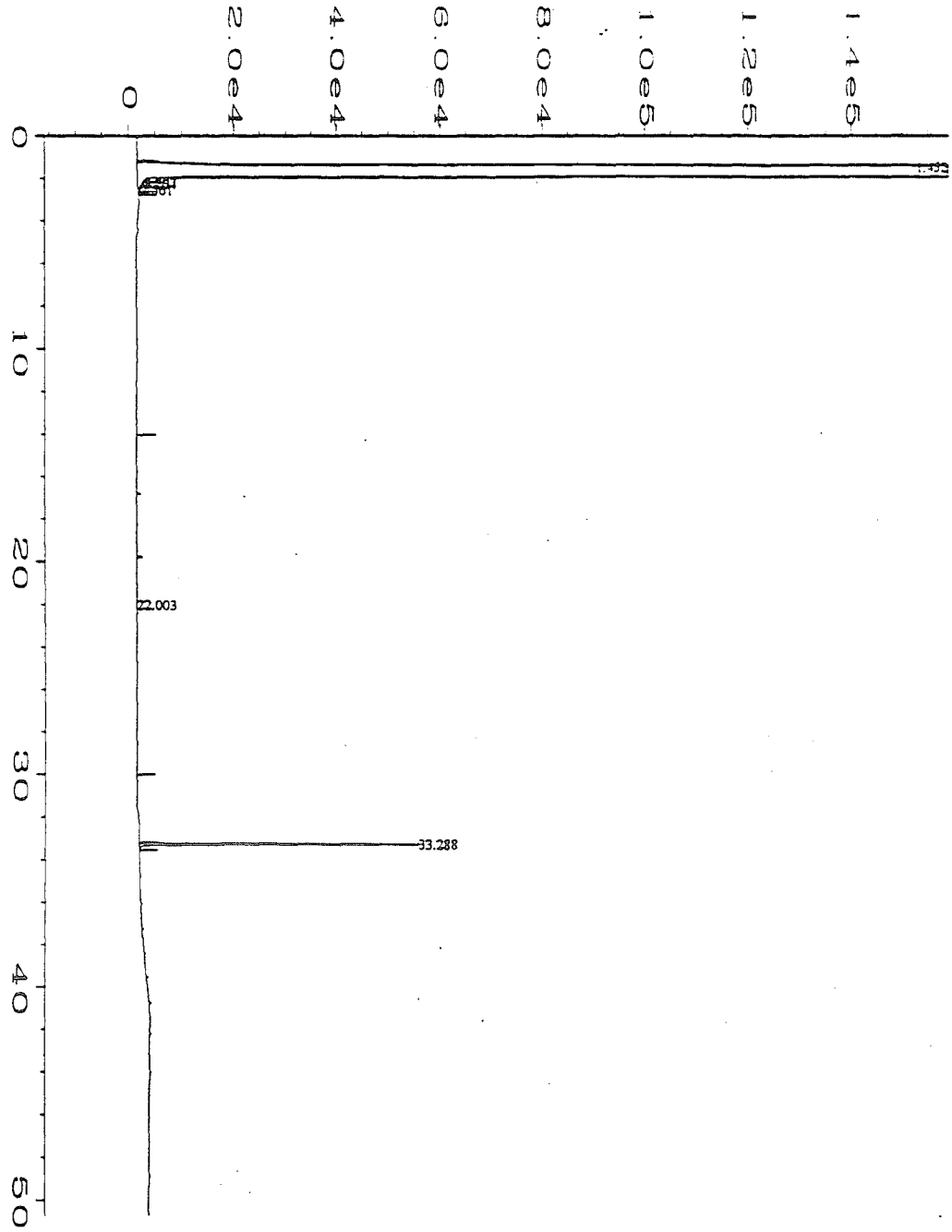
External Standard Report

Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\023F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 23
Sample Name	: SANTICIZER 148	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 06:07 PM	Instrument Method:	RHONE727.M
Report Created on:	20 Aug 93 02:04 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

Sig. 1 in C:\HPCHEM\1\DATA\RHONE-P\023F0101.D

Ret Time	Area	Type	Width	Ref#	UG/ML	Name
3.300	* not found *			1		Toluene
22.003	-23370	BB +	0.000	1	-1.734	WMO
33.372	1472	VV	0.046	1	0.140	Palatinol DOP
1.464	1.12034E+009	BB S	0.196		1.1E+009	* uncalibrated *
2.216	578	BV T	0.029		578.361	* uncalibrated *
2.266	1059	VB T	0.042		1059.115	* uncalibrated *
2.398	81	BB T	0.021		81.165	* uncalibrated *
2.564	1279	BV T	0.079		1279.496	* uncalibrated *
31.843	3509	BB	0.056		3508.678	* uncalibrated *
33.552	2572	VV	0.040		2572.369	* uncalibrated *
33.873	8080	VV	0.051		8080.139	* uncalibrated *
33.946	3696	VV	0.044		3695.588	* uncalibrated *
34.021	3661	VV	0.040		3661.082	* uncalibrated *
34.077	7620	VV	0.051		7619.766	* uncalibrated *
34.185	6636	VV	0.042		6635.802	* uncalibrated *
34.270	10006	VV	0.045		10005.62	* uncalibrated *
34.347	8228	VV	0.053		8227.627	* uncalibrated *
34.583	6041	PV	0.078		6040.723	* uncalibrated *
34.722	1718	VV	0.047		1717.657	* uncalibrated *
34.819	2939	VV	0.051		2939.203	* uncalibrated *
34.867	2794	VV	0.052		2794.292	* uncalibrated *

Not all calibrated peaks were found



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\024F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 24
Sample Name	: PALATINOL DOP	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 07:08 PM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 01:57 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

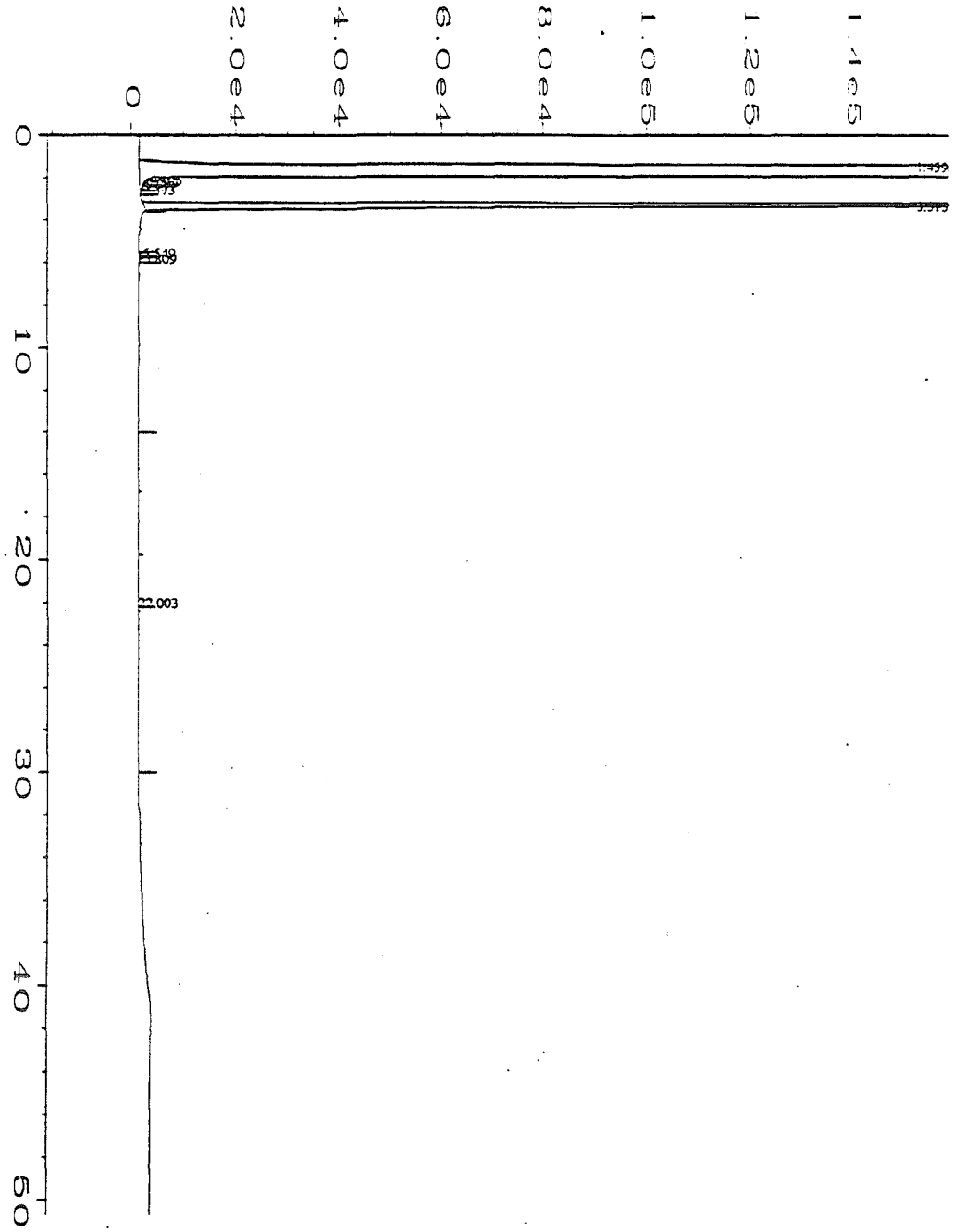
External Standard Report

Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\024F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 24
Sample Name	: PALATINOL DOP	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 07:08 PM	Instrument Method:	RHONE727.M
Report Created on:	20 Aug 93 01:57 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

Sig. 1 in C:\HPCHEM\1\DATA\RHONE-P\024F0101.D

Ret Time	Area	Type	Width	Ref#	UG/ML	Name
3.300	* not found *			1		Toluene
22.003	6844	BB +	0.000	1	0.508	WMO
33.288	133058	BB	0.038	1	12.700	Palatinol DOP
1.452	1.09251E+009	BB S	0.191		1.1E+009	* uncalibrated *
2.207	702	BV T	0.028		701.781	* uncalibrated *
2.264	1250	VB T	0.042		1250.418	* uncalibrated *
2.561	1341	BV T	0.077		1340.926	* uncalibrated *

Not all calibrated peaks were found



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\025F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 25
Sample Name	: TOLUENE 1000	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 08:08 PM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 01:23 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

External Standard Report

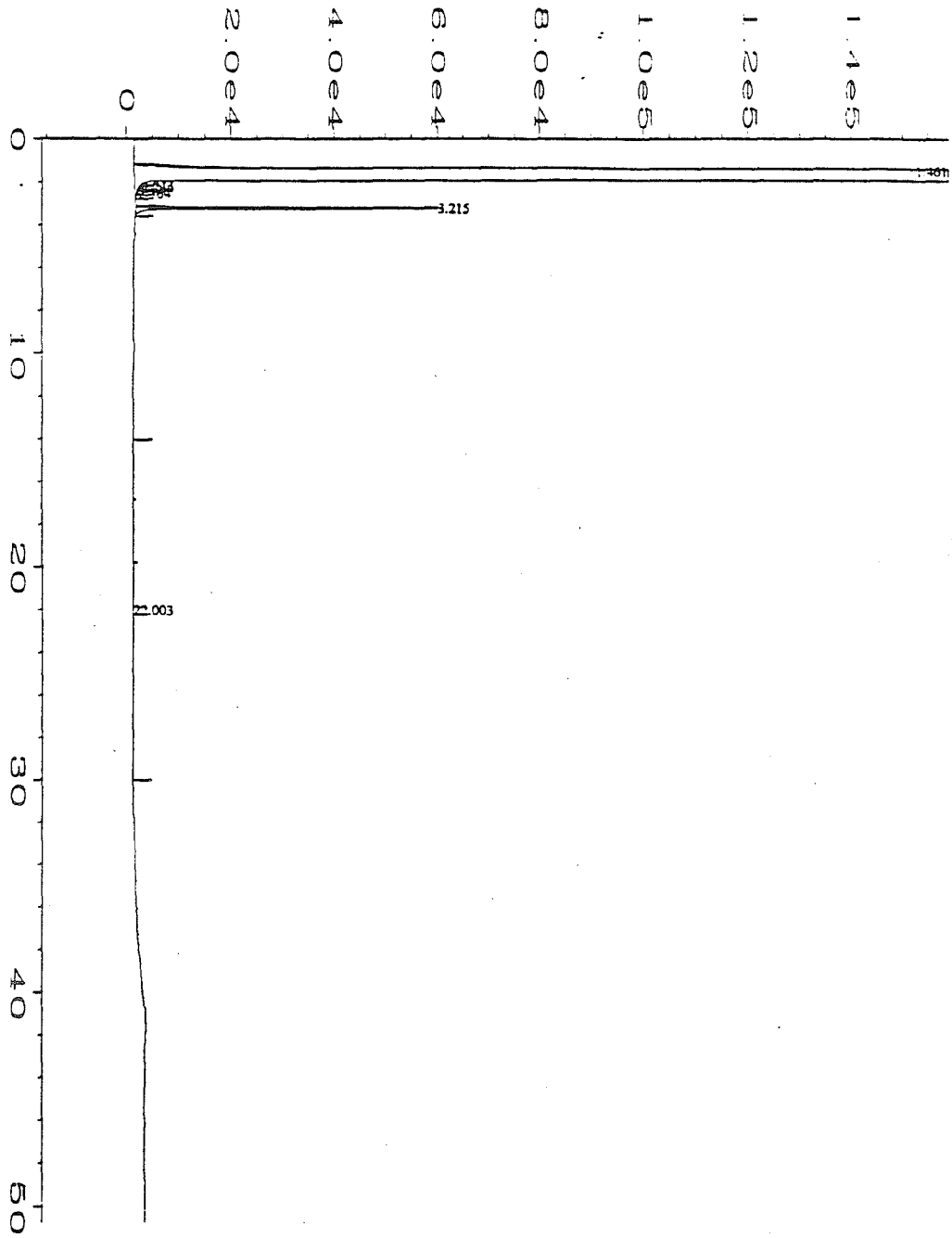
Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\025F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 25
Sample Name	: TOLUENE 1000	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 08:08 PM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 01:23 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

Sig. 1 in C:\HPCHEM\1\DATA\RHONE-P\025F0101.D

Ret Time	Area	Type	Width	Ref#	UG/ML	Name
3.313	1.26714E+007	BBA	0.078	1	1191.203	Toluene
22.003	-2652	BB +	0.000	1	-0.197	WMO
1.459	1.11127E+009	BB S	0.195		1.1E+009	* uncalibrated *
2.125	1203	BV T	0.019		1202.992	* uncalibrated *
2.214	1137	VV T	0.044		1136.915	* uncalibrated *
2.267	1462	VB T	0.043		1461.578	* uncalibrated *
2.397	97	BB T	0.022		97.393	* uncalibrated *
2.573	1546	BV T	0.069		1546.154	* uncalibrated *
5.549	2611	BB	0.051		2610.957	* uncalibrated *
5.809	3818	BB	0.061		3818.111	* uncalibrated *

KEC 8/24/93

AMT/AREA = Σ. $\frac{\cancel{8}}{66518} \times 10^{-5}$



Data File Name : C:\HPCHEM\1\DATA\RHONE-P\026F0101.D
Operator : Kelly Cooki
Instrument : 5890-1
Sample Name : TOLUENE ~~100~~ 10 5/20/93 KEC
Run Time Bar Code:
Acquired on : 26 Jul 93 09:09 PM
Report Created on: 20 Aug 93 01:21 PM
Last Recalib on : 20 Aug 93 01:14 PM
Multiplier : 1

Page Number : 1
Vial Number : 26
Injection Number : 1
Sequence Line : 1
Instrument Method: RHONE727.M
Analysis Method : RHONE727.M
Sample Amount : 0
ISTD Amount :

External Standard Report

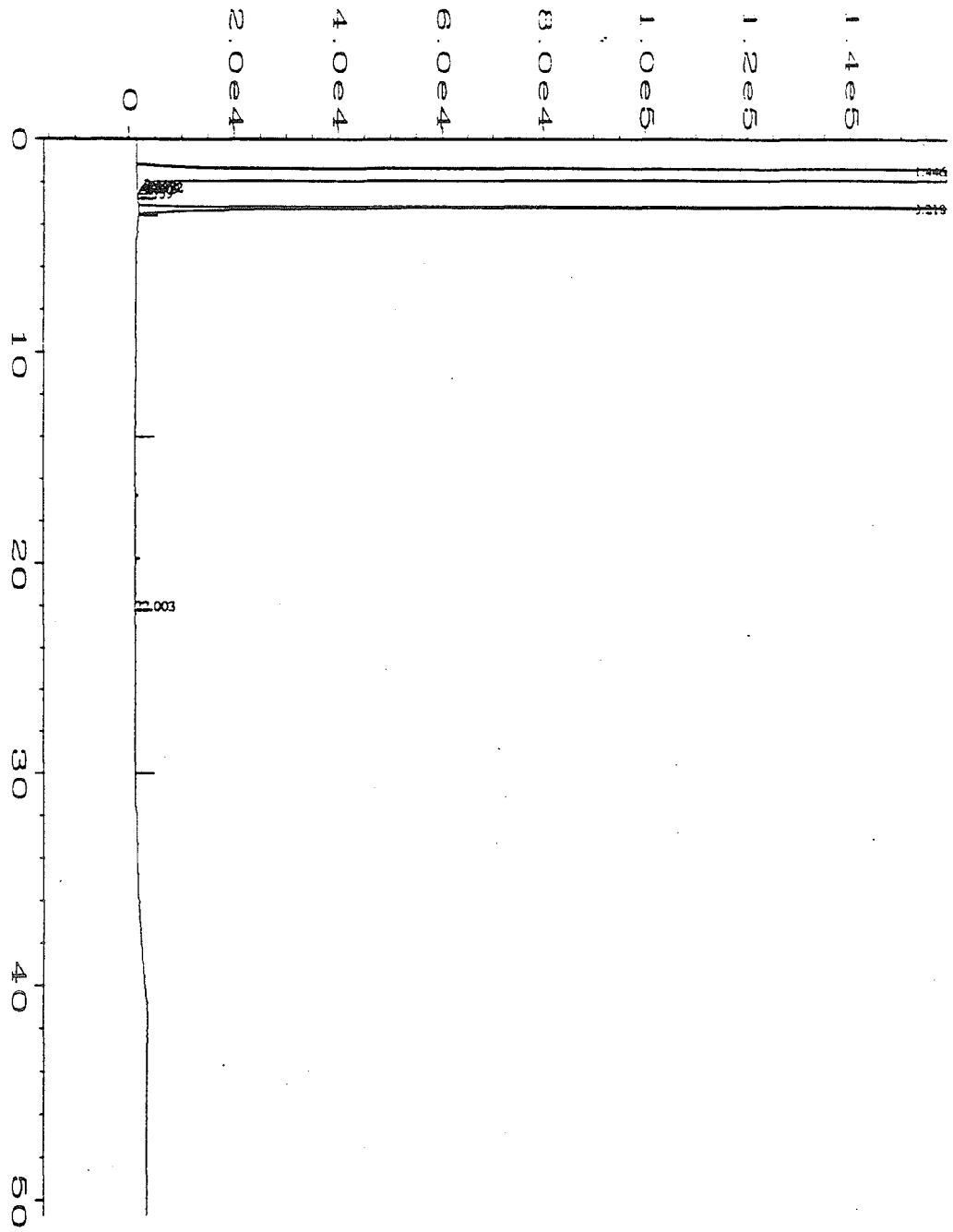
Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\026F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1	Vial Number	: 26
Sample Name	: TOLUENE 100	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 09:09 PM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 01:21 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

Sig. 1 in C:\HPCHEM\1\DATA\RHONE-P\026F0101.D

Ret Time	Area	Type	Width	Ref#	UG/ML	Name
3.348	* not found *			1		Toluene
22.003	-501	BB +	0.000	1	-0.0372	WMO
1.461	1.11292E+009	BB S	0.193		1.1E+009	* uncalibrated *
2.215	764	BV T	0.032		763.763	* uncalibrated *
2.264	1326	VB T	0.045		1325.562	* uncalibrated *
2.398	94	BB T	0.027		94.111	* uncalibrated *
2.564	1476	BV T	0.083		1476.459	* uncalibrated *
3.215	123576	BBA	0.031		123576.1	* uncalibrated *

Not all calibrated peaks were found

AMT / AREA = 10.98 / = 8.98522 x 10^-5



Data File Name	: C:\HPCHEM\1\DATA\RHONE-P\027F0101.D		
Operator	: Kelly Cooki	Page Number	: 1
Instrument	: 5890-1 8/20/93	Vial Number	: 27
Sample Name	: TOLUENE ~~10~~ 100 KEC	Injection Number	: 1
Run Time Bar Code:		Sequence Line	: 1
Acquired on	: 26 Jul 93 10:09 PM	Instrument Method	: RHONE727.M
Report Created on	: 20 Aug 93 01:19 PM	Analysis Method	: RHONE727.M
Last Recalib on	: 20 Aug 93 01:14 PM	Sample Amount	: 0
Multiplier	: 1	ISTD Amount	:

External Standard Report

Data File Name : C:\HPCHEM\1\DATA\RHONE-P\027F0101.D
Operator : Kelly Cooki
Instrument : 5890-1 8/26/93
Sample Name : TOLUENE ~~10~~ 100 KEC
Run Time Bar Code:
Acquired on : 26 Jul 93 10:09 PM
Report Created on: 20 Aug 93 01:19 PM
Last Recalib on : 20 Aug 93 01:14 PM
Multiplier : 1

Page Number : 1
Vial Number : 27
Injection Number : 1
Sequence Line : 1
Instrument Method: RHONE727.M
Analysis Method : RHONE727.M
Sample Amount : 0
ISTD Amount :

Sig. 1 in C:\HPCHEM\1\DATA\RHONE-P\027F0101.D

Ret Time	Area	Type	Width	Ref#	UG/ML	Name
3.348	* not found *			1		Toluene
22.003	10296	BB +	0.000	1	0.764	WMO
1.446	1.07764E+009	BB S	0.188		1.1E+009	* uncalibrated *
2.116	88	BB T	0.022		88.160	* uncalibrated *
2.171	475	BV T	0.018		475.485	* uncalibrated *
2.203	614	VV T	0.029		614.187	* uncalibrated *
2.252	2877	VV T	0.028		2877.183	* uncalibrated *
2.309	1586	VV T	0.022		1586.495	* uncalibrated *
2.389	111	VB T	0.027		110.664	* uncalibrated *
2.559	1453	BV T	0.076		1453.183	* uncalibrated *
3.218	1218840	BBA	0.033		1218840.	* uncalibrated *

AMT/AREA = ~~0.0000826445~~ KEC 8/26/93
0.0000900857
= 9.00857 x10^-5

Not all calibrated peaks were found

109.8/AREA

QUALITATIVE DATA

CH2M HILL
Engineers
Planners
Economists
Scientists

August 5, 1993

CV013522.99

Mr. Kelly Cook
CH2M HILL
2300 N.W. Walnut Blvd.
Corvallis, OR 97330-3538

RE: Analytical Data for Rhone-Poulene, LRD Lab Reference No. 36384

Dear Mr. Cook:

On July 27, 1993, the CH2M HILL Redding Laboratory (LRD) received one sample with a request for analysis of selected organic parameters.

The analytical results and associated quality control data are enclosed. Any unusual difficulties encountered during the analyses of this sample are discussed in the case narratives.

Under CH2M HILL policy, your samples will be stored for up to 30 days after reporting. If you have not given us prior instructions for disposal, we will contact you if any samples require disposal as hazardous waste.

CH2M HILL Laboratories appreciate your business and look forward to serving your analytical needs again. If you should have any questions concerning the data, or if you need additional information, please call our Client Services Representatives, Mr. Mark Cichy or Ms. Mary Paschke, at (916) 244-5227.

Sincerely,

Peggy A. Norton

Peggy A. Norton
Senior Data Package Specialist

Enclosures

CH2M HILL Quality Analytical Laboratory
5090 Caterpillar Road, Redding, California 96003-1412
916.244.5227
FAX 916.244.4109

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CH2M HILL Quality Analytical Laboratory

5090 Caterpillar Road, Redding, California 96003-1412

916.244.5227
FAX 916.244.4109

ORGANIC DATA QUALIFIERS

U Indicates the compound was analyzed for, but not detected. The number adjacent to the "U" qualifier indicates the reporting limit for that compound. The reporting limit can vary from sample to sample depending on dilution factors or percent moisture adjustment when indicated.

J Indicates an estimated value. It is used when the data indicates the presence of a compound below the stated reporting limit.

C This flag applies to GC analytes only. The "C" flag indicates the presence of this compound has been confirmed by GC/MS analysis.

B This flag is used when the analyte is found in the associated blank, as well as the sample. This notation indicates possible blank contamination and suggests the data user evaluate these compounds and their amounts carefully.

E This qualifier indicates that the value reported exceeds the linear calibration range for that compound. Therefore, the sample should be reanalyzed at an appropriate dilution. The "E" qualified amount is an estimated concentration, and the results of the dilution will be reported on a separate Form I.

D This qualifier indicates compounds which have been identified during a diluted reanalysis. "D" qualifiers are used for samples that have been analyzed initially at a lesser dilution than required for accurate quantification.

CH2M HILL Quality Analytical Laboratory
5090 Caterpillar Road, Redding, California 96003-1412
916.244.5227
FAX 916.244.4109

SAMPLE ID QUALIFIERS

The qualifiers that may be appended to the sample ID for organic analyses are defined below:

DL -- Dilution Run. Indicates the sample contained compounds exceeding the calibration range. The sample was diluted and reanalyzed. Both results are reported.

R -- Rerun. The sample was reanalyzed. The "R" is not used if the sample was also re-extracted.

RX -- Re-extraction Analysis. The sample was re-extracted and reanalyzed.

RD -- Diluted Rerun. The sample was re-extracted and a dilution was also required.

MS -- Matrix Spike (may be followed by a digit to indicate multiple matrix spikes within a sample set)

MSD -- Matrix Spike Duplicate (may be followed by a digit to indicate multiple matrix spike duplicates within a sample set)

CH2M HILL Quality Analytical Laboratory
5090 Caterpillar Road, Redding, California 96003-1412
916.244.5227
FAX 916.244.4109

CLIENT SAMPLE CROSS-REFERENCE

CH2M HILL Laboratory Reference No. 36384

Client Sample ID	LRD Lab Sample ID
528704CVO	36384001

CH2M HILL Quality Analytical Laboratory
5090 Caterpillar Road, Redding, California 96003-1412
916.244.5227
FAX 916.244.4109

CASE NARRATIVE
GC/MS SEMIVOLATILE SAMPLES

LABORATORY : CH2M HILL LABORATORIES CLIENT: RHONE-POULENE

CASE NO. : N/A CONTRACT NO.: N/A

LAB REF. NO.: 36384 SDG NO.: N/A

I. RECEIPT

A. Date: July 27, 1993

B. Sample Information:

LAB SAMPLE ID	CLIENT SAMPLE ID	SAMPLE MATRIX	DATE SAMPLED	EXTRACTION DATE	ANALYSIS DATE
36384001	528704CVO	SOLVENT	07/26/93	N/A	07/28/93

C. Documentation Exceptions : No exceptions were encountered.

II. EXTRACTION

A. Holding Times: Not applicable.

B. Extraction Exceptions : Not applicable.

III. ANALYSIS

A. Holding Times: All holding times were met.

B. Analytical Exceptions : Other than a significant level of Toluene, this sample contained aliphatic hydrocarbons in the range of C10 - C20. The majority of the hydrocarbons fell between C14 -C18.

CH2M HILL Quality Analytical Laboratory

5090 Caterpillar Road, Redding, California 96003-1412

916.244.5227
FAX 916.244.4109

IV. QUALITY CONTROL

A. Method Blank : Not applicable.

B. Surrogate Recoveries : Not applicable.

V. I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, except for the conditions detailed above. Release of the data contained in this hard copy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature.

Brian Geers 8-4-93

Brian Geers Date
Manager, Organics Division

CH2M HILL Quality Analytical Laboratory
5090 Caterpillar Road, Redding, California 96003-1412
916.244.5227
FAX 916.244.4109

ORGANICS ANALYSIS DATA SHEET

Laboratory Name: CH2M HILL/LRD
Lab Sample ID: 36384001
Client Sample ID: 528704CV0

Concentration: LOW
Sample Matrix: SOLVENT
Percent Moisture: ____

Date Extracted:
Date Analyzed: 07/28
Dilution Factor: 1

SEMIVOLATILE COMPOUNDS

CAS Number		ng/uL	
62-75-9	N-Nitrosodimethylamine	500	U
108-95-2	Phenol	500	U
111-44-4	bis(2-Chloroethyl)ether	500	U
95-57-8	2-Chlorophenol	500	U
541-73-1	1,3-Dichlorobenzene	500	U
106-46-7	1,4-Dichlorobenzene	500	U
95-50-1	1,2-Dichlorobenzene	500	U
108-60-1	bis(2-Chloroisopropyl)ether	500	U
621-64-7	N-Nitroso-di-n-propylamine	500	U
67-72-1	Hexachloroethane	500	U
98-95-3	Nitrobenzene	500	U
78-59-1	Isophorone	500	U
88-75-5	2-Nitrophenol	500	U
105-67-9	2,4-Dimethylphenol	500	U
111-91-1	bis(2-Chloroethoxy)methane	500	U
120-83-2	2,4-Dichlorophenol	500	U
120-82-1	1,2,4-Trichlorobenzene	500	U
91-20-3	Naphthalene	500	U
87-68-3	Hexachlorobutadiene	500	U
59-50-7	4-Chloro-3-methylphenol	500	U
77-47-4	Hexachlorocyclopentadiene	500	U
88-06-2	2,4,6-Trichlorophenol	500	U
91-58-7	2-Chloronaphthalene	500	U
131-11-3	Dimethylphthalate	500	U
208-96-8	Acenaphthylene	500	U
606-20-2	2,6-Dinitrotoluene	500	U
83-32-9	Acenaphthene	500	U
51-28-5	2,4-Dinitrophenol	2500	U
100-02-7	4-Nitrophenol	2500	U
121-14-2	2,4-Dinitrotoluene	500	U
84-66-2	Diethylphthalate	500	U
7005-72-3	4-Chlorophenyl-phenylether	500	U
86-73-7	Fluorene	500	U
534-52-1	4,6-Dinitro-2-methylphenol	2500	U
86-30-6	N-Nitrosodiphenylamine (1)	500	U
122-66-7	1,2-Diphenylhydrazine	500	U
101-55-3	4-Bromophenyl-phenylether	500	U
118-74-1	Hexachlorobenzene	500	U

CAS Number		ng/uL	
87-86-5	Pentachlorophenol	2500	U
85-01-8	Phenanthrene	500	U
120-12-7	Anthracene	500	U
84-74-2	Di-n-butylphthalate	500	U
206-44-0	Fluoranthene	500	U
129-00-0	Pyrene	500	U
85-68-7	Butylbenzylphthalate	500	U
91-94-1	3,3'-Dichlorobenzidine	1000	U
56-55-3	Benzo(a)anthracene	500	U
218-01-9	Chrysene	500	U
117-81-7	bis(2-Ethylhexyl)phthalate	50	J
117-84-0	Di-n-octylphthalate	500	U
205-99-2	Benzo(b)fluoranthene	500	U
207-08-9	Benzo(k)fluoranthene	500	U
50-32-8	Benzo(a)pyrene	500	U
193-39-5	Indeno(1,2,3-cd)pyrene	500	U
53-70-3	Dibenz(a,h)anthracene	500	U
191-24-2	Benzo(g,h,i)perylene	500	U

(1) - Cannot be separated from diphenylamine.
U - Compound analyzed for but not detected.
J - Reported value less than quantitation limit.

Form I

000003

CH2M HILL Quality Analytical Laboratory
5090 Caterpillar Road, Redding, California 96003-1412
916.244.5227
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1F
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.
528704CVO

ab Name: CH2M HILL/LRD Contract: S36384

b Code: _____ Case No.: S36384 SAS No.: _____ SDG No.: GC-MS

atrix: (soil/water) SOLVENT Lab Sample ID: 36384001

ample wt/vol: _____ (g/mL) ng/uL Lab File ID: 93M3BN3569

evel: (low/med) LOW Date Received: 07/27/93

Moisture: _____ decanted: (Y/N) ___ Date Extracted:

oncentrated Extract Volume: _____(uL) Date Analyzed: 07/28/93

njection Volume: 1.0(uL) Dilution Factor: 50

PC Cleanup: (Y/N) N pH:

umber TICs found: 20

CONCENTRATION UNITS:
(ug/L or ug/Kg) ~~UG/L~~ ng/ul

8/2/93 KEC as per Brian Geers (LRD)

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1. 108-88-3	TOLUENE	5.55	45000	J
2. 6975-98-0	DECANE, 2-METHYL-	18.87	7200	J
3.	UNKNOWN	19.77	2900	J
4.	UNKNOWN	19.85	5200	J
5. 629-62-9	PENTADECANE	20.49	20000	J
6.	UNKNOWN	20.59	3000	J
7.	UNKNOWN	20.72	3000	J
8.	UNKNOWN	21.15	5100	J
9.	UNKNOWN	21.25	4300	J
10.	UNKNOWN	21.32	2600	J
11.	UNKNOWN	21.39	8700	J
12. 544-76-3	HEXADECANE	22.00	25000	J
13.	UNKNOWN	22.07	5000	J
14.	UNKNOWN	22.29	3300	J
15. 25117-26-4	HEXADECANE, 4-METHYL-	22.75	2900	J
16.	UNKNOWN	22.82	3700	J
17. 1795-16-0	CYCLOHEXANE, DECYL-	22.89	9000	J
18. 629-62-9	PENTADECANE	23.37	32000	J
19. 55000-52-7	HEXADECANE, 2,6,10-TRIMETHYL	23.44	13000	J
20. 593-45-3	OCTADECANE	24.65	9200	J

FORM I SV-TIC 3/90

000004

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CH2M HILL
QUALITY ANALYTICAL LABORATORIES

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M HILL Project #: GVE[illegible]/135.33.99
Purchase Order #:
Project Name: Rhone-Poulenc
Company Name/CH2M HILL Office: CVO
Project Manager & Phone #: Mr. ☒ Ms. ☐ Dr. ☐ Kelly E. Cook CVO-x3123
Report Copy to:
Requested Completion Date: 8/5/93
Sampling Requirements: SDWA ☐ NPDES ☐ RCRA ☐ OTHER ☒
Sample Disposal: Dispose ☒ Return ☐

SHADED AREA – FOR LAB USE ONLY: Lab 1 # 36384; Lab 2 #; Quote #; KR Request #; Project #; No. of Samples; Page; of; COC Rev; Login; LIMS Ver; Lock Gen

LAB TEST CODES

ANALYSES REQUESTED: EPA 625 w/TCL

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	EPA 625 w/TCL	REMARKS	LAB 1 ID	LAB 2 ID
7/26	0900					528704CV04	4	X		1	

Sample of LNAPL (#528704)
Diluted 1:50 w/MEC
See Brian Geers for Details
Need copies of ALL data + paperwork

Sampled By & Title (Please sign and print name): Kelly E. Cook	Date/Time: 7/26 0900	Relinquished By (Please sign and print name): Kelly E. Cook	Date/Time: 7/26 1100
Received By (Please sign and print name):	Date/Time:	Relinquished By (Please sign and print name):	Date/Time:
Received By (Please sign and print name):	Date/Time:	Relinquished By (Please sign and print name):	Date/Time:
Received By (Please sign and print name): Nichole LaPlante 7/27/93	Date/Time: 0930	Shipped Via: UPS BUS Fed-Ex Hand Other	Shipping #:
Work Auth By (Please sign and print name):	Remarks:		

HAZWRAP/NESSA: Y N
QC Level: 1 2 3 Other: X
COC Rec Y ICE NO
Ana Req Y TEMP Amb
Cust Seal NO Ph

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: ORIGINAL - LAB Yellow - LAB Pink - Client

000005

Monsanto 2A002327

Monsanto Company 104(e) Response

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ENVIRONMENTAL LABORATORIES

REPORT OF LABORATORY ANALYSIS

Analytical Results - TPH-Extractable
Rhone-Poulenc Incorporated

Client ID:	H-10 LNAPL	Collected:	04/01/95
Description:	LIQUID	Received:	04/03/95
Sample ID:	WQI-001	Prepared:	04/06/95
Matrix:	Other	Analyzed:	04/11/95
Wet/Dry Basis:	NA	Percent Moisture:	NA

CAS No.	Parameter	Concentration, mg/kg (ppm) (A3) Sample	Blank	Detection Limit
NA	Penetech Range Organics	488000	ND	20000

ND-Not Detected at or above the detection limit stated.
(A3) The sample was analyzed at a 1:10 dilution due to high concentrations of target analytes. The detection limit has been adjusted for the dilution since no analysis at a lower dilution was performed.

161 James Drive West, Suite 100
St. Rose, LA 70087
TEL: 504-469-0333
FAX: 504-469-0555

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pace INCORPORATED
ENVIRONMENTAL LABORATORIES

REPORT OF LABORATORY ANALYSIS

Analytical Results - TPH-Extractable
Rhone-Poulenc Incorporated

Client ID:	MW-18 LNAPL	Collected:	04/01/95
Description:	LIQUID	Received:	04/03/95
Sample ID:	WQI-002	Prepared:	04/06/95
Matrix:	Other	Analyzed:	04/11/95
Wet/Dry Basis:	NA	Percent Moisture:	NA

CAS No.	Parameter	Concentration, mg/kg (ppm) Sample	Blank	Detection Limit
NA	Penetech Range Organics	29600	ND	2000

ND-Not Detected at or above the detection limit stated.

161 James Drive West, Suite 100
St. Rose, LA 70087
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1X
8020 VOLATILES DATA SHEET

SAMPLE NO.
MW-18PH1

I Name: PACE Mid-Pacific Contract: _____

Lab Code: PACE_MP Client: CH2M_HILL Case: RHONE SDG: V4006

Matrix: (soil/water) WATER Lab Sample ID: 9504006-01A

Sample wt/vol: 5.0 (g/mL) mL Lab File ID: 0413B07

Level: (low/med) LOW Date Received: 04/03/95

% Moisture: not dec. ____ Heated Purge: __ Date Analyzed: 04/13/95

GC Column: RTX-502.2 ID: 0.530 (mm) Dilution Factor: 50000.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) mg/L	Q
71-43-2	Benzene (8020)	25000	U
108-88-3	Toluene (8020)	920000	
100-41-4	Ethylbenzene (8020)	25000	U
1330-20-7	Total Xylenes (8020)	25000	U
67-64-1	Acetone (8020)	1500000	U

1X
8020 VOLATILES DATA SHEET

SAMPLE NO.
MW-18PH2

Name: PACE Mid-Pacific Contract: _____

Lab Code: PACE_MP Client: CH2M_HILL Case: RHONE SDG: V4006

Matrix: (soil/water) WATER Lab Sample ID: 9504006-02A

Sample wt/vol: 5.0 (g/mL) mL Lab File ID: 0413B06

Level: (low/med) LOW Date Received: 04/03/95

% Moisture: not dec. ____ Heated Purge: __ Date Analyzed: 04/13/95

GC Column: RTX-502.2 ID: 0.530 (mm) Dilution Factor: 20000.0

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L	Q
71-43-2	Benzene (8020)	10000	U
108-88-3	Toluene (8020)	480000	
100-41-4	Ethylbenzene (8020)	10000	U
1330-20-7	Total Xylenes (8020)	10000	U
67-64-1	Acetone (8020)	600000	U