FINAL RISK ASSESSMENT
UNOCAL BULK PLANT 0736

SITKA, ALASKA

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December 2004

Project No. 04-007

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1 INTRODUCTION

This risk assessment has been prepared by OASIS Environmental, Inc. (OASIS) on behalf of GeoEngineers, Inc. (GeoEngineers) for the Unocal Bulk Plant 0736, located at 329 Katlian Street in Sitka, Alaska (see Figure 1 and Figure 2 for vicinity map and site plan). The site was used for the distribution and storage of bulk fuels from 1937 until it was closed in September 1991. The risk assessment is intended to identify human health risks resulting from contamination at the former bulk plant site and develop risk-based cleanup levels.

The Final December 2004 revision incorporates all additional data collected since the risk assessment was accepted by the Alaska Department of Environmental Conservation (ADEC) in April 2003 and comments received from interested parties through November 2004.

1.1 OBJECTIVE

The purpose of the risk assessment is to evaluate potential impacts to human health associated with petroleum hydrocarbons that have been detected in soil and groundwater at the site and on surrounding properties. The risk assessment evaluates both current conditions and likely future conditions of the site. The results of the risk assessment provide a basis for determining whether remediation of impacted media is warranted. In cases where the risk assessment indicated that remediation is needed to protect human health, site-specific risk-based cleanup levels (RBCLs) were calculated.

The risk assessment generally follows the basic procedures outlined in the ADEC *Risk Assessment Procedures Manual* (RAPM) (ADEC, 2000a) and the USEPA *Risk Assessment Guidance for Superfund: Volume I: Human Health Evaluation Manual* (USEPA, 1989).

1.2 REPORT ORGANIZATION

This risk assessment report is organized into the sections listed below.

1 Introduction

2 Site Description – describes the site and all previous investigations, reference to site characterization maps is provided in Section 2.2.

3 Selection of Compounds of Potential Concern (COPC) – provides a summary of compounds of potential concern and identifies data gaps

4 Toxicity Assessment -- presents toxicity information for the COPC

5 Exposure Assessment – Estimates the nature and magnitude of actual or potential exposures to COPC at the site. The exposure assessment includes the following components.

- 5.1 Land Use
- 5.2 Groundwater Considerations
- 5.3 Reasonable Maximum Exposure (RME)
- 5.4 Soil Exposure Areas
- 5.5 Preliminary Conceptual Site Model (CSM)

6 Risk Characterization

- 6.1 Cumulative Risk
- 6.2 On-Site Receptors
- 6.3 Off-site receptors

7 Discussion of Results

8 Data Usability
9 Uncertainty – identifies potential sources of uncertainty and the effects of that uncertainty on the risk assessment
10 Conclusions
11 References

2 SITE DESCRIPTION

The former bulk plant facilities included a tank farm, fuel transfer pipelines, truck and trailer loading rack, and a marine fuel dock. Fuel stored in the tank farm's ten aboveground storage tanks (ASTs) was transferred through the pipelines to a marine fuel dock, and truck and trailer loading rack located at the Sitka Sound dock in the Sitka Harbor channel (Figure 2). The site and associated pipeline easement occupy approximately 0.6 acres. The site was used for the distribution and storage of bulk fuels from 1937 until it was closed in September 1991. The tanks and aboveground fuel piping and appurtenances were removed during 1998.

The former bulk plant's tank farm was located in a residential area of Sitka, on a bluff above the channel. The former tank farm consisted of eight 20,000-gallon capacity ASTs, one 102,000-gallon AST, and one 200,000-gallon AST. The ten ASTs were located on a relatively flat gravel lot surrounded by a chain link fence. The storage facility was reportedly used only for refined petroleum products (diesel No. 1 and 2, regular and unleaded gasoline, heating oil No. 1, kerosene, and aviation gasoline). The tank farm is equipped with an underground oil/water separator, four storm drain inlets, and an earthen berm to contain and treat stormwater drainage. The effluent from the oil/water separator is discharged through a storm drain line to the Sitka Harbor.

Product was delivered to the bulk plant by barge service. The barge transferred the product from the marine fuel dock to the tank farm through the fuel pipelines. The pipelines consisted of four 3-inch diameter fuel lines and one 4-inch diameter storm-drain line that are oriented north-northwest along a 5-foot wide pipeline easement that extends from the dispensing and operations facility to the tank farm. The pipelines are aboveground from Kogwonton Street to just south of the tank farm, but are buried in all other areas.

The bulk plant is located within an area zoned for residential and light industrial and commercial business. Three residences border the tank farm on the north-northeast. A single residence, with access on Kogwonton Street, borders the lot on the east. Undeveloped property borders the bulk plant plot to the south and west with an undeveloped easement for DeArmond Street. The fuel pipeline is bordered primarily by undeveloped property and private residences.

2.1 LOCAL HYDROGEOLOGY

2.1.1 Groundwater

Shallow groundwater overlies bedrock throughout the former bulk plant site. Groundwater is located at a depth of approximately 2 to 9 feet below ground surface (bgs) in sand and silt. Bedrock was encountered at depths between 2.5 and 10 feet bgs.

Based on the *Ground Water Use Survey, Unocal Bulk Plant 0736, Sitka, Alaska*, prepared by GeoEngineers on January 8, 2002 (GeoEngineers, 2002a), in accordance with ADEC regulation 18 AAC 75.350, site groundwater is not used as drinking water. Public comment is required before finalizing the groundwater use determination, but for the purposes of this risk assessment, groundwater is not considered to be a source of drinking water. However, incidental ingestion of groundwater seeping to the surface is evaluated as a potential exposure pathway for the off-site resident. Incidental ingestion of groundwater is considered a complete pathway for the off-site construction worker.

2.1.2 Surface Water

Sitka Sound is the only surface water body in the vicinity of the project area. Groundwater and sediment sampling results indicate that Sitka Sound is not an exposure point for this risk assessment. The four monitoring wells (GW-10, GW-11, GW-12, and GW-5) located furthest downgradient from the former tank farm (e.g., closest to Sitka Sound) were sampled in May 2001, and no water quality criteria were exceeded. In February 2000, four sediment samples were collected from the Sitka Sound beach for analysis of polynuclear aromatic hydrocarbons (PAHs). The sediment sample located outside the downgradient portion of the project area (approximately 80 feet south of the Sitka Sound Seafood wharf), had elevated contaminant concentrations (including an exceedence of the ADEC Method 2 soil cleanup level for benzo(a)pyrene), relative to the three sediment samples located directly downgradient from the former bulk plant site. Results for all PAH compounds in the three samples directly downgradient of the former bulk plant site were below ADEC Method 2 soil cleanup levels (GeoEngineers, 2001).

Several groundwater seeps to the surface have been present downgradient from the former tank farm. The main seep was successfully sampled in April 2003. Detected concentrations of contaminants in this sample were used to calculate risk from exposure to seep water to the offsite resident. The figure noting the location of the seep is presented in Appendix H. The seep sample location is identified as WS-1. Due to the distance between the seeps and Sitka Sound (approximately 200 feet), overland transport of contaminants from the seeps to Sitka Sound is not considered a viable exposure pathway.

2.2 SUMMARY OF PREVIOUS INVESTIGATIONS

Thirteen monitoring events have been conducted at the former bulk plant since 1992. The monitoring results are discussed in detail in GeoEngineers *Site Investigation Report, Unocal Bulk Plant 0736, Sitka, Alaska,* dated November 27, 2001 (GeoEngineers, 2001) and analyzed in GeoEngineers' *Contaminant Distribution Report*, dated May 28, 2002 (GeoEngineers, 2002b). Soil and groundwater monitoring activities occurred within the tank farm, along the pipeline, and on the adjacent properties. Investigation activities included collecting surface soil samples, collecting soil samples from test pits, and installing and sampling groundwater monitoring wells. The samples were analyzed for contaminants commonly associated with petroleum hydrocarbons: diesel-range organics (DRO), gasoline-range organics (GRO), benzene, toluene, ethylbenzene, and xylenes (BTEX), and polynuclear aromatic hydrocarbons (PAHs). In addition, soil samples were analyzed for total organic carbon (TOC), and a limited number were analyzed for metals. Detailed site characterization maps for samples collected prior to 2004 are included in the GeoEngineers' *Site Investigation Report* and *Contaminant Distribution Report.*

Additional soil samples were collected in 2004 and analyzed for contaminants commonly associated with petroleum hydrocarbons. The results of that investigation are reported in the *Site Assessment Report, Former Unocal Bulk Plant No. 0736, Sitka*, *Alaska*, dated October 21, 2004 (GeoEngineers, 2004) and presented in Appendix A of this risk assessment.

Lead data were collected from groundwater seeps and along the pipeline corridor in April of 2003. The results of that investigation are reported in the *Lead Investigation Report*, *Former Unocal Bulk Plant No. 0736, Sitka*, *Alaska*, dated July 16, 2003 (GeoEngineers, 2003) and presented in Appendix A of this risk assessment.

3 SELECTION OF COMPOUNDS OF POTENTIAL CONCERN

In accordance with the ADEC RAPM (ADEC, 2000a), site soil and groundwater sample analytical data were screened to determine the COPCs for human health. The screening results for all soil and water samples collected through 2004are included in Tables 1 and 2. The sample data encompass results from all historical sampling events (15 events since 1992). The data were summarized in the GeoEngineers 2001, 2002, 2003, and 2004 reports and are included in Appendix A.

3.1 SCREENING PROCEDURE

COPCs were screened and identified using the following procedure.

- All soil and groundwater analytical data were tabulated (data provided in Appendix A, tables A-1 through A-4).
- Soil and groundwater analytical results were compared to the appropriate human health risk-based ADEC cleanup levels presented in 18 AAC 75 Tables B and C and Technical Memorandum 01-007 (*Additional Cleanup Values;* ADEC, 2003a). For soil, one-tenth of the ingestion or inhalation soil cleanup levels were used as the human health risk-based benchmarks. For groundwater, one-tenth of the groundwater cleanup levels were used as the human health risk-based benchmarks. Cleanup levels were available for all of the chemicals analyzed at the site using either 18 AAC 75 Tables B and C, or ADEC's Technical Memorandum 01-007.
- Chemicals that were detected above these screening levels were retained as COPCs. Table 1 presents the soil COPCs, and Table 2 presents the groundwater COPCs.
- Chemicals that were not detected at concentrations above human health risk-based benchmarks or standard ADEC Table B or Table C cleanup levels were not considered to be COPCs and were eliminated from further consideration.

3.2 LEAD

Elevated lead concentrations (greater than the Table B cleanup level of 400 milligrams per kilogram [mg/kg]) were detected in two soil samples along the aboveground pipeline corridor. One soil sample collected by the Sitka Tribe exhibited 2,870 mg/kg of lead, and one soil sample collected by GeoEngineers in April 2002 exhibited 1,380 mg/kg lead. The sample containing 1,380 mg/kg lead was collected from soil directly below a painted and weathered metal pipeline support.

In April 2002, GeoEngineers collected 22 surface soil samples (18 samples from the pipeline corridor and three background samples) for lead analysis. The total lead concentrations measured in these samples were less than the 400 mg/kg cleanup level in 21 of the 22 samples. The elevated lead concentrations appear to be directly related to debris, possibly paint chips, present in surface soil. No correlation between areas of elevated petroleum contamination and the high detection of lead could be discerned; consequently, the lead was assumed unrelated to the fuel contamination originating from the bulk plant. In addition, less than 5% of the samples contained lead above the 400 mg/kg cleanup level. Remediation of lead contaminated soil where concentrations are documented to be above ADEC's 400 mg/kg residential cleanup level is scheduled pending approval from the landowner.

Although lead was not retained as a COPC for the purposes of this risk assessment, Unocal conducted additional lead sampling along the pipeline corridor during April 2003. Lead was detected in 9 out of 12 samples at concentrations ranging from 2.59 mg/kg to 12.6 mg/kg. The total lead concentrations measured in these samples were less than the 400 mg/kg cleanup level.

3.3 CONTAMINANTS OF POTENTIAL CONCERN

Based on the COPC screening process described in Section 3.1, COPCs in soil are benzene, ethylbenzene, toluene, total xylenes, GRO, DRO, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene. COPCs in groundwater are benzene, ethylbenzene, toluene, total xylenes, DRO, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene and indeno(1,2,3-c,d)pyrene. The only COPC in the seep is benzo(a)anthracene.

3.4 DATA GAPS

Site soil, groundwater, and groundwater seeps have been adequately characterized for petroleum hydrocarbon constituents.

4 TOXICITY ASSESSMENT

The toxicity assessment evaluates the potential for COPCs detected at the site to cause adverse human health effects. The toxicity assessment consists of collecting data on the toxicological properties of the COPCs, identifying dose response data, and compiling regulatory criteria or other requirements.

Reference doses and slope factors from four sources were reviewed. The following hierarchy was used:

1. *Risk Assessment Information System* (RAIS, 2004)
2. EPA's *Region III Risk-Based Concentration Table* (2004)
3. EPA's *Region IX Preliminary Remediation Goals* (PRGs) (2002)
4. Cleanup Levels Guidance (ADEC, 2000b)

Reference doses and slope factors chosen for the risk assessment are presented in Table 3. These toxicity values were proposed for use in the risk assessment work plan.

4.1 TOXICITY OF NONCARCINOGENS

Reference doses (RfDs) are used to quantitatively evaluate non-carcinogenic health effects of a contaminant. In general, RfDs are developed using no observable adverse effects levels (NOAELs) and extrapolating that data between animals and humans by applying uncertainty factors (multipliers applied to account for uncertainty of effects between species). The RfD is an estimate of the dose of a substance that would not be expected to cause sickness or other adverse effects. Several RfDs were available for each COPC:

- RfD_o is used to assess oral exposure;
- RfD_i is used to assess inhalation exposure;
- RfC is the reference concentration, which is the RfD_i modified for body weight and inhalation rate; and
- ABS_{GI} data and ABS_d were obtained from the Risk Assessment Information System (RAIS, 2004). ABS values for site COPCs are provided in Table 4, and calculated RfD_d values are provided in Table 3.

Petroleum hydrocarbons are difficult to evaluate because they are complex mixtures of compounds. Many methods to evaluate petroleum hydrocarbons have been devised. However, the ADEC provides toxicity values and an approved method to evaluate risk from GRO, DRO, and residual range organics (RRO). This method uses surrogate chemicals of known toxicity for each portion and fraction. Per ADEC *Guidance on Cleanup of Petroleum Contaminated Sites*, the default composition of GRO in soil was considered 70% aliphatic and 50% aromatic. The default composition of DRO in soil was considered 80% aliphatic and 40% aromatic. Aliphatic compounds are largely non-soluble so the default composition of both DRO and GRO in water was 100% aromatic.

4.2 TOXICITY OF CARCINOGENS

Unlike noncarcinogenic adverse health effects, carcinogens do not have a threshold dose below which adverse effects are not expected to occur. Cancer slope factors (CSFs) are developed based on dose-response curves that estimate the probability of cancer over a range of doses. The models extrapolate the dose response curves from the high doses given in laboratory experiments to the low doses to which people are generally exposed. The CSF is based on the 95% upper confidence limit of the extrapolated slope of the dose-response curve. Consequently, the use of published CSFs results in a very conservative estimate of cancer risks. Like reference doses, several CSFs are available for each COPC:

- CSF_o is used to quantify oral risk;
- CSF_i is used to quantify inhalation risk;
- Inhalation unit risk factor (URF) is derived from the CSF_i by considering body weight and inhalation rate; and
- CSF_d is used to quantify dermal exposure risk, typically derived from the CSF_o by dividing CSF_o by the gastrointestinal tract absorption factor (ABS_{GI}). ABS_{GI} values for site COPCs are provided in Table 4, and calculated CSF_d values are provided in Table 3.

5 EXPOSURE ASSESSMENT

The overall goal of the exposure assessment is to estimate the hypothetical exposure to contaminants in environmental media at or near the site. Both current land use and potential future land use were considered in the exposure assessment.

Potentially complete exposure pathways are identified for the former bulk plant in the CSM (Figure 3). CSMs illustrate the conceptual understanding of the contamination sources, release and transport mechanisms, potential exposure pathways/exposure routes, and receptors. Risk to human health and the environment cannot exist unless the contamination at a site has the ability to cause an adverse effect and comes in contact with a human receptor. The CSM establishes whether contamination that is at a site, or that has migrated off-site, can come in contact with human receptors. The assumptions leading to the CSM are discussed in Sections 5.1 through 5.4 of this document, and the CSM itself is discussed in Section 5.5.

5.1 LAND USE

For purposes of the risk assessment, the site has been divided into two parts: on-site and off-site. On-site refers to the fenced area of the tank farm. Off-site refers to the properties surrounding the on-site area. The current use of the on-site area is industrial and current use of the off-site area is residential.

Possible future land use of both on-site and off-site properties is residential. Although the tank farm belonging to the former bulk fuel facility is currently considered to be an industrial use area, it is located within an area zoned for residential or light industrial use and is surrounded by residential properties.

5.2 GROUNDWATER CONSIDERATIONS

Based on the *Ground Water Use Survey, Unocal Bulk Plant 0736, Sitka, Alaska*, prepared by GeoEngineers on January 8, 2002, in accordance with ADEC regulation 18 AAC 75.350, and ADEC's acceptance of this document, site groundwater is not used as drinking water. Consequently, groundwater is not considered to be a source of drinking water and ingestion of groundwater is not considered to be a complete exposure pathway in the CSM (Figure 3). Groundwater data were used to assess indoor air inhalation exposure and direct exposure to off-site workers. Indoor air inhalation exposure was modeled as discussed in Section 6.1.6. Groundwater seep data was collected and used to assess exposure via dermal contact and incidental ingestion.

Groundwater beneath the site likely flows to Sitka Harbor. The groundwater contamination plume appears stable and not likely to reach Sitka Harbor. This interpretation is based on both monitoring data and historical knowledge regarding the spill timing. Specifically, periodic monitoring of three wells located down-gradient from the tank farm (SBPMW-1, -2 and SBPOS-1) has been performed since August 1992. The wells were monitored for BTEX and total petroleum hydrocarbon (TPH) mixtures. Concentrations generally decreased over time (See Table 6, *Site Investigation Report, Unocal Bulk Plant 0736*, 11/27/01 report). In addition, the likely contaminant source areas were removed in 1998.

Maps highlighting the relative concentration of contaminants across the project area are available in GeoEngineers' *Contaminant Distribution Report*. The figures suggest three lobes of contamination coinciding with three drainage features extending from the tank farm down the hill. One lobe is along the former drainage swale, one is along the pipeline corridor and one is along a western drainage feature (only visible from on-site inspection).

5.3 REASONABLE MAXIMUM EXPOSURE

5.3.1 Exposure Point Concentrations

Exposure point concentrations (EPCs) used to calculate risk are presented in Table 5. The procedures used to calculate the EPCs are presented in this section.

5.3.1.1 Soil RME Concentrations

The RME point concentrations were estimated separately for the on-site and off-site soil sample populations, using the 95 percent upper confidence level (UCL) on the arithmetic mean of the contaminant concentrations. The 95 percent UCL was calculated using the nonparametric Bootstrap method. Use of the H statistic for a lognormal population was explored, but the large standard deviation of the DRO dataset resulted in an unreasonable 95% UCL concentration; therefore, the Bootstrap method was used. Spreadsheets used to develop the Bootstrap statistics are provided on a disc in Appendix B.

The Bootstrap method is described in the ADEC Technical Memorandum 01-004, dated January 2, 2003 (ADEC, 2003b). Bootstrap refers to a method for estimating confidence intervals by resampling a data set to form new data sets (called bootstrap samples) with the same sample size as the original data set. As discussed in the ADEC Technical Memorandum, the Bootstrap method has been shown to perform substantially better in estimating the UCL of the mean from lognormally distributed data sets than the H-statistic method, especially when the data set is small (less than 30 samples), highly variable (CV>1), contains outliers, or includes two or more distinct populations.

Implementation of the Bootstrap method is described in a step-by-step manner in the ADEC Technical Memorandum, but use of the method for this risk assessment is described below.

1. The soil analytical data were separated into on-site and off-site populations.
2. The DRO results were used to edit the datasets to include only samples that were inferred to represent the contaminated soil areas. Soil samples with DRO results less than the lowest DRO concentration observed in background samples (137 ppm) were considered "clean" and were removed from the dataset.
3. Nondetects from the edited dataset were assigned numerical values of ½ their detection limit.
4. The number of samples and sample means were calculated for each dataset.
5. The Bootstrap method was applied to each edited dataset by performing the following steps.
    a. The original dataset was resampled to create 1000 replacement (bootstrap) data sets. For example, the off-site DRO dataset contains 41 sample values. The 41 values were resampled to create 1,000 DRO datasets of 41 values each.
    b. The mean of each replacement dataset was calculated.
    c. The bootstrap estimate of the standard error, confidence interval, and 95% UCL were calculated using the following equations:

$$\sigma_B = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(\bar{x} - \bar{x}_B)^2}$$

$$z = \frac{\bar{x}_B - \bar{x}}{\sigma_B}$$

$$95\%UCL = \bar{x}_B + 1.96\sigma_B$$

The DRO data were subjected to specific statistical tests in an effort to determine the best statistical method to use. DRO data were considered representative of all the data sets because DRO was the main contaminant present and DRO is always present when any other contaminants were detected.

The W test (Shapiro and Wilkes) was used to determine if the data fit either a normal or log-normal distribution. The null hypothesis that the distribution has a normal distribution can be rejected at the 99% significance level. The null hypothesis that the distribution has a log normal distribution falls between the 50% and 90% levels of significance meaning a log normal distribution is a reasonable model for the data.

The H statistic (Gilbert, 1987, EPA, 2002) was used to calculate the 95% UCL. The H statistic is a parametric test for lognormal data sets. It does not perform well if the data appear log normal. The H statistic test yielded a 95% UCL of 62,051. This result exceeds all sample results except one by a factor of 5 or greater and implies the entire site could be composed of fuel saturated soil. Several conditions are cited where the H statistic will perform poorly:

- Samples sizes less than 30,
- Highly variable populations with coefficients of variation (CV = standard deviation/mean) exceeding 1,
- Sample sets containing outliers or extreme values, and
- Sample sets that appear to be lognormal but which are actually drawn from two or more distinct populations.

One of the above indicators clearly applies to the data set and a second is likely.

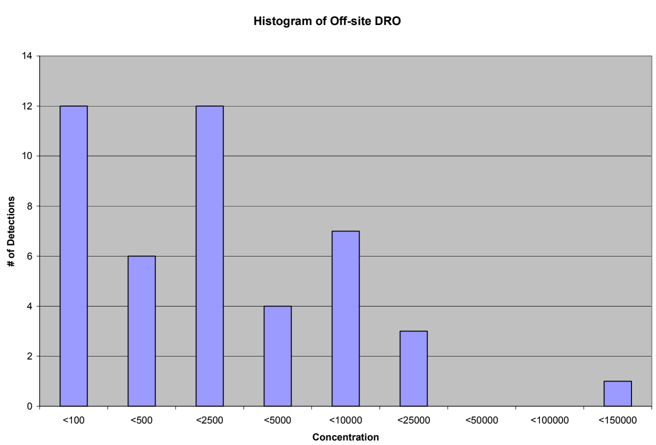
- The DRO data set evaluated was highly variable. The coefficient of variation was 3.5 indicating the standard deviation was 3 ½ times the mean.
- The existence of two or more distinct populations is likely. Spills occurred at different times, in different places, and with different sources of fuel. Each of these spills would have different characteristics and, statistically, would represent different populations.

Two of the indicators do not apply.

- A Rosner's outlier test did not indicate outliers.
- The sample size was 45, i.e. greater than 30.

Based on high variability and potential for multiple populations the H statistic was rejected as an appropriate statistical test.

The bootstrap method was selected because it has been shown to perform substantially better, sometimes orders of magnitude better, in estimating the UCL of the mean from a positively skewed data set (ADEC, 2003b). A positively skewed data set is one where most of the data points are on the left side of a histogram. The histogram for the off-site DRO is depicted below. The data are clearly positively skewed.



In addition, the Bootstrap method was selected because it is appropriate for either parametric or non-parametric data sets. While the data appear lognormally distributed the H statistic test and coefficient of variation imply the underlying distribution is not lognormal; consequently, a non-parametric test will likely yield the best result. Use of the Bootstrap method also has tacit endorsement by ADEC through publishing guidance on the method and direct endorsement though approval of the method for other risk assessments.

5.3.1.2 Groundwater RME Concentrations

The maximum recent groundwater concentrations were used as the RME concentrations for assessing inhalation of vapors from groundwater. For DRO, GRO, and BTEX, the maximum groundwater concentrations detected during the 2001 sampling were used as the RME concentrations. There was only one hit of PAHs that are COPCs, which was sample WS-1 in January 1998. These detections were used as the RME concentrations. There are no recent (later than 1990) on-site groundwater data; therefore, the off-site concentrations were used to represent the RME concentrations for both the on-site and off-site areas.

The maximum recent groundwater concentrations were used instead of a 95% UCL, because the use of temporal groundwater data (e.g., groundwater data from 1990 through 2001) is unreasonable. Contaminant concentrations measured in the early 1990s have declined, presumably due to natural attenuation, and should not be used to estimate current risk.

5.3.2 Exposure Assumptions

Specific assumptions used to estimate exposure are provided with each equation in Appendix C and in Table 6. The climate of Sitka and typical Alaska business cycles were used as the basis for many of the assumptions. Specifically, Sitka is very wet and cool for much of the year. Children would not reasonably be expected to spend all day, every day outside playing in the soil. Consequently, it was conservatively estimated children would spend 180 days per year playing in soil. Dermal contact with soil is assumed to continue all day (until being washed off). Child exposure to seeps was assumed to be one hour per day. Adults were estimated to spend 0.5 hours per day exposed to seeps. More likely, exposure would last for a few days or weeks per season; consequently, a 180-day residential scenario is considered conservative. Likewise, very few if any construction projects would result in more than 30 days exposure to contaminated soil and groundwater for a worker. More likely exposure would last for a few days during excavation of a foundation or utility line; consequently, a 30-day, 8 hours per day site worker scenario is considered conservative.

5.3.3 Indoor Air Inhalation

Exposure to indoor air was evaluated using the Johnson Ettinger 1991 Model for Subsurface Vapor Intrusion into Buildings. Input parameters and results from the Johnson Ettinger Model are provided in Appendix F.

5.4 SOIL EXPOSURE AREAS

As discussed in Section 5.1, the risk assessment area has been divided into on-site and off-site areas. In both areas, surface soil is defined as the top two feet, and subsurface soil is defined as the interval between 2 feet bgs and bedrock. Bedrock was encountered at a maximum depth of 10 feet bgs. In accordance with the *Risk Assessment Procedures Manual*, both residents and workers are generally considered to be potentially exposed to surface and subsurface soil. For this reason, subsurface and surface soil data were grouped together and not evaluated separately. Both workers and residents could potentially be exposed to volatilized contaminants from both surface and subsurface soil. Soil sample data was used to assess potential exposure as described in Section 5.3.

5.5 CONCEPTUAL SITE MODEL

5.5.1 Contaminant Sources

As shown in the CSM for the former bulk plant (Figure 3), the primary on-site contaminant source is residual hydrocarbons trapped in subsurface soil. Contaminants may have migrated downward to groundwater as a separate phase or leached from soil to groundwater in a dissolved phase. The volatile fraction of the hydrocarbons (BTEX) may have volatilized to the atmosphere from soil and groundwater.

It may be possible that berries are harvested in the vicinity of the bulk fuel tank farm to a limited extent. It is possible to apply plant uptake factors to analytical data for soil to estimate the amount of COPCs present in berries. These modeled concentrations then may be included in exposure estimates and risk calculations. However, of the COPCs present at the site, only BETX and the aromatic fraction of GRO are capable of transport into the shoots of plants (Trapp and McFarlane, 1995). No samples collected from shallow soil (<5 feet bgs) had concentrations of GRO or BETX above State cleanup levels (18 AAC 75 Table B); therefore, ingestion of berries was not considered a complete pathway.

5.5.2 On-site Receptors

The potential on-site receptors are current site workers and potential future residents. There are no full-time workers employed at the former bulk plant; the most exposed site worker is assumed to be a utility worker or other worker who spends only a fraction of his workday at this site. Both adult and child residential receptors are evaluated. Exposure parameters are provided in Table 6.

Site workers can be exposed to contamination by inadvertently ingesting contaminated soil, by dermal contact with contaminated soil or groundwater, or by breathing contaminants volatilized to the air from contaminated subsurface soil and groundwater. Exposure to soil contamination was evaluated by grouping all soil data together. Outdoor inhalation pathways were evaluated in this assessment. Since there is no surface water at the site, site workers would not likely be exposed to surface water and sediment contamination; therefore, these pathways were not evaluated. It is theoretically possible that site workers could inadvertently ingest contaminated groundwater while working in an excavation, and risk attributable to this pathway is quantified by assuming dermal contact with and incidental ingestion of groundwater for the off-site worker

Future area residents could be exposed to contamination by inadvertently ingesting contaminated soil, by dermal contact with contaminated soil, breathing contaminants in outdoor air volatilized from soil or groundwater, or by breathing contaminants volatilized to potential future site buildings (houses) from contaminated soil and groundwater. Since there is no surface water at the site, site residents would not likely be exposed to surface water or sediment contamination, and these pathways are not evaluated.

Subsistence use of the former bulk plant site is not considered to be a reasonable exposure pathway. The site is currently an industrial site (former tank farm) that does not provide the necessary ecological habitat for subsistence use. The likely future residential land use is also inconsistent with subsistence use. Aerial photographs of the area indicated that there are no gardens in the vicinity of the bulk fuel tank.

5.5.3 Off-site Receptors

The potential receptors identified for properties surrounding the former bulk plant are workers and residents. There is no difference between the current and potential future land uses of the properties surrounding the former bulk plant. There are no full-time workers employed at the properties adjacent to the former bulk plant; the most exposed site worker is assumed to be a utility worker or other worker who spends a fraction of his workday at this site. Both adult and child residential receptors are evaluated. Exposure parameters are provided in the RBCL discussion in Section 6.1 and Table 6.

Off-site workers can be exposed to contamination by inadvertently ingesting contaminated soil, by dermal contact with contaminated soil or groundwater, or by breathing contaminants volatilized to the air from contaminated subsurface soil and groundwater. Exposure to contamination was evaluated by grouping soil data together. Outdoor inhalation pathways were evaluated in this assessment. The surface water at the site is a groundwater seep; consequently, site workers would not likely be exposed to sediment contamination and this pathway was not evaluated. It is theoretically possible that site workers could inadvertently ingest contaminated groundwater while working in an excavation, and risk attributable to this pathway is quantified by assuming dermal contact with and incidental ingestion of groundwater.

Area residents can be exposed to contamination by inadvertently ingesting contaminated soil, by dermal contact with contaminated surface or subsurface soil, breathing contaminants in outdoor air volatilized from soil or groundwater, or by breathing contaminants volatilized to buildings (houses) from contaminated soil and groundwater. Residents can also be exposed to contaminated groundwater that is transported to the surface as seeps. Residents could potentially encounter contamination by dermal contact with contaminated seep water or inadvertently ingesting contaminated seep water.

Subsistence use of the properties surrounding the former bulk plant site is not considered to be a reasonable exposure pathway. The site is currently a residential area that does not provide the necessary ecological habitat for subsistence use. Aerial photographs of the area indicated that there are no gardens in the vicinity of the bulk fuel tank.

5.6 ECOLOGICAL ASSESSMENT

Both on-site and off-site properties are not considered to be viable ecological habitat. The basis for eliminating ecological receptors is provided below.

The site is located in a developed urban area. Although transient wildlife may be present, viable populations of terrestrial receptors cannot be supported. Ecological risk assessment evaluates risks to populations, not individuals.

Aquatic receptors in Sitka Sound may currently be impacted by multiple contaminant sources along the Sitka waterfront. Impacts from earlier spills or releases at the Unocal bulk fuel facility are impossible to delineate at this point in time.

Groundwater contaminant concentrations have attenuated over time. Contaminants do not appear to be reaching Sitka Sound via the groundwater migration pathway.

6 RISK CHARACTERIZATION

The information from the exposure assessment and the toxicity assessment is integrated to form the basis for the characterization of human health risks. The risk characterization presents qualitative and quantitative descriptions of risk, and serves as the bridge between risk assessment and risk management. Cumulative risk is reported for all six receptors: on-site worker, on-site adult resident, on-site child resident, off-site worker, off-site adult resident, and off-site child resident.

For noncarcinogens, a hazard quotient (HQ) is calculated as the average daily dose for an exposure period divided by the RfD. The HQ for each potential receptor is summed, and is reported as a hazard index (HI). A hazard index greater than 1 indicates that an adverse effect may occur. In this assessment, the HI was set at 1 and RBCLs were calculated. This procedure calculates the maximum concentration of a COPC that is not expected to have adverse effects. Next, the exposure point concentrations were substituted in the equation to calculate the HI.

For carcinogens, risks are defined as the likelihood of an individual developing cancer over a lifetime as a result of exposure to a COPC. Cancer risks are evaluated by multiplying the estimated average exposure rate by the CSF of the COPC. The CSF converts estimated daily intakes averaged over a lifetime to incremental risk of an individual developing cancer. Because cancer risks are averaged over a person's lifetime, longer-term exposure to a carcinogen will result in higher risks than shorter-term exposure to the same carcinogen, if all other exposure assumptions are constant. The target cancer risk was set at 10^{-5} to calculate RBCLs for carcinogenic COPCs. Next, the exposure point concentrations were substituted in the equation to calculate the cancer risk.

Baseline risk and RBCLs were calculated for each completed exposure pathway indicated in the CSM (Figure 3) using equations provided in Appendix C. The results are presented in this section. RBCLs for each receptor and COPC are provided in Appendix D. The relevant exposure assumptions are presented in Table 6.

Both child and adult residential receptors are evaluated. However, the indoor air pathway is only specifically evaluated for adult receptors using the Johnson Ettinger Indoor Air Inhalation Model, because the inhalation reference dose and unit risk calculations are based on adult receptors. Although child body weights and inhalation rates can be substituted into the inhalation equations, the change may be incorrect due to the methods used to derive the reference concentration or unit risk (RAIS, 2004). The Johnson-Ettinger model used to model indoor air risk is designed specifically for adult receptors; however, use of this model to evaluate indoor air is extremely conservative. The contribution of risk and hazards from indoor air to cumulative risk for child residential receptors is evaluated qualitatively by adding the incremental risk from the adult calculations to the cumulative risk for the child. This issue is discussed in the uncertainty section.

6.1 CUMULATIVE RISK

Cumulative risk is the sum of risks resulting from exposure to contaminants via multiple exposure pathways (ADEC, 2000c). The ADEC requires that cumulative noncarcinogenic risk not exceed HQ=1.0, and cumulative carcinogenic risk not exceed 1 in 100,000 (1×10^{-5}). To ensure that cumulative carcinogenic risk and HI standards are not exceeded, the ADEC outlines an approach for calculating risk in the *Guidance on Calculating Cumulative Risk, Final Draft* dated December 15, 2000 (ADEC, 2000c). Equations used for calculating the cumulative carcinogenic and noncarcinogenic risk are provided below.

Cumulative Carcinogenic Risk

$$Cumulative\ Risk = \sum \left[\left(\frac{Concentration}{RBCL} \right) x10^{-5} \right]$$

where: RBCL = risk-based cleanup level

Cumulative Noncarcinogenic Risk

$$HI = \sum \left[\left(\frac{Concentration}{RBCL} \right) x1.0 \right]$$

where: HI = hazard index
RBCL = risk-based cleanup level

6.2 ON-SITE RECEPTORS

6.2.1 Worker

The results of risk calculations for each pathway and COPC are presented in Table 7.

Total carcinogenic risk to the on-site worker is 5E-07. The pathway contributing most to risk is ingestion of soil containing benzo(a)pyrene.

The HI for the on-site worker is 0.002.

The cumulative HI for aliphatic and aromatic DRO fractions is 0.07.

6.2.2 Potential Future Adult Resident

The results of risk calculations for each pathway and COPC are presented in Table 8.

Total carcinogenic risk to the on-site resident is 3E-06. Pathways contributing most to carcinogenic risk are ingestion of benzo(a)pyrene in soil and inhalation of benzene from soil in indoor air.

The HI for the on-site resident is 0.27. The pathway contributing most to the HI is inhalation of toluene from soil in indoor air.

The cumulative HI for aliphatic and aromatic DRO fractions is 0.27.

6.2.3 Potential Future Child Resident

The results of risk calculations for each pathway and COPC are presented in Table 9.

Total carcinogenic risk to the on-site resident is 3E-06.

The HI for the on-site resident is 0.01. The cumulative HI for aliphatic and aromatic DRO fractions is 1.6.

6.3 OFF-SITE RECEPTORS

6.3.1 Worker

The results of risk calculations for each pathway and COPC are presented in Table 10.

Total carcinogenic risk to the off-site worker is 3E-06. The pathway contributing most to risk is ingestion of benzo(a)pyrene in soil.

The HI for the off-site worker is 0.00034.

The cumulative HI for aliphatic and aromatic DRO fractions is 0.07.

6.3.2 Adult Resident

The results of risk calculations for each pathway and COPC are presented in Table 11.

Total carcinogenic risk to the off-site resident is 1E-05. The pathways contributing most to risk are ingestion of benzo(a)pyrene in soil and inhalation of benzene from soil into indoor air.

The HI for the off-site resident is 0.004.

The cumulative HI for aliphatic and aromatic DRO fractions is 0.26.

6.3.3 Child Resident

The results of risk calculations for each pathway and COPC are presented in Table 12.

Total carcinogenic risk to the off-site resident is 2E-05. The pathways contributing most to risk are ingestion of benzo(a)pyrene in soil and inhalation of benzene from soil into indoor air.

The HI for the off-site resident is 0.004.

The cumulative HI for aliphatic and aromatic DRO fractions is 1.54.

7 DISCUSSION OF RESULTS

7.1 NONCARCINOGENIC HAZARDS

The noncarcinogenic risk calculated for all receptors was significantly less than the target level of 1.0, indicating that adverse health effects caused by noncarcinogenic compounds are not expected as a result of soil and groundwater contamination associated with the Former Bulk Plant.

Calculated cumulative HI for child residents on- and off site for the aliphatic and aromatic portions of DRO were over one. These values are presented below:

	HI for Aliphatic DRO fraction	HI for Aromatic DRO fraction	Total HI
On-site Future Child	0.70	0.90	1.6
Off-site Child	0.68	0.86	1.54

The aliphatic and aromatic portions of DRO are not expected to pose hazards to receptors on or near the site because individually, the hazard quotients are below one. Cumulative effects are not expected because different systems are affected. ADEC provides toxicity information for petroleum mixtures in *Cleanup Levels Guidance* (ADEC, 2000b). The toxicity of the aromatic fraction causes decreased body weight. The toxicity of the aliphatic fraction causes hepatic and hematological changes. These two effects are not expected to be additive. Most importantly, the EPC of DRO in soil was calculated using all the soil data. High concentrations of DRO were not found in surface soil, only subsurface soil. The exposure pathway for children is realistically complete for surface soil, but not subsurface soil. Furthermore, the concentrations of PAHs and BTEX in soil were low, indicating that the toxic components of fuel are not actually present in DRO-contaminated soil.

7.2 CARCINOGENIC RISK

Cumulative carcinogenic risks to all potential on-site receptors (future adult and child residents, and workers) and the off-site worker were estimated to be below 1E-05, the target risk level. Cumulative risks to both the off-site adult and child residents were estimated to be 1E-05 and 2E-05 respectively, which slightly meet or exceed the target risk level of 1E-05. Most of this potential risk is attributable to inhalation of benzene from soil in indoor air.

8 UNCERTAINTY

The results of the risk assessment are presented with a discussion of the uncertainties associated with such assessments. These uncertainties, which arise at every step of a risk assessment, provide an indication of the relative degree of uncertainty associated with a risk estimate and an RBCL. Risk estimates and RBCLs are calculated by combining site data, assumptions about exposures to impacted media, and toxicity data. The uncertainties in a risk assessment can be grouped into four main categories that correspond to the following:

1) Uncertainties in environmental sampling and analysis (e.g., sampling and monitoring data, selection of COPCs, and current and future land uses).
2) Uncertainties in assumptions concerning exposure scenarios (e.g., selection of exposure pathways, fate and transport modeling, determination of exposure point concentrations, exposure assessment assumptions).
3) Uncertainties in toxicity data and dose-response extrapolations (e.g., limited toxicity data for single chemicals, limited understanding of the interactions of multiple chemicals).
4) Uncertainties regarding the quality of the analytical data. Data have been compiled from a number of different sources and have varying degrees of quality, qualification, and documentation.

For this assessment, there is no detailed quantitative evaluation of error. Instead, a qualitative evaluation is made by discussing the potential impact that alternative exposure assumptions and input parameters would have on the RBCLs derived. In general, assumptions were made to err on the side of safety.

Uncertainties from different sources are compounded in the risk assessment. For example, if a person's daily intake rate for a COPC is combined with an RfD to determine potential health risks, the uncertainties in the concentration measurements, exposure assumptions, and toxicities will all be expressed in the results. Therefore, by combining all upper-bound (conservative estimates) numbers together, the uncertainty is compounded and the resulting risk estimate will overestimate actual risk at the site.

Several specific uncertainties are identified for this risk assessment. All these sources of uncertainty most likely overestimate risk:

- Using surface and subsurface soil data together to estimate risk from exposure to surface soil significantly overestimates exposure. Most of the soil contamination at the site is subsurface, yet all detected soil concentrations were used to calculate an exposure point concentration. This approach adds yet another layer of conservatism which overestimates risk to residential receptors from contact with contaminants in surface soil.
- Use of oral toxicity data to assess dermal exposure for petroleum mixtures will overestimate risk.
- Use of modified benzo(a)pyrene toxicity data to quantify toxicity of other PAHs is likely to overestimate risk.
- The use of the Johnson Ettinger Model to estimate risk from exposure to indoor air is very conservative. Use of the model at this site is even more conservative because homes in the vicinity are on pilings. The JE model assumes a direct pathway to indoor air. Consequently, the JE Model is overly conservative at this site. No samples collected from shallow soil (<5 feet bgs) had concentrations of GRO or BETX above State cleanup levels (18 AAC 75 Table B). Given the piling house construction and absence of contamination in surface soil, calculating indoor air exposure using the JE Model was an extremely conservative methodology. Conservative assumptions were used to bolster

confidence in the assessment, but it is necessary to use best professional judgment regarding exposure pathways and the significance of the results of the risk assessment.

Other sources of uncertainty may underestimate risk:

- Use of BTEX data only to estimate indoor air inhalation risk from groundwater and soil may underestimate risk.
- The assumption that the incremental increase in risk from indoor inhalation to adults is similar to the incremental increase in children may underestimate risk; however, using the JE model to estimate risk from indoor air at this site was an extremely protective (conservative) methodology.

9 DATA USABILITY

High-quality data is critical to risk assessment. All analytical data available for the former bulk plant was provided in the GeoEngineers reports (2001, 2002, 2003, 2004) and were considered usable for the risk assessment. Most of the DRO and GRO analyses were performed by methods AK101 and AK102. Some historical data were analyzed by methods other than AK101 and AK102. The EPA analytical methods used in these instances are sufficiently similar to the AK methods to warrant inclusion in the risk assessment. Non-AK101 and 102 analyzed data included in the risk assessment are described below.

- DRO by EPA method 8100M
    - 3 soil samples from 1992
    - 14 soil samples from January 1998
    - 4 soil samples from December 1998
- GRO by EPA method 8015M
    - 14 soil samples from 1998

Results from the following analytical methods were not used in the risk assessment, because the results are not directly comparable with screening levels and cleanup levels currently in use.

- TPH data measured by USEPA method 418.1
    - 4 soil samples from 1990
    - Groundwater samples from SBPMW-1, SBPMW-2, and oil/water separator from 1992 through 1998
- Gasoline, diesel #1, and diesel #2 data measured by EPA method 8015
    - 12 water samples from 1990
    - 3 soil samples from 1996

The TOC data from May 2001 were used to develop site -specific TOC values. TOC data are presented in Appendix E. The numerical average value was used in the risk assessment. Some DRO were detected in all 33 samples; however, many of these detections are in background areas. A qualitative analysis of the sample locations was performed to ensure the average TOC values are representative of natural conditions and are not impacted by fuel contamination.

10 CONCLUSIONS

Concentrations of contaminants present in soil and groundwater at the Unocal Bulk Plant 0736 are not likely to pose carcinogenic risks or adverse health effects to human receptors on- and off-site. No individual pathways or contaminants resulted in risks or hazard indices above 1.0, over 1E-05, the target risk levels. Cumulative risks and hazard indices for individual constituents do not exceed target levels with the exception of cumulative carcinogenic risk to an off-site child receptor (risk = 2E-5). The major contribution to risk for this receptor is inhalation of benzene from soil to indoor air. Estimation of risk from the indoor air pathway was calculated using extremely conservative methodology and assumptions and it is not likely that true risk from exposure to benzene in subsurface soil approaches the risk values calculated.

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TABLES

Table 1: Human Health Compounds of Potential Concern (COPCs)
Soil

1. COPC	2. Units	3. Detection Frequency	4. Minimum Concentration (above SQL)	5. Maximum Concentration (above SQL)	6. Detection Limits	7. Background Concentration	8. RBSL[a] (carcinogen)	9. Detection Frequency above RBSL (carcinogen)	10. RBSL[a] (noncarcinogen)	11. Detection Frequency above RBSL (noncarcinogen)	12. Potential ARAR/TBC[b]	13. Detection Frequency above ARAR/TBC
Benzene	mg/kg	6/80	0.011	0.508	0.00547 - 1.78	--	0.64	0/68			0.02[mig]	3/68
Ethylbenzene	mg/kg	9/80	0.0563	150	0.012 - 1.78	--			8.9	1/68	5[mig]	1/68
Toluene	mg/kg	5/80	0.0557	150	0.012 - 1.78	--			18	1/68	4.8[mig]	1/68
Xylenes	mg/kg	18/80	0.0877	2200	0.012 - 5.41	--			8.1	2/68	69[mig]	1/68
GRO (AK101)	mg/kg	26/72	2.13	269	1.37 - 20	--			140	2/60	260[mig]	1/60
DRO (AK102)	mg/kg	98/121	4.22	134000	4 - 77.5	--			825	41/109	230[mig]	61/109
Benzo(a) anthracene	mg/kg	9/57	0.0137	2.73	0.01 - 1.08	--	0.9	1/45			5.5[mig]	0/45
Benzo(a) pyrene	mg/kg	9/56	0.017	3.07	0.01 - 1.08	--	0.09	6/44			0.9[ing]	1/44
Benzo(b) fluoranthene	mg/kg	7/57	0.0385	1.43	0.01 - 1.08	--	0.9	1/45			9[ing]	0/45
Dibenz(a,h) anthracene	mg/kg	1/42	0.573	0.573	0.01 - 1.08	--	0.09	7/42			0.9[ing]	1/42
Indeno(1,2,3-cd) pyrene	mg/kg	3/44	0.0204	1.24	0.01 - 1.08	--	0.9	1/44			9[ing]	0/44
Contaminants detected, but screened out as COPCs												
Anthracene	mg/kg	1/12	0.0141	0.0141	0.01	--			2490	0/12	3900[mig]	0/12
Benzo(k) fluoranthene	mg/kg	1/12	0.0104	1/12	0.01	--	9.3	0/12			93[ing]	0/12
Chrysene	mg/kg	1/12	0.0134	1/12	0.01	--	93	0/12			550[mig]	0/12
Fluoranthene	mg/kg	3/12	0.0175	0.0694	0.01	--			330	0/12	1900[mig]	0/12
Fluorene	mg/kg	1/12	0.0148	1/12	0.01	--			330	0/12	240[mig]	0/12
1-methylnaphthalene	mg/kg	1/12	0.015	0.015	0.01	--						
2-methylnaphthalene	mg/kg	3/12	0.011	0.0262	0.01	--						
Naphthalene	mg/kg	2/12	0.0117	0.0186	0.01	--			9.2	0/12	19[mig]	0/12
Phenanthrene	mg/kg	2/12	0.011	0.0943	0.01	--						
Pyrene	mg/kg	2/12	0.0221	0.0869	0.01	--			250	0/12	1400[mig]	0/12
Lead	mg/kg	26/39	1.99	2870	0.5 - 8.96	20.8 - 41.8			40	15/27	400[ing]	3/27

Notes
RBSL - risk based screening level
a Values are 10% of value from Table B 18AAC75, lowest ingestion or inhalation value for over 40 inch zone
b Values are from Table B 18AAC75, migration to groundwater, inhalation or ingestion noted.
Detection limits for contaminants not detected were compared to RBSL. No detection limits exceeded respective RBSLs.

Table 2: Human Health Compounds of Potential Concern (COPCs)
Water

1. COPC	2. Units	3. Detection Frequency	4. Minimum Concentration (above SQL)	5. Maximum Concentration (above SQL)	6. Detection Limits	6a. Detection Limits Above RBSL*	7. Background Concentration	8. RBSL[a] (carcinogen)	9. Detection Frequency above RBSL (carcinogen)	10. RBSL[a] (noncarcinogen)	11. Detection Frequency above RBSL (noncarcinogen)	12. Potential ARAR/TBC[b]	13. Detection Frequency above ARAR/TBC
Detected Contaminants in Groundwater													
Benzene	ug/L	30/57	0.227	80	0.2 - 50	14/27	--	0.5	25/57			5	7/57
Ethylbenzene	ug/L	19/57	0.75	910	0.5 - 50	0/38	--			70	3/57	700	1/57
Toluene	ug/L	17/57	0.51	2800	0.5 - 50	0/40	--			100	2/57	1000	2/57
Xylenes	ug/L	31/57	1.05	12050	1 - 50	0/26	--			1000	3/57	10000	2/57
GRO (AK101)	ug/L	5/13	71.2	329	50 - 50	0/8	--			130	1/13	1300	0/13
DRO (AK102)	ug/L	10/11	268	24000	156 - 156	1/1	--			150	10/11	1500	4/11
Benzo(a) anthracene	ug/L	1/10	0.126	0.126	0.1 - 0.118	3/9	--	0.1	1/10			1	0/10
Benzo(a) pyrene	ug/L	1/10	0.126	0.126	0.1 - 0.118	9/9	--	0.02	1/10			0.2	0/10
Benzo(b) fluoranthene	ug/L	1/10	0.168	0.168	0.1 - 0.118	3/9	--	0.1	1/10			1	0/10
Indeno(1,2,3-cd) pyrene	ug/L	1/10	0.105	0.105	0.1 - 0.118	3/9	--	0.1	1/10			1	0/10

Detected Contaminants in Seeps

Xylenes (total)	ug/L	1/1	1.46	1.46			--			1000	0/1	10000	0/1
Benzo(a)anthracene	ug/L	1/1	0.064	0.064			--	0.1	0/1			1	0/1
Pyrene	ug/L	1/1	0.603	0.603			--	110	0/1			110	0/1
DRO (AK 102)	ug/L	1/1	284	284			--			150	0/1	1500	0/1

Notes
RBSL - risk based screening level
a Values are 10% of value from Table C 18AAC75
b Values are from Table C 18AAC75
Detection limits for contamaintns not detected were compared to RBSL. No detection limits exceeded respective RBSLs.

Table 3. Slope Factors and Reference Doses

	Oral RfD[3]	Dermal RfD[3]	Inhal RfD[1] RfD[1]	Inhal RfC[1] RfC[1]	Oral CSF[4]	Dermal CSF[4]	Inhal CSF[2]	URF2
	mg/kg/day	mg/kg/day	mg/kg/day	mg/m^3	1/(mg/kg/day)	1/(mg/kg/day)	1/(mg/kg/day)	$1/(ug/m^3)$
benzo(a)anthracene					0.73	2.35	0.31	8.86E-05
benzo(a)pyrene					7.3	24	3.1	8.86E-04
benzo(b)fluoranthene					0.73	2.35	0.31	8.86E-05
indeno(1,2,3-cd)pyrene					0.73	2.35	0.31	8.86E-05
dibenzo(a,h)anthracene					7.3	24	3.1	8.86E-04
benzene	0.003	0.003	0.0017	5.95E-03	0.055	0.056	0.027	8.30E-06
ethylbenzene	0.10	0.097	0.286	1.001				
toluene	0.20	0.16	0.114	0.399				
xylenes	2.00	1.84	0.2	0.7				
DRO Aliphatic	0.1	0.1	0.2857	1				
DRO Aromatic	0.04	0.04	0.0571	0.2				
GRO Aliphatic	5	5	5.2571	18.4				
GRO Aromatic	0.2	0.2	0.1143	0.4				

Notes:

Equation (1) provides the conversion between inhal RfD and Inhal RfC.
Equation (2) provides the conversion between Inhal CSF and URF.
Equation (3) provides the conversion between Oral RfD and Dermal RFD.
Equation (4) provides the conversion between Oral CSF and Dermal CSF.
ABS_{GI} values are provided in Table 4.

1. Inhal RfD (mg/kg/day) = Inhal RfC (mg/m^3) x 20 (m^3/day) / 70 kg

2. Inhal CSF(1/mg/kg/day) = URF ($1/ug/m^3$) x 70 kg x 1000 ug/mg / 20 (mg^3/day)

3. Dermal $RfD_d = RfD_o$ (mg/kg/day) x ABS_{GI}

4. Dermal $CSF_d = CSF_o$ (1/mg/kg/day) / ABS_{GI}

Table 4. Chemical Specific Parameters

CAS NUMBER	CHEMICAL NAME	K_{oc} (L/kg)	Di,w (cm^2/s)	Di,a (cm^2/s)	S (mg/L)	H' (unitless)	ABS_{GI} (unitless)	ABS_d (unitless)	PC (cm/hr)
56-55-3	**Benzo(a)anthracene**	3.98E+05	9.00E-06	5.10E-02	0.0094	1.37E-04	3.10E-01	0.01	8.10E-01
50-32-8	**Benzo(a)pyrene**	1.02E+06	9.00E-06	4.30E-02	0.00162	4.63E-05	3.10E-01	0.01	1.20E+00
205-99-2	**Benzo(b)fluoranthene**	1.23E+06	5.56E-06	2.26E-02	0.0015	4.55E-03	3.10E-01	0.01	1.20E+00
193-39-5	**Indeno(1,2,3-c,d)pyrene**	3.47E+06	5.66E-06	1.90E-02	0.000022	6.56E-05	3.10E-01	0.01	1.90E+00
53-70-3	**Dibenzo(a,h)anthracene**	3.80E+06	5.18E-06	2.02E-02	0.00249	6.03E-07	3.10E-01	0.01	2.70E+00
71-43-2	***Benzene***	58.9	9.80E-06	8.80E-02	1750	2.28E-01	9.70E-01	0.01	2.10E-02
100-41-4	Ethylbenzene	363	7.80E-06	0.075	169	3.23E-01	9.70E-01	0.01	7.40E-02
108-88-3	Toluene	182	8.60E-06	0.087	526	2.72E-01	8.00E-01	0.01	4.50E-02
1330-20-7	Xylenes (total)	363	7.80E-06	0.07	161	2.10E-01	9.20E-01	0.01	8.00E-02
PETROLEUM HYDROCARBONS									
Equivalent Carbon Number(EC)									
14	C10 - C25 - Aliphatics	5.37E+06	1.00E-05	1.00E-01		7.59E+01	0.8	0.01	0.25
14	C10 - C25 - Aromatics	5.01E+03	1.00E-05	1.00E-01		3.02E-02	0.8	0.01	0.25
8	C6 - C10 - Aliphatics	1.07E+04	1.00E-05	1.00E-01		5.75E+01	0.8	0.01	0.045
8	C6 - C10 - Aromatics	1.26E+03	1.00E-05	1.00E-01		7.24E-01	0.8	0.01	0.045

Notes:

All parameters were obtained from Appendix C-1 and C-2 of the ADEC Guidance on Cleanup Standards Equations and Input Parameters (ADEC, 1999a) or the RAIS website (2004).

Acronym Definitions:
Koc = Organic carbon partition coefficient
Di,w = Diffusivity for water
Di, a = Air Diffusivity
S = Solubility
H = Henry's Law Coefficient
ABS_{GI} = GI Absorption Factor (RAIS, 2004)
ABS_d = Dermal absorption factor (RAIS, 2004)
PC = Permeability Constant
Bold represents carcinogenic compounds.
Non-bold represents noncarcinogenic compounds

Table 5. Exposure Point Concentrations for Soil, Groundwater, and Seeps

	On-site		Off-Site		
CHEMICAL NAME **Bold Type = Carcinogenic Substances** ***Bold Italic = Both Carcinogenic and Noncarcinogenic Substances***	**Soil (mg/kg)**	**Groundwater (mg/L)**	**Soil (mg/kg)**	**Groundwater (mg/L)**	**Seep Water (mg/L)**
Benzo(a)anthracene	0.068	0.000126	0.481	0.000126	0.000164
Benzo(a)pyrene	0.242	0.000126	0.506	0.000126	
Benzo(b)fluoranthene	0.038	0.000168	0.295	0.000168	
Indeno(1,2,3-c,d)pyrene	0.017	0.000105	0.262	0.000105	
Dibenzo(a,h)anthracene	0.017		0.189		
Benzene	0.021	0.00218	0.104	0.00218	
Ethylbenzene	15.89	0.0126	0.169	0.0126	
Toluene	16.25	0.00116	0.112	0.00116	
Xylenes (total)	225	0.00625	1.01	0.00625	0.00146
DRO Aliphatic	9915.2		9506.4		
DRO Aromatic	4957.6	24	4753.2	24	0.284
GRO Aliphatic	34.4		29.3		
GRO Aromatic	24.6	0.329	20.9	0.329	
DRO		24		24	0.284
GRO		0.329		0.329	

blank cell indicates contaminant not detected

Table 6. Exposure Assumptions

Parameters	Worker	Resident	Child Resident
THQ - target hazard quotient (unitless)	1	1	1
TR - target cancer risk (unitless)	1.00E-05	1.00E-05	1.00E-05
AT - averaging time for carcinogens (years)	70	70	70
AT - averaging time for non-carcinogens (years)	5	30	6
BW - body weight (kg)	70	70	15
ED - exposure duration (years)	5	30	6
EF - exposure frequency to soil and seep water (days/year)	30	180	180
EF - exposure frequency for inhalation pathway (days/year)	NA	350	NA
SA - Skin Surface Area (cm2/day) - soil	3120	3120	2380
AF - Soil to Skin Adherence Factor (mg/cm2)	0.2	0.2	0.2
IRw - groundwater ingestion rate (L/day)	0.05	0.05	0.05
IRs - soil ingestion rate-noncarcinogens (mg/day)	200	100	200
T - exposure interval (seconds)	9.50E+08	9.50E+08	9.50E+08
O/C over 40 inch zone - inverse of mean conc. @ 0.5 acre center2 (g/m2-s per kg/m3)	82.72	82.72	82.72
SA - Skin Surface Area (m^2) - water	0.312	0.312	0.238
ET - Exposure Time to surface water (hr/d)	1	0.5	1

Table 7. Risk to On-Site Worker

Detected Compound	Soil Exposure Point Concentration (mg/kg)	Groundwater Exposure Point Concentration (mg/L)	Exposure Pathway	Ingestion of Soil	Dermal Contact with Soil	Outdoor Inhalation of Vapors in Soil	Indoor Inhalation of Vapors in Soil	Indoor Inhalation of Vapors in Groundwater	Dermal Contact with Groundwater	Incidental Ingestion of Groundwater		
							Johnson Ettinger	Johnson Ettinger				
			Cumulative Carcinogenic **Risk** (per exposure pathway)	**5.E-07**	**3.E-09**	**1.E-10**						
			Cumulative Noncarcinogenic **Hazard Indices** (per exposure pathway)	**0.00008**	**0.000003**	**0.001**						
benzo(a)anthracene	0.068	0.000126		1.E-08	8.E-11	1.E-12	Pathway not complete	Pathway not complete	Pathway not complete	Pathway not complete		
benzo(a)pyrene	0.242	0.000126		4.E-07	3.E-09	1.E-11						
benzo(b)fluoranthene	0.038	0.000168		7.E-09	5.E-11	1.E-12						
indeno(1,2,3-cd)pyrene	0.017	0.000105		3.E-09	2.E-11	4.E-14						
Dibenzo(a,h)anthracene	0.017	ND		3.E-08	2.E-10	2.E-13						
benzene	0.021	0.00218		3.E-10	6.E-13	1.E-10						
benzene	0.021	0.00218		0.0000016	0.0000001	0.00003						
ethylbenzene	15.89	0.0126		0.000037	0.000001	0.0001						
toluene	16.25	0.00116		0.000019	0.000001	0.0002						
xylenes	225	0.00625		0.000026	0.000001	0.0011						
Cumulative Risk Calculations do not include DRO and GRO												
DRO Aliphatic - 80% of conc.	9915.2			0.02	0.0007	0.01					0.030299	**Cum DRO Ali**
DRO Aromatic - 40% of conc.	4957.6	24		0.03	0.0009	0.01					0.04028	**Cum DRO Aro**
GRO Aliphatic - 70% of conc.	34.4			0.0000016	0.0000001	0.00002					2.46E-05	**Cum GRO Ali**
GRO Aromatic - 50% of conc.	24.6	0.329		0.000029	0.0000009	0.00025					0.000278	**Cum GRO Aro**
			DRO	0.05	0.0016	0.0166					0.070579	
			GRO	3.05002E-05	9.51606E-07	0.000271186					0.000303	

On-Site Worker	
Cumulative Carcinogenic Risk	**Cumulative Noncarcinogenic Risk**
5E-07	**0.002**

ND - Contaminant not detected in media

Table 8. Risk to On-Site Adult Resident

Detected Compound	Soil Exposure Point Concentration (mg/kg)	Groundwater Exposure Point Concentration (mg/L)	Exposure Pathway	Ingestion of Soil	Dermal Contact with Soil	Outdoor Inhalation of Vapors in Soil	Indoor Inhalation of Vapors in Soil	Indoor Inhalation of Vapors in Groundwater	Dermal Contact with Groundwater	Incidental Ingestion of Groundwater		
							Johnson Ettinger	Johnson Ettinger				
			Cumulative Carcinogenic **Risk** (per exposure pathway)	**1.E-06**	**1.E-07**	**5.E-09**	**1.E-06**	**3.E-07**				
			Cumulative Noncarcinogenic **Hazard Indices** (per exposure pathway)	**0.0003**	**0.00002**	**0.00862**	**0.26**	**0.001**				
benzo(a)anthracene	0.068	0.000126		3.E-08	3.E-09	4.E-11	2.E-12	1.E-10	Pathway not complete	Pathway not complete		
benzo(a)pyrene	0.242	0.000126		1.E-06	1.E-07	5.E-10	9.E-12	3.E-10				
benzo(b)fluoranthene	0.038	0.000168		2.E-08	2.E-09	4.E-11	5.E-12	1.E-09				
indeno(1,2,3-cd)pyrene	0.017	0.000105		9.E-09	8.E-10	2.E-12	2.E-14	3.E-11				
Dibenzo(a,h)anthracene	0.017	ND		9.E-08	8.E-09	8.E-12	2.E-15	NA				
benzene	0.021	0.00218		8.E-10	2.E-11	4.E-09	1.E-06	3.E-07				
benzene	0.021	0.00218		0.000005	0.0000003	0.0002041	NA	NA				
ethylbenzene	15.89	0.0126		0.0001	0.00001	0.00041	0.04	0.00				
toluene	16.25	0.00116		0.0001	0.00000	0.00148	0.22	0				
xylenes	225	0.00625		0.0001	0.00001	0.00652	NA	NA				
Cumulative Risk Calculations do not include DRO and GRO												
DRO Aliphatic - 80% of conc.	9915.2			0.0699	0.0044	0.0377	NA	NA			0.1119	**Cum DRO Ali**
DRO Aromatic - 40% of conc.	4957.6	24		0.0873	0.0054	0.0616	NA	NA			0.1544	**Cum DRO Aro**
GRO Aliphatic - 70% of conc.	34.4			0.0000	0.0000	0.0001	NA	NA			0.2663	**Cum GRO Ali**
GRO Aromatic - 50% of conc.	24.6	0.329		0.0001	0.0000	0.0015	NA	NA			0.0016	**Cum GRO Aro**
			DRO	0.1572	0.0098	0.0993					0.2663	
			GRO	0.0001	0.0000	0.0016					0.2679	

On-Site Resident	
Cumulative Carcinogenic Risk	**Cumulative Noncarcinogenic Risk**
3E-06	**0.3**

ND - Contaminant not detected in media
NA - Contaminant not assessed for pathway

Table 9. Risk to On-Site Child Resident

Detected Compound	Soil Exposure Point Concentration (mg/kg)	Groundwater Exposure Point Concentration (mg/L)	Exposure Pathway	Ingestion of Soil	Dermal Contact with Soil	Outdoor Inhalation of Vapors in Soil	Indoor Inhalation of Vapors in Soil	Indoor Inhalation of Vapors in Groundwater	Dermal Contact with Groundwater	Incidental Ingestion of Groundwater		
							Johnson Ettinger	Johnson Ettinger				
			Cumulative Carcinogenic **Risk** (per exposure pathway)	**3.E-06**	**9.E-08**	**1.E-09**						
			Cumulative Noncarcinogenic **Hazard Indices** (per exposure pathway)	**0.0024**	**0.0001**	**0.00862**						
benzo(a)anthracene	0.068	0.000126		7.E-08	2.E-09	7.E-12	Pathway not assessed	Pathway not assessed	Pathway not complete	Pathway not complete		
benzo(a)pyrene	0.242	0.000126		2.E-06	8.E-08	1.E-10						
benzo(b)fluoranthene	0.038	0.000168		4.E-08	1.E-09	8.E-12						
indeno(1,2,3-cd)pyrene	0.017	0.000105		2.E-08	5.E-10	3.E-13						
Dibenzo(a,h)anthracene	0.017	ND		2.E-07	5.E-09	2.E-12						
benzene	0.021	0.00218		2.E-09	2.E-11	9.E-10						
benzene	0.021	0.00218		0.00005	0.000001	0.0002041						
ethylbenzene	15.89	0.0126		0.0010	0.00003	0.00041						
toluene	16.25	0.00116		0.0005	0.00002	0.00148						
xylenes	225	0.00625		0.0007	0.00002	0.00652						
Cumulative Risk Calculations do not include DRO and GRO												
DRO Aliphatic - 80% of conc.	9915.2			0.6520	0.0155	0.0377					0.7052	**Cum DRO Ali**
DRO Aromatic - 40% of conc.	4957.6	24		0.8149	0.0194	0.0616					0.8959	**Cum DRO Aro**
GRO Aliphatic - 70% of conc.	34.4			0.0000	0.0000	0.0001					0.0002	**Cum GRO Ali**
GRO Aromatic - 50% of conc.	24.6	0.329		0.0008	0.0000	0.0015					0.0023	**Cum GRO Aro**
			DRO	1.4669	0.0349	0.0993					1.6011	
			GRO	0.0009	0.0000	0.0016					0.0025	

On-Site Resident	
Cumulative Carcinogenic Risk	**Cumulative Noncarcinogenic Risk**
3E-06	**0.01**

ND - Contaminant not detected in media

Table 10. Risk to Off-Site Worker

Detected Compound	Soil Exposure Point Concentration (mg/kg)	Groundwater Exposure Point Concentration (mg/L)	Seep Exposure Point Concentration (mg/L)	Exposure Pathway	Ingestion of Soil	Dermal Contact with Soil	Outdoor Inhalation of Vapors in Soil	Indoor Inhalation of Vapors in Soil	Indoor Inhalation of Vapors in Groundwater	Dermal Contact with Groundwater	Incidental Ingestion of Groundwater		
								Johnson Ettinger	Johnson Ettinger				
				Cumulative Carcinogenic **Risk** (per exposure pathway)	**1.E-06**	**1.E-08**	**7.E-10**			**1.E-06**	**6.E-09**		
				Cumulative Noncarcinogenic **Hazard Indices** (per exposure pathway)	**0.0000088**	**0.00000028**	**0.000197**			**0.00007**	**0.00006**		
benzo(a)anthracene	0.481	0.000126	0.000164		8.E-08	6.E-10	8.E-12	Pathway not complete	Pathway not complete	6.E-08	4.E-10		
benzo(a)pyrene	0.506	0.000126	ND		9.E-07	6.E-09	3.E-11			9.E-07	4.E-09		
benzo(b)fluoranthene	0.295	0.000168	ND		5.E-08	4.E-10	1.E-11			1.E-07	5.E-10		
indeno(1,2,3-cd)pyrene	0.262	0.000105	ND		4.E-08	3.E-10	7.E-13			1.E-07	3.E-10		
Dibenzo(a,h)anthracene	0.189	ND	ND		3.E-07	2.E-09	3.E-12			ND	ND		
benzene	0.104	0.00218	ND		1.E-09	3.E-12	7.E-10			7.E-10	5.E-10		
benzene	0.104	0.00218	ND		0.0000081	0.000000254	0.0001890			0.00007	0.00005		
ethylbenzene	0.169	0.0126	ND		0.0000004	0.000000013	0.0000008			0.000007	0.0000074		
toluene	0.112	0.00116	ND		0.00000013	0.000000005	0.0000019			0.0000002	0.0000003		
xylenes	1.01	0.00625	NA		0.00000012	0.000000004	0.0000055			0.0000002	0.0000002		
Cumulative Risk Calculations do not include DRO and GRO													
DRO Aliphatic - 80% of conc.	9506.4				0.02	0.00070	0.01					0.03	**Cum DRO Ali**
DRO Aromatic - 40% of conc.	4753.2	24	0.284		0.03	0.00087	0.01			1.30E-08	4.17E-09	0.04	**Cum DRO Aro**
GRO Aliphatic - 70% of conc.	29.3				0.0000014	0.00000004	0.0000220					0.00002	**Cum GRO Ali**
GRO Aromatic - 50% of conc.	20.9	0.329	ND		0.0000245	0.0000008	0.0002379			ND	ND	0.00026	**Cum GRO Aro**
				DRO	0.05	0.002	0.02					0.07	
				GRO	2.59162E-05	8.08587E-07	0.000259817					0.00029	

Off-Site Worker	
Cumulative Carcinogenic Risk	**Cumulative Noncarcinogenic Risk**
3E-06	**0.00034**

ND - Contaminant not detected in media

Table 11. Risk to Off-Site Adult Resident

Detected Compound	Soil Exposure Point Concentration (mg/kg)	Groundwater Exposure Point Concentration (mg/L)	Seep Exposure Point Concentration (mg/L)	Exposure Pathway	Ingestion of Soil	Dermal Contact with Soil	Outdoor Inhalation of Vapors in Soil	Indoor Inhalation of Vapors in Soil	Indoor Inhalation of Vapors in Groundwater	Dermal Contact with Seep Water	Incidental Ingestion of Seep Water		
								Johnson Ettinger	Johnson Ettinger				
				Cumulative Carcinogenic **Risk** (per exposure pathway)	**4.E-06**	**4.E-07**	**6.E-09**	**5.E-06**	**3.E-07**	**1.E-06**	**1.E-08**	#VALUE!	
				Cumulative Noncarcinogenic **Hazard Indices** (per exposure pathway)	**0.00003**	**0.0000017**	**0.00105**	**0.002**	**7.517E-04**	**0.000E+00**	**0.000E+00**		
benzo(a)anthracene	0.481	0.000126	0.000164		2.E-07	2.E-08	3.E-10	2.E-11	1.E-10	1.E-06	1.E-08		
benzo(a)pyrene	0.506	0.000126	ND		3.E-06	2.E-07	1.E-09	2.E-11	3.E-10	NA	NA	#VALUE!	
benzo(b)fluoranthene	0.295	0.000168	ND		2.E-07	1.E-08	3.E-10	4.E-11	1.E-09	NA	NA		
indeno(1,2,3-cd)pyrene	0.262	0.000105	ND		1.E-07	1.E-08	2.E-11	3.E-13	3.E-11	NA	NA		
Dibenzo(a,h)anthracene	0.189	ND	ND		1.E-06	8.E-08	9.E-11	2.E-14	NA	NA	NA		
benzene	0.104	0.00218	ND		4.E-09	1.E-10	4.E-09	5.E-06	3.E-07	NA	NA		
benzene	0.104	0.00218	ND		0.000024	0.0000015	0.0010109	ND	ND	NA	NA		
ethylbenzene	0.169	0.0126	ND		0.000001	0.0000001	0.000004	0.0005	0.000612	NA	NA		
toluene	0.112	0.00116	ND		0.0000004	0.00000003	0.00001	0.001	0.0001	NA	NA		
xylenes	1.01	0.00625	NA		0.0000004	0.00000002	0.00003	NA	NA	NA	NA		
					Cumulative Risk Calculations do not include DRO and GRO								
DRO Aliphatic - 80% of conc.	9506.4				0.066972681	0.004179095	0.0362	NA	NA			0.11	**Cum DRO Ali**
DRO Aromatic - 40% of conc.	4753.2	24	0.284		0.083715851	0.005223869	0.0591	NA	NA	5.5E-07	0.000002	0.15	**Cum DRO Aro**
GRO Aliphatic - 70% of conc.	29.3				4.12838E-06	2.57611E-07	0.0001	NA	NA			0.00012	**Cum GRO Ali**
GRO Aromatic - 50% of conc.	20.9	0.329	ND		7.36204E-05	4.59391E-06	0.0015	NA	NA	2.7E-10	0.00000001	0.0016	**Cum GRO Aro**
				DRO	0.15	0.01	0.10					0.26	
				GRO	7.8E-05	4.9E-06	0.0016					0.002	

Off-Site Resident	
Cumulative Carcinogenic Risk	**Cumulative Noncarcinogenic Risk**
1E-05	**0.004**

NA - Not assessed. Contaminant is not a COPC in that media.
ND - Contaminant not detected in media

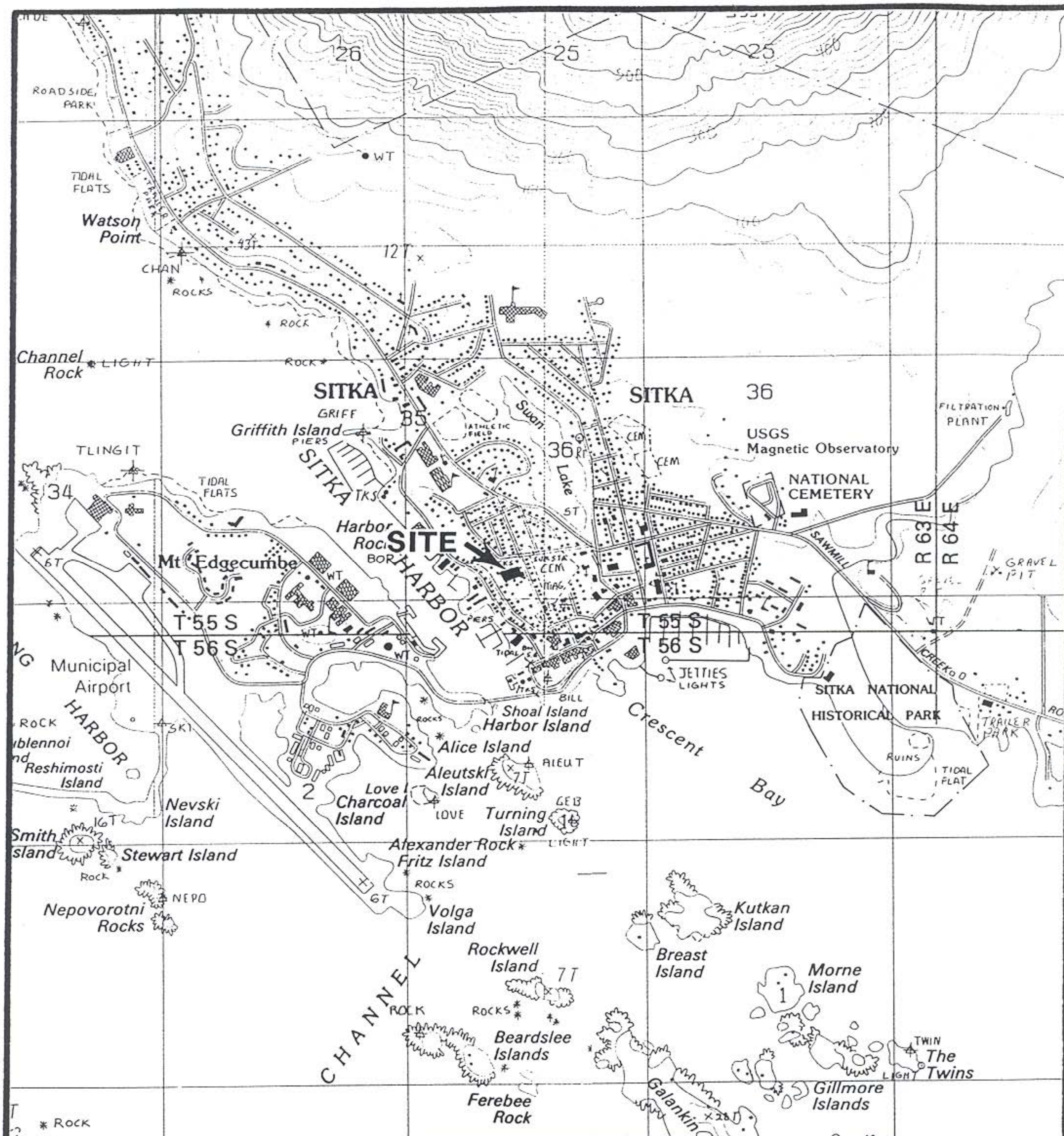
Table 12. Risk to Off-Site Child Resident

Detected Compound	Soil Exposure Point Concentration (mg/kg)	Groundwater Exposure Point Concentration (mg/L)	Seep Exposure Point Concentration (mg/L)	Exposure Pathway	Ingestion of Soil	Dermal Contact with Soil	Outdoor Inhalation of Vapors in Soil	Indoor Inhalation of Vapors in Soil	Indoor Inhalation of Vapors in Groundwater	Dermal Contact with Seep Water	Incidental Ingestion of Seep Water		
								Johnson Ettinger	Johnson Ettinger				
				Cumulative Carcinogenic **Risk** (per exposure pathway)	**8.E-06**	**3.E-07**	**1.E-09**	*5.E-06*	*3.E-07*	**2.E-06**	**2.E-08**	8.E-06	
				Cumulative Noncarcinogenic **Hazard Indices** (per exposure pathway)	**0.00025**	**0.0000059**	**0.00105**	*0.002*	*0.00075*				
benzo(a)anthracene	0.481	0.000126	0.000164		5.E-07	2.E-08	5.E-11	*Pathway not assessed for children. Added JE calculated risk to adult receptors for cumulative risk evaluation.*	*Pathway not assessed for children. Added JE calculated risk to adult receptors for cumulative risk evaluation.*	2.E-06	2.E-08	#VALUE!	
benzo(a)pyrene	0.506	0.000126	ND		5.E-06	2.E-07	2.E-10			NA	NA		
benzo(b)fluoranthene	0.295	0.000168	ND		3.E-07	9.E-09	7.E-11			NA	NA		
indeno(1,2,3-cd)pyrene	0.262	0.000105	ND		3.E-07	8.E-09	5.E-12			NA	NA		
Dibenzo(a,h)anthracene	0.189	ND	ND		2.E-06	6.E-08	2.E-11			NA	NA		
benzene	0.104	0.00218	ND		8.E-09	8.E-11	9.E-10			NA	NA		
benzene	0.104	0.00218	ND		0.000228	0.0000054	0.0010109			NA	NA		
ethylbenzene	0.169	0.0126	ND		0.000011	0.0000003	0.000004			NA	NA		
toluene	0.112	0.00116	ND		0.000004	0.0000001	0.00001			NA	NA		
xylenes	1.01	0.00625	NA		0.000003	0.0000001	0.00003			NA	NA		
					Cumulative Risk Calculations do not include DRO and GRO								
DRO Aliphatic - 80% of conc.	9506.4				0.6	0.01	0.04					0.6761	**Cum DRO Ali**
DRO Aromatic - 40% of conc.	4753.2	24	0.284		0.8	0.02	0.06			2.E-07	1.E-07	0.8590	**Cum DRO Aro**
GRO Aliphatic - 70% of conc.	29.3				3.9E-05	9.2E-07	0.0001					0.0002	**Cum GRO Ali**
GRO Aromatic - 50% of conc.	20.9	0.329	ND		0.00069	1.6E-05	0.0015			ND	ND	0.0022	**Cum GRO Aro**
				DRO	1.4	0.03	0.10			2.31479E-07	1.16712E-07	1.53513	
				GRO	0.00073	0.00002	0.00161						

Off-Site Resident	
Cumulative Carcinogenic Risk	**Cumulative Noncarcinogenic Risk**
2E-05	**0.004**

NA - Not assessed. Contaminant is not a COPC in that media.
ND - Contaminant not detected in media

FIGURES



0 2000 4000

SCALE IN FEET

N

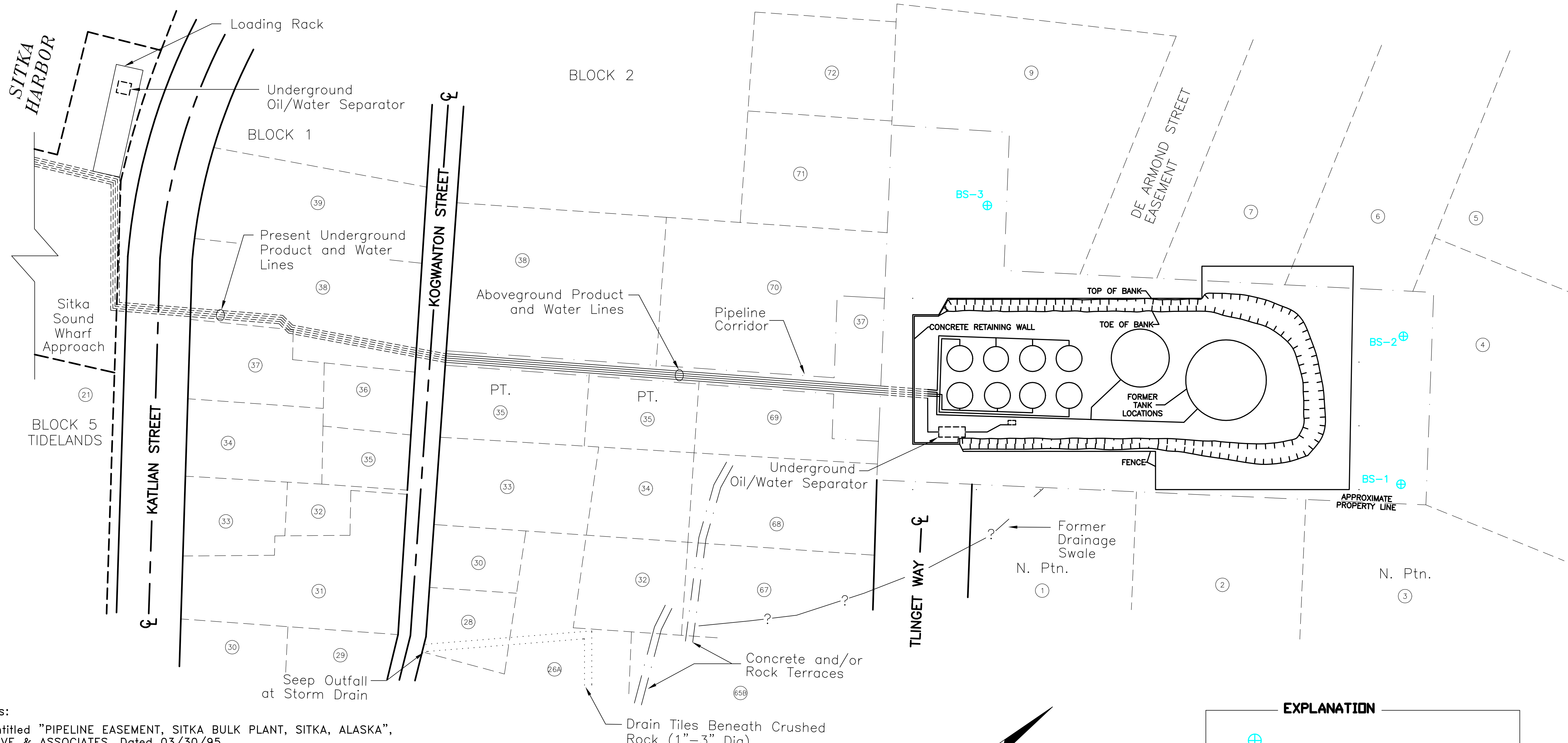
Reference: USGS 1:25,000-scale series topographic quadrangle maps,
"Sitka (A-4) SW, AK" provisional edition 1987 and
"Sitka (A-5) SE, AK" provisional edition 1987.

GeoEngineers

VICINITY MAP

FIGURE 1

0161-302-P18 PJS:MAD 10/29/92



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SCALE IN FEET

EXPLANATION

BS-1 BACKGROUND SOIL SAMPLE BY GEI, JANUARY 1998

References:

Drawing Entitled "PIPELINE EASEMENT, SITKA BULK PLANT, SITKA, ALASKA", By C.A. GOVE & ASSOCIATES, Dated 03/30/95.

Drawing Entitled "MASTER PROPERTY PLAT", By City of Sitka, Assessors Office, Dated 02/23/95.

Drawing Entitled "Site Plan, Tank Cleaning, Sitka Bulk Plant BPN 0736, Sitka, Alaska", By C.A. GOVE & ASSOCIATES, Dated 06/23/92.

USGS Topographic Map, Sitka (A-S) SE, Alaska, Dated 1987.

Report Entitled "Sitka Sound Bulk Plant Site Investigation Report" by PTI Environmental Services, Dated November 1990.

Report Entitled "Sitka Sound Seafoods, Initial Subsurface Investigation, Unocal Subsurface Hydrocarbon Release," dated May 14, 2000.

Field sketches by GeoEngineers, dated 09/25/96, 04/23/97, 01/29/98, 02/11/00, 12/06/00 and 05/15/01.

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

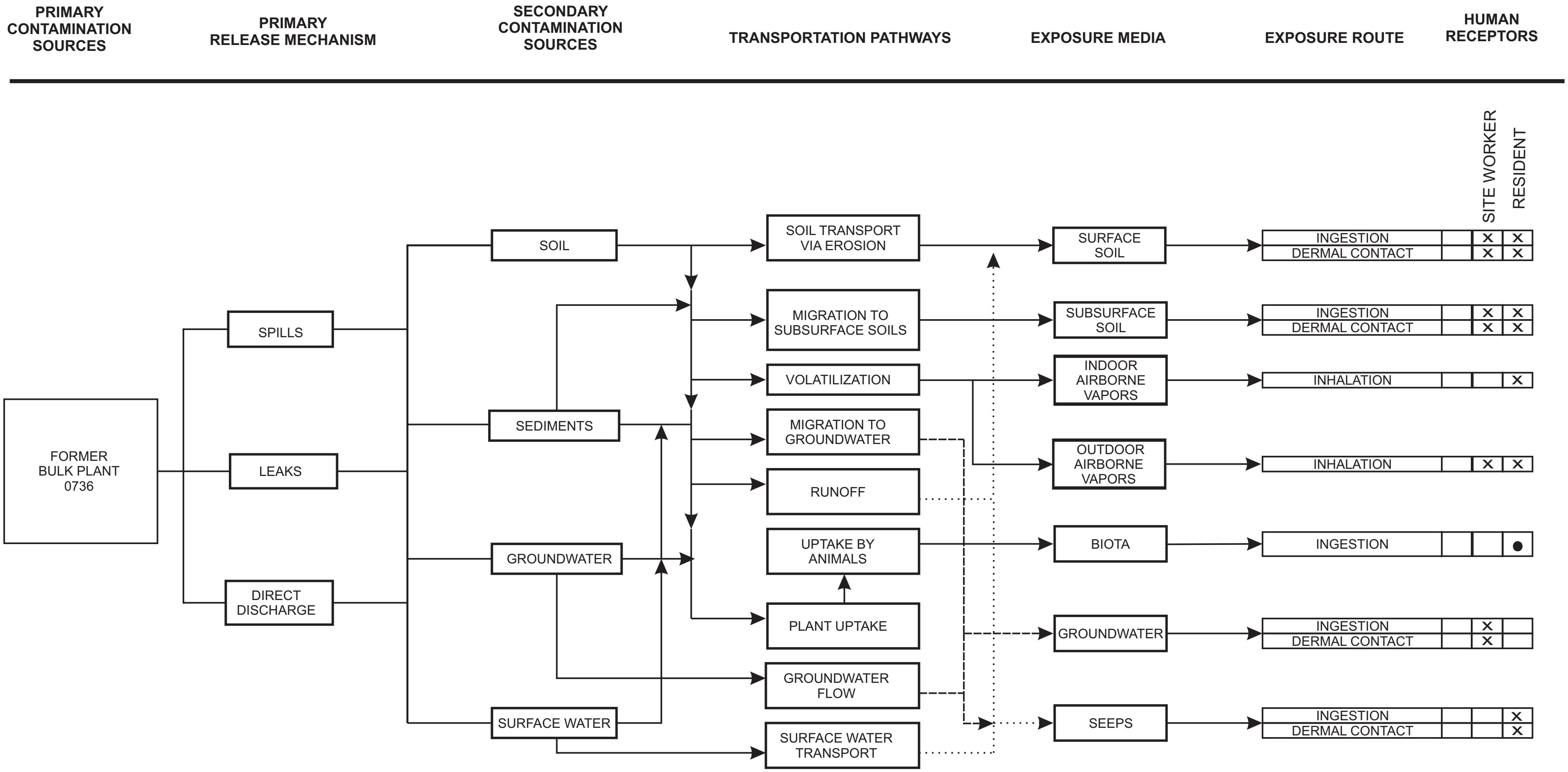
UNOCAL BULK PLANT 0736
329 KATLIAN STREET
SITKA, ALASKA

GeoEngineers

SITE PLAN

FIGURE 2

0161-302-01:6/5/01 0161-302-01F2.dwg JJO:DKR



NOTES:

● Insignificant Exposure Pathway

X Pathway Complete

HUMAN HEALTH CONCEPTUAL SITE MODEL UNOCAL FORMER BULK PLANT 0736 SITKA, ALASKA		
PJT. MANAGER:	COREL FILE NAME: Human Health CSM	FIGURE NO.: 3
DRAWN BY: K. GRAHAM	PROJ. NO.:	DATE: NOV 2004

Appendix A
Soil and Groundwater Data Tables

Table A1
Soil Analytical Results
DRO, GRO, BTEX
Unocal Bulk Plant 0736
Sitka, Alaska

(mg/kg)

Sample ID	Off-site or On-site	Depth (feet)	Date	Benzene	RL	Ethylbenzene	RL	Toluene	RL	Xylenes	RL	GRO (AK101)	RL	DRO (AK102)	RL
Background and Stockpile Samples															
BS-1	Background	1	01/27/98	<0.02	0.02	<.05	0.05	<.05	0.05	<.1	0.1	<5.0	5	137	
BS-2	Background	1	01/27/98	<0.02	0.02	<.05	0.05	<.05	0.05	<.1	0.1	<5.0	5	218	
BS-3	Background	1	01/27/98	<0.02	0.02	<.05	0.05	<.05	0.05	<.1	0.1	<5.0	5	664	
Stockpile-1 (1')	Stockpile	1	05/17/01											1,070	
Stockpile-2 (1')	Stockpile	1	05/17/01											7,050	
Site-Related Samples															
HA-1A	Off	0.25	05/15/01											32.9	
HA-2A	Off	0.67	05/15/01											430	
HA-1B	Off	1.00	05/15/01											10.8	
HA-4A	Off	1.50	05/16/01											3,110	
HA-3A	Off	1.83	05/16/01	<0.108	0.108	<0.270	0.27	<0.270	0.27	0.615		35.5		8,540	
HA-4B	Off	2.03	05/16/01	<0.0636	0.0636	<0.159	0.159	<0.159	0.159	<0.318	0.318	<15.9	15.9	8,110	
HA-1C	Off	2.25	05/15/01											5.45	
HA-2B	Off	2.42	05/15/01											58.0	
HA-3B	Off	3.17	05/16/01											120	
HA-4C	Off	3.50	05/16/01											47.4	
TP-X-3.5	Off	3.5	05/16/01											1,530	
HA-2C	Off	3.67	05/15/01											27.0	
TP-X-8	Off	8	05/16/01	<0.0514	0.0514	<0.129	0.129	<0.129	0.129	1.06		66.8		17,900	
NPP1-1.5	Off-NPP	1.5	04/17/00	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<2.00	2	<25.0	25
NPP16-1.5	Off-NPP	1.5	04/19/00	<0.151	0.151	<0.151	0.151	<0.151	0.151	<0.151	0.151	8.19		575	
NPP2-1.5	Off-NPP	1.5	04/17/00	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<2.00	2	90.7	
NPP5-1.5	Off-NPP	1.5	04/17/00	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<2.00	2	503	
NPP14-2	Off-NPP	2.0	04/19/00	<0.0500	0.05	0.0622		<0.0500	0.05	0.626		55.1		2,650	
NPP15-2	Off-NPP	2.0	04/19/00	<0.155	0.155	<0.155	0.155	<0.155	0.155	<0.155	0.155	8.23		<77.5	77.5
NPP6-2	Off-NPP	2.0	04/18/00	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<2.00	2	72.7	
NPP3-2.5	Off-NPP	2.5	04/17/00	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<2.00	2	<25.0	25
NPP11-3	Off-NPP	3.0	04/18/00	<0.153	0.153	<0.153	0.153	<0.153	0.153	0.311		24.9		2,330	
NPP7-3	Off-NPP	3.0	04/18/00	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<2.00	2	<25.0	25
NPP10-4	Off-NPP	4.0	04/18/00	<0.201	0.201	<0.201	0.201	<0.201	0.201	<0.201	0.201	15.8		3,680	
NPP15-4	Off-NPP	4.0	04/19/00	<0.0500	0.05	0.147		0.0557		0.664		62.8		7,420	
NPP4-4	Off-NPP	4.0	04/17/00	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<2.00	2	<25.0	25
NPP8-4	Off-NPP	4.0	04/18/00	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<2.00	2	<25.0	25
NPP9-4	Off-NPP	4.0	04/18/00	<0.177	0.177	<0.177	0.177	<0.177	0.177	<0.177	0.177	<7.08	7.08	1,450	
NPP11-5	Off-NPP	5.0	04/18/00	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	0.125		15.0		5,540	
NPP13-6	Off-NPP	6.0	04/18/00	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	0.106		17.4		6,280	
NPP13-7	Off-NPP	7.0	04/19/00	<0.0500	0.05	0.0563		<0.0500	0.05	0.276		31.3		11,600	
NPP12-8	Off-NPP	8.0	04/18/00	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	2.13		36.6	
NPP13-8	Off-NPP	8.0	04/19/00	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	0.149		13.7		1,260	
NPP13-10	Off-NPP	10.0	04/19/00	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	0.0877		10.7		747	
PS-1	Off-PL	0.5	01/27/98	<0.02	0.02	<.05	0.05	<.05	0.05	<.1	0.1	<5.0	5	69.6	
PS-2	Off-PL	0.5	01/27/98	<0.02	0.02	<.05	0.05	<.05	0.05	<.1	0.1	<5.0	5	312	
PS-3	Off-PL	0.5	01/27/98	<0.02	0.02	<.05	0.05	<.05	0.05	<.1	0.1	<5.0	5	803	
PS-4	Off-PL	0.5	01/27/98	<0.02	0.02	<.05	0.05	<.05	0.05	<.1	0.1	<5.0	5	803	
HA-6A	Off-PL	0.83	05/16/01											296	
HA-7A	Off-PL	1.58	05/17/01											2,380	
TP-W-2	Off-PL	2	05/16/01											64.3	
HA-6B	Off-PL	2.17	05/16/01											537	
HA-7B	Off-PL	4.00	05/17/01	0.0205		<0.0500	0.05	<0.0500	0.05	<0.100	0.1	<5.00		116	
TP-W-4	Off-PL	4	05/16/01	0.0184		<0.0404	0.0404	<0.0404	0.0404	<0.0807	0.0807	<4.04		6.24	
C116-14	Off-PL		10/04/90	<0.012	0.012	<0.012	0.012	<0.012	0.012	<0.012	0.012				
C116-15	Off-PL		10/04/90	<0.012	0.012	<0.012	0.012	<0.012	0.012	<0.012	0.012				
HA-5A	Off-PL*	1.33	05/16/01											7,240	
HA-5B	Off-PL*	2.25	05/16/01											9,710	
C116-16	Off-PL*		10/04/90	<0.012	0.012	<0.012	0.012	<0.012	0.012	<0.012	0.012				
TP-1/S-2	Off-swale	2.5	01/28/98	0.508		1.37		0.38		11.3		269		4,310	
TP-1R2.5	Off-swale	2.5	12/02/98											128	
TP-1R3.5	Off-swale	3.5	12/02/98											76.9	
TP-2/S-3	Off-swale	6	01/28/98	<0.04	0.04	<.1	0.1	<.1	0.1	<.2	0.2	11.7		1,300	
TP-5R6	Off-swale	6.0	12/02/98											229	
TP-4/S-3	Off-swale	7	01/28/98	<0.02	0.02	<.05	0.05	<.05	0.05	<.1	0.1	<5.0	5	124	
TP-4/S-4	Off-swale	9	01/28/98	<0.02	0.02	<.05	0.05	0.0813		0.221		<5.0	5	100	
TP-1/S-4	Off-swale	9.5	01/28/98	<0.02	0.02	<.05	0.05	<.05	0.05	<.3	0.3	7.47		28.3	
TP-3/S-4	Off-swale	9.5	01/28/98	<0.02	0.02	<.05	0.05	<.05	0.05	<.1	0.1	<5.0	5	9.48	
TP-5/S-4	Off-swale	9.5	01/28/98	<0.04	0.04	<.1	0.1	<.1	0.1	<1	1	32.3		134000	
TP-5R10	Off-swale	10.0	12/02/98	<1.78	1.78	<1.78	1.78	<1.78	1.78	<3.57	3.57			12,900	
TPB/0.5-1.1ft	On	0.8	08/08/92	<0.05	0.05	2.16		<0.05	0.05	7.99				32,000	
TPA/0.6-1.2ft	On	0.9	08/08/92	<0.05	0.05	<0.05	0.05	<0.05	0.05	<0.05	0.05			73,000	
C+00 1+00-1	On	1	05/17/01											613	
TPC/0.9-1.5ft	On	1.2	08/08/92	<0.05	0.05	150		150		2200				120,000	
B+12.5; 1+50.0	On	1.5	12/05/00	<0.00825	0.00825	<0.0206	0.0206	<0.0206	0.0206	<0.0412	0.0412	<2.06	2.06	760	
C+00.0; 1+55.0	On	1.5	12/05/00	<0.0137	0.0137	<0.0342	0.0342	<0.0342	0.0342	<0.0683	0.0683	<3.42	3.42	16	
B+05 1+00-2	On	2	05/17/01											15,600	
C+00 0+5.0-2	On	2	05/17/01											11,100	
D+00 0+50-2	On	2	05/16/01											266	
A+15.5; 1+00.0	On	3.0	12/06/00	<0.0158	0.0158	<0.0395	0.0395	<0.0395	0.0395	<0.0790	0.079	<3.95	3.95	13.2	
B+00 0+50.0-3	On	3	05/17/01											7,290	
B+05 0+75-3	On	3	05/17/01											341	
C+00 0+25.0-3	On	3	05/17/01											8.31	
C+00 1+00-3	On	3	05/17/01											592	
C+00 1+75-3	On	3	05/16/01											765	
D+00 0+62.5-3	On	3	05/16/01											315	
D-08.0; 1+37.5	On	3.0	12/05/00	<0.0120	0.012	<0.0301	0.0301	<0.0301	0.0301	<0.0602	0.0602	<3.01	3.01	21.7	
B+00 1+25-4	On	4	05/17/01											3,950	
C+00 0+50.0-4	On	4	05/17/01											17,000	
D+05.0; 0+75.0	On	4.0	12/06/00											<8.21	8.21
D-05.0; 1+25.0	On	4.0	12/05/00	<0.0118	0.0118	<0.0295	0.0295	<0.0295	0.0295	<0.0590	0.059	<2.95	2.95	4.68	
B+8.0 0+20.0-4.5	On	4.5	05/17/01											15,300	
C+00 0+5.0-4.5	On	4.5	05/17/01	0.0259		0.427		<0.0403	0.0403	1.25		36.5		16,200	
B+12.5; 1+60.0	On	5.0	12/05/00											<4.00	4
C+00 1+25-5	On	5	05/17/01											125	
D+00 0+37.5-6	On	6	05/16/01											3,520	
D+00.0; 0+25.0	On	6.0	12/05/00	<0.0291	0.0291	0.123		<0.0726	0.0726	0.609		40.8		256	
D-08.0; 1+50.0	On	6.0	12/05/00	<0.00547	0.00547	<0.0137	0.0137	<0.0137	0.0137	<0.0273	0.0273	<1.37	1.37	4.26	
A+18 0+62.5-7	On	7	05/17/01											15.3	
C+00 1+25-7	On	7	05/17/01											26.3	
D+00 0+12.5-10	On	7	05/16/01											9.23	
TP-Y-7	On	7	05/16/01											<8.16	
TP-Z-7	On	7	05/16/01											7.59	
A+10.0; 1+37.5	On	7.5	12/06/00	<0.0287	0.0287	<0.259	0.259	<0.0718	0.0718	<0.920	0.92	44.4		5,860	
D+05.0; 0+87.5	On	7.5	12/06/00	<0.00996	0.00996	<0.0249	0.0249	<0.0249	0.0249	<0.0498	0.0498	<2.49	2.49	<4.00	4
D+05.0; 1+00.0	On	7.5	12/06/00	<0.00944	0.00944	<0.0236	0.0236	<0.0236	0.0236	<0.0472	0.0472	<2.36	2.36	<4.00	4
A+15.0; 1+37.5	On	8.0	12/05/00	<0.0324	0.0324	<0.0809	0.0809	<0.0809	0.0809	<1.86	1.86	64.3		8,370	
A+16.0; 0+50.0	On	8.0	12/05/00	<0.0163	0.0163	<0.0409	0.0409	<0.0409	0.0409	<0.0817	0.0817	<4.09	4.09	6.02	
D+00 0+50-8	On	8	05/16/01											6.22	
D+00 0+62.5-8	On	8	05/16/01											10.6	
D+00.0; 1+12.5	On	8.0	12/05/00	<0.0182	0.0182	<0.0454	0.0454	<0.0454	0.0454	<0.0908	0.0908	<4.54	4.54	6.83	
A+18.0; 0+75.0	On	8.5	12/06/00	<0.0283	0.0283	<0.354	0.354	<0.0820	0.082	<0.820	0.82	61.7		14,500	
A+10.0; 1+25.0	On	9.0	12/06/00	<0.0678	0.0678	<0.569	0.569	<0.169	0.169	<2.20	2.2	102		10,700	
A+18.0; 0+87.5	On	9.0	12/06/00	0.0110		<0.0250	0.025	<0.0250	0.025	<0.0499	0.0499	<2.50	2.5	<4.00	4
A+18.0; 0+87.5	On	9.0	12/06/00	0.0153		<0.0247	0.0247	<0.0247	0.0247	<0.0493	0.0493	<2.47	2.47		
D+00 0+37.5-9	On	9	05/16/01											11,000	
A+10.0; 1+12.5	On	9.5	12/06/00	<0.0497	0.0497	<1.37	1.37	<0.176	0.176	<5.41	5.41	241		10,400	
B+00.0; 1+60.0	On	9.5	12/05/00	<0.00980	0.0098	<0.0245	0.0245	<0.0245	0.0245	<0.0490	0.049	<2.45	2.45	4.22	
A+15.5; 1+00.0	On	10.0	12/06/00	<0.152	0.152	0.227		<0.200	0.2	1.32		<20.0	20	417	
A+16.0; 0+50.0	On	10.0	12/05/00	<0.00859	0.00859	<0.0215	0.0215	<0.0215	0.0215	<0.0429	0.0429	<2.15	2.15	4.36	
D+00 0+12.5-7	On	10	05/16/01											10.3	
TP-Y-10	On	10	05/16/01	<0.0296	0.0296	<0.0741	0.0741	<0.0741	0.0741	0.225		21.4		3,720	
TP-Z-11	On	11	05/16/01											524	
C116-13	On		10/04/90	<0.012	0.012	<0.012	0.012	<0.012	0.012	<0.012	0.012				
Statistics															
# rows				114		114		114		114		114		114	
# blanks				46		46		46		46		54		5	
# samples				68		68		68		68		60		109	
# of Hits				6		9		4		18		26		97	
Max Hit				0.508		150		150		2200		269		134000	
Min Hit				0.011		0.0563		0.0557		0.0877		2.13		4.22	
Max RL					1.78		1.78		1.78		5.41		20		77.5
Min RL					0.00547		0.012		0.012		0.012		1.37		4
# RLs above RBSL					1		0		0		0		0		0
RBSL (1/10 of Ing or Inh)				0.64		8.9		18		8.1		140		825	
# Hits above RBSL				0		1		1		2		2		41	
ARAR/TBC (Table C)				0.02		5		4.8		69		260		230	
# Hits above Table C				3		1		1		1		1		61	

Notes:
Shaded values are from stockpile samples
Statistical calculations are based on site-related samples only

Table A2
Soil Analytical Results
PAHs
Unocal Bulk Plant 0736
Sitka, Alaska

Sample ID	Date	Depth (feet)	Acenaphthene	RL	Acenaphthylene	RL	Anthracene	RL	Benzo(a) anthracene	RL	Benzo(a) pyrene	RL	Benzo(b) fluoranthene	RL	Benzo(g,h,i) perylene	RL	Benzo(k) fluoranthene	RL	Chrysene	RL	Dibenz(a,h) anthracene	RL	Fluoranthene	RL	Fluorene	RL	Indeno(1,2,3-cd) pyrene	RL	Naphthalene	RL	Phenanthrene	RL	Pyrene	RL
Background and Sediment Samples																																		
BS-1	01/27/98	1			0.0233								0.019		0.0106				0.0106				0.019		0.038		0.0127				0.0148		0.0211	
BS-2	1/27/1998	1											0.0196										0.0228		0.0359								0.0196	
BS-3	1/27/1998	1			0.0166		0.0666		0.0262		0.0143		0.0571		0.0238		0.0143		0.0333				0.0856		0.038		0.0238		0.019		0.0761		0.0927	
Sample A	2/11/2000		0.0980				0.1920		0.1660		0.1660		0.2750		0.1580		0.0830		0.3390		<0.0500	0.05	0.3880		<0.0500	0.05	0.4150				0.3050		0.3020	
Sample B	2/11/2000		0.0942				0.205		0.233		0.229		0.229		0.201		0.102		0.283		<0.0500		0.442		0.152		0.479				0.557		0.455	
Sample C	2/11/2000		0.152				0.0851		0.222		0.189		0.444		0.155		0.115		0.285		<0.0500		0.255		<0.0500		0.4				0.074		0.233	
Sample D	2/11/2000		0.293				0.569		1.63		1.18		2.5		0.833		0.833		2.66		0.209		5.7		0.117		3.34				0.921		5.11	
Site-Related Samples																																		
PS-1	1/27/1998	0.5			0.0159		0.051		0.025		0.017		0.0556		0.0204		0.0136		0.0647				0.0363				0.0204						0.0567	
PS-2	1/27/1998	0.5					0.0599		0.0228		0.0171		0.0385		0.0242		0.0114		0.0143				0.0314				0.0257				0.0128		0.0442	
TP-5R10	12/2/1998	10	1.97		0.37		0.22		0.19				0.1						0.17				15.6		4.66				1.54		5.05		1.18	
NPP1-1.5	04/17/00	1.5	0.0152		<0.0134	0.0134	<0.0134	0.0134	0.0137		0.0201		<0.0134	0.0134	0.0135		<0.0134	0.0134	0.0178		<0.0134	0.0134	0.0174		<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	0.0197		0.0344	
NPP2-1.5	04/17/00	1.5	<0.268	0.268	<0.268	0.268	0.346		0.443		0.515		<0.268	0.268	0.325		0.315		0.478		<0.268	0.268	0.762		<0.268	0.268	<0.268	0.268	<0.268	0.268	1.180	1.18	1.170	1.17
NPP3-2.5	04/17/00	2.5	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134
NPP4-4	04/17/00	4	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134
NPP5-1.5	04/17/00	1.5	1.340		<0.335	0.335	2.190		2.730		3.070		1.430		1.710		1.590		2.860		0.573		4.740		0.794		1.240		0.906		8.170		7.240	
NPP10-4	04/18/00	4	<5.380	5.38	<1.080	1.08	<1.080	1.08	<1.080	1.08	<1.080	1.08	<1.080	1.08	<1.080	1.08	<1.080	1.08	<1.080	1.08	<1.080	1.08	<1.080	1.08	<5.380	5.38	<1.080	1.08	<5.380	5.38	<1.080	1.08	<1.080	1.08
NPP11-3	04/18/00	3	<8.190	8.19	<0.819	0.819	<4.100	4.1	<0.819	0.819	<0.819	0.819	<0.819	0.819	<0.819	0.819	<0.819	0.819	<0.819	0.819	<0.819	0.819	<0.819	0.819	<4.100	4.1	<0.819	0.819	<4.100	4.1	<0.819	0.819	<0.819	0.819
NPP11-5	04/18/00	5	<6.700	6.7	<1.340	1.34	<1.340	1.34	<0.134	0.134	<0.134	0.134	<0.134	0.134	<0.134	0.134	<0.134	0.134	<0.134	0.134	<0.134	0.134	<0.134	0.134	<1.340	1.34	<0.134	0.134	<1.340	1.34	0.314		<0.134	0.134
NPP12-8	04/18/00	8	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	0.0338		<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	0.0374	
NPP13-6	04/18/00	6	<2.010	2.01	<2.010	2.01	<2.010	2.01	<0.0804	0.0804	<0.0804	0.0804	<0.0804	0.0804	<0.0804	0.0804	<0.0804	0.0804	<0.0804	0.0804	<0.0804	0.0804	<0.0804	0.0804	<2.010	2.01	<0.0804	0.0804	<2.010	2.01	0.156		<0.0804	0.0804
NPP6-2	04/18/00	2	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134
NPP7-3	04/18/00	3	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134
NPP8-4	04/18/00	4	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134	<0.0134	0.0134
NPP9-4	04/18/00	4	<0.474	0.474	<0.474	0.474	<5.930	5.93	<0.474	0.474	<0.474	0.474	<0.474	0.474	<0.474	0.474	<0.474	0.474	<0.474	0.474	<0.474	0.474	<0.474	0.474	<0.474	0.474	<0.474	0.474	<1.190	1.19	<0.474	0.474	<0.474	0.474
NPP13-10	04/19/00	10	<1.610	1.61	<0.0804	0.0804	<0.0804	0.0804	<0.0804	0.0804	<0.0804	0.0804	<0.0804		<0.0804		<0.0804		<0.0804		<0.0804		<0.0804		<0.804		<0.0804		0.465		<0.0804		<0.0804	
NPP13-7	04/19/00	7	<8.380	8.38	<1.680	1.68	<1.680	1.68	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<0.0335	0.0335	<1.680	1.68	<0.0335	0.0335	<1.680	1.68	0.188		<0.0335	0.0335
NPP13-8	04/19/00	8	<0.804	0.804	<0.804	0.804	<0.804	0.804	<0.0804	0.0804	<0.0804	0.0804	<0.0804		<0.0804		<0.0804		<0.0804		<0.0804		<0.0804		<0.804		<0.0804		0.692		0.106		<0.0804	
A+15.0; 1+37.5	12/05/00	8	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	0.0204		<0.0100	0.01	0.0933		1.38		<0.0100	0.01	0.169		3.63		0.152	
A+16.0; 0+50.0	12/05/00	8	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100	
D+00.0; 0+25.0	12/05/00	6	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	1.47		<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204
A+10.0; 1+12.5	12/06/00	9.5	<0.0100	0.01	<0.0100	0.01	5.97		<0.0100	0.01	<0.0100	0.01	<0.0100		<0.0100		<0.0100		0.0186		<0.0100		0.0992		4.4		<0.0100		1.24		<0.0100		0.224	
A+10.0; 1+25.0	12/06/00	9	<0.0100	0.01	<0.0100	0.01	6.29		<0.0100	0.01	<0.0100	0.01	<0.0100		<0.0100		<0.0100		0.0144		<0.0100		0.123		3.55		<0.0100		0.0687		<0.0100		0.204	
A+10.0; 1+37.5	12/06/00	7.5	<0.0100	0.01	<0.0100	0.01	2.78		<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	0.0109		<0.0100	0.01	0.0765		1.28		<0.0100	0.01	0.0964		<0.0100	0.01	0.125	
D+00 0+37.5-9	05/16/01	9	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500		<0.0500		<0.0500		<0.0500		0.0923		<0.0500		<0.0500		3.75		<0.0500		4.14		5.33		0.254	
D+00 0+50-8	05/16/01	8	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	0.0137		<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01
D+00 0+62.5-8	05/16/01	8	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	0.0127		<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01
HA-3B	05/16/01	3.17	0.0905		<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	0.226		<0.0500	0.05	0.31		<0.0500	0.05	<0.0500	0.05
HA-4B	05/16/01	2.03	1.01		<0.275	0.275	<0.275	0.275	<0.275	0.275	<0.275	0.275	<0.275	0.275	<0.275	0.275	<0.275	0.275	<0.275	0.275	<0.275	0.275	<0.275	0.275	3.1		<0.275	0.275	<0.275	0.275	1.39		0.293	
HA-6B	05/16/01	2.17	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02
TP-W-4	05/16/01	4	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01
TP-X-8	05/16/01	8	<0.0420	0.042	<0.0420	0.042	<0.0420	0.042	<0.0420	0.042	<0.0420	0.042	<0.0420	0.042	<0.0420	0.042	<0.0420	0.042	<0.0420	0.042	<0.0420	0.042	<0.0420	0.042	0.218		<0.0420	0.042	0.42		0.185		<0.0420	0.042
TP-Y-10	05/16/01	10	0.931		0.378		<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	<0.0200	0.02	0.142		3.08		<0.0200	0.02	1.25		4.35		<0.0200	0.02
TP-Y-7	05/16/01	7	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204	<0.0204	0.0204
TP-Z-11	05/16/01	11	0.0226		<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	0.0975		<0.0100	0.01	0.0442		0.134		0.0172	
TP-Z-7	05/16/01	7	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01
B+00 1+25-4	05/17/01	4	0.475		<0.0500	0.05	2.92		<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	2.17		<0.0500	0.05	1.22		2.47		<0.0500	0.05
B+05 0+75-3	05/17/01	3	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	0.0134		<0.0100	0.01	0.0134		0.0122		<0.0100	0.01
B+8.0 0+20.0-4.5	05/17/01	4.5	0.796		<0.0500	0.05	<0.0500	0.05	0.38		0.0791		0.183		<0.0500	0.05	0.0791		0.509		<0.0500	0.05	1.93		3.07		<0.0500	0.05	2		4.15		1.99	
C+00 0+50.0-4	05/17/01	4	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	0.372		<0.100	0.1	<0.100	0.1	6.34		5.79		0.372	
C+00 1+00-3	05/17/01	3	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		0.0211		<0.0100		<0.0100		<0.0100		<0.0100		0.0336	
C+00 1+25-5	05/17/01	5	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100	0.01	<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100	
HA-7B	05/17/01	2.17	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	<0.0500	0.05	0.133		<0.0500	0.05	<0.0500	0.05
Statistics																																		
# rows			45		45		45		45		45		45		45		45		45		45		45		45		45		45		45		45	
# blanks			2		1		0		0		1		0		1		1		0		3		0		2		1		2		1		0	
# samples			43		44		45		45		44		45		44		44		45		42		45		43		44		43		44		45	
# of Hits			9		3		9		7		7		5		5		5		12		1		15		17		3		18		18		16	
Max Hit			1.97		0.378		6.29		2.73		3.07		1.43		1.71		1.59		2.86		0.573		15.6		4.66		1.24		6.34		8.17		7.24	
Min Hit			0.0152		0.0159		0.051		0.0137		0.017		0.0385		0.0135		0.0114		0.0109		0.573		0.0174		0.0127		0.0204		0.0134		0.0122		0.0172	
Max RL				8.38		2.01		5.93		1.08		1.08		1.08		1.08		1.08		1.08		1.08		1.08		5.38		1.08		5.38		1.18		1.17
Min RL				0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01
# RLs above RBSL				0		0		0		1		6		1		0		0		0		7		0		0		1		0		0		0
RBSL (1/10 of Ing or Inh)			500		500		2490		0.9		0.09		0.9		250		9.3		93		0.09		330		330		0.9		330		2490		250	
# Hits above RBSL			0		0		0		1		6		1		0		0		0		7		0		0		1		0		0		0	
ARAR/TBC (Table B)			190		190		3900		5.5		0.9		9		2500		93		550		0.9		1900		240		9		38		3900		1400	
# Hits above Table C			0		0		0		0		1		0		0		0		0		1		0		0		0		0		0		0	

Notes:
All results are in mg/kg
Shaded values are from background samples
Statistical calculations are based on site-related samples only

Table A3
Water Analytical Results
DRO, GRO, BTEX
Unocal Bulk Plant 0736
Sitka, Alaska

		(µg/l)								mg/L					mg/L		
Sample ID	Date	Benzene	RL	Ethylbenzene	RL	Toluene	RL	Xylenes	RL	TPH	GRO (AK101)	RL	DRO (AK102)	RL	Gasoline (8015)	Diesel 1 (8015)	Diesel 2 (8015)
C116-1	10/04/90	<50	50	110		<50	50	1020							<25	<25	3,000
C116-10	10/04/90	60		910		2550		12050							360	<40	<80
C116-11	10/04/90	80		680		2800		10050							510	<13	530
C116-12	10/04/90	<50	50	<50	50	<50	50	<50	50						<13	<13	460
C116-2	10/04/90	<50	50	<50	50	<50	50	510							<13	<13	190
C116-3	10/04/90	<50	50	<50	50	<50	50	245							<25	<13	650
C116-4	10/04/90	<50	50	<50	50	<50	50	177							<25	<13	190
C116-5	10/04/90	<50	50	<50	50	<50	50	<50	50						<25	<13	130
C116-6	10/04/90	<50	50	<50	50	<50	50	<50	50						<2.5	<2.5	28
C116-7	10/04/90	<50	50	<50	50	<50	50	<50	50						<25	<25	2,600
C116-8	10/04/90	<50	50	<50	50	<50	50	<50	50						<2.5	<2.5	<5
C116-9	10/04/90	<50	50	<50	50	<50	50	<50	50						<2.5	<2.5	14
SBPMW-1	08/08/92	5.4		<1.0	1	<1.0	1	3		7.7							
SBPMW-2	08/08/92	23.2		18		3		12		0.8							
SBPOS-1	08/08/92									<0.5							
SBPMW-1	11/12/92	0.7		<1.0	1	<1.0	1	<1.0	1	<0.5							
SBPMW-2	11/12/92	18.6		15		4		14		0.6							
SBPOS-1	11/12/92	0.6		2		2		22		6.1							
SBPMW-1	02/19/93	6		<1.0	1	<1.0	1	<1.0	1	1.7							
SBPMW-2	02/19/93	<0.5	0.5	8		6		8		1.2							
SBPMW-1	05/06/93	10.8		<1.0	1	<1.0	1	2		2.5							
SBPMW-2	05/06/93																
SBPOS-1	05/06/93	<0.5	0.5	1		1		3		<0.5							
SBPMW-1	10/20/94	0.93		<0.5	0.5	<0.5	0.5	<1.0	1	<1.0							
SBPMW-2	10/20/94	4.1		9.8		0.9		4.8		1.3							
SBPOS-1	10/20/94	0.91		0.75		1.8		5.4		11							
SBPMW-1	06/23/95	1.3		<0.5	0.5	<0.5	0.5	<1.0	1	3.1							
SBPOS-1	06/23/95																
SBPMW-1	03/19/96	1.2		<0.5	0.5	<0.5	0.5	<1.0	1	<0.05							
SBPMW-2	03/19/96	3.2		5.6		<0.5	0.5	2.5		0.58							
SBPOS-1	03/19/96	<0.5	0.5	<0.5	0.5	0.56		2.4		<0.05							
SBPMW-2	06/23/96																
SBPMW-1	09/25/96	<0.5	0.5	<0.5	0.5	<0.5	0.5	<1.0	1	<1.0							
SBPMW-1	09/25/96	<0.5	0.5	<0.5	0.5	<0.5	0.5	<1.0	1	<1.0							
SBPMW-2	09/25/96	1.25		1.83		<0.5	0.5	1.61		<1.0							
SBPOS-1	09/25/96	<0.5	0.5	<0.5	0.5	<0.5	0.5	1.31		<1.0							
SBPMW-1	04/03/97	0.62		<0.5	0.5	<0.5	0.5	<1.0	1	<1.0							
SBPMW-2	04/03/97	1.11		2.92		0.99		2.57		<1.0							
SBPOS-1	04/03/97	<0.5	0.5	<0.5	0.5	<0.5	0.5	2.78		<1.0							
GW-1	01/29/98	<2.50	2.5	2.9		<2.50	2.5	19.9		10.3							
GW-1	01/29/98	<10.0	10	<10.0	10	<10.0	10	<20.0	20	13.5							
WS-1	01/29/98	<0.500	0.5	<0.500	0.5	<0.500	0.5	<1.00	1	<1.00							
GW-2	01/30/98	<25.0	25	<25.0	25	<25.0	25	<50.0	50								
GW-3	01/30/98	<0.500	0.5	<0.500	0.5	<0.500	0.5	<1.00	1								
GW-4	01/30/98	2.65		8.18		<0.500	0.5	4.84									
SBPMW-1	01/30/98	<0.5	0.5	<0.5	0.5	<0.5	0.5	<1.0	1	<1.00							
SBPMW-2	01/30/98	<2.00	2	<2.00	2	<2.00	2	<6.00	6	<1.00							
SBPOS-1	01/30/98	<0.50	0.5	<0.50	0.5	<0.50	0.5	<1.00	1	<1.00							
SBPMW-1	12/03/98									<1.00							
SBPMW-2	12/03/98									<1.00							
SBPOS-1	12/03/98																
GW-9	05/17/01	2.18		4.63		0.625		6.25			0.0953		1.67				
GW-11	05/18/01	<0.200	0.2	<0.500	0.5	0.758		1.55			<0.05	0.05	0.268				
GW-2	05/18/01	0.359		<0.500	0.5	<0.500	0.5	1.98			0.0712		1.75				
GW-3	05/18/01	<0.200	0.2	<0.500	0.5	<0.500	0.5	<1.00	1		<0.05	0.05					
GW-4	05/18/01	0.999		12.6		0.552		5.97			0.0777						
GW-5	05/18/01	0.227		<0.500	0.5	0.581		1.95			<0.05	0.05	<0.156	0.156			
GW-6	05/18/01	0.31		<0.500	0.5	<0.500	0.5	1.05			<0.05	0.05	24				
GW-7	05/18/01	0.323		4.72		0.51		3.83			0.0733		14.1				
GW-8	05/18/01	0.483		<0.500	0.5	<0.500	0.5	<1.00	1		<0.05	0.05	0.76				
SBPMW-1	05/18/01	0.637		<0.500	0.5	<0.500	0.5	<1.00	1		<0.05	0.05	0.577				
SBPMW-2	05/18/01	1.18		0.765		1.16		4.52			0.329		1.36				
GW-10	05/19/01	1.49		<0.500	0.5	<0.500	0.5	<1.00	1		<0.05	0.05	0.618				
GW-12	05/19/01	0.734		<0.500	0.5	<0.500	0.5	<1.00	1		<0.05	0.05	0.397				

Notes:
µg/L = micrograms per liter
mg/L = milligrams per liter

	Benzene	RL	Ethylbenzene	RL	Toluene	RL	Xylenes	RL	TPH	GRO	RL	DRO	RL	Gasoline	Diesel 1	Diesel 2
# rows	64		64		64		64		64	64		64		64	64	64
# blanks	7		7		7		7		32	51		53		52	52	52
# samples	57		57		57		57		32	13		11		12	12	12
# of Hits	30		19		17		31		13	5		10		2	0	10
Max Hit	80		910		2800		12050		13.5	0.329		24		510	0	3000
Min Hit	0.227		0.75		0.51		1.05		0.58	0.0712		0.268		360	0	14
Max RL		50		50		50		50			0.05		0.156			
Min RL		0.2		0.5		0.5		1			0.05		0.156			
# RLs above RBSL		14		0		0		0			0		1			
RBSL (1/10 of Table C)	0.5		70		100		1000			0.13		0.15				
# Hits above RBSL	25		3		2		3			1		10				
ARAR/TBC (Table C)	5		700		1000		10000			1.3		1.5				
# Hits above Table C	7		1		2		2			0		4				

Table A4
Groundwater Analytical Results
PAHs
Unocal Bulk Plant 0736
Sitka, Alaska

Sample ID	Date	Acenaphthene	RL	Acenaphthylene	RL	Anthracene	RL	Benzo(a) anthracene	RL	Benzo(a) pyrene	RL	Benzo(b) fluoranthene	RL	Benzo(g,h,i) perylene	RL	Benzo(k) fluoranthene	RL
WS-1	01/29/98	<0.100	0.1	0.105		<0.100	0.1	0.126		0.126		0.168		0.105		<0.100	0.1
GW-1	01/29/98	3.74		1.04		1.07		<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1
GW-5	05/18/01	<0.111	0.111	<0.111	0.111	<0.111	0.111	<0.111	0.111	<0.111	0.111	<0.111	0.111	<0.111	0.111	<0.111	0.111
GW-6	05/18/01	1.21		<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1
GW-7	05/18/01	6.51		<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1
GW-8	05/18/01	0.164		<0.117	0.117	<0.117	0.117	<0.117	0.117	<0.117	0.117	<0.117	0.117	<0.117	0.117	<0.117	0.117
GW-9	05/17/01	0.901		<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1
GW-11	05/18/01	<0.118	0.118	<0.118	0.118	<0.118	0.118	<0.118	0.118	<0.118	0.118	<0.118	0.118	<0.118	0.118	<0.118	0.118
SBPMW-1	05/18/01	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1
SBPMW-2	05/18/01	0.353		<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1

Sample ID	Date	Chrysene	RL	Dibenz(a,h) anthracene	RL	Fluoranthene	RL	Fluorene	RL	Indeno(1,2,3-cd) pyrene	RL	Naphthalene	RL	Phenanthrene	RL	Pyrene	RL
WS-1	01/29/98	0.168		<0.100	0.1	<0.300	0.3	<0.100	0.1	0.105		<0.300	0.3	0.232		0.400	
GW-1	01/29/98	0.109		<0.100	0.1	0.326		12.9		<0.100	0.1	19.7		18.0		0.652	
GW-5	05/18/01	<0.111	0.111	<0.111	0.111	<0.111	0.111	0.111		<0.111	0.111	1.40		<0.111	0.111	<0.111	0.111
GW-6	05/18/01	<0.100	0.1	<0.100	0.1	<0.100	0.1	3.74		<0.100	0.1	<0.100	0.1	2.64		<0.100	0.1
GW-7	05/18/01	0.714		<0.100	0.1	<0.100	0.1	16.6		<0.100	0.1	22.7		25.4		1.92	
GW-8	05/18/01	<0.117	0.117	<0.117	0.117	<0.117	0.117	0.397		<0.117	0.117	0.210		<0.117	0.117	<0.117	0.117
GW-9	05/17/01	<0.100	0.1	<0.100	0.1	<0.100	0.1	2.28		<0.100	0.1	2.26		0.440		<0.100	0.1
GW-11	05/18/01	<0.118	0.118	<0.118	0.118	<0.118	0.118	<0.118	0.118	<0.118	0.118	<0.118	0.118	<0.118	0.118	<0.118	0.118
SBPMW-1	05/18/01	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1
SBPMW-2	05/18/01	<0.100	0.1	<0.100	0.1	<0.100	0.1	0.750		<0.100	0.1	<0.100	0.1	<0.100	0.1	<0.100	0.1

Notes:
µg/L = micrograms per liter
mg/L = milligrams per liter

	Acenaphthene	RL	Acenaphthylene	RL	Anthracene	RL	Benzo(a) anthracene	RL	Benzo(a) pyrene	RL	Benzo(b) fluoranthene	RL	Benzo(g,h,i) perylene	RL	Benzo(k) fluoranthene	RL
# rows	10		10		10		10		10		10		10		10	
# blanks	0		0		0		0		0		0		0		0	
# samples	10		10		10		10		10		10		10		10	
# of Hits	6		2		1		1		1		1		1		0	
Max Hit	6.51		1.04		1.07		0.126		0.126		0.168		0.105		0	
Min Hit	0.164		0.105		1.07		0.126		0.126		0.168		0.105		0	
Max RL		0.118		0.118		0.118		0.118		0.118		0.118		0.118		0.118
Min RL		0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.1
# RLs above RBSL		0		0		0		3		9		3		0		0
RBSL (1/10 of Table C)	220		220		1100		0.1		0.02		0.1		110		1	
# Hits above RBSL	0		0		0		1		1		1		0		0	
ARAR/TBC (Table C)	2200		2200		11000		1		0.2		1		1100		10	
# Hits above Table C	0		0		0		0		0		0		0		0	

	Chrysene	RL	Dibenz(a,h) anthracene	RL	Fluoranthene	RL	Fluorene	RL	Indeno(1,2,3-cd) pyrene	RL	Naphthalene	RL	Phenanthrene	RL	Pyrene	RL
# rows	10		10		10		10		10		10		10		10	
# blanks	0		0		0		0		0		0		0		0	
# samples	10		10		10		10		10		10		10		10	
# of Hits	3		0		1		7		1		5		5		3	
Max Hit	0.714		0		0.326		16.6		0.105		22.7		25.4		1.92	
Min Hit	0.109		0		0.326		0.111		0.105		0.21		0.232		0.4	
Max RL		0.118		0.118		0.3		0.118		0.118		0.3		0.118		0.116
Min RL		0.1		0.1		0.1		0.1		0.1		0.1		0.1		0.1
# RLs above RBSL		0		10		0		0		3		0		0		0
RBSL (1/10 of Table C)	10		0.01		146		146		0.1		146		1100		110	
# Hits above RBSL	0		0		0		0		1		0		0		0	
ARAR/TBC (Table C)	100		0.1		1460		1460		1		1460		11000		1100	
# Hits above Table C	0		0		0		0		0		0		0		0	

TABLE A5
SUMMARY OF 2004 SOIL SAMPLING RESULTS
FORMER UNOCAL BULK PLANT NO. 0736
SITKA, ALASKA

Sample ID	Sample Depth (feet)	Date Sampled	BETX[1] (mg/kg) B	E	T	X	GRO[2] (mg/kg)	DRO[3] (mg/kg)	Lead[4] (mg/kg)	PAH[5] (mg/kg)
1-2	5-7	09/01/04	<0.00504	<0.0101	<0.0101	<0.0151	<1.01	<28.0	12.6	Note [6]
1-3	7.5-9.5	09/01/04	<0.00723	<0.0145	<0.0145	<0.0217	<1.45	<28.8	5.14	Note [6]
1-4	10-12	09/01/04	<0.00848	<0.0170	<0.0170	<0.0255	<1.70	<28.2	5.25	Note [6]
2-1	2.5-4.5	09/01/04	<0.00903	<0.0181	<0.0181	<0.0271	<1.81	<28.4	2.58	Note [6]
2-2	5-7	09/01/04	<0.00679	<0.0136	<0.0136	<0.0204	<1.36	<25.0	4.21	Note [6]
3-1	7.5-9.5	09/01/04	<0.00506	<0.0101	<0.0101	<0.0152	<1.01	<28.3	3.84	Note [6]
3-2	10-12	09/01/04	<0.00854	<0.0171	<0.0171	<0.0256	<1.71	<28.1	2.89	Note [6]
4-1	12.5-14.5	09/01/04	<0.00894	<0.0179	<0.0179	<0.0268	<1.79	<25.0	8.96	Note [6]
4-2	15-17	09/01/04	<0.00588	<0.0118	<0.0118	<0.0176	<1.18	<28.9	6.39	Note [6]
5-4	10-12	09/01/04	<0.0617	<0.123	<0.123	<0.185	<12.3	<77.4	<5.46	Note [6]
5-5	15-17	09/01/04	<0.0166	<0.0333	<0.0333	<0.0500	<3.33	32.1	<2.00	Note [6]
5-6	17.5-19.5	09/01/04	<0.0105	<0.0210	0.149	<0.0315	<2.10	<27.9	<2.00	Note [6]
ADEC Method Two Cleanup Level[7]			0.02	5	4.8	69	260	230	400	Various

Notes:

[1]B = benzene, E = ethylbenzene, T = toluene, X = xylenes; by Alaska Method AK101

[2]GRO = Gasoline-Range Organics by Alaska Method AK101

[3]DRO = Diesel-Range Organics by Alaska Method AK102

[4]Lead (Total Metals) by U.S. Environmental Protection Agency (EPA) 6000/7000 Series Methods

[5]PAH = Polycyclic Aromatic Hydrocarbons by GC/MS with Selected Ion Monitoring

[6]PAH compounds either not detected or less than applicable Method Two Cleanup Level.

[7]Alaska Department of Environmental Conservation (ADEC), Method Two, Over 40-Inch Zone, Migration to Groundwater Pathway.

mg/kg = milligrams per kilogram

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
PL 1.5-0.5'	B3D0597-01	Soil	04/24/03 11:15	04/26/03 09:30
PL 1.5-1.5'	B3D0597-02	Soil	04/24/03 11:20	04/26/03 09:30
PL 10-0.3'	B3D0597-03	Soil	04/24/03 11:50	04/26/03 09:30
PL 10-0.6'	B3D0597-04	Soil	04/24/03 13:00	04/26/03 09:30
PL 10-2.0'	B3D0597-05	Soil	04/24/03 13:05	04/26/03 09:30
PL 18.5-0.4'	B3D0597-06	Soil	04/24/03 12:05	04/26/03 09:30
PL 18.5-1.8'	B3D0597-07	Soil	04/24/03 12:10	04/26/03 09:30
PL 30-0.4'	B3D0597-08	Soil	04/24/03 13:20	04/26/03 09:30
PL 30-1.8'	B3D0597-09	Soil	04/24/03 13:25	04/26/03 09:30
PL 42.3-0.3'	B3D0597-10	Soil	04/24/03 13:35	04/26/03 09:30
PL 42.3-1.6'	B3D0597-11	Soil	04/24/03 13:40	04/26/03 09:30
PL 53-0.4'	B3D0597-12	Soil	04/24/03 13:50	04/26/03 09:30
PL 53-2.0'	B3D0597-13	Soil	04/24/03 13:55	04/26/03 09:30
PL 64.4-0.4'	B3D0597-14	Soil	04/24/03 14:55	04/26/03 09:30
PL 64.4-1.3'	B3D0597-15	Soil	04/24/03 15:00	04/26/03 09:30
PL 71.3-0.5'	B3D0597-16	Soil	04/24/03 15:20	04/26/03 09:30
PL 71.3-1.5'	B3D0597-17	Soil	04/24/03 15:25	04/26/03 09:30
PL 75.4-0.5'	B3D0597-18	Soil	04/24/03 15:50	04/26/03 09:30
PL 75.4-1.5'	B3D0597-19	Soil	04/24/03 15:55	04/26/03 09:30
PL 81-0.5'	B3D0597-20	Soil	04/24/03 16:10	04/26/03 09:30
PL 81-1.7'	B3D0597-21	Soil	04/24/03 16:15	04/26/03 09:30
PL 86.4-0.5'	B3D0597-22	Soil	04/24/03 16:45	04/26/03 09:30
PL 86.4-1.5'	B3D0597-23	Soil	04/24/03 16:50	04/26/03 09:30
PL 91-0.5'	B3D0597-24	Soil	04/24/03 17:00	04/26/03 09:30
PL 91-1.5'	B3D0597-25	Soil	04/24/03 17:05	04/26/03 09:30
PL 98.5-0.5'	B3D0597-26	Soil	04/24/03 17:10	04/26/03 09:30
PL 98.5-1.0'	B3D0597-27	Soil	04/24/03 17:15	04/26/03 09:30
Seep	B3D0597-28	Water	04/24/03 09:30	04/26/03 09:30

North Creek Analytical - Bothell

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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4951 Eagle St	Project Number: 0161-302-03	**Reported:**
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Polynuclear Aromatic Hydrocarbons by GC/MS-SIM
North Creek Analytical - Bothell

Seep (B3D0597-28) Water Sampled: 04/24/03 09:30 Received: 04/26/03 09:30

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Acenaphthene	ND	0.137	ug/l	1	3D29009	04/29/03	05/01/03	EPA 8270C-SIM	
Acenaphthylene	ND	0.137	"	"	"	"	"	"	
Anthracene	ND	0.137	"	"	"	"	"	"	
Benzo (a) anthracene	**0.164**	0.137	"	"	"	"	"	"	
Benzo (a) pyrene	ND	0.137	"	"	"	"	"	"	
Benzo (b) fluoranthene	ND	0.137	"	"	"	"	"	"	
Benzo (ghi) perylene	ND	0.137	"	"	"	"	"	"	
Benzo (k) fluoranthene	ND	0.137	"	"	"	"	"	"	
Chrysene	ND	0.137	"	"	"	"	"	"	
Dibenz (a,h) anthracene	ND	0.137	"	"	"	"	"	"	
Fluoranthene	ND	0.137	"	"	"	"	"	"	
Fluorene	ND	0.137	"	"	"	"	"	"	
Indeno (1,2,3-cd) pyrene	ND	0.137	"	"	"	"	"	"	
1-Methylnaphthalene	ND	0.137	"	"	"	"	"	"	
2-Methylnaphthalene	ND	0.137	"	"	"	"	"	"	
Naphthalene	ND	0.137	"	"	"	"	"	"	
Phenanthrene	ND	0.137	"	"	"	"	"	"	
Pyrene	**0.603**	0.137	"	"	"	"	"	"	
Surrogate: p-Terphenyl-d14	*49.3 %*	*30-150*			"	"	"	"	

North Creek Analytical - Bothell

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Gasoline Hydrocarbons (n-Hexane to <n-Decane) and BTEX by AK101/EPA 8021B

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
PL 10-0.6' (B3D0597-04) Soil Sampled: 04/24/03 13:00 Received: 04/26/03 09:30									
Gasoline Range Hydrocarbons	**525**	5.36	mg/kg dry	2	3E01008	05/01/03	05/02/03	AK 101	G-02
Benzene	ND	0.0215	"	"	"	"	"	"	
Toluene	**0.0798**	0.0536	"	"	"	"	"	"	I-06
Ethylbenzene	**0.622**	0.0536	"	"	"	"	"	"	
Xylenes (total)	**6.15**	0.107	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*%*	*60-120*			"	"	"	"	*S-02*
Surrogate: a,a,a-TFT (FID)	*88.4 %*	*50-150*			"	"	"	"	
Surrogate: 4-BFB (PID)	*%*	*64-125*			"	"	"	"	*S-02*
Surrogate: a,a,a-TFT (PID)	*84.5 %*	*50-150*			"	"	"	"	
PL 10-2.0' (B3D0597-05) Soil Sampled: 04/24/03 13:05 Received: 04/26/03 09:30									
Gasoline Range Hydrocarbons	**12.4**	2.64	mg/kg dry	1	3E01008	05/01/03	05/02/03	AK 101	G-01
Benzene	ND	0.0105	"	"	"	"	"	"	
Toluene	ND	0.0264	"	"	"	"	"	"	
Ethylbenzene	ND	0.0264	"	"	"	"	"	"	
Xylenes (total)	**0.159**	0.0527	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*151 %*	*60-120*			"	"	"	"	*S-04*
Surrogate: a,a,a-TFT (FID)	*80.3 %*	*50-150*			"	"	"	"	
Surrogate: 4-BFB (PID)	*116 %*	*64-125*			"	"	"	"	
Surrogate: a,a,a-TFT (PID)	*83.6 %*	*50-150*			"	"	"	"	
PL 75.4-0.5' (B3D0597-18) Soil Sampled: 04/24/03 15:50 Received: 04/26/03 09:30									
Gasoline Range Hydrocarbons	ND	22.1	mg/kg dry	1	3E01008	05/01/03	05/02/03	AK 101	
Benzene	ND	0.0883	"	"	"	"	"	"	
Toluene	ND	0.221	"	"	"	"	"	"	
Ethylbenzene	ND	0.221	"	"	"	"	"	"	
Xylenes (total)	ND	0.442	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*90.1 %*	*60-120*			"	"	"	"	
Surrogate: a,a,a-TFT (FID)	*65.8 %*	*50-150*			"	"	"	"	
Surrogate: 4-BFB (PID)	*92.7 %*	*64-125*			"	"	"	"	
Surrogate: a,a,a-TFT (PID)	*66.8 %*	*50-150*			"	"	"	"	

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Gasoline Hydrocarbons (n-Hexane to <n-Decane) and BTEX by AK101/EPA 8021B

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
PL 75.4-1.5' (B3D0597-19) Soil Sampled: 04/24/03 15:55 Received: 04/26/03 09:30									
Gasoline Range Hydrocarbons	ND	9.79	mg/kg dry	1	3E01008	05/01/03	05/02/03	AK 101	
Benzene	ND	0.0392	"	"	"	"	"	"	
Toluene	ND	0.0979	"	"	"	"	"	"	
Ethylbenzene	ND	0.0979	"	"	"	"	"	"	
Xylenes (total)	ND	0.196	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*96.2 %*	*60-120*			"	"	"	"	
Surrogate: a,a,a-TFT (FID)	*59.1 %*	*50-150*			"	"	"	"	
Surrogate: 4-BFB (PID)	*95.7 %*	*64-125*			"	"	"	"	
Surrogate: a,a,a-TFT (PID)	*61.1 %*	*50-150*			"	"	"	"	
PL 86.4-0.5' (B3D0597-22) Soil Sampled: 04/24/03 16:45 Received: 04/26/03 09:30									
Gasoline Range Hydrocarbons	ND	17.5	mg/kg dry	1	3E01008	05/01/03	05/02/03	AK 101	
Benzene	ND	0.0699	"	"	"	"	"	"	
Toluene	ND	0.175	"	"	"	"	"	"	
Ethylbenzene	ND	0.175	"	"	"	"	"	"	
Xylenes (total)	ND	0.349	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*90.0 %*	*60-120*			"	"	"	"	
Surrogate: a,a,a-TFT (FID)	*69.1 %*	*50-150*			"	"	"	"	
Surrogate: 4-BFB (PID)	*94.2 %*	*64-125*			"	"	"	"	
Surrogate: a,a,a-TFT (PID)	*70.3 %*	*50-150*			"	"	"	"	
PL 86.4-1.5' (B3D0597-23) Soil Sampled: 04/24/03 16:50 Received: 04/26/03 09:30									
Gasoline Range Hydrocarbons	ND	20.7	mg/kg dry	1	3E01008	05/01/03	05/02/03	AK 101	
Benzene	ND	0.0826	"	"	"	"	"	"	
Toluene	ND	0.207	"	"	"	"	"	"	
Ethylbenzene	ND	0.207	"	"	"	"	"	"	
Xylenes (total)	ND	0.413	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*88.4 %*	*60-120*			"	"	"	"	
Surrogate: a,a,a-TFT (FID)	*50.4 %*	*50-150*			"	"	"	"	
Surrogate: 4-BFB (PID)	*95.0 %*	*64-125*			"	"	"	"	
Surrogate: a,a,a-TFT (PID)	*51.8 %*	*50-150*			"	"	"	"	

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Gasoline Hydrocarbons (n-Hexane to <n-Decane) and BTEX by AK101/EPA 8021B

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Seep (B3D0597-28) Water Sampled: 04/24/03 09:30 Received: 04/26/03 09:30									
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	3D30011	05/01/03	05/01/03	AK 101	
Benzene	ND	0.200	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	**1.46**	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*90.8 %*	*60-120*			"	"	"	"	
Surrogate: 4-BFB (PID)	*100 %*	*62-120*			"	"	"	"	

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Diesel Hydrocarbons (C10-C25) by AK102
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Seep (B3D0597-28) Water Sampled: 04/24/03 09:30 Received: 04/26/03 09:30									
Diesel Range Hydrocarbons	**0.284**	0.118	mg/l	1	3D30002	04/30/03	05/01/03	AK 102	
Surrogate: 2-FBP	*73.1 %*	*50-150*			"	"	"	"	

North Creek Analytical - Bothell

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Total Metals by EPA 6000/7000 Series Methods

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
PL 1.5-0.5' (B3D0597-01) Soil Sampled: 04/24/03 11:15 Received: 04/26/03 09:30									
Lead	**45.1**	0.500	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 1.5-1.5' (B3D0597-02) Soil Sampled: 04/24/03 11:20 Received: 04/26/03 09:30									
Lead	**14.5**	0.500	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 10-0.3' (B3D0597-03) Soil Sampled: 04/24/03 11:50 Received: 04/26/03 09:30									
Lead	**20.3**	0.500	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 10-0.6' (B3D0597-04) Soil Sampled: 04/24/03 13:00 Received: 04/26/03 09:30									
Lead	**5.48**	0.500	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 10-2.0' (B3D0597-05) Soil Sampled: 04/24/03 13:05 Received: 04/26/03 09:30									
Lead	**3.53**	0.500	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 18.5-0.4' (B3D0597-06) Soil Sampled: 04/24/03 12:05 Received: 04/26/03 09:30									
Lead	**101**	1.13	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 18.5-1.8' (B3D0597-07) Soil Sampled: 04/24/03 12:10 Received: 04/26/03 09:30									
Lead	**40.3**	1.02	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 30-0.4' (B3D0597-08) Soil Sampled: 04/24/03 13:20 Received: 04/26/03 09:30									
Lead	**198**	0.500	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 30-1.8' (B3D0597-09) Soil Sampled: 04/24/03 13:25 Received: 04/26/03 09:30									
Lead	**18.8**	1.96	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Total Metals by EPA 6000/7000 Series Methods
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
PL 42.3-0.3' (B3D0597-10) Soil Sampled: 04/24/03 13:35 Received: 04/26/03 09:30									
Lead	**282**	1.08	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 42.3-1.6' (B3D0597-11) Soil Sampled: 04/24/03 13:40 Received: 04/26/03 09:30									
Lead	**55.1**	1.49	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 53-0.4' (B3D0597-12) Soil Sampled: 04/24/03 13:50 Received: 04/26/03 09:30									
Lead	**723**	7.85	mg/kg dry	5	3D28036	04/28/03	04/29/03	EPA 6020	
PL 53-2.0' (B3D0597-13) Soil Sampled: 04/24/03 13:55 Received: 04/26/03 09:30									
Lead	**173**	1.40	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 64.4-0.4' (B3D0597-14) Soil Sampled: 04/24/03 14:55 Received: 04/26/03 09:30									
Lead	**460**	1.46	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 64.4-1.3' (B3D0597-15) Soil Sampled: 04/24/03 15:00 Received: 04/26/03 09:30									
Lead	**44.9**	1.21	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 71.3-0.5' (B3D0597-16) Soil Sampled: 04/24/03 15:20 Received: 04/26/03 09:30									
Lead	**961**	7.46	mg/kg dry	5	3D28036	04/28/03	04/29/03	EPA 6020	
PL 71.3-1.5' (B3D0597-17) Soil Sampled: 04/24/03 15:25 Received: 04/26/03 09:30									
Lead	**34.7**	1.59	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	
PL 75.4-0.5' (B3D0597-18) Soil Sampled: 04/24/03 15:50 Received: 04/26/03 09:30									
Lead	**209**	1.72	mg/kg dry	1	3D28036	04/28/03	04/29/03	EPA 6020	

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Total Metals by EPA 6000/7000 Series Methods

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
PL 75.4-1.5' (B3D0597-19) Soil Sampled: 04/24/03 15:55 Received: 04/26/03 09:30									
Lead	**228**	1.21	mg/kg dry	1	3D28037	04/28/03	04/29/03	EPA 6020	
PL 81-0.5' (B3D0597-20) Soil Sampled: 04/24/03 16:10 Received: 04/26/03 09:30									
Lead	**1030**	6.59	mg/kg dry	5	3D28037	04/28/03	04/29/03	EPA 6020	
PL 81-1.7' (B3D0597-21) Soil Sampled: 04/24/03 16:15 Received: 04/26/03 09:30									
Lead	**201**	2.22	mg/kg dry	1	3D28037	04/28/03	04/29/03	EPA 6020	
PL 86.4-0.5' (B3D0597-22) Soil Sampled: 04/24/03 16:45 Received: 04/26/03 09:30									
Lead	**1340**	13.7	mg/kg dry	10	3D28037	04/28/03	04/29/03	EPA 6020	
PL 86.4-1.5' (B3D0597-23) Soil Sampled: 04/24/03 16:50 Received: 04/26/03 09:30									
Lead	**282**	2.07	mg/kg dry	1	3D28037	04/28/03	04/29/03	EPA 6020	
PL 91-0.5' (B3D0597-24) Soil Sampled: 04/24/03 17:00 Received: 04/26/03 09:30									
Lead	**1260**	12.3	mg/kg dry	10	3D28037	04/28/03	04/29/03	EPA 6020	
PL 91-1.5' (B3D0597-25) Soil Sampled: 04/24/03 17:05 Received: 04/26/03 09:30									
Lead	**581**	2.38	mg/kg dry	1	3D28037	04/28/03	04/29/03	EPA 6020	
PL 98.5-0.5' (B3D0597-26) Soil Sampled: 04/24/03 17:10 Received: 04/26/03 09:30									
Lead	**1130**	4.22	mg/kg dry	2	3D28037	04/28/03	04/29/03	EPA 6020	
PL 98.5-1.0' (B3D0597-27) Soil Sampled: 04/24/03 17:15 Received: 04/26/03 09:30									
Lead	**495**	1.99	mg/kg dry	1	3D28037	04/28/03	04/29/03	EPA 6020	

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Geo Engineers - Alaska	Project:	UNOCAL BP #0736	
4951 Eagle St	Project Number:	0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager:	Liz Shen	05/09/03 16:04

Dissolved Metals by EPA 6000/7000 Series Methods

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Seep (B3D0597-28) Water Sampled: 04/24/03 09:30 Received: 04/26/03 09:30									
Lead	ND	0.00100	mg/l	1	3D29030	04/29/03	04/30/03	EPA 6020	

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

TCLP Metals by EPA 1311/6000/7000 Series Methods

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
PL 86.4-0.5' (B3D0597-22) Soil Sampled: 04/24/03 16:45 Received: 04/26/03 09:30									
Lead	ND	2.50	mg/l	50	3E07024	05/07/03	05/09/03	EPA 6020	
PL 91-0.5' (B3D0597-24) Soil Sampled: 04/24/03 17:00 Received: 04/26/03 09:30									
Lead	ND	2.50	mg/l	50	3E07024	05/07/03	05/09/03	EPA 6020	
PL 98.5-0.5' (B3D0597-26) Soil Sampled: 04/24/03 17:10 Received: 04/26/03 09:30									
Lead	ND	2.50	mg/l	50	3E07024	05/07/03	05/09/03	EPA 6020	

North Creek Analytical - Bothell

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Jeff Gerdes

Jeff Gerdes, Project Manager

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Physical Parameters by APHA/ASTM/EPA Methods
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
PL 1.5-0.5' (B3D0597-01) Soil Sampled: 04/24/03 11:15 Received: 04/26/03 09:30									
Dry Weight	**58.8**	1.00	%	1	3E01015	05/01/03	05/02/03	BSOPSPL003R07	
PL 1.5-1.5' (B3D0597-02) Soil Sampled: 04/24/03 11:20 Received: 04/26/03 09:30									
Dry Weight	**54.5**	1.00	%	1	3E01015	05/01/03	05/02/03	BSOPSPL003R07	
PL 10-0.3' (B3D0597-03) Soil Sampled: 04/24/03 11:50 Received: 04/26/03 09:30									
Dry Weight	**52.5**	1.00	%	1	3E01015	05/01/03	05/02/03	BSOPSPL003R07	
PL 10-0.6' (B3D0597-04) Soil Sampled: 04/24/03 13:00 Received: 04/26/03 09:30									
Dry Weight	**82.9**	1.00	%	1	3E01015	05/01/03	05/02/03	BSOPSPL003R07	
PL 10-2.0' (B3D0597-05) Soil Sampled: 04/24/03 13:05 Received: 04/26/03 09:30									
Dry Weight	**83.5**	1.00	%	1	3E01015	05/01/03	05/02/03	BSOPSPL003R07	
PL 18.5-0.4' (B3D0597-06) Soil Sampled: 04/24/03 12:05 Received: 04/26/03 09:30									
Dry Weight	**44.1**	1.00	%	1	3E01015	05/01/03	05/02/03	BSOPSPL003R07	
PL 18.5-1.8' (B3D0597-07) Soil Sampled: 04/24/03 12:10 Received: 04/26/03 09:30									
Dry Weight	**48.9**	1.00	%	1	3E01015	05/01/03	05/02/03	BSOPSPL003R07	
PL 30-0.4' (B3D0597-08) Soil Sampled: 04/24/03 13:20 Received: 04/26/03 09:30									
Dry Weight	**50.5**	1.00	%	1	3E01015	05/01/03	05/02/03	BSOPSPL003R07	
PL 30-1.8' (B3D0597-09) Soil Sampled: 04/24/03 13:25 Received: 04/26/03 09:30									
Dry Weight	**25.5**	1.00	%	1	3E01015	05/01/03	05/02/03	BSOPSPL003R07	

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Geo Engineers - Alaska	Project:	UNOCAL BP #0736	
4951 Eagle St	Project Number:	0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager:	Liz Shen	05/09/03 16:04

Physical Parameters by APHA/ASTM/EPA Methods
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
PL 42.3-0.3' (B3D0597-10) Soil Sampled: 04/24/03 13:35 Received: 04/26/03 09:30									
Dry Weight	**46.4**	1.00	%	1	3E01015	05/01/03	05/02/03	BSOPSPL003R07	
PL 42.3-1.6' (B3D0597-11) Soil Sampled: 04/24/03 13:40 Received: 04/26/03 09:30									
Dry Weight	**37.3**	1.00	%	1	3E01015	05/01/03	05/02/03	BSOPSPL003R07	
PL 53-0.4' (B3D0597-12) Soil Sampled: 04/24/03 13:50 Received: 04/26/03 09:30									
Dry Weight	**31.9**	1.00	%	1	3E01015	05/01/03	05/02/03	BSOPSPL003R07	
PL 53-2.0' (B3D0597-13) Soil Sampled: 04/24/03 13:55 Received: 04/26/03 09:30									
Dry Weight	**35.8**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	
PL 64.4-0.4' (B3D0597-14) Soil Sampled: 04/24/03 14:55 Received: 04/26/03 09:30									
Dry Weight	**37.9**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	
PL 64.4-1.3' (B3D0597-15) Soil Sampled: 04/24/03 15:00 Received: 04/26/03 09:30									
Dry Weight	**41.3**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	
PL 71.3-0.5' (B3D0597-16) Soil Sampled: 04/24/03 15:20 Received: 04/26/03 09:30									
Dry Weight	**33.5**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	
PL 71.3-1.5' (B3D0597-17) Soil Sampled: 04/24/03 15:25 Received: 04/26/03 09:30									
Dry Weight	**35.0**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	
PL 75.4-0.5' (B3D0597-18) Soil Sampled: 04/24/03 15:50 Received: 04/26/03 09:30									
Dry Weight	**29.1**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	

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Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Physical Parameters by APHA/ASTM/EPA Methods

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
PL 75.4-1.5' (B3D0597-19) Soil Sampled: 04/24/03 15:55 Received: 04/26/03 09:30									
Dry Weight	**41.4**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	
PL 81-0.5' (B3D0597-20) Soil Sampled: 04/24/03 16:10 Received: 04/26/03 09:30									
Dry Weight	**37.9**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	
PL 81-1.7' (B3D0597-21) Soil Sampled: 04/24/03 16:15 Received: 04/26/03 09:30									
Dry Weight	**22.5**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	
PL 86.4-0.5' (B3D0597-22) Soil Sampled: 04/24/03 16:45 Received: 04/26/03 09:30									
Dry Weight	**36.6**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	
PL 86.4-1.5' (B3D0597-23) Soil Sampled: 04/24/03 16:50 Received: 04/26/03 09:30									
Dry Weight	**24.2**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	
PL 91-0.5' (B3D0597-24) Soil Sampled: 04/24/03 17:00 Received: 04/26/03 09:30									
Dry Weight	**40.8**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	
PL 91-1.5' (B3D0597-25) Soil Sampled: 04/24/03 17:05 Received: 04/26/03 09:30									
Dry Weight	**23.3**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	
PL 98.5-0.5' (B3D0597-26) Soil Sampled: 04/24/03 17:10 Received: 04/26/03 09:30									
Dry Weight	**23.7**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	
PL 98.5-1.0' (B3D0597-27) Soil Sampled: 04/24/03 17:15 Received: 04/26/03 09:30									
Dry Weight	**25.1**	1.00	%	1	3E01016	05/01/03	05/02/03	BSOPSPL003R07	

North Creek Analytical - Bothell

Jeff Gerdes, Project Manager

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Geo Engineers - Alaska	Project:	UNOCAL BP #0736	
4951 Eagle St	Project Number:	0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager:	Liz Shen	05/09/03 16:04

Polynuclear Aromatic Hydrocarbons by GC/MS-SIM - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3D29009: Prepared 04/29/03 Using EPA 3520C										
Blank (3D29009-BLK1)										
Acenaphthene	ND	0.100	ug/l							
Acenaphthylene	ND	0.100	"							
Anthracene	ND	0.100	"							
Benzo (a) anthracene	ND	0.100	"							
Benzo (a) pyrene	ND	0.100	"							
Benzo (b) fluoranthene	ND	0.100	"							
Benzo (ghi) perylene	ND	0.100	"							
Benzo (k) fluoranthene	ND	0.100	"							
Chrysene	ND	0.100	"							
Dibenz (a,h) anthracene	ND	0.100	"							
Fluoranthene	ND	0.100	"							
Fluorene	ND	0.100	"							
Indeno (1,2,3-cd) pyrene	ND	0.100	"							
1-Methylnaphthalene	ND	0.100	"							
2-Methylnaphthalene	ND	0.100	"							
Naphthalene	ND	0.100	"							
Phenanthrene	ND	0.100	"							
Pyrene	ND	0.100	"							
Surrogate: p-Terphenyl-d14	*45.9*		*"*	*50.0*		*91.8*	*30-150*			
LCS (3D29009-BS1)										
Acenaphthene	7.94	0.100	ug/l	10.0		79.4	40-150			
Acenaphthylene	7.16	0.100	"	10.0		71.6	40-150			
Anthracene	8.70	0.100	"	10.0		87.0	40-150			
Benzo (a) anthracene	9.54	0.100	"	10.0		95.4	40-150			
Benzo (a) pyrene	9.42	0.100	"	10.0		94.2	40-150			
Benzo (b) fluoranthene	8.24	0.100	"	10.0		82.4	40-150			
Benzo (ghi) perylene	7.20	0.100	"	10.0		72.0	40-150			
Benzo (k) fluoranthene	7.86	0.100	"	10.0		78.6	40-150			
Chrysene	8.14	0.100	"	10.0		81.4	40-150			
Dibenz (a,h) anthracene	7.04	0.100	"	10.0		70.4	40-150			
Fluoranthene	9.48	0.100	"	10.0		94.8	40-150			
Fluorene	8.50	0.100	"	10.0		85.0	40-150			
Indeno (1,2,3-cd) pyrene	7.98	0.100	"	10.0		79.8	40-150			
Naphthalene	7.76	0.100	"	10.0		77.6	40-150			

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
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Polynuclear Aromatic Hydrocarbons by GC/MS-SIM - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3D29009: Prepared 04/29/03 Using EPA 3520C										
LCS (3D29009-BS1)										
Phenanthrene	7.92	0.100	ug/l	10.0		79.2	40-150			
Pyrene	8.72	0.100	"	10.0		87.2	40-150			
Surrogate: p-Terphenyl-d14	*45.7*		*"*	*50.0*		*91.4*	*30-150*			
LCS Dup (3D29009-BSD1)										
Acenaphthene	10.2	0.100	ug/l	10.0		102	40-150	24.9	50	
Acenaphthylene	8.76	0.100	"	10.0		87.6	40-150	20.1	50	
Anthracene	10.3	0.100	"	10.0		103	40-150	16.8	50	
Benzo (a) anthracene	11.8	0.100	"	10.0		118	40-150	21.2	50	
Benzo (a) pyrene	11.7	0.100	"	10.0		117	40-150	21.6	50	
Benzo (b) fluoranthene	9.90	0.100	"	10.0		99.0	40-150	18.3	50	
Benzo (ghi) perylene	8.70	0.100	"	10.0		87.0	40-150	18.9	50	
Benzo (k) fluoranthene	9.74	0.100	"	10.0		97.4	40-150	21.4	50	
Chrysene	10.4	0.100	"	10.0		104	40-150	24.4	50	
Dibenz (a,h) anthracene	8.76	0.100	"	10.0		87.6	40-150	21.8	50	
Fluoranthene	10.7	0.100	"	10.0		107	40-150	12.1	50	
Fluorene	10.5	0.100	"	10.0		105	40-150	21.1	50	
Indeno (1,2,3-cd) pyrene	10.2	0.100	"	10.0		102	40-150	24.4	50	
Naphthalene	10.2	0.100	"	10.0		102	40-150	27.2	50	
Phenanthrene	9.50	0.100	"	10.0		95.0	40-150	18.1	50	
Pyrene	10.9	0.100	"	10.0		109	40-150	22.2	50	
Surrogate: p-Terphenyl-d14	*55.9*		*"*	*50.0*		*112*	*30-150*			

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Gasoline Hydrocarbons (n-Hexane to <n-Decane) and BTEX by AK101/EPA 8021B - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3D30011: Prepared 05/01/03 Using EPA 5030B (P/T)										
Blank (3D30011-BLK1)										
Gasoline Range Hydrocarbons	ND	50.0	ug/l							
Benzene	ND	0.200	"							
Toluene	ND	0.500	"							
Ethylbenzene	ND	0.500	"							
Xylenes (total)	ND	1.00	"							
Surrogate: 4-BFB (FID)	*43.9*		*"*	*48.0*		*91.5*	*60-120*			
Surrogate: 4-BFB (PID)	*48.5*		*"*	*48.0*		*101*	*62-120*			
LCS (3D30011-BS1)										
Gasoline Range Hydrocarbons	498	50.0	ug/l	502		99.2	60-120			
Benzene	7.10	0.200	"	6.21		114	80-120			
Toluene	35.8	0.500	"	38.1		94.0	80-120			
Ethylbenzene	9.12	0.500	"	8.94		102	80-120			
Xylenes (total)	44.0	1.00	"	44.0		100	80-120			
Surrogate: 4-BFB (FID)	*47.6*		*"*	*48.0*		*99.2*	*60-120*			
Surrogate: 4-BFB (PID)	*47.2*		*"*	*48.0*		*98.3*	*62-120*			
LCS Dup (3D30011-BSD1)										
Gasoline Range Hydrocarbons	489	50.0	ug/l	502		97.4	60-120	1.82	20	
Benzene	6.38	0.200	"	6.21		103	80-120	10.7	40	
Toluene	35.7	0.500	"	38.1		93.7	80-120	0.280	40	
Ethylbenzene	9.06	0.500	"	8.94		101	80-120	0.660	40	
Xylenes (total)	43.7	1.00	"	44.0		99.3	80-120	0.684	40	
Surrogate: 4-BFB (FID)	*48.0*		*"*	*48.0*		*100*	*60-120*			
Surrogate: 4-BFB (PID)	*46.8*		*"*	*48.0*		*97.5*	*62-120*			
Matrix Spike (3D30011-MS1)					**Source: B3D0593-04**					
Gasoline Range Hydrocarbons	504	50.0	ug/l	502	10.7	98.3	60-120			
Benzene	6.78	0.200	"	6.21	0.138	107	80-134			
Toluene	36.9	0.500	"	38.1	ND	96.9	68-114			
Ethylbenzene	9.38	0.500	"	8.94	ND	105	72-128			
Xylenes (total)	45.4	1.00	"	44.0	ND	103	67-125			
Surrogate: 4-BFB (FID)	*48.1*		*"*	*48.0*		*100*	*60-120*			
Surrogate: 4-BFB (PID)	*47.1*		*"*	*48.0*		*98.1*	*62-120*			

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Gasoline Hydrocarbons (n-Hexane to <n-Decane) and BTEX by AK101/EPA 8021B - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3D30011: Prepared 05/01/03 Using EPA 5030B (P/T)										
Matrix Spike Dup (3D30011-MSD1)					**Source: B3D0593-04**					
Gasoline Range Hydrocarbons	490	50.0	ug/l	502	10.7	95.5	60-120	2.82	20	
Benzene	6.78	0.200	"	6.21	0.138	107	80-134	0.00	40	
Toluene	37.2	0.500	"	38.1	ND	97.6	68-114	0.810	40	
Ethylbenzene	9.39	0.500	"	8.94	ND	105	72-128	0.107	40	
Xylenes (total)	45.6	1.00	"	44.0	ND	104	67-125	0.440	40	
Surrogate: 4-BFB (FID)	*47.3*		*"*	*48.0*		*98.5*	*60-120*			
Surrogate: 4-BFB (PID)	*47.4*		*"*	*48.0*		*98.8*	*62-120*			
Batch 3E01008: Prepared 05/01/03 Using EPA 5030B (P/T)										
Blank (3E01008-BLK1)										
Gasoline Range Hydrocarbons	ND	5.00	mg/kg							
Benzene	ND	0.0200	"							
Toluene	ND	0.0500	"							
Ethylbenzene	ND	0.0500	"							
Xylenes (total)	ND	0.100	"							
Surrogate: 4-BFB (FID)	*2.11*		*"*	*2.40*		*87.9*	*60-120*			
Surrogate: a,a,a-TFT (FID)	*2.52*		*"*	*2.40*		*105*	*50-150*			
Surrogate: 4-BFB (PID)	*2.21*		*"*	*2.40*		*92.1*	*64-125*			
Surrogate: a,a,a-TFT (PID)	*2.60*		*"*	*2.40*		*108*	*50-150*			
LCS (3E01008-BS1)										
Gasoline Range Hydrocarbons	25.8	5.00	mg/kg	25.1		103	60-120			
Benzene	0.309	0.0200	"	0.310		99.7	80-120			
Toluene	1.71	0.0500	"	1.90		90.0	80-120			
Ethylbenzene	0.437	0.0500	"	0.447		97.8	80-120			
Xylenes (total)	2.10	0.100	"	2.20		95.5	80-120			
Surrogate: 4-BFB (FID)	*2.34*		*"*	*2.40*		*97.5*	*60-120*			
Surrogate: a,a,a-TFT (FID)	*2.60*		*"*	*2.40*		*108*	*50-150*			
Surrogate: 4-BFB (PID)	*2.17*		*"*	*2.40*		*90.4*	*64-125*			
Surrogate: a,a,a-TFT (PID)	*2.49*		*"*	*2.40*		*104*	*50-150*			

Geo Engineers - Alaska	Project: UNOCAL BP #0736	
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Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Gasoline Hydrocarbons (n-Hexane to <n-Decane) and BTEX by AK101/EPA 8021B - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3E01008: Prepared 05/01/03 Using EPA 5030B (P/T)										
LCS Dup (3E01008-BSD1)										
Gasoline Range Hydrocarbons	25.8	5.00	mg/kg	25.1		103	60-120	0.00	20	
Benzene	0.308	0.0200	"	0.310		99.4	80-120	0.324	40	
Toluene	1.70	0.0500	"	1.90		89.5	80-120	0.587	40	
Ethylbenzene	0.435	0.0500	"	0.447		97.3	80-120	0.459	40	
Xylenes (total)	2.09	0.100	"	2.20		95.0	80-120	0.477	40	
Surrogate: 4-BFB (FID)	*2.35*		*"*	*2.40*		*97.9*	*60-120*			
Surrogate: a,a,a-TFT (FID)	*2.62*		*"*	*2.40*		*109*	*50-150*			
Surrogate: 4-BFB (PID)	*2.19*		*"*	*2.40*		*91.2*	*64-125*			
Surrogate: a,a,a-TFT (PID)	*2.51*		*"*	*2.40*		*105*	*50-150*			

Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Diesel Hydrocarbons (C10-C25) by AK102 - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3D30002: Prepared 04/30/03 Using EPA 3520C										
Blank (3D30002-BLK1)										
Diesel Range Hydrocarbons	ND	0.100	mg/l							
Surrogate: 2-FBP	*0.233*		*"*	*0.320*		*72.8*	*50-150*			
LCS (3D30002-BS1)										
Diesel Range Hydrocarbons	1.74	0.100	mg/l	2.00		87.0	75-125			
Surrogate: 2-FBP	*0.236*		*"*	*0.320*		*73.8*	*50-150*			
LCS Dup (3D30002-BSD1)										
Diesel Range Hydrocarbons	1.77	0.100	mg/l	2.00		88.5	75-125	1.71	20	
Surrogate: 2-FBP	*0.262*		*"*	*0.320*		*81.9*	*50-150*			

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Geo Engineers - Alaska	Project:	UNOCAL BP #0736	
4951 Eagle St	Project Number:	0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager:	Liz Shen	05/09/03 16:04

Total Metals by EPA 6000/7000 Series Methods - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3D28036: Prepared 04/28/03 Using EPA 3050B										
Blank (3D28036-BLK1)										
Lead	ND	0.500	mg/kg							
LCS (3D28036-BS1)										
Lead	40.9	0.500	mg/kg	40.8		100	80-120			
LCS Dup (3D28036-BSD1)										
Lead	40.1	0.500	mg/kg	40.0		100	80-120	1.98	20	
Matrix Spike (3D28036-MS1)					**Source: B3D0597-01**					
Lead	112	0.500	mg/kg dry	66.0	45.1	101	62-137			
Matrix Spike Dup (3D28036-MSD1)					**Source: B3D0597-01**					
Lead	120	0.500	mg/kg dry	69.4	45.1	108	62-137	6.90	30	
Post Spike (3D28036-PS1)					**Source: B3D0597-01**					
Lead	129	0.500	mg/kg dry	88.5	45.1	94.8	75-125			
Batch 3D28037: Prepared 04/28/03 Using EPA 3050B										
Blank (3D28037-BLK1)										
Lead	ND	0.500	mg/kg							
LCS (3D28037-BS1)										
Lead	38.9	0.500	mg/kg	39.6		98.2	80-120			
LCS Dup (3D28037-BSD1)										
Lead	38.4	0.500	mg/kg	39.2		98.0	80-120	1.29	20	

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Total Metals by EPA 6000/7000 Series Methods - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3D28037: Prepared 04/28/03 Using EPA 3050B										
Matrix Spike (3D28037-MS1)					**Source: B3D0578-02**					
Lead	54.5	0.500	mg/kg dry	51.0	5.55	96.0	62-137			
Matrix Spike Dup (3D28037-MSD1)					**Source: B3D0578-02**					
Lead	53.9	0.500	mg/kg dry	51.0	5.55	94.8	62-137	1.11	30	
Post Spike (3D28037-PS1)					**Source: B3D0578-02**					
Lead	67.6	0.500	mg/kg dry	63.8	5.55	97.3	75-125			

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
4951 Eagle St	Project Number: 0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager: Liz Shen	05/09/03 16:04

Dissolved Metals by EPA 6000/7000 Series Methods - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3D29030: Prepared 04/29/03 Using EPA 3005A										
Blank (3D29030-BLK1)										
Lead	ND	0.00100	mg/l							
LCS (3D29030-BS1)										
Lead	0.196	0.00100	mg/l	0.200		98.0	80-120			
LCS Dup (3D29030-BSD1)										
Lead	0.197	0.00100	mg/l	0.200		98.5	80-120	0.509	20	
Matrix Spike (3D29030-MS1)					**Source: B3D0590-03**					
Lead	0.0923	0.00100	mg/l	0.100	ND	92.3	75-125			
Matrix Spike Dup (3D29030-MSD1)					**Source: B3D0590-03**					
Lead	0.0939	0.00100	mg/l	0.100	ND	93.9	75-125	1.72	20	

North Creek Analytical - Bothell

Jeff Gerdes

Jeff Gerdes, Project Manager

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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Geo Engineers - Alaska	Project:	UNOCAL BP #0736	
4951 Eagle St	Project Number:	0161-302-03	**Reported:**
Anchorage AK/USA, 99503-7432	Project Manager:	Liz Shen	05/09/03 16:04

TCLP Metals by EPA 1311/6000/7000 Series Methods - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3E07024: Prepared 05/07/03 Using EPA 3020A										
Blank (3E07024-BLK1)										
Lead	ND	2.50	mg/l							
LCS (3E07024-BS1)										
Lead	4.10	2.50	mg/l	4.00		102	80-120			
LCS Dup (3E07024-BSD1)										
Lead	4.07	2.50	mg/l	4.00		102	80-120	0.734	20	
Matrix Spike (3E07024-MS1)					**Source: B3E0093-01**					
Lead	4.35	2.50	mg/l	4.00	ND	109	80-120			
Matrix Spike Dup (3E07024-MSD1)					**Source: B3E0093-01**					
Lead	4.34	2.50	mg/l	4.00	ND	108	80-120	0.230	40	
Post Spike (3E07024-PS1)					**Source: B3E0093-01**					
Lead	2.71	2.50	mg/l	2.50	ND	108	80-120			

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Geo Engineers - Alaska	Project: UNOCAL BP #0736	
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Physical Parameters by APHA/ASTM/EPA Methods - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3E01015: Prepared 05/01/03 Using Dry Weight										
Blank (3E01015-BLK1)										
Dry Weight	100	1.00	%							
Batch 3E01016: Prepared 05/01/03 Using Dry Weight										
Blank (3E01016-BLK1)										
Dry Weight	100	1.00	%							

Geo Engineers - Alaska	Project:	UNOCAL BP #0736	
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Notes and Definitions

G-01	Results reported for the gas range are primarily due to overlap from diesel range hydrocarbons.
G-02	The chromatogram for this sample does not resemble a typical gasoline pattern. Please refer to the sample chromatogram.
I-06	The analyte concentration may be artificially elevated due to coeluting compounds or components.
S-02	The surrogate recovery for this sample cannot be accurately quantified due to interference from coeluting organic compounds present in the sample.
S-04	The surrogate recovery for this sample is outside of established control limits due to a sample matrix effect.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

Appendix B

Disc with Bootstrap Calculations

Appendix C

RBCL and Risk Equations and Assumptions

EQUATIONS FOR RISK CALCULATIONS

Risk Based Cleanup Level (RBCL) equations are presented in the following sections; the same equations were rearranged for use in baseline risk calculations. For example, baseline risk for soil ingestion was calculated using Equation 1 with the following substitutions: the soil RME for each COPC was substituted for the cleanup level, and the HQ (baseline risk) was substituted for the THQ. Chemical-specific parameters for the RBCLs are provided in Table 4 of the risk assessment.

1 INGESTION OF SOIL

The calculation for the cleanup level for noncarcinogenic chemicals based on the ingestion of soil pathway is presented in Equation 1 (Equation 3 of the ADEC *Guidance on Cleanup Standards, Equations, and Input Parameters* [ADEC, 1999]).

Equation 1. Soil Cleanup Level Equation for Ingestion of Noncarcinogenic Contaminants

$$\text{Cleanup Level (mg/kg)} = \frac{\text{THQ x BW x AT x 365 d/yr}}{1/\text{RfD}_o\text{x}10^{-6}\text{ kg/mg x EF x ED x IR}}$$

Parameter/Definition (units)	Industrial/Child Residential/Adult Residential Values
THQ/target hazard quotient (unitless)	1
BW/body weight (kg)	70/15/70
AT^1/averaging time (yr)	5/6/30
RfD_o/oral reference dose (mg/kg-d)	chemical-specific (Table 3)
EF^2/exposure frequency (d/yr)	30/180/180
ED^1/exposure duration (yr)	5/6/30
IR/soil ingestion rate (mg/d)	200/200/100

Notes:

All values are default values provided in ADEC's *Guidance on Cleanup Levels Equations and Input Parameters* (July 28, 1999), except the following:

[1] Industrial scenario used an ED and AT of 5 years and EF of 30 days per year. These values were based on best professional judgment. The only workers potentially exposed to the site contaminants would be utility workers or other workers at the site on a limited, project-specific basis.

[2] Residential scenario used an EF of 180 days per year. Given the weather constraints, best professional judgment dictates that a child would be outside playing in soil and seeps for no more than 180 days per year.

The calculation for the cleanup level for carcinogenic chemicals based on the ingestion of soil pathway is presented in Equation 2 (Equation 4 of the ADEC *Guidance on Cleanup Standards, Equations, and Input Parameters* [ADEC, 1999]).

Equation 2. Soil Cleanup Level Equation for Ingestion of Carcinogenic Contaminants

$$\text{Cleanup Level (mg/kg)} = \frac{TR \times AT \times 365\ d/yr}{CSF_o \times 10^{-6}\ kg/mg \times EF \times IF_{soil/adj}}$$

Parameter/Definition (units)	Industrial/Child Residential/Adult Residential Values
TR/target cancer risk (unitless)	$10^{-5}/10^{-5}$
AT/averaging time (yr)	70
CSF_o/oral slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific (Table 3)
EF[1,2]/exposure frequency (d/yr)	30/180/180
$IF_{soil/adj}$/soil ingestion factor (mg-yr/kg-d)	200/200/100

Notes:

All values are default values provided in ADEC's *Guidance on Cleanup Levels Equations and Input Parameters* (July 28, 1999), except the following:

[1] Industrial scenario used an EF of 30 days per year. This value was based on best professional judgment. The only workers potentially exposed to the site contaminants would be utility workers or other workers at the site on a limited, project-specific basis.

[2] Residential scenario used an EF of 180 days per year. Given the weather constraints, best professional judgment dictates that a child would be outside eating dirt for no more than 180 days per year.

2 INHALATION OF VOLATILES FROM SOIL

The calculation for the cleanup level for noncarcinogenic chemicals based on the inhalation of volatiles from soil is presented in Equation 3 (Equation 7 of the ADEC *Guidance on Cleanup Standards, Equations, and Input Parameters* [ADEC, 1999]).

Equation 3. Soil Cleanup Level Equation for Direct Inhalation of Noncarcinogenic Contaminants in Soil

$$\text{Cleanup Level (mg/kg)} = \frac{\text{THQ x AT x 365 d/yr}}{\text{EF x ED x [(1/RfC) x (1/VF)]}}$$

Parameter/Definition (units)	Industrial/Residential Values
THQ/target hazard quotient (unitless)	1/1
AT[1]/averaging time (yr)	5/6/30
EF/exposure frequency (d/yr)	30/180/180
ED[1]/exposure duration (yr)	5/6/30
RfC/inhalation reference concentration (mg/m^3)	chemical-specific (see Table 3)
VF/soil-to-air volatilization factor (m^3/kg)	calculated for each chemical using Eqn. 5

Notes:

All values are default values provided in ADEC's *Guidance on Cleanup Levels Equations and Input Parameters* (July 28, 1999), except the following:
[1] Industrial scenario used an ED and AT of 5 years and EF of 30 days per year. These values were based on best professional judgment. The only workers potentially exposed to the site contaminants would be utility workers or other workers at the site on a limited, project-specific basis.

The calculation for the cleanup level for noncarcinogenic chemicals based on the inhalation of volatiles from soil is presented in Equation 4 (Equation 6 of the ADEC *Guidance on Cleanup Standards, Equations, and Input Parameters* [ADEC, 1999]).

Equation 4. Soil Cleanup Level Equation for Direct Inhalation of Carcinogenic Volatile Contaminants in Soil

$$\text{Cleanup Level (mg/kg)} = \frac{\text{TR x AT x 365 d/yr}}{\text{URF x 1000 } \mu\text{g/mg x EF x ED x [1/VF]}}$$

Parameter/Definition (units)	Industrial/Residential Values
TR/target cancer risk (unitless)	$10^{-5}/10^{-5}$
AT/averaging time (yr)	70/70
URF/inhalation unit risk factor $(\mu g/m^3)^{-1}$	chemical-specific (see Table 3)
EF[1]/exposure frequency (d/yr)	30/180/180
ED[1]/exposure duration (yr)	5/6/30
VF/soil-to-air volatilization factor (m^3/kg)	calculated for each chemical using Eqn. 5

Notes:

All values are default values provided in ADEC's *Guidance on Cleanup Levels Equations and Input Parameters* (July 28, 1999), except the following:
[1] Industrial scenario used an ED of 5 years and EF of 30 days per year. These values were based on best professional judgment. The only workers potentially exposed to the site contaminants would be utility workers or other workers at the site on a limited, project-specific basis.

The calculation for the chemical-specific volatilization factor necessary to evaluate the inhalation pathways is presented in Equation 5 (Equation 8 of the ADEC *Guidance on Cleanup Standards, Equations, and Input Parameters* [ADEC, 1999]).

The average, site-specific TOC data was used in Equation 5 (and Equation 6, following). Appendix B provides tabulated TOC values for the site (Table B-1) and summary statistics for the TOC data (Table B-2). Only those TOC values corresponding to DRO values less than 2,300 mg/kg were used in the summary statistics. For the risk assessment, the average TOC value for all soil samples taken from greater than 2 feet in depth (onsite = 5.6%, and offsite = 4.4%) was used in all risk assessment calculations.

Equation 5. Derivation of the Volatilization Factor

$$VF\ (m^3/kg) = \frac{Q/C \times (3.14 \times D_A \times T)^{1/2} \times 10^{-4} m^2/cm^2}{(2 \times \rho_b \times D_A)}$$

where

$$D_A = \frac{[(\theta_a^{10/3} D_i H' + \theta_w^{10/3} D_w)/n^2]}{\rho_b K_d + \theta_w + \theta_a H'}$$

Parameter/Definition (units)	Values
VF/volatilization factor (m^3/kg)	---
Q/C/inverse of the mean conc. at the center of a 0.5 acre square source (g/m^2-s per kg/m^3)	Over 40 Inch Zone= 82.72
T/exposure interval (s)	9.5×10^8
ρ_b/dry soil bulk density (g/cm^3)	1.5
ρ_s/soil particle density (g/cm^3)	2.65
n/total soil porosity (L_{pore}/L_{soil})	0.434 or site specific, if available
θ_w/water-filled soil porosity (L_{water}/L_{soil})	$w\rho_b$
θ_a/air-filled soil porosity (L_{air}/L_{soil})	$n - w\rho_b$
D_i/diffusivity in air (cm^2/s)	chemical-specific (see Table 4)
H'/ dimensionless Henry's law constant	chemical-specific (see Table 4)
w/average soil moisture content (g_{water}/g_{soil} or cm^3_{water}/g_{soil})	0.1 or site specific, if available
D_w/diffusivity in water (cm^2/s)	chemical-specific (see Table 4)
K_d/soil-water partition coefficient (cm^3/g)	$K_{oc} \times f_{oc}$ (organics)
K_{oc}/organic carbon partition coefficient (cm^3/g)	chemical-specific
f_{oc}/organic carbon content of soil (g/g)	site specific average (onsite = 5.6%, offsite = 4.4%)
	0.1 or site specific

The soil saturation concentration corresponds to the contaminant concentration in soil at which the absorptive limits of the soil particles, the solubility limits of the soil pore water, and saturation of soil pore air have been reached. Above this concentration, the soil contaminant may be present in free phase, i.e. nonaqueous phase liquids for contaminants that are liquid at ambient soil temperatures and pure solid phases for compounds that are solid at ambient soil temperatures. At the soil saturation limit, the emission flux from soil to air for a chemical reaches a plateau. Volatile emissions will not increase above this level no matter how much more chemical is added to the soil. According to USEPA 1996a, compounds with generic volatile inhalation soil screening levels greater than the saturation concentration are significantly below the screening risk of 1×10^{-6} and HQ of 1. In other words, for chemicals where the calculated RBCL is greater than the saturation concentration, the inhalation route is not likely to be of concern.

The RBCL and the soil saturation concentration was calculated for those COPCs where the 18 AAC 75 cleanup level is based on the soil saturation limit. Detected concentrations of these COPCs were compared to the site-specific soil saturation limit and the calculated RBCL. If the RBCL is greater than the soil saturation concentration, adverse effects from exposure to these

COPCs are not expected. These compounds may contribute to cumulative risk; therefore they were included in the cumulative risk calculations.

The calculation for derivation of the soil saturation limit is presented in Equation 6 (Equation 9 of the ADEC *Guidance on Cleanup Standards, Equations, and Input Parameters* [ADEC, 1999]).

Equation 6. Derivation of the Soil Saturation Limit

Note = The Soil Saturation Limit is used as an upper limit for volatiles for the Inhalation Pathway Calculations.

$$C_{sat}\ (mg/kg) = \frac{S}{\rho_b}\left(K_d\,\rho_b + \theta_w + H'\theta_a\right)$$

Parameter/Definition (units)	Default
C_{sat}/soil saturation concentration (mg/kg)	---
S/solubility in water (mg/L-water)	chemical-specific (see Table 4)
ρ_b/dry soil bulk density (kg/L)	1.5
ρ_s/soil particle density (kg/L)	2.65
n/total soil porosity (L_{pore}/L_{soil})	0.434 or site specific, if available
θ_w/water-filled soil porosity (L_{water}/L_{soil})	$w\rho_b$
θ_a/air-filled soil porosity (L_{air}/L_{soil})	$n - w\rho_b$
K_d/soil-water partition coefficient (L/kg)	K_{oc} x f_{oc}
K_{oc}/soil organic carbon/water partition coefficient (L/kg)	chemical-specific (see Table 4)
f_{oc}/fraction organic carbon of soil (g/g)	site specific average (onsite = 5.6%, offsite = 4.4%)
w/average soil moisture (kg_{water}/kg_{soil} or L_{water}/kg_{soil})	0.1 or site specific, if available
H'/Henry's law constant (unitless)	chemical-specific (see Table 4)

3 DERMAL CONTACT WITH SOIL

Equations to calculate dermal contact with soil were modified from the equations provided in *Risk Assessment Guidance for Superfund* (USEPA, 1989). The calculation for the cleanup level for noncarcinogenic chemicals based on dermal contact with soil is presented below.

Equation 7: Dermal Contact with Noncarcinogenic Contaminants in Soil

$$\text{Cleanup Level (mg/kg)} = \frac{\text{THQ x BW x AT x 365 d/yr}}{\frac{1}{\text{RfDd}} \text{ x } 10^{-6} \text{ kg/mg x SA x AF x ABS x EF x ED}}$$

Parameter/Definition (units)	Industrial/Child Residential/Adult Residential Values
RfD_d = dermal reference dose (mg/kg-d)	chemical-specific (see Table 3)
SA[1] = skin surface area (cm^2/d)	3120/2380
AF[2] = soil to skin adherence factor (mg/cm^2)	0.2/0.2/0.2
ABS[6] = absorption factor (unitless)	chemical-specific (see Table 4)
THQ = Target Hazard Quotient (unitless)	1/1
BW[3] = body weight (kg)	70/15/70
AT[4,5] = averaging time (yr)	5/6/30
EF[4,5] = exposure frequency (d/yr)	30/180/180
ED[4,5] = exposure duration (yr)	5/6/30

Notes:

[1] Industrial skin surface area is based on mean surface area of hands and arms for adult (USEPA, 1997). Residential skin surface area is based on mean surface area of head, forearms, hands, and lower legs for a child (USEPA, 2001).

[2] Soil to skin adherence factor (USEPA, 2001)

[3] Industrial scenario is based on adult body weight of 70 kg; residential scenario is based on child body weight of 15 kg.

[4] Industrial scenario parameters are the same as for soil ingestion and inhalation pathways; i.e., AT and ED of 5 years and EF of 30 days per year.

[5] AT and ED of 30 years and an EF of 180 days per year.

[6] An ABS value of 0.01 is appropriate for all COPCs identified (RAIS 2002)

The calculation for the cleanup level for carcinogenic chemicals based on dermal contact with soil is presented below.

Equation 8: Dermal Contact with Carcinogenic Contaminants in Soil

$$\text{Cleanup Level (mg/kg)} = \frac{\text{TR x BW x AT x 365 d/yr}}{\text{SFd x } 10^{-6} \text{ kg / mg x SA x AF x ABS x EF x ED}}$$

Parameter/Definition (units)	**Industrial/Child Residential/Adult Residential Values**
SF_d = dermal slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific (see Table 3)
TR = target cancer risk (unitless)	$10^{-5}/10^{-5}$
BW[3] = body weight (kg)	70/15/70
AT = averaging time (yr)	70/670
SA[1] = skin surface area (cm^2/d)	3120/2380/3120
AF[2] = soil to skin adherence factor (mg/cm^2)	0.2/0.2
ABS[6] = absorption factor (unitless)	chemical-specific (see Table 4)
EF[5] = exposure frequency (d/yr)	30/180/180
ED[4,5] = exposure duration (yr)	5/6/30

Notes:

[1] Industrial skin surface area is based on mean surface area of hands and arms for adult (USEPA, 1997). Residential skin surface area is based on mean surface area of head, forearms, hands, and lower legs for a child (USEPA, 2001).

[2] Soil to skin adherence factor (EPA, 2001).

[3] Industrial scenario is based on adult body weight of 70 kg; residential scenario is based on child body weight of 15 kg.

[4] Industrial scenario parameters are the same for soil ingestion and inhalation pathways; i.e., ED of 5 years and EF of 30 days per year.

[5] ED of 30 years and an EF of 180 days per year.

[6]An ABS value of 0.01 is appropriate for all COPCs identified (RAIS 2002)

4 DERMAL CONTACT WITH GROUNDWATER

Equations to calculate dermal contact with groundwater were modified from the equations provided in *Risk Assessment Guidance for Superfund* (USEPA, 1989). The calculation for the cleanup level for noncarcinogenic chemicals based on dermal contact with water (groundwater or surface water) is presented below.

Equation 9: Dermal Contact with Noncarcinogenic Contaminants in Water

$$\text{Cleanup Level (mg/L)} = \frac{(\text{TQH x ATx365 days/year xBW})}{\left(\frac{1}{\text{RfDd}} \text{x} \frac{1\text{m}}{100\text{cm}} \text{x} \frac{1000\text{L}}{\text{m3}} \text{xPCxSAxETxEDxEF}\right)}$$

<u>Parameter/Definition (units)</u>	<u>Industrial/Child Residential/Adult Residential Values</u>
THQ = Target Hazard Quotient (unitless)	1
BW[2] = body weight (kg)	70/15/70
AT[3,4] = averaging time (yr)	5/6/30
RfD_d = dermal reference dose (mg/kg-d)	chemical specific (See Table 3)
SA[1] = skin surface area (m^2)	0.312/0.238/0.312
EF[3] = exposure frequency (d/yr)	30/180/180
ET = exposure time (hr/d)	8/1/0.5
PC = permeability constant (cm/hr)	chemical-specific (see Table 4)
ED[3,4] = exposure duration (yr)	5/6/30

Notes:

[1] Industrial skin surface area is based on mean surface area of hands and arms for adult (USEPA, 1997). Residential skin surface area is based on mean surface area of head, forearms, hands, and lower legs for a child (USEPA, 2001).The most exposed resident was assumed to be a child playing in seep water. The most exposed worker was assumed to be an excavation worker.

[2] Based on adult body weight of 70 kg and child body weight of 15 kg

[3] Industrial scenario parameters are the same as for soil ingestion and inhalation pathways; i.e., AT of 5 years and EF of 30 days per year, and an exposure time of 8 hours per day.

[4] Residential scenario parameter is based on a child playing in a seep: AT of 6 years and EF of 180 days per year. These values are based on best professional judgment. They are reasonable upper limit values for a child to be playing in seep water in Sitka, Alaska.

The calculation for the cleanup level for carcinogenic chemicals based on dermal contact with water (groundwater or surface water) is presented below. The USEPA *Update to Exposure Factors Handbook* (USEPA, 1997) was the source for this equation.

Equation 10: Dermal Contact with Carcinogenic Contaminants in Water

$$\text{Cleanup Level (mg/L)} = \frac{(\text{TR x ATx365 days/year xBW})}{\left(SF_d\, x\, \frac{1m}{100cm}\, x\, \frac{1000L}{m3}\, xPCxSAxETxEFxED\right)}$$

Parameter/Definition (units)	Industrial/Child Residential/Adult Residential Values
TR = Target Cancer Risk (unitless)	$10^{-5}/10^{-5}$
BW^2 = body weight (kg)	70/15/70
AT = averaging time (yr)	70/70/70
SA^1 = skin surface area (m^2)	0.312/0.238/0.312
SF_d = dermal slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific (see Table 3)
$EF^{3,4}$ = exposure frequency (d/yr)	30/180/180
ET = exposure time (hr/d)	8/1/0.5
$ED^{3,4}$ = exposure duration (yr)	5/6/30
PC = permeability constant (cm/hr)	chemical-specific (see Table 4)

Notes:

[1] Industrial skin surface area is based on mean surface area of hands and arms for adult (USEPA, 1997). Residential skin surface area is based on mean surface area of head, forearms, hands, and lower legs for a child (USEPA, 2001).The most exposed resident was assumed to be a child playing in seep water. The most exposed worker was assumed to be an excavation worker.

[2] Based on adult body weight of 70 kg and child body weight of 15 kg

[3] Industrial scenario parameters are the same as for soil ingestion and inhalation pathways; i.e., ED of 5 years and EF of 30 days per year, and an exposure time of 8 hours per day.

[4] Residential scenario parameter is based on a child playing in a seep: ED of 6 years, and EF of 180 days per year. These values are based on best professional judgment. They are reasonable upper limit values for a child to be playing in seep water in Sitka, Alaska.

5 INCIDENTAL INGESTION OF GROUNDWATER

The calculation for the cleanup level for noncarcinogenic chemicals based on the ingestion of groundwater pathway is presented in Equation 11 (Equation 1 of the ADEC *Guidance on Cleanup Standards, Equations, and Input Parameters* [ADEC, 1999]). The most exposed residential receptor is the child playing in the seep who incidentally ingests groundwater.

Equation 11. Groundwater Cleanup Level Equation for Ingestion of Noncarcinogenic Contaminants

$$\text{Cleanup Level (mg/L)} = \frac{THQ \times RfD_o \times BW \times AT \times 365\ d/yr}{EF \times ED \times IR \times A}$$

Parameter/Definition (units)	Industrial/Child Residential/Adult Residential Values
THQ/target hazard quotient (unitless)	1
BW/body weight (kg)	70/15/70
AT[1]/averaging time (yr)	5/6/30
RfD_o/oral reference dose (mg/kg-d)	chemical-specific (see Table 3)
EF/exposure frequency (d/yr)	180 d/yr
ED[1]/exposure duration (yr)	5/6/30
IR[2]/ingestion rate (L/d)	1/1/0.05
A/Absorption Factor	1

Notes:

[1] Residential scenario parameter is based on a child playing in a seep: ED and AT of 6 years and EF of 180 days per year. These values are based on best professional judgment. They are reasonable upper limit values for a child to be playing in seep water in Sitka, Alaska.

[2] Ingestion rate estimated based on Region IV Supplemental Guidance to RAGS value for incidental ingestion during recreational swimming of 0.05 L/hr (USEPA, 1995) and an assumption of one hour per day of seep play involving incidental ingestion.

The calculation for the cleanup level for carcinogenic chemicals based on the ingestion of soil pathway is presented in Equation 12 (Equation 2 of the ADEC *Guidance on Cleanup Standards, Equations, and Input Parameters* [ADEC, 1999]).

Equation 12. Groundwater Cleanup Level Equation for Ingestion of Carcinogenic Contaminants

$$\text{Cleanup Level (mg/L)} = \frac{TR \times BW \times AT \times 365\ d/yr}{CSF_o \times IR \times EF \times ED \times A}$$

Parameter/Definition (units)	Industrial/Child Residential/Adult Residential Values
TR/target cancer risk (unitless)	10^{-5}
Body Weight (kg)	70/15/70
AT/averaging time (yr)	70/70/70
CSF_o/oral slope factor $(mg/kg\text{-}d)^{-1}$	chemical-specific (see Table 3)
IR[2]/ingestion rate (L/d)	1/1/.05
EF[1]/exposure frequency (d/yr)	30/180/180
ED[1]/exposure duration (yr)	5/6/30
A/absorption factor	1

Notes:

[1] Residential scenario parameter is based on a child playing in a seep: ED of 6 years and EF of 180 days per year. These values are based on best professional judgment. They are reasonable upper limit values for a child to be playing in seep water in Sitka, Alaska.

[2] Ingestion rate estimated based on Region IV Supplemental Guidance to RAGS value for incidental ingestion during recreational swimming of 0.05 L/hr (USEPA, 1995) and an assumption of one hour per day of seep play involving incidental ingestion.

6 INHALATION OF INDOOR AIR

The Johnson-Ettinger Model (Environmental Quality Management, Inc., 1991) for Subsurface Vapor Intrusion into Buildings was used to estimate the baseline risk posed by indoor air exposure to contaminated groundwater and subsurface soil and to calculate RBCLs for indoor air exposure. This model is a screening tool approved by the USEPA to estimate the transport of contaminant vapors emanating from subsurface soils or groundwater into indoor spaces located directly above or in close proximity to the source of contamination. The Johnson-Ettinger model is a one-dimensional analytical solution to convective and diffusive vapor transport into indoor spaces and provides an estimated attenuation coefficient that relates the vapor concentration in the indoor space to the vapor concentration at the source of contamination. Inputs to the model include chemical properties of the contaminant, saturated and unsaturated zone soil properties, and structural properties of the building. Model inputs specific to the former bulk plant site are presented below.

- The model is limited to use on an adult receptor, so a child resident was not be evaluated for this pathway. The discrepancy between modeling inhalation to adults and other exposures to children is addressed in the uncertainty section.
- Default values were used for hypothetical floor-wall seam cracks.
- Assuming that the representative building may be used for future residential purposes, the residential exposure scenario values presented in ADEC's *Guidance on Cleanup Standards, Equations, and Input Parameters* (1999) were used as model inputs.
- Sand was used as the representative soil type to estimate vapor permeability. Within the model, sand has the highest value of hydraulic conductivity, resulting in conservatively large exposure concentrations. The average on-site TOC value of 5.6 percent was used in

the model. Default values were used for other soil properties such as bulk density and porosity.

- Indoor air risk and RBCLs were calculated based on the actual BTEX concentration present in groundwater. The total GRO concentration was not used to assess indoor inhalation risk. Total GRO data was not used because physical parameters for a mixture of GRO constituents cannot be assigned and most of the risk associated with GRO vapors is assumed attributable to the BTEX fraction.

Appendix D

Calculated RBCLs

CHEMICAL NAME **Bold Type = Carcinogenic Substances** ***Bold Italic = Both Carcinogenic and Noncarcinogenic Substances***	**RBCL - based on Worker (mg/kg)**	**RBCL - based on Adult Resident (mg/kg)**	**RBCL - based on Child Resident (mg/kg)**
benzo(a)anthracene	8,114	225	317
benzo(a)pyrene	811	23	32
benzo(b)fluoranthene	8,114	225	317
indeno(1,2,3-cd)pyrene	8,114	225	317
Dibenzo(a,h)anthracene	811	23	32
benzene	340,468	9,457	13,284
ethylbenzene	13,239,049	2,206,508	619,835
toluene	21,837,607	3,639,601	1,022,409
xylenes	251,132,479	41,855,413	11,757,703
DRO Aliphatic	13,648,504	2,274,751	639,006
DRO Aromatic	5,459,402	909,900	255,602
GRO Aliphatic	682,425,214	113,737,536	31,950,280
GRO Aromatic	27,297,009	4,549,501	1,278,011
benzene nc	409,455	68,243	19,170

App D. Soil Ingestion

CHEMICAL NAME **Bold Type = Carcinogenic Substances** ***Bold Italic = Both Carcinogenic and Noncarcinogenic Substances***	**RBCL - based on Worker (mg/kg)**	**RBCL - based on Adult Resident (mg/kg)**	**RBCL - based on Child Resident (mg/kg)**
benzo(a)anthracene	58	19.44	9.72
benzo(a)pyrene	6	1.94	0.97
benzo(b)fluoranthene	58	19.44	9.72
indeno(1,2,3-cd)pyrene	58	19.44	9.72
Dibenzo(a,h)anthracene	6	1.94	0.97
benzene	774	258	129
ethylbenzene	425,833	141,944	15,208
toluene	851,667	283,889	30,417
xylenes	8,516,667	2,838,889	304,167
DRO Aliphatic	425,833	141,944	15,208
DRO Aromatic	170,333	56,778	6,083
GRO Aliphatic	21,291,667	7,097,222	760,417
GRO Aromatic	851,667	283,889	30,417
benzene nc	12,775	4,258	456

CHEMICAL NAME **Bold Type = Carcinogenic Substances** ***Bold Italic = Both Carcinogenic and Noncarcinogenic Substances***	**RBCL - Based on Worker (mg/L)**	**RBCL - Based on Adult (mg/L)**	**RBCL - Based on Child (mg/L)**
Benzo(a)anthracene	0.0200	0.0011	0.0008
Benzo(a)pyrene	0.0014	0.00008	0.0001
Benzo(B)fluoranthene	0.0135	0.0008	0.0005
indeno(1,2,3-cd)pyrene	0.0085	0.0005	0.0003
Benzene	32.43	1.80	1.27
ethylbenzene	1,789	3,578	101
toluene	4,853	9,706	273
xylenes	31,392	62,783	1,764
DRO Aliphatic	546	1,092	31
DRO Aromatic	218	437	12
GRO Aliphatic	151,650	303,300	8,520
GRO Aromatic	6,066	12,132	341
benzene nc	16	33	1

CHEMICAL NAME **Bold Type = Carcinogenic Substances** ***Bold Italic = Both Carcinogenic and Noncarcinogenic Substances***	**RBCL - based on Worker (mg/L)**	**RBCL - based on Adult (mg/L)**	**RBCL - based on Child (mg/L)**
benzo(a)anthracene	3.267	0.09	0.10
benzo(a)pyrene	0.327	0.01	0.010
benzo(b)fluoranthene	3.267	0.09	0.1
indeno(1,2,3-cd)pyrene	3.267	0.09	0.10
benzene	43.36	1.20	1.29
ethylbenzene	1,703	284	61
toluene	3,407	568	122
xylenes	34,067	5,678	1,217
DRO Aliphatic	1,703	284	61
DRO Aromatic	681	114	24
GRO Aliphatic	85,167	14,194	3,042
GRO Aromatic	3,407	568	122
benzene nc	51	9	2

App D. Indoor Soil Inh JE

CHEMICAL NAME Bold Type = Carcinogenic Substances *Bold Italic = Both Carcinogenic and Noncarcinogenic Substances*	RBCL - based on Worker	RBCL - based on Resident (mg/kg)
benzo(a)anthracene		277,000
benzo(a)pyrene		257,000
benzo(b)fluoranthene		78,400
indeno(1,2,3-cd)pyrene		8,020,000
Dibenzo(a,h)anthracene		90,400,000
benzene		0.201
ethylbenzene		367
toluene		75
xylenes		
DRO Aliphatic		
DRO Aromatic		
GRO Aliphatic		
GRO Aromatic		

App D. Groundwater Inh JE

CHEMICAL NAME **Bold Type = Carcinogenic Substances** ***Bold Italic = Both Carcinogenic and Noncarcinogenic Substances***	**RBCL - based on Worker (mg/L)**	**RBCL - based on Resident (mg/L)**
benzo(a)anthracene		12.1
benzo(a)pyrene		4.45
benzo(b)fluoranthene		1.2
indeno(1,2,3-cd)pyrene		40.400
benzene		0.067
ethylbenzene		20.6
toluene		8.28
xylenes		
DRO Aliphatic		
DRO Aromatic		
GRO Aliphatic		
GRO Aromatic		

CHEMICAL NAME Bold Type = Carcinogenic Substances *Bold Italic = Both Carcinogenic and Noncarcinogenic Substances*	DA-onsite	DA-offsite	VF-onsite	VF-offsite	On-site RBCL - based on Worker (mg/kg)	Off-site RBCL - based on Worker (mg/kg)	RBCL - based on Adult (mg/kg)	RBCL - based on Child (mg/kg)	Soil Saturation Limit (mg/kg)
benzo(a)anthracene	1.94E-11	2.46E-11	3.42E+07	3.03E+07	658,362	583,576	18,288	91,439	165
benzo(a)pyrene	2.87E-12	3.65E-12	8.89E+07	7.88E+07	170,915	151,500	4,748	23,738	73
benzo(b)fluoranthene	8.04E-11	1.02E-10	1.68E+07	1.49E+07	323,020	286,327	8,973	44,864	81
indeno(1,2,3-cd)pyrene	5.29E-13	6.74E-13	2.07E+08	1.83E+08	3,981,034	3,528,809	110,584	552,921	3
Dibenzo(a,h)anthracene	1.59E-13	2.02E-13	3.78E+08	3.35E+08	727,300	644,683	20,203	101,014	416
benzene	3.12E-04	3.93E-04	8.53E+03	7.60E+03	1,750	1,560	49	243	4786
ethylbenzene	6.33E-05	8.03E-05	1.89E+04	1.68E+04	230,601	204,625	38,434	38,434	2727
toluene	1.22E-04	1.55E-04	1.36E+04	1.21E+04	66,078	58,689	11,013	11,013	4292
xylenes	3.84E-05	4.88E-05	2.43E+04	2.16E+04	206,903	183,571	34,484	34,484	2594
DRO Aliphatic	1.35E-06	1.72E-06	1.30E+05	1.15E+05	1,576,801	1,397,694	262,800	262,800	
DRO Aromatic	5.76E-07	7.33E-07	1.98E+05	1.76E+05	482,883	428,052	80,480	80,480	
GRO Aliphatic	5.04E-04	6.39E-04	6.71E+03	5.96E+03	1,501,484	1,334,187	250,247	250,247	
GRO Aromatic	5.47E-05	6.96E-05	2.04E+04	1.81E+04	99,083	87,868	16,514	16,514	
benzene	3.12E-04	3.93E-04	8.53E+03	7.60E+03	617	550	103	103	4786

A. Site-Specific Information

Fields requiring site-specific input are highlighted in yellow.

1. Site Characteristics/Soil Properties

Parameter	Formula Relationship	Parameters By Calcs (limited site-specific data available)	Values
Land-Use / Future Land Use Category	-	-	
Climate Zone	-	-	
ρs - soil particle density	$(\rho_b/(1-n))$	***2.65***	**2.65**
θ_w - water-filled soil porosity	$w\rho_b$	0.15	**0.15**
θ_a - air-filled soil porosity (L/L)	$n-w\rho_b$	0.28	**0.28**
n - total soil porosity (L/L)	$(1-(\rho_b/\rho_s))$	0.43	**0.43**
w - moisture content (kg/kg)	-	***0.10***	**0.10**
ρ_b - dry soil bulk density (kg/L)	-	***1.50***	**1.50**
foc - onsite			**0.056**
foc - offsite			**0.044**

* ***Bold/Italicized*** parameters represent required input fields to calculate dependent data.

3. Default Values

Parameter	Arctic	Under 40"	Over 40"
ρ_b - dry soil bulk density (kg/L)	1.5	1.5	1.5
n - total soil porosity (L/L)	0.434	0.434	0.434
w - moisture content (kg/kg)	0.1	0.1	0.1
θ_w - water-filled soil porosity	0.15	0.15	0.15
θ_a - air-filled soil porosity (L/L)	0.284	0.284	0.284
foc Soil organic carbon (decimal fraction)	0.001	0.001	0.001
DF - Dilution Factor (unitless)	-	3.3	1.9
K - Hydraulic Conductivity (m/yr)	-	876	876
i - Hydraulic Gradient (m/m)	-	0.002	0.002
I - Infiltration Rate (m/yr)	-	0.13	0.6
Mixing Zone Depth (m)	-	5.5	10
d_a - Aquifer Thickness (m)	-	10	10
L - Source Length (m)	-	32	32

Appendix E

TOC Data and Summary Tables

Table B-1
Analytical Results
TOC and DRO
Unocal Bulk Plant 0736

Station	Depth (feet)	On-site or off-site	Total Organic Carbon APHA/EPA Methods (mg/kg)			DRO (mg/kg)
			Average	High	Low	
C+00.0; 1+55.0	1.5	On	18,500	19,100	17,300	16
D+00 0+50-2	2	On	332,000	358,000	317,000	266
A+15.5; 1+00.0	3.0	On	10,400	10,500	10,200	13.2
B+05 0+75-3	3	On	12,900	13,800	12,300	341
C+00 1+75-3	3	On	7,730	8,120	6,780	765
D+00 0+62.5-3	3	On	278,000	310,000	249,000	315
B+00 1+25-4	4	On	8,540	11,500	5,270	3,950
B+8.0 0+20.0-4.5	4.5	On	23,300	27,100	19,900	15,300
C+00 1+25-5	5	On	13,600	15,300	12,600	125
A+18 0+62.5-7	7	On	15,500	16,100	14,500	15.3
D+00 0+12.5-10	7	On	13,700	14,800	11,000	9.23
TP-Y-7	7	On	140,000	156,000	124,000	<8.16
TP-Z-7	7	On	27,900	29,900	26,600	7.59
D+05.0; 0+87.5	7.5	On	1,050	1,200	760	<4.00
D+05.0; 1+00.0	7.5	On	413	504	150	<4.00
D+00 0+62.5-8	8	On	15,600	16,700	15,000	10.6
A+18.0; 0+75.0	8.5	On	21,300	22,000	20,600	14,500
A+18.0; 0+87.5	9.0	On	17,400	18,100	16,600	<4.00
B+00.0; 1+60.0	9.5	On	591	1,220	150	4.22
A+15.5; 1+00.0	10.0	On	385,000	397,000	366,000	13.2
A+16.0; 0+50.0	10.0	On	150	150	150	6.02
TP-Y-10	10	On	30,000	32,800	26,500	3,720
TP-Z-11	11	On	17,000	20,400	14,300	524
HA-1A	0.25	Off	154,000	220,000	116,000	32.9
HA-2A	0.67	Off	184,000	191,000	173,000	430
HA-6A	0.83	Off	46,200	61,700	35,400	296
HA-1B	1.00	Off	58,100	61,700	50,800	10.8
HA-5A	1.33	Off	147,000	154,000	139,000	7,240
HA-4A	1.50	Off	236,000	250,000	214,000	3,110
HA-7A	1.58	Off	97,200	103,000	92,800	2,380
HA-3A	1.83	Off	211,000	228,000	203,000	8,540
HA-4B	2.03	Off	330,000	354,000	304,000	8,110
HA-6B	2.17	Off	25,700	30,900	19,700	537
HA-1C	2.25	Off	6,350	11,500	500	5.45
HA-5B	2.25	Off	35,400	39,400	29,300	9,710
HA-2B	2.42	Off	74,200	91,700	66,900	58.0
HA-3B	3.17	Off	81,500	115,000	58,200	120
HA-4C	3.50	Off	8,390	11,600	4,950	47.4
HA-2C	3.67	Off	54,100	56,200	52,800	27.0
HA-7B	4.00	Off	88,800	101,000	80,400	116
TP-W-4	4	Off	11,700	13,800	9,580	6.24
TP-X-8	8	Off	131,000	172,000	103,000	17,900

Notes:
Shaded samples have DRO concentrations exceeding 2,300 mg/kg.

Table B-2
TOC Statistics
Unocal Bulk Plant 0736

	Total Organic Carbon APHA/EPA Methods (mg/kg)			Total Organic Carbon APHA/EPA Methods (mg/kg)			Total Organic Carbon APHA/EPA Methods (mg/kg)		
	Average	High	Low	Average	High	Low	Average	High	Low
On-site	**All Samples**			**Shallow (<2 feet) Samples**			**Deep (>2 feet) Samples**		
Max	385,000	397,000	366,000	332,000	358,000	317,000	385,000	397,000	366,000
Min	150	150	150	18,500	19,100	17,300	150	150	150
Mean	68,812	74,047	63,915	175,250	188,550	167,150	**56,290**	60,576	51,770
Median	15,500	16,100	14,300	175,250	188,550	167,150	13,700	15,300	12,600
SD	122,082	130,255	114,675	221,678	239,638	211,920	110,058	116,904	102,462
Count	19	19	19	2	2	2	17	17	17
No. of ND's	1	1	3	0	0	0	1	1	3
Off-site	**All Samples**			**Shallow (<2 feet) Samples**			**Deep (>2 feet) Samples**		
Max	184,000	220,000	173,000	184,000	220,000	173,000	88,800	115,000	80,400
Min	6,350	11,500	500	46,200	61,700	35,400	6,350	11,500	500
Mean	66,087	80,508	55,686	110,575	133,600	93,800	**43,843**	53,963	36,629
Median	56,100	61,700	51,800	106,050	126,350	83,400	39,900	43,550	36,250
SD	56,036	68,172	50,116	68,738	83,863	63,312	34,828	43,276	31,365
Count	12	12	12	4	4	4	8	8	8
No. of ND's	0	0	1	0	0	0	0	0	1

Notes:

Three onsite samples had lows of <300 mg/kg. One had a high of <300 mg/kg. All NDs were deeper than 2 feet.
One offsite boring had a low <1,000 mg/kg.
Non-detect results have been set to 0.5 times the reporting limit for statistical calculations.
Sample results with DRO >2,300 mg/kg were removed before calculating statistics.
Bolded results are used in the risk assessment: 5.6% for on-site soil
4.4% for off-site soil

Appendix F

Johnson Ettinger Indoor Inhalation Model

Input and Result Spreadsheets

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	2.06E+04	2.06E+04	1.69E+05	2.06E+04

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE SUMMARY BELOW:

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

]

SL-SCREEN
Version 2.3; 03/01

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	**ENTER** Initial soil conc., C_R (μg/kg)	Chemical
71432		Benzene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	**ENTER** Depth below grade to top of contamination, L_t (cm)	**ENTER** Average soil temperature, T_S (°C)	**ENTER** Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	**ENTER** User-defined vadose zone soil vapor permeability, k_v (cm^2)
200	400	10	s		

MORE ↓

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	**ENTER** Vadose zone soil total porosity, n^V (unitless)	**ENTER** Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	**ENTER** Vadose zone soil organic carbon fraction, f_{oc}^V (unitless)
1.5	0.43	0.15	0.056

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	**ENTER** Averaging time for noncarcinogens, AT_{NC} (yrs)	**ENTER** Exposure duration, ED (yrs)	**ENTER** Exposure frequency, EF (days/yr)	**ENTER** Target risk for carcinogens, TR (unitless)	**ENTER** Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-05	1
				Used to calculate risk-based soil concentration.	

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (μg/kg)	Indoor exposure soil conc., noncarcinogen (μg/kg)	Risk-based indoor exposure soil conc., (μg/kg)	Soil saturation conc., C_{sat} (μg/kg)	Final indoor exposure soil conc., (μg/kg)
NA	3.67E+05	3.67E+05	3.46E+06	3.67E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

SL-SCREEN
Version 2.3; 03/01

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
100414		Ethylbenzene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Average soil temperature, T_S (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)
200	400	10	s		

MORE ↓

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	ENTER Vadose zone soil organic carbon fraction, f_{oc}^V (unitless)
1.5	0.43	0.15	0.056

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-05	1

Used to calculate risk-based soil concentration.

END

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (μg/kg)	Indoor exposure soil conc., noncarcinogen (μg/kg)	Risk-based indoor exposure soil conc., (μg/kg)	Soil saturation conc., C_{sat} (μg/kg)	Final indoor exposure soil conc., (μg/kg)
NA	7.51E+04	7.51E+04	5.43E+06	7.51E+04

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

SL-SCREEN
Version 2.3; 03/01

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	**ENTER** Initial soil conc., C_R (μg/kg)	Chemical
108883		Toluene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	**ENTER** Depth below grade to top of contamination, L_t (cm)	**ENTER** Average soil temperature, T_S (°C)	**ENTER** Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	**ENTER** User-defined vadose zone soil vapor permeability, k_v (cm^2)
200	400	10	s		

MORE ↓

ENTER Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	**ENTER** Vadose zone soil total porosity, n^V (unitless)	**ENTER** Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)	**ENTER** Vadose zone soil organic carbon fraction, f_{oc}^V (unitless)
1.5	0.43	0.15	0.056

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	**ENTER** Averaging time for noncarcinogens, AT_{NC} (yrs)	**ENTER** Exposure duration, ED (yrs)	**ENTER** Exposure frequency, EF (days/yr)	**ENTER** Target risk for carcinogens, TR (unitless)	**ENTER** Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-05	1

Used to calculate risk-based soil concentration.

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
6.70E+01	NA	6.70E+01	1.75E+06	6.70E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

]

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
71432		Benzene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)
200	400	S	10

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
S			1.5	0.43	0.15

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-05	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
(enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
100414		Ethylbenzene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)
200	400	S	10

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
S			1.5	0.43	0.15

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-05	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	2.06E+04	2.06E+04	1.69E+05	2.06E+04

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	8.28E+03	8.28E+03	5.26E+05	8.28E+03

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE SUMMARY BELOW:
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

END

]

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
108883		Toluene

MORE ↓

ENTER Depth below grade to bottom of enclosed space floor, L_F (15 or 200 cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, T_S (°C)
200	400	S	10

MORE ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined vadose zone soil vapor permeability, k_v (cm^2)	ENTER Vadose zone soil dry bulk density, ρ_b^V (g/cm^3)	ENTER Vadose zone soil total porosity, n^V (unitless)	ENTER Vadose zone soil water-filled porosity, θ_w^V (cm^3/cm^3)
S			1.5	0.43	0.15

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-05	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

Appendix G

Responsiveness Summary

S. Pingree Review of
Risk Assessment Unocal Bulk Plant 0736
Sitka, Alaska
June 7, 2002

No	Page	Section	Comment/Recommendation	Response/Action
1	13	6.3.2 & 7	Table 10 shows the carcinogenic risk to the off-site resident is 4E-5, not 3E-5. This appears to be a typo.	Corrected.
2	13	7	Exceedence of cumulative risk standards due to benzo(a)pyrene are explained in this section, yet even if benzo(a)pyrene was excluded as a COC there is still exceedances of cumulative risk standards. This should be explained in this section. Dealing with the benzo(a)pyrene alone would not cause "acceptable" risks at this site. Ingestion of soil contaminated with DRO also exceeds the hazard index standard. This is not obvious because the HQ for DRO-aliphatics and DRO-aromatics are show separately. If these were summed the risks would be above a HI of 1. This should be indicated. According to the DEC *Guidance on Cleanup of Petroleum Contaminated Sites* DRO-aliphatic and DRO-aromatic have different target organs. The HI, then, could be separated out by target organ. This would result in a HI less than the DEC standard of 1, but this should be explained.	Risk associated with exposure to BaP for the off-site adult receptor is 2E-5. Risk from all other pathways and chemicals is 1E-5. A large portion of the remaining risk is from indoor inhalation of benzene (5E-6). Risk from other COPCs for the dermal exposure to GW pathway is 6E-6). For the child receptor, risk from BaP is 2E-5, risk from all other COPCs is 8E-6. Cumulative risk to aliphatic and aromatic portions of DRO will be discussed in the final RA using the target system information from the *Guidance on Cleanup of Petroleum Contaminated Sites.*
3	9	5.5	More explanation is needed on how the resident receptor is evaluated. It is not clear that a child is being evaluated and then, to be conservative, inhalation by	The final RA calculates risk for the both adult and the child receptor. The adult receptor risk calculations include the JE

			adult receptors is added to the child exposure scenario. This should be clarified. In addition, please explain why outdoor air is not evaluated for the resident.	risk results in the cumulative risk calculations. The child receptor indoor inhalation pathway is not assessed. Exposure to outdoor air was added to the resident.
4	15	10	Resampling WS-1 for other PAHs, besides benzo(a)pyrene may address the exceedance of the cumulative risk standard even when B(a)P is not included in the calculations. The conclusions and recommendations should include all PAHs that were detected in this sample.	Accepted.
5	Table 1		Although the screening procedure used is correct, this table is confusing. Screening is being done at 1/10 the Table B1 or B2 ingestion or inhalation level or the migration to groundwater cleanup level. These levels do not always coincide with the RBSL (carcinogen) or RBSL (non-carcinogen). For instance, the inhalation screening levels for toluene, ethylbenzene and xylene are 1/10 the saturation concentration and not the RBSL. Based on the text, lead was obviously sampled and exceeds a benchmark and thus should be included in this table. The rationale for not including it as a COPC appears sufficient but it should be reflected in that table that lead is above a screening level.	The RBSL used for screening is 1/10 of the ADEC 18AAC75 Table B cleanup level. The potential ARAR/TBC levels are the lowest of the Table B cleanup levels (inhalation, ingestion, migration to gw). These tables will include source notes in the final revision. Lead will be included in the table.
6	Table 2		Although the screening procedure used is correct, this table is confusing. Screening is being done at 1/10 the Table C cleanup levels. These levels do not always coincide with the RBSL (carcinogen) or RBSL (non-carcinogen). For instance, the screening level for	The RBSL used for screening is 1/10 of the ADEC 18AAC75 Table C cleanup level. The potential ARAR/TBC levels are the Table C cleanup levels. These values will include source notes in the final revision.

			benzene is 1/10 the drinking water MCL and not a risk-based level. Switching units in the table is confusing. It may be best to show everything in mg/L to be consistent within the table and with DEC tables.	The screening level for benzene is 1/10 the Table C value provided in 18 AAC 75. Units were made consistent in the table.
7	Table 3		The benzene ingestion and inhalation reference doses are missing. The proper values were included in the work plan. The benzene URF is not correct, although the conversion equation is. The proper value is 8.29E-6 $(ug/m3)^{-1}$. This is the value that was used in the work plan.	The table values from the work plan will be included in the final revision.
8	Table 4		All exposure parameters are not shown in this chart. For instance, exposure time for groundwater exposure is not included. The indoor air parameters are not shown, as well. My understanding is that to be conservative, indoor air exposure was evaluated for the full year (365 or 350 d/yr) and not the 180 d/yr that was used for the other pathways. I believe this is why inhalation of outdoor air was not included. Please show exposure parameters for this pathway in the table.	Values for exposure time to seep groundwater and indoor air exposure parameters will be added to the table. Indoor air exposure was evaluated for the whole year (350 days).
9	Tables 7 – 10		Benzene should have a risk and HQ calculated. This will make the table confusing because the column headings only indicate risk is being calculated. It may help to separate out risk and non-cancer HI's in the table. Although DRO and GRO risks should not be included in the cumulative risk calculations for BETX and PAHs,	Both a risk and HQ for benzene are calculated for all pathways except indoor air in the final revision. Column and row headings in the table are modified to make risk and non-cancer HIs more obvious. The calculation tables are modified to show cumulative risk to DRO and GRO.

			the receptor cumulative risk for each should be shown (i.e. sum all risks for ingestion, dermal, etc. for DRO aliphatics).	
10	Tables 8 & 10		Although separately, DRO aliphatics and aromatics do not exceed the cumulative risk standard, DRO total would. Please explain this.	DRO exceedance of cumulative risk standards will be explained in the final revision.
11	Appendix B		This section has been sent out for third party review.	
12	Appendix C	Eq 7 & 8	Please indicate which ABS is used in these equations.	The ABS for dermal absorption of 0.01 was used for all COPCs.
13	Appendix C	11	Not enough information is presented to verify the indoor air calculations. Please include which JEM version was used or provide the spreadsheets. The spreadsheets are preferred. What exposure frequency was used in the modeling? I assume 350 days were used to represent a conservative exposure scenario. I was unable get the same indoor air risks as those presented using the 2001 version of the JEM. I calculate risks much lower than those presented. Inclusion of the spreadsheet of input parameters and results within the risk assessment will help clarify this.	The spreadsheets from JE will be included as an appendix to the final revision.

410 Willoughby Ave., Ste 303
Juneau, AK 99801-1795
PHONE: (907) 465-5390
FAX: (907) 465-5262
http://www.state.ak.us/dec/home.htm

**DIVISION OF SPILL PREVENTION AND RESPONSE
CONTAMINATED SITES PROGRAM**

January 9, 2003

Mr. Lawrence Widmark
Chairman, Sitka Tribe of Alaska
456 Katlian Street
Sitka, AK 99835

Re: Response to Comments - Unocal Bulk Plant 0736 Draft Risk Assessment

Dear Mr. Widmark:

The Alaska Department of Environmental Conservation (DEC) has reviewed the comments the Sitka Tribe of Alaska (STA) submitted on September 26, 2002. The responses to these comments are enclosed.

DEC has determined that no substantive modifications to the draft risk assessment are necessary. The comments submitted by STA were invaluable in that they required DEC to critically examine many technical and policy-level issues in great detail. This exercise has strengthened our assertion that the risk assessment conservatively portrays human health and environmental risks based on site-specific conditions at the former Unocal facility.

The September 26, 2002 cover letter that accompanied STA's comments referenced DEC's policy on government-to-government relations with federally recognized tribes. We will make every effort to meet the specific requirements of the policy throughout the remainder of this project.

In your September 26 letter you suggested a meeting in Sitka to discuss the risk assessment comments. Please let me know by February 15, 2003 several available meeting dates. I will not direct Unocal to finalize the risk assessment until STA has reviewed the comment responses and discussed them with DEC. Our target date for finalizing the risk assessment and proceeding to the next phase of the project is mid-March 2003.

DEC appreciates the time and effort the Sitka Tribe of Alaska has dedicated to participate in this risk assessment review. I look forward to the upcoming meeting in Sitka.

Sincerely,

William Janes
Project Manager

Enclosures

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	Page/Section	Comment/Issue	Response
1	STA - Page 1 Lifetime Exposure Cross Ref #52, #60, #78, #94	The Risk Assessment does not look at lifetime exposure. Most people living in the Sitka Indian Village have lived there all of their lives (this is on record in the Sitka Tribe of Alaska Realty Office). These people will also likely live out their lives in the Village. Therefore, it is necessary to establish a lifetime exposure scenario, as this is likely to show the most risk.	The scope of the risk assessment is the area immediately around and downgradient of the tank farm. Of the nine developed properties downgradient of the tank farm, three are commercial businesses, three have changed ownership one or more times in the past five years, and two residents have lived there in excess of 25 years. For carcinogenic contaminants, the time of exposure is averaged over a lifetime (generally assumed to be 70 years). This approach is based on the assumption that a high dose received over a short period of time is equivalent to a low dose spread over a lifetime (EPA, 1989). Cancer risk is reported as the probability of a case of cancer in a population of a certain size (for example, one case in a million [1E-6] or 3 cases in one thousand [3E-3]). Even though exposure may have happened over 1 or 2 or 50 years, the probability of getting cancer is spread over the whole lifetime. The risk assessment contractor conducted a sensitivity analysis regarding exposure assumptions and cancer risk as a result of exposure to off-site soil. These calculations assume 30-year and 70-year exposure duration, and 180-day and 350-day exposure frequency. The increased exposure assumptions increase risk; however, risk is still within DEC regulatory standards (see appendix).
2	STA - Page 1	According to the draft Risk Assessment, after the	The risk assessment does not state that after the pica

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	Lifetime Exposure	'pica child' reaches age six, the child is assumed to be risk-free. This is simply untrue. The 'pica child' grows up and lives out his or her life as a resident of the Village, continually at risk of contamination from Unocal's activities at Bulk Plant 0736. The Risk Assessment must establish real-to-life exposure scenarios in order to establish a true risk characterization.	child reaches six, he/she is assumed to be free of risk. Carcinogenic risk assessment calculations inherently incorporate lifetime exposure and average risk over the six childhood years and 24 subsequent years. The default lifetime exposure assumption is 30 years of exposure to a site averaged over 70 years. For noncarcinogenic contaminants, the averaging time is the same as the time of exposure (EPA, *Risk Assessment Guidance for Superfund*, 1989, Section 6.4.1). Noncarcinogenic exposure over time is not additive. There is a toxic threshold, above which effects are expected, below which effects are not expected. Thus, mathematically, exposure duration does not contribute in the calculation for noncarcinogenic hazards, it is cancelled by the averaging time (see appendix).
3	STA - Page 1 Exposure Cross Ref #60, #78, #94	In the report, Unocal assumes that, because of our "harsh climate," Sitka Indian Village residents only spend 180 days per year outdoors. This is simply wrong and not conservative enough to establish true risk. On page 8 of the draft Risk Assessment, the text states, "[s]pecific studies to document human behavior in Sitka are not available;" which means that neither GeoEngineers nor Unocal consulted with Sitka Tribe on this.	The risk assessment does not assume that residents of the Sitka Indian Village do not go outside or engage in normal activities 365 days per year. The risk assessment assumption of 180 days means 180 days of spending one hour per day exposed to contaminated seep water and actively engaging in dermal contact with contaminated soil for one hour per day for 180 days. DEC believes the assumptions used in the risk assessment are conservative estimates of true risk. It is improbable that exposure to contaminated seep water and soil will occur every day of the year, especially during colder and wetter winter months. Text referencing the unavailability of human

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			behavior studies specific to Sitka will be either modified or deleted from the final risk assessment. However, DEC does not believe the information contained in such studies will change the exposure assumptions or the risk assessment conclusions.
4	STA - Page 1 Exposure Cross Ref #50, #78	There is ample information on human behavior in the Sitka Tribal offices, but neither party contacted Sitka Tribe on this point. Additionally, it appears that DEC, in conjunction with the University of Alaska, has developed exposure frequencies based on quite a bit of analysis (see DEC Cleanup level Guidance, Appendix A). … As reported in the Cleanup level document, the exposure estimates are "low-end conservative estimates representative of the reasonable exposure for the zone as a whole." As Sitka receives over 80 inches of rain per year, it should be assumed that Sitka Indian Village residents spend at least 330 days per year exposed to these contaminants. There are few days during the year that snow covers the ground for more than a few hours. The only reasonable way to complete the Risk Assessment would be to use the DEC default exposure values.	State regulations allow a Method 4 Risk Assessment when the exposure to a site does not match the default exposure values. Using the DEC default exposure assumptions is the equivalent of using the Table B and C cleanup values. The exposure assumptions are not based on snow cover, but on the idea of how much time a person may spend wading or playing in surface (seep water if present) and engaging in dermal contact with soil.
5	STA - Page 2 Risk Assessment Format Cross Ref #76, #96	The draft Risk Assessment is vague, hard to understand, and not clearly delineated. The document should be easy to read by ordinary people. Also, all points made should reference data in a chart, graph, or map so that anyone could see why they make an assumption. The draft Risk Assessment makes several references to data that are not supported in the graphs. An important component of a risk	Risk assessments in general are difficult to understand because they must balance technical information with readability. The risk assessors will make every effort to ensure that the final document is as clear and understandable as possible without compromising essential reporting requirements. One of the other comments states that the CSM is not

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		assessment is a diagram, showing how all exposure points are-accounted for in the document. Otherwise, the document is very difficult to understand and, therefore, unacceptable.	presented as a wire diagram/flow chart. This type of CSM was used during the scoping meetings with DEC. However, the authors thought that the CSM table (labeled Figure 3 in the risk assessment) was a more simple and readable way to present the conceptual site model. The original wire diagram CSM is included with this comment response.
6	STA - Page 2 Biota Sampling	The draft Risk Assessment makes the assumption that eating berries growing in contaminated soil is not hazardous to one's health. No evidence is shown to prove this. Many people living in the Village pick berries and should not be concerned that the berries are contaminated. Additionally, Village residents should be able to have gardens in their yards. No testing of biota has ever been done in the Village.	It may be possible that berries are harvested in the vicinity of the bulk fuel tank farm to a limited extent. Although biota sampling is useful in estimating risks from dietary exposures, it is not always necessary. Plant uptake factors may be applied to analytical data for soil to estimate the amount of COPCs present in berries. These modeled concentrations then may be included in exposure estimates and risk calculations. Of the COPCs present at the site, only BETX and the aromatic fraction of GRO are capable of transport into the shoots of plants. No samples collected from shallow soil (<5 feet bgs) had concentrations of GRO or BETX above State cleanup levels 18 AAC 75 Table B). Aerial photographs of the area indicated that there are no gardens in the vicinity of the bulk fuel tank.
7	STA - Page 2 Biota Sampling Cross Ref #51	Plants have been proven to take up petrochemicals into their roots. In fact, bioremediation is a well-accepted way of mediation for soil contaminated with petrochemicals. While bioremediation would be a good way to get rid of oil in an area, little is known about eating the plants that have taken up the oil into its roots.	Bioremediation of petroleum is a process using naturally occurring microorganisms in soil (bacteria) to break down the hydrocarbon bonds. Bioremediation is performed by adding nutrients and oxygen to contaminated soil, e.g. landfarming. Phytoremediation is a process using specialized

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		In order to allay concerns of our Tribal Citizens about contamination, Unocal will have to sample foods grown in the soil around Bulk Plant 0736. Testing is the only way to show people that they are safe from contamination from these carcinogens. In order for the Risk Assessment to be complete, Unocal must prove that all pathways are safe, including biota.	plants that uptake certain compounds preferentially (phytoremediation). DEC does not believe biota sampling is necessary in order to conservatively evaluate risks associated with contaminants at this site.
8	STA - Page 2 Cultural Site Contamination	If oil drains down underneath a Clan house, as it has with the Kayash Ka Hit, a cultural site is desecrated and this should be addressed by the State. This Clan House is extremely important to the Coho Clan of Sitka and its spiritual value should not be underestimated by the Risk Assessment.	Worst-case health impacts have been calculated for residential settings, such as the Clan house. However, assessment of spiritual value is outside the scope of a human health risk assessment
9	STA - Page 2 Cultural Site Contamination	Unocal Bulk Plant 0736 was constructed on a former Tlingit cemetery. A valuable cultural site was disturbed and should be addressed by the State for reconciliation purposes. Sitka Tribe of Alaska suggests that DEC consult with the State Historic Preservation Office before proceeding with the Risk Assessment.	The Alaska State Historic Preservation Office (ASHPO) has been contacted to determine if there are any known historic or archeological sites in the area. The information obtained from the ASHPO, although not pertinent to the outcome of the risk assessment, will be important if cleanup is required. The issue of reconciliation is outside the scope of the risk assessment.
10	STA - Page 2 Native Alaskan Risk	The draft Risk Assessment ignores an important point: Native Americans are at higher risk for cancer than the general population. Certain risk factors come into play at a much higher rate with Alaska Natives, such as smoking and diabetes. An additional factor for which our Tribal Citizens now have to deal with is petrochemicals quietly seeping into their homes. If Unocal is responsible for "breaking the camel's back" with contamination seeping into the Sitka Indian Village, they should be held responsible. Sitka Tribe of Alaska recommends that DEC consult with a	One of the largest sources of uncertainty overestimating risk is the use of standard toxicity values. Toxicity values published by the EPA (Integrated Risk Information System, HEAST) are developed using numerous uncertainty factors in order to account for more vulnerable members of the population, including Native Alaskans. However, there are no specific safety factors for Native populations or other specific sub-populations within Alaska.

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		contractor who is familiar with such "Cultural-based Risk Assessments."	
11	STA - Page 3 Changes to Regulatory Criteria	In a GeoEngineers report, "Results of Monitoring and Ground Water Sampling," dated May 26, 1994, page 3, proposed DEC groundwater cleanup levels are listed … Several water samples taken from the site have levels of BTEX well over these proposed cleanup levels. Additionally, Table 6 of the GeoEngineers "Contaminant Distribution Report," dated May 28, 2002, lists Benzene concentrations for ten samples as simply "<50 (ug/1)." There is no indication on this graph just how much contamination is present in these samples. If the DEC standard detection limit for sites like this one is 5 µg/l, it is possible that all ten samples are over this DEC-set limit. Additionally, on Table 6 of the Contaminant Distribution Report, there are six documented exceedances of the DEC cleanup levels. There is no justification given for not using these standard cleanup levels at Unocal Bulk Plant 0736.	Standard cleanup levels do not necessarily have to be met under DEC's current regulations. As with soil, it is possible to apply alternative cleanup levels to groundwater based on a risk assessment (method 4) that evaluates all potential exposure pathways. Elevated detection limits such as 50 µg/l for benzene are a laboratory-derived number. Non-detects were handled in the data set in the standard manner for risk assessments: the non-detect result is assigned a value of ½ the detection limit. It is possible that all 10 samples exceeded the DEC standard cleanup level of 5 µg/l.
12	STA - Page 3 Method Two/Three versus Method One Cross Ref #48	A watered down methodology was used to calculate risk-based benchmarks. DEC gives four possible "Methods" for calculating risk, and the one Unocal used allows for much higher levels of contaminants to exist in the soil than if Method One had been used. It appears that the regulatory framework allows for a risk assessment to be used to establish screening levels. However, certain default values must be	The risk assessment does not calculate risk-based benchmarks or screening levels, it calculates risk and/or risk-based cleanup levels. The methodology used was method 4, not a variant of methods 2 and 3. Method 4 is an approved method of determining cleanup levels according to state guidance and regulation (18 AAC 75.340).

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		followed in this case in order to establish true risk. Making faulty assumptions about exposure frequencies and cumulative risk can lead to inadequate characterization of the true risk.	In this case DEC requested Unocal to conduct a site-specific risk assessment to accurately identify site risks. Using default values would not accomplish this goal. The exposure assumptions for typical receptors at this site are based on residential exposure, which is the most conservative exposure scenario used in either state or federal risk assessments. Cumulative risk was evaluated according to standard practice.
13	STA - Page 3 Elimination of Lead as a Contaminant of Particular Concern (COPC) Cross Ref #63, #73, #98	It has been well established that there are concentrations of lead in the pipeline area. However, it is insignificant that the source of the lead is fuel leakage or lead paint on the outside of the pipe. The important point is that Unocal installed and used the pipeline. Today there is lead in the ground as a direct result of Unocal's activities. The statement on page 4 of the draft Risk Assessment, "the lead was assumed unrelated to the fuel contamination originating from the bulk plant" is not supportable by evidence. At least one fuel type used at the tank farm contained lead. The lead originates at the pipeline, which was installed and owned by Unocal. For this reason, Unocal should be responsible for its own mess and lead should not be eliminated as a COPC.	Lead was not included in risk calculations on the basis of DEC guidance (Guidance on Calculating Cumulative Risk) because the EPA found it inappropriate to apply a reference dose or cancer slope factor to lead (IRIS, 1988). The lead cleanup levels in Tables B1 and C of 18 AAC 75 are based on the Integrated Exposure Uptake Biokinetic (IEUBK) model and are the cleanup levels appropriate at the site.
14	STA - Page 4 Background Concentrations Cross Ref #56	In the DEC manual "Technical Guidance Document on Determination of Background Concentrations," several points are raised that have been ignored in the draft Risk Assessment. For example, on page 3 of that document, …guidelines are listed for selecting a place to take a background sample …	The reviewer refers to a single background sample, apparently Sample "D" which was collected during the February 2000 shoreline sampling that included samples A-C. The samples were collected directly down gradient of the site, near the terminus of the fuel pipeline at the Sitka Sound Seafoods dock. Sample D was collected a considerable distance to

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		It does not appear that the background sample was taken from the appropriate place for this process. The sample was taken almost directly downhill and downgradient from the site. Nor does it appear that the background sample was taken from a similar geographic strata as the study area. The soil particles in the tidelands area are quite different from the soils at and near Unocal Bulk Plant 0736. As the background sample is the basis for many assumptions in the risk assessment, using the proper protocol is of utmost importance.	the east, as being representative of "background" conditions for this specific sampling event. In addition, three background samples (BS-1, BS-2 and BS-3) were collected from within the limits of the tank farm property in 1998. BS-1 and BS-2 were collected upgradient of the former tank storage area while BS-3 was collected from a location that is cross-gradient from the former tank storage area. These sample locations are indicated on Figure 2 of the draft Risk Assessment. The samples were collected by GeoEngineers, at proper locations and using sound methodology as described in the *Supplemental Site Investigation* report dated May 29, 1998.
15	STA - Page 4 Site Characterization Cross Ref #65, #88, #89	The draft Risk Assessment attempts to portray the site as easily divisible into two distinct areas: On-site and Off-site. This is clearly in error, as the Off-site areas are not similar, with similar amounts of contamination. On the contrary, there appear to be pockets of extremely high levels of contamination, while other areas are barely affected by Unocal activities. … For the Risk Assessment, the site should be categorized into four distinct areas: 1. The Tank Farm area; 2. The Pipeline corridor; 3. The Former Drainage Swale; and 4. The Western Drainage feature.	The areas were divided between on- and off-site because there are no residents living in the tank farm area although residents do live adjacent to it. Further, it was assumed that concentrations on-site would be significantly higher than off-site. A residential exposure scenario was evaluated for both on- and off-site areas. Dividing the site into four separate (small) areas would result in four areas with different exposure scenarios. For example, a residential scenario would not be valid for the Western Drainage Feature – the downgradient properties are commercial. Residential exposure would also not be expected for the Pipeline Corridor. Furthermore, the areas are small and it is unlikely for transient receptors in the Pipeline Corridor to be expected to spend a large amount of time there. Organizing the risk assessment like this would dilute estimates of potential risk to residential receptors.

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			In addition, the intent of omitting low (below the assumed background concentration) and non-detect DRO concentrations was to further focus the exposure point concentrations on contaminated areas. The site investigation was focused on sampling potentially contaminated areas. The risk assessment assumed that residential receptors were exposed to contaminated soil. Removing low and non-detect samples from the dataset **increased** the mean concentration of contaminants off-site. Therefore, estimated risk from exposure to soil for both on- and off-site residential receptors is similar.
16	STA - Page 5 Site and Spill History Cross Ref #26	In the GeoEngineers Phase I Environmental Site Assessment, dated May 16, 1995, several spills are discussed. One spill of over 200 gallons of fuel was mentioned in the report, but there is no mention of this in the draft Risk Assessment. One important point about this spill is that Unocal claims not to have any record of the spill event. Knowledge of the spill comes from a contractor's recollection (GeoEngineers 95, B-67).	A diesel fuel spill of 200 gallons was documented in the Phase I ESA as having occurred during 1978. Knowledge of the spill for the ESA was obtained through review of a 1995 PHR Environmental Consultants, Inc. document entitled *Sitka Marketing Station Corporate Records Search Report with Appended Documents.* The appended document (stamped: "Marketing, Aug 5 - 1992, General Files) refers to a spill of (erroneously noted to be over 300 gallons) of diesel fuel from an above ground tank in 1978. The report notes that the "product was retained by the tank dike and was cleaned up by pumping and the use of sorbent material, ostensibly to the satisfaction of the Coast Guard." The spill history also mentions an alleged minor overfill of 30 gallons and leaking discharge from the oil/water separator. Petroleum contamination at the site due to "these cited incidents and 54 years of product handling practices" has been acknowledged by Unocal and is

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			considered established background information upon which the risk assessment is based. As the spills occurred more than 20 years ago, assessment of risk to human health and the environment today and in the future, is based on known quantities of hydrocarbons in the subsurface, regardless of how they were introduced. In addition to the spill reference cited by the reviewer (GeoEngineers 95, B-67), the spill of the estimated 200 gallons was discussed in a Union Oil Company memorandum dated November 28, 1978 included in the ESA on page B-201.
17	STA - Page 5 Site and Spill History	Additionally, in the May 16, 1995 GeoEngineers report, several Unocal documents refer to pipes that were out-dated and leaky. While several lines in the dock area were replaced in 1971, it appears that upland pipelines were not replaced until 1977, when it was more convenient for the company. There is certainly the possibility that gallons of fuel per day were leaking from these pipes and that this is the fuel that is contaminating the soil in the Sitka Indian Village.	Please refer to response to comment #16.
18	STA - Page 5 Site and Spill History	All spills (documented and undocumented) and leaky pipes should be well documented in a public report so that all parties are aware of the extent of the contamination.	Please refer to response to comment # 16. A document summarizing all spills on record was prepared in 1995 and issued as a Phase 1 Environmental Site Assessment.
19	STA - Page 5 Incomplete Investigations	The draft Risk Assessment was completed using information from a previous (November 27, 2001) GeoEngineers report. However, as an EPA toxicologist reported to us in a report dated April 30, 2002, "it is not clear whether the [GeoEngineers 11/27/01] report was comprehensive enough to...provide a basis for a human health risk	Discussions about subsurface conditions, hydrogeology and contaminant fate and transport issues were provided in the May 28, 2002 *Contaminant Distribution Report*. The EPA toxicologist's comments were made in a memorandum dated April 30, 2002, prior to issuance of the May 28, 2002 report. No further comments

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		assessment."	were received and we assume that these concerns were subsequently satisfied.
20	STA - Page 5 Incomplete Investigations	The toxicologist states in the 4/30/02 report that: "[f]or all the contaminated media reported, a link must be established that will represent scenarios whereby humans and other receptors will come into contact with the media and subsequently the contaminants." It seems that Unocal has never been required to compare the sampled media to any benchmarks. There has never been an adequate justification for abandoning established benchmarks. Sitka Tribe of Alaska will not be satisfied that risk has adequately been characterized in the Sitka Indian Village until adequate reasoning is given for abandoning the Method One cleanup levels for Diesel Range Organics and BTEX.	Method 1 is typically applied to small, less complicated sites where it is more cost-effective to simply clean up to very conservative levels than to collect data. An example would be a home heating oil tank spill where a few cubic yards of soil have been contaminated. DEC recognizes that cleanup will be very difficult with the infrastructure in the vicinity, and that it is likely that contamination will need to remain in place. Unocal was therefore requested to conduct a risk assessment under 18 AAC 340. If the risk assessment concludes that site risks are higher than regulatory thresholds, measures will need to be taken to manage those risks.
21	STA - Page 5 Incomplete Investigations	Additionally, Sitka Tribe of Alaska is not satisfied with the amount of testing that has been done in the Village. Sample TP-5/S-4, taken at 9.5 feet below grade surface in the former drainage swale, shows levels of Diesel Range Organics at a level of 134,000 mg/kg. This is over 670 times higher than the DEC Level B Soil matrix cleanup level of 200 mg/kg. The area of the drainage swale needs to be more adequately characterized before we can assume that 134,000 mg/kg is a mere fluke that can be diluted with bootstrapping.	The process of identifying an exposure point concentration to perform a risk assessment using statistical methods to establish a mean is standard methodology. The bootstrap method was used in order to estimate the mean of a population with wildly varying data. Other statistical methods would require removing high outliers in order to calculate a mean. The bootstrap method was chosen because it kept those anomalous high concentrations present in the dataset to contribute to the mean. In addition, that DRO concentration referred to is 9.4 feet below ground surface. Typically in a risk assessment, for residential exposure, the soil data

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			included in the exposure point concentration is from samples less than 2 feet below ground surface (with the exception of the volatilization pathway). The risk assessment assumes that receptors may ingest and have contact with all soil, regardless of the depth of the samples. This is an extremely conservative assumption that overestimates risk.
22	STA - Page 6 Burden of Proof	Throughout this process, Unocal has used the minimum amount of evidence to show that remediation is not necessary. However, when an area is sampled and the results show contamination, Unocal must be held accountable for this. There has never been any evidence that would show a house heating oil tank caused contamination in the former drainage swale. In fact, the very idea that natural drainage off-site from the tank farm went through this area should be enough evidence that the contamination was caused by Unocal's activities.	DEC recognizes the former drainage swale as a likely contaminant migration pathway for spills that may have occurred at the Unocal facility. However, a thorough understanding of the risk to residents due to the distribution of contaminants must consider all potential sources of these contaminants. Given reports of unregulated dumping in the former drainage swale, coupled with retrieval of man-made debris during test pit excavations there, DEC believes that consideration of additional potential sources is warranted.
23	STA - Page 6 Burden of Proof	A containment wall to divert rainwater through an oil-water separator was not built until 1992. Therefore, it is assumed that petrochemicals drained off-site in the natural drainage pathways. These pathways have not been adequately characterized for contamination.	Site investigations have been based on the premise that these natural drainage features are likely to be the most highly contaminated. DEC believes that adequate sampling has been conducted in these areas.
24	STA - Page 6 Burden of Proof	In a memo dated November 29, 1978, a Mr. J.M. Peck states that the local operations manual was changed in response to a run-over spill. He acknowledged that one person should be on the dock, monitoring the connections at the boat off-loading fuel and another should be up at the tank farm, watching to make sure the tanks did not over-fill. Two conclusions can be drawn from this statement: 1. that Unocal's contractors operated the tank farm	Please refer to response to Comment #16.

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		from 1933 to 1978 with an operations manual that did not require a second person be on site while tanks were filled, and 2. that spills occurred at least until operations procedures were changed in late 1978.	
25	STA - Page 6 Burden of Proof	It should be noted that no official Unocal report was ever issued regarding the 200-gallon spill in 1978. Therefore, it must be assumed that other spills occurred, but were not officially reported by Unocal.	Please refer to response to Comment #16
26	AESE - Page 1 Site Characterization Cross Ref #16	The site is not completely characterized, and the nature and extent of contamination is not fully identified. Spill history is not described, nor are the relative volumes of the different products or the history of products as chemical formulation changed over time. There is not any discussion of the chemical composition of the various products stored and spilled, and no mention of additives or metals. The RA Report, page 6, last sentence, refers to "historical knowledge regarding spill timing" but no citation is provided on spill history or volumes. It is obvious from the high concentrations of DRO in the soil and groundwater inside and outside the containment area that there were large spills and leaks. The analytical data seem to indicate a history of spills and leaks of different products, some deep and some shallow, some on the surface and some via groundwater.	Please refer to response to Comment # 21 Spill history, land ownership and facilities development are presented in a Phase 1 Environmental Site Assessment dated May 16, 1995. The information requested would be interesting but it is not critical to the outcome of the risk assessment. Petroleum is a complex chemical mixture and DEC understands there may be petroleum constituents that would not be evaluated when determining risk based on indicator compounds. Indicator compounds are used because toxicity has been verified for very few petroleum constituents and many petroleum constituents have been found to present minimal risk. Carcinogenic effects of petroleum were evaluated by calculating the cancer risk for various indicator contaminants, primarily BTEX and PAHs. Under EPA's *Guidelines for the Health Risk Assessment of Chemical Mixtures* (1986) the most preferred method for evaluating the hazards from chemical mixtures is to use toxicological data for the mixture itself. Since determining the chemical

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			composition and toxicity of weathered fuel is generally not feasible, the department provides conservative reference doses to use when assessing non-carcinogenic risk for fuel mixtures in the *Guidance for Cleanup of Petroleum Contaminated Sites* (ADEC 2000). Differences in toxicity due to variation in fuel mixtures is accounted for by overestimating the aliphatic and aromatic fractions to total 120%. The department believes the approach used is consistent with accepted risk assessment procedures and protective of the cumulative risk posed by exposure to petroleum hydrocarbons.
27	AESE - Page 1 Site Characterization	Since there was no Data Quality Objectives (DQO) or DQO-like process, sampling plan, or workplan, the analytical methods have been selected without consideration of VOC, SVOC, metals, additives, MTBE/ETBE, or the weathering fate above and below ground in cooler, wet climates.	Site characterization work plans, with accompanying COPC lists, were approved by DEC as required under its regulatory authority. It is not standard practice to sample for the many chemical additives that are often present in petroleum products. Moreover, MTBE and ETBE were not additives during the time period this bulk fuel facility operated. DEC's 2000 "Guidance for Cleanup of Petroleum Contaminated Sites" states that lead should be sampled if leaded gasoline is a COPC. However, on-site and off-site GRO soil concentrations, with the exception of three data points, were below DEC's conservative method 1, category B cleanup level (100 mg/kg). At these concentrations it is very unlikely that lead would be present above the residential cleanup level of 400 mg/kg. For this reason DEC has not required additional sampling for lead. Finally, the weathering of petroleum products is

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			recognized and may drive the COPC list for a particular site. For example, weathered diesel will generally exhibit low BTEX concentrations.
27A	AESE - Page 1 Site Characterization	The Sitka Tribe also detected Pb in soil up to 2870 mg/kg, confirmed up to 1380 mg/kg, but it is improperly excluded from the risk assessment.	Please refer to response to Comment #13.
27B	AESE - Page 1 Site Characterization	The contaminant concentrations in the text disagree with the tables; the highest hits are eliminated by the bootstrap method as being 'unreasonable' and do not appear in the narrative.	Highest hits were not eliminated and were included in all statistical calculations. The bootstrap method provides a method to calculate a mean when data contain outliers and does not have a specific distribution. See response to Comment #21.
27C	AESE - Page 1 Site Characterization	For groundwater, the earlier samples (which were higher) may be the samples that were not included in the narrative; however, there is not any supporting evidence indicating that levels appear to be decreasing at some locations.	See chart of historical ground water concentrations.
28	AESE - Page 2 Site Characterization	It appears that most of the physical features of interest were at least surficially sampled. However, deeper soil may not have been sampled outside the containment area. Clarification is needed in several areas:	Sample depths and locations are provided in the data tables. Most soil explorations were extended to top of bedrock. Backhoe test pits in the former drainage swale, however, encountered fill at a thickness that exceeded the maximum reach of backhoe equipment.
29	AESE - Page 2 Site Characterization	The containment area has a dirt bottom, with 3 buried drains on the bedrock surface to intercept infiltrating contaminants. It appears that this entire area is contaminated. The drains originally connected to underground pipes, but these have been removed, possibly allowing the drain to continue to release material directly to the downhill soil.	The pipes connecting the french drain system to the oil/water separator have not been removed. However, it is DEC's understanding that some of the drains were disturbed during the 2001 explorations inside the former tank farm. Given the high organic content of the containment area soils it is unlikely that ongoing contaminant migration continues. Highly organic soils are known for their capacity to effectively bind petroleum constituents.
30	AESE - Page 2	At one of the houses, drain tiles beneath crushed rock	Without an apparent source at this residence, it is not

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	Site Characterization	were apparently installed to carry water from the toe of the former drainage swale around the house to the storm drain. Since there are high hits in the swale area, this residence would probably benefit from more sampling.	likely that contaminant concentrations at this down-gradient location would be higher than those found in the vicinity of TP5/S4, the highest DRO location. Risk based on the higher concentrations (as was determined in the draft RA) would actually be more protective to potential down gradient receptors than if additional sampling were conducted at down-gradient locations.
31	AESE - Page 2 Site Characterization	The former drainage swale has the highest DRO concentration, indicating past spills and probably a preferential flow channel even though the swale has been filled.	DEC agrees.
32	AESE - Page 2 Site Characterization	The portion of the product line that is still underground has not been sampled.	Underground portions of the piping have been exposed and sampled where accessible.
33	AESE - Page 2 Site Characterization	The above ground pipeline corridor and drainage trench were sampled, but perhaps not with both shallow and deep soil samples.	Steep terrain along these areas is best described as a bluff. It is physically impossible to use any kind of drilling equipment to assist explorations along the bluff. However, because it is a bluff and because bedrock is found exposed near the base of the bluff within the western drainage feature, it is likely that soil cover is very thick along the face of the bluff. Hand explorations along the bluff were advanced to a maximum depth of 4 feet.
34	AESE - Page 2 Site Characterization	The underground oil/water separator at the loading rack was partially sampled, but there may have been a second separator at the containment area. No history is given of the oil-water separator(s) and what it (they) discharged, how it was monitored, or how much oil was removed.	There are no records indicating that there was a second oil water separator at the loading rack
35	AESE - Page 2 Site Characterization	There are other small gullies, especially the western drainage feature, that are clearly contaminated. Sampling may have been adequate here although perhaps not extending down to groundwater.	As discussed in the November 27, 2001 *Site Investigation Report*, Hand auger samples near the base of the western drainage feature (HA-1 through HA-5) were extended to bedrock. Samples HA-6 and

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			HA-7 as well as TP-W, located near the base of the pipeline corridor were also extended to bedrock. In the vicinity of the former drainage swale, test pits TP-1 through TP-5 were extended to one to two feet below the ground water table in January 1998, as described in the summary report for this investigation.
36	AESE - Page 2 Site Characterization	A storm drain crosses the product lines where they went from above ground to below ground at Kogwanton St. The storm drain may have received some of the spilled product, depending on when it was installed. There was no sampling in the drain or at its outfall.	The pipeline corridor does represent a cross-gradient preferential flow pathway. However, no free product has been detected in ground water samples upgradient of the utilities, and samples collected just upgradient of the utilities meet DEC ground water quality criteria. The Kogwanton Street storm drain was installed in 1982 to a depth of approximately 3 feet. Sanitary sewer and water lines were also installed to depths of approximately 8.5 and 5.5 feet, respectively, within the street right-of-way. For free phase fuel product to enter the storm drain, it would have to flow overland to a catch basin. The only known catch basin within the project area is along Kogwanton Street near the southeastern corner of Lot 30. Unocal, its consultants and DEC are unaware of any incidences of fuel flowing overland at the site.
37	AESE - Page 3 Site Characterization	Fig 6 shows wavy arrows from Katlian St. to the shore -- are these specific seeps or gullies, or are they indicative of groundwater flow? If they are groundwater flow, then the groundwater contamination must be moving so the plume is not stable.	Figure 6 in the Contaminant Distribution Report is vague with reference to the "wavy arrows." The intention was to differentiate the five contaminant zones discussed in the report. The arrows below Katlian Street are shown to indicate the "Shoreline Area" which is also referred to as the "Waterfront Area" in the text.
38	AESE - Page 3	There is not a good discussion of where the	This site typifies the Southeast Alaska coastal area.

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	Site Characterization Cross Ref #87	groundwater actually goes (seeps, beach discharge, sediment upwelling and pore water, tidal influence). The RA Report, Section 5.2 says "the groundwater plume appears stable and not likely to reach Sitka Harbor." There is no supporting evidence for this - other statements say that groundwater flows toward the Sound over the sloping bedrock. There is no groundwater plume map, water table map, or directional flow map. Since most of the discussion focuses on overland flow rather than on a good understanding of groundwater, groundwater was given short shrift.	The primary factors that contribute to ground water flow at the site are steep terrain, shallow bedrock, thin soil cover and lack of a bedrock aquifer. Ground water flow follows both topography and the underlying sloping bedrock surface, both generally directed toward the shoreline. Groundwater certainly reaches the shoreline and DEC cannot discount the possibility that contaminants may have as well in the past. As the draft risk assessment points out, however, periodic monitoring over 10 years has shown groundwater contamination to be stable, if not decreasing. Figure 8 and 9 of the Contaminant Distribution Report (CDR) graphically show the distribution of contaminants at the site.
39	AESE - Page 3 Site Characterization	The Contaminant Distribution report says the concrete retaining wall in the front of the containment area goes down to bedrock with 3 drain interceptors, implying that there is no groundwater plume outside the containment area. This further implies that offsite groundwater contamination is the result of locations where surface runoff has seeped into the soil and down to groundwater. However, Figure 8 (locations of benzene in groundwater) could also be interpreted as indicative of an actual groundwater plume with three arms - the western drainage arm, the pipeline corridor arm, and the drainage swale arm crossing under Kogwanton Street. Figure 9 (DRO in groundwater) follows the same pattern but not as distant. In fact, the RA Report, page 11 top, refers to just such plume maps in the Contamination Distribution Report, but they are not actually included. Comparing Figs. 9 and 10	A three-lobed groundwater plume may exist but DEC believes it unnecessary to substantiate this to adequately characterize human health risks. Had there been drinking water wells in the area, groundwater plume delineation would be addressed in more detail.

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		in the CD report indicates that benzene is at the highest concentration within the containment area while DRO is highest outside the area. This could be due simply to different tanks leaking at different times, or to a combination of some tanks leaking directly to groundwater and other tanks spilling over land and then seeping down (or most likely both).	
40	AESE - Page 3 Site Characterization	The reports say "no free product has been identified" but the distinction between free product and dissolved product is not clear. Since there is no spill history, it is not clear whether or where free product (LNAPL, oil sheen, etc.) would be expected.	Qualified field personnel have collected ground water samples from both monitoring wells and implant wells across the site. Qualified field personnel are trained to observe and note the presence of sheen or phase-separated product whether it is expected or not.
41	AESE - Page 3 Site Characterization	The simplified description of hydrocarbon migration does not distinguish between different petroleum products and their additives. It implies that (it) all products are transported at the same rate, proportional to distance and time but not affected by K_d (however, the previous discussion mentions benzene as indicator substance in water, indicating some differential partitioning and movement).	Benzene is one of the most mobile petroleum constituents and is commonly used as an indicator compound.
42	AESE - Page 4 Site Characterization	Water and sewer emplacements are mentioned as possibly creating physical conduits, as well as the storm drain carrying contamination to its outfall (no mention of where that is). Some of this discussion may be an attempt to suggest that some contamination is non-site related, or the migration was due to non-site-related actions that someone else is responsible for.	As recognized in the risk assessment, groundwater flow is the transport mechanism for petroleum contaminants. Water samples collected upgradient of the closest utilities suggest that contaminant concentrations in groundwater meet water quality standards.
43	AESE - Page 4 Site Characterization	There appear to be attempts to suggest other petroleum sources, such as: (1) refuse in the drainage swale (only wood and metal was detected); (2)household heating oil tanks (no sampling was done to confirm this and any delivery leaks would be	There are other potential sources of petroleum hydrocarbons in the area. With the exception of the drainage swale, these are believed to be minimal. Sumps have not been identified in the area and local construction practice supports this observation.

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		small); (3) nonpoint sources (streets were not paved until 1980, oiling was common practice and implicated as the source of the so-called background levels of DRO); and (4) sump pumps and septic systems were mentioned as a possible source (but actually this identifies sumps as an exposure pathway that was omitted from the risk assessment). Only one soil sample was located at a household above-ground storage tank, with low detection, whereas the containment area, swale, and drainage contained many hits of much higher concentrations.	Developed areas are typically affected by multiple sources of petroleum contamination. A discussion of other potential contaminant sources will not change the risk assessment conclusions.
44	AESE - Page 4 Site Characterization	Biota has not been sampled. Groundwater is so shallow that roots could reach groundwater.	Please refer to response to Comment #6.
45	AESE - Page 4 Site Characterization	Groundwater has not been sampled in the containment area since 1990. A good groundwater monitoring plan needs to be developed and implemented.	Three french drains, which intersect ground water are connected to the oil/water separator. Samples collected from the oil/water separator effluent line are an indicator of ground water quality in the tank farm area. Groundwater in the vicinity is not a present or reasonably anticipated future source of drinking water; consequently additional sampling is not warranted. Sentinel wells near the shoreline may need to be monitored in the future to ensure compliance with surface water quality standards.
46	AESE - Page 4 Site Characterization	There is a general question about concentration trends over time. This is relevant to whether most of the product has already moved through groundwater to the Sound or how much is still moving down through the ground toward groundwater. There is a	See Chart of concentration trends Vapor exposure was modeled by the Johnson Ettinger model. Additional data to support specific remedial options was not conducted as part of the

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		statement (RA report, p.8) that groundwater concentrations have declined since 1990 off site, but the assertion is not supported with evidence. Another statement says the groundwater plume appears to not be moving, which is attributed to the source (tanks) being removed. Soil vacuum tests to see how much product would actually volatilize have not been performed. Vapor movement was modeled, not bench-tested, or evaluate in the field. Because some of the remedies could be soil removal and thermal treatment, bioremediation, or in situ sparging, this might be a useful avenue to pursue.	risk assessment.
47	AESE - Page 4 Site Characterization	For inhalation of volatiles from soil there is a VF (soil to air volatilization factor). This factor may be appropriate if the soil is characterized properly (loam on top, coarse glacial till below) - the report did not discuss this, but said that TOC from soil greater than 2 ft in depth was used. Table B-1 gives the depth of each soil sample - on-site soil had been dug out to install the drains and refilled so strata would have been destroyed, and TOC ranges from 413 to 385,000 mg/kg (not proportional to depth) and there is no discernable trend of higher DRO with higher TOC. The off- site samples are all shallow with higher TOC as expected, but with just as high or higher contaminant concentrations. It is not possible to determine how much deep contamination there is off site or in different soil types, but one off-site 8 ft deep sample had the highest DRO in the entire data set; this sample would have been near or in the water table. This general assumption needs to be discussed with respect to the soil types at different depths and	Average TOC was calculated after separating the surface vs. subsurface samples because the mean TOC for surface samples is much higher than the mean TOC for subsurface samples both on and off site. The average TOC for subsurface samples was chosen to calculate the VF because a lower estimated TOC results in a lower VF, which results in higher estimated risk. This was a conservative assumption.

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		the depth of various samples. The original description of soil indicates a large difference between surface loam and deeper glacial material, but the analysis averaged the TOC, so this may be an important issue for the indoor air volatilization pathway as well as for identification of deeper soil and groundwater contamination.	
48	AESE - Page 5 Baseline HHRA Cross Ref #12	DEC Guidance has several methods for establishing cleanup goals. Method 1 uses a point system for establishing DRO and GRO cleanup goals, whereas Methods 2 and 3 are site-specific risk calculations based on exposure assumptions and additional contaminants. Methods 2 or 3 are preferable if the exposure scenario is complete and specific for the true receptors, which was not done in this case. The second most preferable is the Method 1 cleanup goals with default concentrations, although Method 1 goals may not be fully protective of the Tribe, either. However, the Unocal site is using a variant of Methods 2 and 3, but with inappropriate exposure factors.	Method 1 was developed in Alaska using the California Leaking Underground Storage Tank manual. The cleanup levels were based on protection of groundwater from contaminants leaching through soil from leaking underground storage tanks. In Alaska, the method is typically used for very small sites with limited contamination and limited analytical data. When data are available, Method 2 is universally used, unless DEC or the responsible party opts to use a more risk-based approach. Method 2 cleanup levels are defaults based on conservative risk exposure assumptions (inhalation and ingestion pathways) and conservative fate and transport assumptions (migration to groundwater pathway). Method 3 is a procedure for calculating alternative cleanup levels by modifying site-specific soil data, using an approved fate and transport model, or applying commercial/industrial exposure parameters. As pointed out in an earlier comment, DEC directed Unocal to conduct a risk assessment (method 4) at this site to accurately quantify human health risks. It is the most preferable method because it accounts for site-specific assumptions and exposure scenarios. It

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			is essential at this site because the proximity of structures and other infrastructure limits access and remedial options. It is therefore likely that contaminated soil will remain in place.
49	AESE - Page 5 Reasonable Foreseeable Land Use Sensitive Receptors	There is no real discussion of the receptors, just statements about residential zoning. The entire area is zoned residential, and houses are located as near to the site as the steep slopes allow, and the contamination appears to be in residential yards. There is not an explicit discussion on who the future owners might be, or their residential characteristics (how long would they live there, do they have gardens, etc.). Thus, there is no RME (reasonable maximum exposure) description as required by DEC guidance. Children's risk was evaluated, but not in a lifetime context. The RA report, page 9, says "the most exposed resident is a pica child" but pica soil ingestion rates were not used (200 mg is for an average child, not a pica child), so the pica child was not evaluated.	Risk assessments customarily group potential receptors according to labels like "residential" or "industrial" receptors. The risk assessors attempted to estimate the magnitude of exposure sustained by a typical resident. The term "pica" was not used appropriately in the risk assessment. Risk assessments generally assume that normal children ingest some amount of soil. There is no justification for evaluating a true pica child at this site. Please refer to response to Comment #1.
50	AESE - Page 5 Receptor and pathway identification Cross Ref #4	The site-specific pathways and exposure factors are not the ones described in either DEC or EPA guidance. Most factors have been lowered from DEC guidance (for example, the daily exposure frequency to soil is 330 d/yr in DEC guidance, not 180 d/yr as used in the RA report).	Please refer to response to Comment #1.
51	AESE - Page 6 Receptor and Pathway Identification Cross Ref #7	Lack of garden and biota pathways. The garden pathway has been excluded with no rationale for its omission. This pathway should include adult soil ingestion, uptake of contaminants into plants (particularly root crops), and above ground vegetation and fruits and vegetables including berries	Please refer to response to Comment #6.

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		and other native plants growing on site. Several components of petroleum are known to taken up by plants, so the garden pathway is potentially significant.	
52	AESE - Page 6 Receptor and Pathway Identification Cross Ref #1, #60, #78, #94	Lack of lifetime exposure. Lifetime exposure has not been evaluated. The evaluation includes only exposures to carcinogens for 5 or 6 years averaged over 70 years. It is not standard to use such short exposure periods (worker = 5 years x 30 d/yr; child = 6 yrs x 180 d/yr) and then average the exposures over 70 years to determine whether the DEC cancer risk target of 1E-5 was met. This means that the entire quota of cancer risk would be allowed to occur during those 150 days (worker) or 1080 days (child) as if no other exposure to carcinogens ever occurs. The standard methodology is to assume longer exposures (30 yrs or 70 yrs).	Please refer to response to Comment #1.
53	AESE - Page 6 Receptor and Pathway Identification	Soil Ingestion Factor. The RA report, Table 6, indicates a soil ingestion factor (IF) of 3.6 (industrial) and 80 (child). According to DEC guidance (DEC Cleanup Levels Guidance, 2001) the IF is an age-adjusted soil ingestion factor which simply adds the ingestion rate for 6 years of childhood (200 mg/d; 15 kg body weight) and 24 years of young adulthood from 7 to 31 years of age (100 mg/d; 70 kg body weight). The default soil ingestion rate for combined childhood and young adulthood is 114 mg/d. [Note that the adult soil ingestion rate is 100 mg/d in the DEC document, not the 50 mg/d used in the RA report.] The IF is not defined in the RA report and does not appear to have any relation to the DEC definition of IF, or is incorrectly used. This could significantly change the risk results for the soil ingestion pathway (the	The IF was incorrectly calculated for the risk assessment and should have been 114 (mg-yr/kg-day). Please refer to response to Comment #1.

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		primary exposure pathway).	
54	AESE - Page 6 Receptor and Pathway Identification	Indoor air. Indoor air via subsurface vapor intrusion into buildings from soil and groundwater used a 1-D screening model with BTEX data. It includes seams and cracks but not sump areas. Since there is physical evidence that drainage is a problem (drain tiles at house), the water table is shallow, and sump pumps are mentioned in the uncertainty section of the RA report, the sump area would appear to be a point of direct entry of groundwater. How many houses have sump pumps? Some of the actual exposure parameters in this model are not given - inhalation rate, how many hours indoors, how many years? This could be a significant pathway that is not evaluated.	The Johnson Ettinger model used is conservative in that a much larger crack in a foundation is assumed than is usually present. The typical construction in Sitka and in that area is on pilings. There is one house in the vicinity with a foundation, and it was confirmed to be dry. Sump pumps are not mentioned in the uncertainty section of the report. However, any uncertainty involved with a sump would relate more to direct exposure to groundwater rather than inhalation. Sumps are used to get water out of the house and would not result in the creation of a large area of water. Furthermore, flooding situations are generally of short duration and would likely result in extreme dilution of any contaminants present.
55	AESE - Page 7 Ecological Risk Cross Ref #80	Ecological risk has not been evaluated. Although there are no major habitats on the site, there are berry bushes, soil organisms, small mammals and birds. Uptake factors for native plants would also pertain to garden plants.	This site was screened from further risk evaluation based on habitat considerations, contaminant types and quantities, and the completeness of potential contaminant migration pathways. The site and adjacent areas do not represent important or quality habitat to terrestrial ecological populations. Sitka Sound is recognized aquatic receptor habitat but it does not appear that ongoing contaminant migration is a significant concern. Please refer to response to Comment #6 regarding uptake in plants.
56	AESE - Page 7 Background	Background DRO. The first mention of background for DRO is in the RA report, page 7, which says that	The background data were presented in the work plan. Elimination of non-detects and samples with

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	concentrations and Sample Size Cross Ref #14	background DRO is 137 ppm. There are no data to support this assertion, no formal designation of background areas, and no data to indicate that this contamination does not come from the site itself given its apparent long history of spills and overland flow. In fact, this supposed 'background' concentration could require cleanup under Method 1 (see below). Because these samples were removed from the database before bootstrapping, this alters the exposure point concentrations and therefore leads to an underestimate of the risk. All the contaminants are man- made and have background concentrations of zero outside of naturally-seeping oil fields. Additionally, from a health perspective the receptor does not care who is legally responsible for the contamination, and cannot discriminate between different sources.	less than an assumed background level concentration is an extremely conservative approach. The below background samples were eliminated from the data set to avoid diluting the exposure point concentration estimate with lots of non-detect samples and samples collected in uncontaminated areas. This step resulted in increasing the exposure point concentrations and was done to avoid underestimating risk. There is no basis to assume all diesel range organics (DRO) are anthropogenic. The presence of naturally occurring DRO in the thousands of parts per million range is well documented. The solvents that extract DRO in the laboratory also extract all hydrocarbons within the DRO range, including biogenic hydrocarbons such as those found in peat and other organic soils.
57	AESE - Page 7 Background concentrations and Sample Size	Non-detects. Although non-detects have been set at half of the detection limit, the samples below the supposed background of DRO (137 mg/kg) samples were first removed from the data set. Detection limits and the relation of detection limit to screening level are shown in Table 1 (RA report). Column 6a suggests that several detection limits are at or close to the screening level, which means that there are risks associated with 'non-detect' levels; setting the concentrations to 0.5 DL largely corrects this. Note also in Table 1 that the risk-based limit for benzene in soil is 0.64 ppm while the ARAR (no citation) is 0.02 - this illustrates how using the risk based screening level process can be skewed with non-protective assumptions.	Laboratory detection levels are based on the technological limits of the laboratory measuring devices (instrumentation) and often vary depending upon the level of contamination, type of matrix, etc. Without taking extraordinary measures, the detection levels achieved for this project are typical and expected. Samples in which a contaminant is not detected are reported at the detection limit, typically denoted by a "less than" sign. Risk assessments make the assumption that it can't be assumed that the contaminant is not present, so the accepted EPA methodology (*Risk Assessment Guidance for Superfund*), is to include them in the statistical calculations at a concentration of half the detection

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			limit. The 0.02 mg/kg benzene standard is based on protection of groundwater from contaminants migrating from soil. It is not a risk-based value. The 0.64 mg/kg value is risk based for protection of humans from inhalation of benzene in groundwater, and is the appropriate screening level to use. The screening step of a risk assessment is done to identify the contaminants of potential concern to include in the risk assessment. The contaminant will be included in the risk assessment if even only one sample has a concentration greater than the screening level. DEC risk assessment procedures are to set the screening levels at one tenth of the cleanup values from Tables B and C in 18 AAC 75. The procedure was followed for this risk assessment. The assumptions used in the risk assessment are protective and the process of screening was not skewed to underestimate risk. On the contrary, the screening process, the use of half the detection limit as a concentration when the contaminant has not been detected, and the procedure of using only DRO concentrations from contaminated areas (dropping all the low values and non-detects from the DRO dataset) are all methods that will result in an overestimate of potential risk.
58	AESE - Page 7 Background concentrations and Sample Size	Sample size. In addition to the problem of incompletely sampling groundwater and not sampling any biota, the number of soil samples was probably inadequate. A statistical sampling plan was not developed. Rather samples were taken where	Bootstrap does not dilute high hits. All detections are given the same weight in the bootstrap analysis. Indeed, Bootstrap provides a means to statistically evaluate extremely high hits when most of the data are orders of magnitude lower. Other statistical

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		physical features indicated contamination might be based on field judgement. A combined approach would have been better - physical features as well as a sampling grid for contamination not located on the surface. The small number of soil samples were first reduced by removing all DRO data below 137 mg/kg (as supposedly being background and therefore defining the nature and extent of contamination). The remaining samples have been divided into onsite and offsite subsets. Then the high "hits" were diluted by using the bootstrap method. Together, this makes the probability of having found all the contamination very low. Similarly, this small number of samples makes it impossible to demonstrate that the site is clean (the number of samples required to prove lack of contamination with a certain degree of certainty is a statistical question that cannot be answered by bootstrapping).	methods would either result in nonsense results or eliminate the high hits as outliers. The sampling method used was biased high. That is, samples were collected in areas thought to be contaminated or where there was evidence of contamination. A grid sampling would almost certainly result in many non-detects and an overall lower exposure point concentration; therefore, a less conservative risk assessment. The purpose of a risk assessment is not to demonstrate that a site is clean. In this risk assessment, high biased data were collected to provide reasonable maximum exposure point estimates. The data collected are adequate to characterize the site sufficiently to estimate risk.
59	AESE - Page 8 Screening Concentrations, COPC, and target analytes	COPC and COCS. The COPC list includes only BTEX, DRO, GRO, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Given the many other additives and other compounds in the various products and the detection of high lead levels, this COPC list is incomplete. No formal Target Analyte List was developed based on the chemical ingredients of the products.	Please reference the response to comment 27.
60	AESE - Page 8 Screening Concentrations, COPC, and target analytes Cross Ref #1, #3, #52, #78, #94	Screening assumptions. Tribal exposure factors are not used to establish detection limits or screening levels. This could change the screening levels significantly, as well as the Nature and Extent of contamination.	Screening was performed according to state guidance and regulation. Tribal exposure factors have no relevance in establishing detection limits. Detection limits are the limits of the methods and instruments used to measure the concentration of the contaminant in the

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			laboratory.
61	AESE - Page 8 Screening Concentrations, COPC, and target analytes	Using individual pathways for screening prevents multipathway RA. The cleanup levels used for screening are not for multiple pathways, but for individual pathways. For example, Equations 8 and 9 in Appendix C derive cleanup levels for dermal contact with soil as if this one pathway fully uses the entire risk quota of 1E-5 and HI=1. Therefore, COPCs are screened in only if they exceed this level, whereas they should be screened in if they exceed a fraction of this concentration, such as 1E-7 (see next comment).	Individual COPCs were screened against 1/10 the Table B and C 18 AAC 75 cleanup levels. This is the approved state methodology for screening and accounts for cumulative risk when identifying chemicals to carry through the risk assessment.
62	AESE - Page 8 Screening Concentrations, COPC, and target analytes	Cumulative multipathway risk versus screening levels. "(Alaska] regulation requires that the risk from hazardous substances does not exceed a cumulative carcinogenic risk of 1 in 100,000 across all pathways and a cumulative noncarcinogenic hazard index of 1.0 for each exposure pathway." It is probable that contaminants have been inappropriately screened out when they in fact could be shown to contribute risk using exposure factors specific to the actual receptors. "When more than one hazardous substance is present at a site or multiple exposure pathways exist, the Cleanup levels in Tables B1 and C may need to be adjusted downward." (DEC Cumulative Risk Guidance, 2001). This means that the statement on page 4 of the RA, second and third bullets, that "chemicals that were detected above human health risk-based benchmarks or standard DEC Table B or C cleanup levels were retained as COPCS" demonstrates an improper screening process. There is also a concern with the DEC guidance that allows the HI=l to be filled by risks through each of several pathways, potentially	Specific receptor exposure factors are not part of the screening process. COPC screening for the risk assessment was performed according to DEC risk assessment guidance. Cumulative multipathway risk is accounted for by screening against one tenth the values provided in 18 AAC 75. The risk assessment states in Section 3.1*"For soil, one-tenth of the ingestion or inhalation Table B soil cleanup levels were used as the human health risk-based benchmarks. For groundwater, one-tenth of the Table C groundwater cleanup levels were used as the human health risk-based benchmarks."* Cumulative risk from all COPCs and all pathways was calculated for the risk assessment.

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		resulting in a HI>1 for cumulative exposures.	
63	AESE - Page 8 Screening Concentrations, COPC, and target analytes Cross Ref #13, #73, #98	Lead. The RA report says that "although elevated lead concentrations were detected...the lead does not appear related to the petroleum contamination and is not considered a COPC." This is clearly in error - it is clearly associated with gasoline, and there is no mention of the purported "paint chips" flaking off of the pipeline being identified in the Contaminant Distribution Report. Even if the lead is due to paint flaked from the pipeline, the pipeline is part of the site and cannot be excluded. Again, from a health perspective, it does matter where the lead came from. Additionally, the Alaska lead cleanup level of 400 ppm may not be acceptable to the Tribe, since it is based on allowing 5% of children to incur blood lead levels above 10 µg/dl , which is a frank-effect level.	Lead can be associated with gasoline, but the detected GRO concentrations in this area were not associated with elevated lead concentrations. However, STA samples were: GRO — Lead <4 — 32 <400 — 138 <4 — 2,870 Please refer to response to Comment #13. EPA uses 400 mg/kg as a residential screening level for lead at Superfund sites. Screening levels are not cleanup goals. Rather, they may be used as a tool to determine which sites or portions of sites do not require further study. A screening level defined as a level of contamination, above which there may be enough concern to warrant site-specific study of risks. Levels of contamination above the screening level would NOT automatically require a removal action, nor designate a site as “contaminated” (OSWER Directive # 9355.4-12). DEC, however, has adopted 400 mg/kg as a conservative residential lead cleanup level. Of the 22 samples collected by GeoEngineers in April 2002, only one exceeded this level. Two earlier samples also exceeded 400 mg/kg. Hot-spot soil removal may therefore be required in some areas of the pipeline. Note that under state regulations a responsible party

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			can propose an alternative lead cleanup level when a site-specific risk assessment is conducted under method 4. Unocal does not intend to propose an alternative lead cleanup level.
64	AESE - Page 9 Exposure point concentrations	Statistics. A number of hot spots are detected both on and off-site, suggesting that there may be other undiscovered hot spots as well. What is the probability of having found all the truly highest hits, given the small number of samples? The statement that "the large standard deviation resulted in an unreasonable 95% UCL" (RA section 5.3. 1. 1) is actually due to real data and real hot spots. Since the large standard deviation and small n is the justification for bootstrapping, it is important to establish whether the highest hits are rare quirks or representative of other hotspots throughout the site.	The hot spots were used in the statistical analysis and are reflected in the baseline risk. While other hot spots could exist, the use of high biased sampling techniques and over ten years of investigation involving hundreds of samples does not constitute a minimal effort. DEC and Unocal's consultants view the data as adequate to characterize the site. The reviewer does not indicate a basis for the perception the sampling is inadequate. Please note that much of the site is covered by gravel, pavement and buildings. The actual areas available for sampling and the reasonable contaminant migration pathways have been addressed adequately. The goal of site sampling is to find hot spots and areas of highest contamination. The reason that the data distribution is not appropriate for derivation of the 95% UCL on the arithmetic (or lognormal) mean is because the data does not have a normal distribution. This is because the sampling used a biased approach designed to find contaminated areas. In this case, the bootstrap method was chosen as the appropriate statistical method to estimate the real mean of the population.
65	AESE - Page 9 Exposure point	Division of data into onsite and offsite subsets. There is no logical reason to divide the already small	During the scoping of the risk assessment, it made sense to divide the areas between on- and off-site,

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	concentrations Cross Ref #15, #88, #89	number of samples into on-site and off-site subsets. The fenced area is designated for residential use (RA Report section 5.1), and the risks are not different enough to support this (in fact, the cancer risk to the child is higher offsite than the onsite).	because there are no residents living in the tank farm area and there are residents living adjacent to it. Further, it was assumed by the risk assessors that concentrations on-site would be significantly higher than off-site. A residential exposure scenario was evaluated for both on and off-site areas. The increased risk to offsite receptors is not due to soil contamination, but as a result of potential exposure to shallow groundwater, specifically, one PAH hit in one sample drove the risk to the off-site receptor.
66	AESE - Page 9 Exposure point concentrations Cross Ref #77, #97	Bootstrapping. 41 soil samples were 'bootstrapped' into a computer-generated dataset of 1000 samples from which the 95% UCL was extrapolated. The rationale is that (a) the sample size is small, and (b) the high hits are outliers caused by some analytical problem or some improbable or unusual event not related to the pattern of contamination throughout the rest of the site (i.e., the distribution is homoscedastic). In particular, this refers to very high DRO in the swale (offsite) and in the containment area (onsite). Clearly these are real hotspots; if they are eliminated via bootstrap dilution from the dataset used to determine exposure point concentration, the associated risks will not be adequately evaluated and those spots will not be remediated (since the RA report concludes that there no unacceptable risk). The alternative to bootstrapping is to simply calculate a 95% UCL based on actual data including the high hits, which will elevate the exposure point concentration and the risks. Since the risks are within or slightly above the DEC target risk levels, this could make the difference between remediation and	The process of identifying an exposure point concentration to perform a risk assessment using statistical methods to establish a mean is standard methodology. It was not assumed that the high concentrations were the result of an analytical problem or improbable event. The bootstrap method was used in order to estimate the mean of a population with wildly varying data. Other statistical methods would require removing high outliers in order to calculate a mean. The bootstrap method was chosen because it kept those anomalous high concentrations present in the dataset to contribute to the mean. It is typical to estimate some sort of average for the exposure point concentration. It is not conceivable that a receptor would be exposed 100% of the time to one or several high hits collected at approximately 9 feet below ground surface.

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		no remediation (aside from the woefully inadequate exposure assumptions).	
67	AESE - Page 9 Exposure point concentrations	Aliphatic/Aromatic DRO and GRO. There is a factor in Tables 7-10 of the RA Report that indicates that DRO/GRO Aliphatic and Aromatic concentrations have been reduced to 40% to 80% of the bootstrapped 95% UCL, if we are interpreting the tables correctly. The differences in toxicity have already been accounted for by the RfDs and slope factors (Table 3, per DEC guidance), so there is no reason and no explanation for this. This is not due to an assumption that DRO is 80% aliphatic and 20% aromatic, because the correction factors do not add up to 100%. Perhaps this is explained in DEC guidance, but it is not referenced.	The process of dividing petroleum aliphatic and aromatic fractions is based on DEC guidance (*Guidance on Cleanup Standards, Equations, and Input Parameters)*. It does not reduce the fractions, but in fact, increases potential toxicity from each fraction (by totaling more than 100%).
68	AESE - Page 10 …risk from multiple COC, …multiple sources and multiple media Cross Ref #97	Pathways and contaminants are screened out inappropriately given the reported intended future use of the site. Pathways that are included are temporally shortened or evaluated in non-standard ways. Thus, even though risks are added for the COCs and pathways, cumulative risk has not been assessed. Tables 7-10 in the RA Report show 'cumulative' risks in boxes at the bottom, but there are enough omissions that this is a misnomer. Also, these numbers need to be checked; for instance, Table 9 shows a dermal noncancer risk of 0.0001, but the cumulative noncancer risk from all pathways is 0.00007, or lower than the dermal pathway when it should be the same or higher unless this is a rounding difference (if so, the dermal risk should not be rounded).	The inconsistency in Table 9 is due to a rounding error in the spreadsheet. The values are correct and cumulative noncancer risk is 0.00007. DEC believes that pathways were appropriately and conservatively estimated.
69	AESE - Page 10 Risk Characterization and Uncertainties	This language includes statements about how risk assessments are supposed to be overestimates of actual risk. Two sources of underestimation were	Upper bounds are default results in Tables B and C. Whole point is to look at site and make site specific upper bound estimates.

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		listed, but there are as many or more reasons how risks in this report are underestimated than overestimated. For instance, (a) not all exposure factors are upper bounds - inhalation rate is an average (but the parameter is not discussed), (b) soil ingestion may be underestimated, (c) a full lifetime of exposure is not evaluated, (d) biota-related pathways are not included, (e) lead is not included, (f) other COPCs are expected to be present given the products that were on site, (g) the full nature and extent of contamination is not complete, (h) DRO samples <137 mg/kg are omitted due to the supposed natural. Note that a-h, above, does not constitute an exhaustive complete list	a) See response to Comment #1. b) See response to Comment #1. c) See response to Comment #1. d) Biota related pathways were qualitatively evaluated and are not a significant contributing pathway. e) Lead is not included in cumulative risk calculations as per EPA. f) Products used at the bulk fuel tank farm are well documented g) The site investigation has been ongoing for 12 years and is considered complete. h) Removal of low and non-detect DRO concentrations increases the estimated exposure assumption and will overestimate risk at the site.
70	AESE - Page 10 RA Report section on 'Conclusions'	Given the omissions indicated above, the conclusions that the site poses no cancer risk or noncancer risk are unsupported. In fact, the cancer risk to the onsite worker with only 30 d/yr x 5 yrs x 8 hrs/d = 1200 hours of exposure is 1E-5, which is actually quite high. Off-site concentrations are just as high as on-site, and this is reflected in the same cancer risk for workers offsite as onsite (the difference in noncancer risk between onsite and offsite appears to be due to PAHs). The omission of lifetime exposures and biota pathways, and the use of less than protective exposure assumptions was a conscious choice on the part of the assessors. Since there was no risk assessment workplan or consultation with the Tribe, this has resulted in a flawed conclusion.	Estimated risk to on-site workers as a result of exposure to soil are of the 1E-8 magnitude. The calculated risk of 1E-5 is the result of the assumption that the worker spent 8 hours/day, 30 days/year, for five years exposed to <u>groundwater</u> contaminated with PAHs. The risk assessors are confident that this is an overestimate of exposure. The offsite residential receptors had the additional exposure pathway of dermal contact with and ingestion of groundwater. The increased estimated risk to the offsite receptor is the result of lengthy estimated dermal contact with one high PAH concentration. DEC disagrees that the exposure assumptions used are less than protective. Moreover, in late April 2002 the Tribe was sent the final workplan and given an opportunity to discuss it with DEC. The Tribe did not

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			see a need to meet at that time.
71	AESE - Page 11 Method 1…	Comment: Under DEC Method 1, the above cleanup levels are required, as well as the cleaning up specifically for BTEX and PAHS. The concentrations of DRO at the Unocal site range up to 134,000. This would clearly require cleanup of not only the entire site, but possibly also some of the more peripheral areas that were (inappropriately) labeled as 'background.' Note that the risk-based screening level in the RA report for DRO is 825 (rather than 100 or 200 under Method 1) and for GRO is 140 (rather than 50 or 100) (see RA report, Table 1). In other words, the risk based screening level, using the assumptions for limited exposures, are much higher than Method 1 cleanup levels. No rationale is given for not simply using Method 1 cleanup goals (or preferably using Methods 2-3 with appropriate exposure factors).	Please reference the response to Comment #48.
72	EPA - Page 1 General Comments	Overall, the presentation of the risk assessment was in accordance with DEC and EPA guidelines. The risk assessment followed the approaches outlined in the DEC risk assessment procedures manual, and in some cases utilized methods provided in the EPA guidance.	Comment noted.
73	EPA - Page 1 General Comments Cross Ref #13, #63, #98	In the report, it was indicated that lead was detected along the above ground pipeline corridor in 1996 (2870 mg/kg) and in 2002 (1380 mg/kg), however, these levels detected were waived off and not included in the risk assessment. The justification presented for this action was that new round of sampling conducted the same year by GeoEngineers (April 2002) from the same area showed that the lead levels were less than the cleanup level of 400 mg/kg,	Please refer to response to Comment #63.

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		hence, there was no apparent correlation between areas of elevated petroleum contamination and high detected lead. Consequently, the elevated lead levels detected were attributed to debris, possibly paint chips associated with weathered pipelines. Since lead appears to be a constituent of petroleum products, it is most likely that they may be associated with fuel stored at the facility, thus, it makes sense to assume that any elevated lead level detected at the site must be connected to past activities.	
74	EPA - Page 2 General Comments	Some data gap exists concerning groundwater seeps in the down gradient area at the site: adequate characterization of groundwater seeps is vital in this risk assessment, as seeps may contain contaminants in groundwater at the site.	Seeps encountered at the site are intermittently flowing and can only be sampled when active. The risk assessment modeled the most conservative scenario of contaminated groundwater (and corresponding concentrations) transported directly to the ground surface. DEC will require additional seep water monitoring.
75	EPA - Page 2 General Comments	EPA guidance suggests that the hierarchy of toxicity information for contaminants of potential concern (COPCS) in a risk assessment should include, integrated risk information system (IRIS), health effects assessment summary tables (HEAST), EPA criteria document, ATSDR minimal risk levels (MRL), and other pertinent sources like state guidance and open literature. It looks like the toxicity information hierarchy used in this risk assessment did not follow the guidelines as suggested in the EPA guidance.	The hierarchy of toxicity information for COPCs was agreed on with the DEC at the work plan stage. EPA Region III RBCs and Region IV PRGs use the hierarchy of IRIS, HEAST, EPA Criteria Documents, ATSDR MRLs and other sources to complete the toxicity data tables.
76	EPA - Page 2 General Comments Cross Ref #5, #96	The exposure assessment in a risk assessment culminates in the development of the conceptual site model (CSM). Normally, the CSM is presented in a flowchart format, and helps in the identification of	The flow chart CSM is included with this response.

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		the receptors that would be most impacted by the COPCs (i.e., complete exposure pathways). The CSM as presented in this risk assessment, lacks the required elements, and is therefore, unacceptable.	
77	EPA - Page 2 General Comments Cross Ref #;66, #92	The estimation of the exposure point concentration (EPC) for soils as presented in the risk assessment Using the Bootstrap method may be appropriate, however, the derivation of EPCs for groundwater seemed to be more straightforward. The maximum detected values in groundwater were used for this purpose. In contrast, the estimations of EPCs for soils were calculated using the Bootstrap method. The justification presented for this apparent dichotomy was that the soils data were highly variable. In particular, the variability in the diesel range organics (DRO) data for soils necessitated the use of the Bootstrap method to derive the EPCS. The Bootstrap method is a valuable statistical approach, but in some cases, its application may be improper due to the type of data available for analysis. In the Unocal case, it would have been useful to assess the entire soil data to see if the data is amenable to the Bootstrap method. From the analysis presented in the report, it does not seem that adequate review was conducted on the soil data: data should have been mapped out to ascertain the spatial distribution of contaminants; data available should have been evaluated to see if they represent the underlying population; data available should have been examined thoroughly to see if they represent an accurate characterization of population in all respect, and not just its mean and standard deviation. The estimation of soil EPC using the Bootstrap method because of a single outlier (DRO dataset), may be	The process of identifying an exposure point concentration to perform a risk assessment using statistical methods to establish a mean is standard methodology. The bootstrap method was used in order to estimate the mean of a population with wildly varying data. Justification for use of this statistical method is provided in DEC guidance. The DRO data were subjected to specific statistical tests in an effort to determine the best statistical method to use. DRO data were considered representative of all the data sets because DRO was the main contaminant present and DRO is always present when any other contaminants were detected. The W test (Shapiro and Wilk) was used to determine if the data fit either a normal or log-normal distribution. The null hypothesis that the distribution has a normal distribution can be rejected at the 99% significance level. The null hypothesis that the distribution has a log normal distribution falls between the 50% and 90% levels of significance meaning a log normal distribution is a reasonable model for the data. The H statistic (Gilbert 1987, EPA 1992) was used to calculate the 95% UCL. The H statistic is a parametric test for lognormal data sets. It does not perform well if the data only appear log normal. The H statistic test yielded a 95% UCL of 62,051. This

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		appropriate, but it would have been more convincing if sufficient explanation was provided for its use in the risk assessment.	result exceeds all sample results except one by a factor of 5 or greater and implies the entire site could be composed of fuel saturated soil. Several conditions are cited where the H statistic will perform poorly (EPA 1997): • Samples sizes less than 30, • Highly variable populations with coefficients of variation (CV = standard deviation/mean) exceeding 1, • Sample sets containing outliers or extreme values, and • Sample sets that appear to be lognormal but which are actually drawn from two or more distinct populations. One of the above indicators clearly applies to the data set and a second is likely. • The DRO data set evaluated was highly variable. The coefficient of variation was 3.5 indicating the standard deviation was 3 ½ times the mean. • The existence of two or more distinct populations is likely. Spills occurred at different times, in different places, and with different sources of fuel. Each of these spills would have different characteristics and, statistically, would represent different populations. Two of the indicators do not apply. • A Rosner's outlier test did not indicate outliers.

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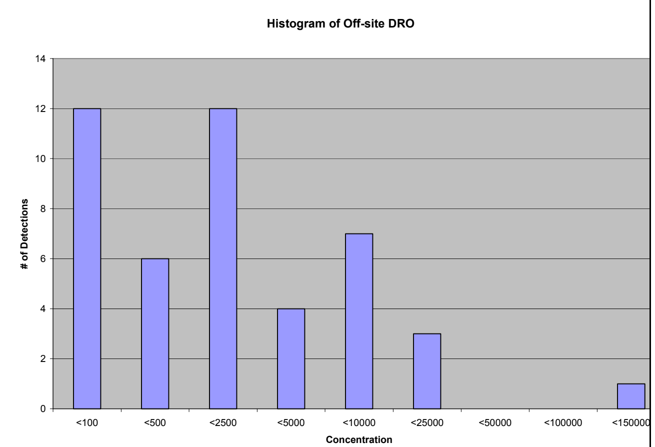
			• The sample size was 45, i.e. greater than 30. Based on high variability and potential for multiple populations the H statistic was rejected as an appropriate statistical test. The bootstrap method was selected because it has been shown to perform substantially better, sometimes orders of magnitude better, in estimating the UCL of the mean from a positively skewed data set (ADEC 2001). A positively skewed data set is one where most of the data points are on the left side of a histogram. The histogram for the off-site DRO is depicted below. The data are clearly positively skewed.  The Bootstrap method was also selected because it is appropriate for either parametric or non-parametric data sets. While the data appear log normally distributed the H statistic test and coefficient of

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			variation imply the underlying distribution is possibly not log normal; consequently, a non-parametric test will likely yield the best result. Use of the Bootstrap method also has tacit endorsement by ADEC through publishing guidance on the method and direct endorsement though approval of the method for other risk assessments.
78	EPA - Page 3 General Comments Cross Ref #1, #2, #3, #52, #60, #94	The exposure assumption incorporated in the risk assessment included the use of exposure frequencies of 30 and 180 days per year for a worker and a resident, respectively. These values were derived based on best professional judgement on the notion that there are no available data on human behavior in Sitka, Alaska, and as such, represent the best estimate for these two exposure scenarios. These values appear to be outside of the "traditional" numbers that have been used in risk assessments and at the same time, it would be erroneous to use the EPA standard default values-for Sitka, Alaska. Additionally, it appears that the weather condition in Sitka was instrumental in the genesis of these "aberrant" exposure frequencies. Therefore, it does not make any sense using arbitrary numbers just for the sake of justifying that there are exposure limitations in Sitka, Alaska, that may be attributed to unfavorable weather conditions. All exposure numbers should be agreed upon and verified to make sure they represent the best values for the scenarios evaluated.	Please refer to response to Comments #1 and #3.
79	EPA - Page 3 General Comments	The off-site exposure setting was not well defined. Potential receptors identified were limited to workers and residents within the former bulk plant. Since a subsistence lifestyle is prevalent in Alaska, threat to	DEC recognizes the subsistence lifestyle of many members of the Sitka Tribe. However, the site and downgradient properties do not appear to be a significant subsistence gathering area. The site is in

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		other receptors should-not be ruled out for off-site areas near the site.	downtown Sitka in an urban setting. There are numerous structures, parking spaces and driveway pads.
80	EPA - Page 3 General Comments Cross Ref #55	In the ecological assessment, there was no clear delineation of the ecological habitats that are present near the site. Also, no mention was made on the type of receptors that may utilize areas outside the site, and what type habitat would support such receptors. However, it was mentioned that some wildlife may likely move through Katlian Street up to Kogwanton Street, but these wildlife were classified as transient, because they have not been documented to reside on or near the site. From an ecological risk standpoint, it would be ideal to conduct an area wide reconnaissance in an effort to identify what types of receptors are present in the area and what type of habitat exists that support and/or attract them. To fully understand the potential ecological issues at the site, it may be necessary to document and catalog the types of wildlife that inhabit the area.	Please reference comment 55.
81	EPA - Page 4 General Comments	If the water table at the site is shallow, it seems logical that seeps coming out of this shallow groundwater may be potentially contaminated. Hence, the seeps may be an appealing source of drinking water for these transient wildlife.	The seeps discussed in the risk assessment are little more than wet spots on the ground. It is unlikely that transient wildlife use these seeps when plentiful fresh water is available elsewhere.
82	EPA - Page 4 General Comments	The water body reported to be closest to the site is the Sitka Sound. It was stated that this water body does not appear to be threatened by contaminants at the site. This statement needs to be clarified: there is no data in the risk assessment that shows that near shore samples (surface water, seeps, and sediment) have been collected to substantiate this.	Upgradient sampling of ground water suggest that Sitka Sound is not threatened by the contaminant migration. Concentrations of petroleum hydrocarbons in upgradient ground water are within surface water quality criteria.
83	EPA - Page 4	There was indication of heavy rainfall in the area: the	The location of intermittently active seeps is

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	General Comments	area may be prone to flooding; this makes it logical not to discount that contaminant may, migrate off-site. Also, it appears that the only aquatic systems documented in the report are intermittent seeps which apparently empty into Sitka Sound. These intermittent seeps may be a potential migration pathway for groundwater contaminants from the site to move off-site, which may eventually threaten aquatic wildlife in Sitka Sound.	approximately 250 feet from the normal high tideline. Flooding is not known to be a problem in the site vicinity due to the steep terrain and man-made conveyances. During the few times the seeps were noted to be active, they formed a small wet spot on the order of 20 square feet and were not flowing overland. Additionally the concentrations of hydrocarbons in ground water do not threaten Sitka Sound.
84	EPA - Page 4 General Comments	The inhalation exposure assessment was performed using the Johnson and Ettinger model, however, there was no mention in this report of the input parameters used, and how the model was applied at the site. Also, the risk assessment report should include some narrative statement about the outcome of the model and some of the limitations.	There was not enough site specific data regarding soil properties to warrant using the advanced version of the Johnson Ettinger model. The most current version of the screening model was used. All default assumptions were used. The default assumptions in the model assume residential exposure 24 hours per day, 350 days per year, for a 30 year exposure duration. The model was used in order to account for potential risks from indoor air in cumulative risk. This model is an approved EPA inhalation model and documentation is readily available on the web.
85	EPA - Page 4 Specific Comments	Section 2.1.2: The conclusion that Sitka Sound is not impacted by site contaminants, and was also not considered an exposure point for both human and nonhuman receptors in the risk assessment may be misleading and may trivialize the risk issue at the site. Since groundwater and sediments at the site are potential "sinks" for site-related contaminants that may discharge into Sitka Sound, therefore, it may be inaccurate to conclude that these sources may not contribute to exposure at the site. In addition, it was assumed that the concentration of contaminants in the seeps may correspond with the levels in groundwater; this may be correct, but there is no way	Please refer to response to Comments #38, #74 and #83.

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		to corroborate this without collecting actual seep samples and also tracking any potentially above and below surface contaminant migration pathways.	
86	EPA - Page 5 Specific Comments Cross Ref #13, #63, #73	Section 3.1: Lead detected along the above ground pipeline corridor in 1996 (2870 mg/kg) and in 2002 (1380mg/kg) should have been carried through in the risk assessment. The reason(s) presented for excluding them in the risk assessment were not convincing. It makes sense to infer that any elevated lead level detected at the site must be related to past activities. Also, lead appears to be a constituent of petroleum products, and it is most likely that it may be associated with fuel storage and other activities at the facility.	Please refer to response to Comments #13, #27 and #63.
87 I	EPA - Page 5 Specific Comments Cross Ref #89	A data gap exists regarding groundwater in the down gradient area at the site: adequate characterization of groundwater seeps is vital in this risk assessment, as seeps may represent an exposure source to contaminants in groundwater at the site.	Please refer to response to Comment #74.
88	EPA - Page 5 Specific Comments Cross Ref #15, #65	Section 5.1: It was not clear in this report if the partitioning of the site into "on-site and off-site" are real or arbitrary. For this risk assessment to meaningful, it would be imperative to distinguish which area(s) of the site is most impacted, and needs remediation. The delineation of the site into these two categories, for the purposes of this risk assessment appears to be subjective; a more factual land use designation at the site would be needed that highlights areas that need careful and/or detailed evaluation for the purposes of risk reduction.	During the scoping of the risk assessment, it made sense to divide the areas between on- and off-site, because there are no residents living in the tank farm area and there are residents living adjacent to it. Further, it was assumed by the risk assessors that concentrations on-site would be significantly higher than off-site. A residential exposure scenario was evaluated for both on and off-site areas. Please refer to response to Comment #15.
89	EPA - Page 5 Specific Comments Cross Ref #87	Section 5.2: Groundwater data was used to estimate the concentration of contaminants in seeps, because it was assumed that the level of contamination in the seeps was the same as that in groundwater. This may	Please refer to response to Comment #74.

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		be valid, but was never substantiated in the report. It is impossible to substantiate this assumption without collecting actual seep data and also tracking any potentially above and below surface migration pathways. In fact, this approach should be considered as the last resort, and should in no way be used as a substitute for real groundwater seep data.	
90	EPA - Page 6 Specific Comments	It was stated in the report that groundwater beneath the site likely flows to Sitka Harbor, and also appears to be stable. Furthermore, it was also stated that this conclusion was reached based on monitoring well data and historical knowledge of the spill timing at the site. Perhaps, this situation may have prevailed when groundwater samples were taken 11/27/01, but there was no data presented in this report to corroborate this claim. In addition, it was also indicated that contaminant source areas at the site were removed in 1998, and this may have eliminated the potential for contaminants migrating into groundwater in the areas of concern. The report should have included data from most current groundwater data to determine whether further attenuation has occurred, and if levels of previously detected contaminants have decreased.	Refer to Site Characterization Report and Contaminant Distribution Report Refer to chart.
91	EPA - Page 6 Specific Comments	Section 5.3.1.1: The reasonable maximum exposure (RME) concentrations for on-site and off-site soils were estimated separately, using the 95 percent upper confidence limit (UCL) on the arithmetic mean. Also, it was stated that the 95 percent UCL was calculated using the nonparametric Bootstrap method. It was not clear which soil RME concentration (on-site or off-site) was estimated with either method. This needs to be clarified.	The bootstrap method is a statistical method designed to calculate the 95% UCL on the mean. The population did not have an identifiable distribution, thus, the nonparametric bootstrap method was used. Both on and offsite exposure point concentration were calculated using the bootstrap method. Please refer to response to Comment # 77.
92	EPA - Page 6	The Bootstrap method is a valuable statistical tool,	Data were evaluated for statistical appropriateness of

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	Specific Comments Cross Ref #;66, #77	and may be appropriate when properly used, but in some cases, its application may be inappropriate. The analysis presented in this risk assessment, appears somewhat one-dimensional, and it seems like available soil data may not have been thoroughly investigated to see if the data was amenable to the Bootstrap technique. Furthermore, it appears that the H-statistics approach was abandoned due to the large standard deviation that resulted from the single DRO dataset. In order to determine the appropriateness of the Bootstrap method for data analyses: data available should be evaluated to discern if they represent the underlying population; data available must represent an accurate characterization of population in all respect, and not just its mean and standard deviation.	using the bootstrap method. Use of this method was approved by the DEC prior to performing the risk assessment. Please refer to response to Comment #77.
93	EPA - Page 7 Specific Comments	Section 5.3.1.2: The RME for groundwater used in the risk assessment appears to be straightforward and appropriate; maximum recent groundwater concentrations were used instead of the 95 percent UCL. Also, it was stated that a 1998 PAHs groundwater data was used for the risk assessment. It would have been appropriate to use the most recent groundwater PAHs data, for consistency. Please provide the justification why the most recent groundwater data was not used in the risk assessment.	The 1998 data was the most recent data collected and analyzed for PAHs. This data was collected and analyzed using the SIMS method (lower detection limits) in order to address groundwater in a risk assessment.
94	EPA - Page 7 Specific Comments Cross Ref #1, #3, #52, #60, #78	Section 5.3.2: In the exposure parameters, several "non-traditional" values were used. For example, exposure frequencies of 30 and 180 days per year for a worker and a resident, respectively; these values were derived based on best professional judgement on the notion that there are no available data on human behavior in Sitka, Alaska, and as such,	The Sitka Tribe was given the opportunity to review and discuss the final risk assessment work plan in April 2002. Please refer to response to Comments #1 and #3.

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		represent the best estimate for these two exposure scenarios. These values appear to be less conservative and may result in the underestimation of risk at the site. It would have been ideal if the parties involved agreed ahead of time on what values should be used: these must be verified to make sure that they represent the best values for the scenarios evaluated. Further, it appears that the climate in Sitka is a modifying factor in the risk assessment, accordingly, it would be inappropriate to use exposure parameters that are inconsistent which do not take into account the impact of climate.	
95	EPA - Page 7 Specific Comments	Section 5.4: Surface soil exposure scenarios for on-site and off-site locations, was defined as the top two feet and subsurface is the interval between two feet below ground surface (bgs) and bedrock. For the on-site scenario, no mention was made of the potentia1 exposures to volatilized contaminants below two feet bgs.	Section 5.4 of the Risk Assessment also states "*In accordance with the Risk Assessment Procedures Manual, both residents and workers are generally considered to be potentially exposed to surface and subsurface soil. For this reason, subsurface and surface soil data were grouped together and not evaluated separately. Both workers and residents could potentially be exposed to volatilized contaminants from both surface and subsurface soil.*
96	EPA - Page 7 Specific Comments Cross Ref #5, #76	Section 5.5: The exposure assessment in a risk assessment culminates in the development of the CSM. The CSM in a risk assessment is the " window" that establishes the potential interaction between receptors and contaminant, and is usually illustrated in a flowchart format, and not as presented in this risk assessment. The CSM establishes the link between receptors and COPCS, and assists in the identification of where complete exposure pathways exist between receptors and the COPCs at the site. Therefore, the CSM as presented in this risk assessment, lacks the required elements, and is unacceptable.	Figure 3 of the risk assessment contains all the required elements of a CSM and was considered more readily understandable to a reader. The flow chart CSM from the scoping phase of the risk assessment is included with these responses.

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97	EPA - Page 8 Specific Comments Cross Ref #68	Section 6.1: Cumulative risk means combining risk-from aggregate exposures resulting from exposure to multiple agents or stressors via multiple pathways. Cumulative risk estimates as described in this risk assessment were derived based on available DEC guidance. EPA is in the process of publishing a cumulative risk guidance: this document will provide more detailed approach on how to deal with chemical mixtures at contaminated sites, and will exceed what is currently practiced.	The EPA cumulative risk guidance was not available at the time this risk assessment was performed and is not available now. DEC guidance was used to determine cumulative risk.
98	EPA - Page 8 Specific Comments Cross Ref #13, #63, #73	Section 8: Lead which was excluded from the risk assessment should be mentioned in the uncertainty. The lead levels detected along the pipeline corridor in 1996 are high and should have been included in the risk assessment. In addition, the levels detected are above the residential and industrial screening criteria.	Please refer to response to Comments #63.
99	EPA - Page 8 Specific Comments	Data gaps exist regarding groundwater in the down gradient area at the site. Adequate characterization of groundwater seeps is vital in this risk assessment, as seeps may represent a source of exposure to contaminants in groundwater at the site. Furthermore, the use of groundwater data to estimate the risk from exposure to seeps may seem acceptable, but may have in essence introduced additional uncertainty in the risk assessment.	Please refer to response to Comment #74. During the few times the seeps were noted to be active, they formed a small wet spot on the order of 20 square feet and were not flowing overland. The assumptions used in the risk assessment were extremely conservative. Since actual sample data for seep water has not been available, it was assumed that concentrations of COPCs present in subsurface groundwater was present in the seeps. This assumption is unrealistic and conservative. Further, it was assumed that residents were exposed to this seep water for an hour per day. Uncertainty added to the risk assessment from this assumption overestimates risk dramatically.
100	EPA - Page 8 Specific Comments	The inhalation exposure assessment was performed using the Johnson and Ettinger model, however,	Please refer to response to Comment #84.

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		there was no mention in this report of the input parameters used, and how the model was applied at the site. Also, the risk assessment report-should include some narrative statement about the outcome of the model and some of the limitations.	
101	EPA - Page 8 Specific Comments	The remark concerning the use of adult receptors to estimate inhalation risk for the child as a source of uncertainty in the risk assessment may be true, however, in the Johnson and Ettinger model, the finite source data is what is used to estimate indoor air concentration. The model does not differentiate whether adult or child values are used. Thus, it is inconsequential whether adult or child values are used, because two separate calculations could be performed to estimate risk for each population (i.e., adult and child). Furthermore, it appears that the Screening version of Johnson and Ettinger model was used in the inhalation risk assessment; the new advanced version of the model is now available and should be used. The advanced version could be downloaded at: [http://www.epa.gov/superfund/programs/ risk/airmodel/johnson-ettinger.htm)	Please refer to response to Comment #84.
102	EPA - Page 9 Specific Comments	Appendix C. The equation used for calculating both cancer and non cancer soil ingestion, and dermal pathways used exposure frequencies of 30 and 180 days per year for a worker and a resident, respectively. These values were supposedly derived based on best professional judgement on the notion that no available data on human behavior in Sitka, Alaska. It was suggested that they represented the best estimate for these two exposure scenarios. The use of these values in the cleanup calculation is unacceptable and appears to be less conservative.	Use of default assumptions would not be a site-specific risk assessment. Please refer to response to Comments #1 and #3.

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		Default values published in the DEC Manual and EPA guidance should be used. In addition, the use of these values may have resulted in the underestimation of risk at the site.	
103	Brady - Page 1 Paragraphs 2 and 3	It is our opinion that the site characterization work described in the Contaminant Distribution Report is not complete. The report indicated that the contaminants migrated through bedrock swales from the former Unocal Tank Farm. In addition, the report also indicated that lateral migration of contaminants outside these swales is likely limited. The report concludes that the contamination appears to be substantially limited to the Tank Farm and drainage features uphill from Kogwanton Street. Based on our review of the report, we disagree with Unocal's conclusion that the contaminants are substantially limited to areas uphill from Kogwanton Street. We believe the data does not support Unocal's conclusion. Contaminants have been detected below Kogwanton Street. In addition, there has been no detailed evaluation of bedrock topography, especially between the former pipeline corridor and the former drainage swale. There has been no significant soil sampling in this area. It appears that the sampling that has been completed in the area did not specifically target bedrock drainage features.	"Ground truth" investigations of site topograpy clearly show the drainage features identified as the western drainage feature and the pipeline corridor. Historical information suggested the presence of the former drainage swale, and this was confirmed through subsurface investigations. Where terrain is steep (such as the bluff area below the tank farm) and known soil conditions are silt and fine silty sand overlying bedrock, the likelihood of a significant drainage feature without a surface expression is considered low.
104	Brady - Page 2 Paragraph 1	The western drainage feature located behind the Sitka Sound Seafoods "Managers House" was discovered only after we advanced an exploration trench. We previously recommended to Unocal to explore bedrock topography through trenching or	Minor bedrock drainage features may exist without a surface topographic expression. However, the risk assessment is based on information gathered from within the major bedrock drainage features, which are more likely to have the highest concentrations of

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		other means (geophysical methods) to locate other potential bedrock drainage features. There is no way to evaluate the soil samples collected at the top of the slope near Tlinget Way without knowing bedrock topography.	contaminants passing through the site. DEC recognizes the work Brady Environmental did to initially identify contamination in the western drainage feature, but further trenching along the bluff appears unnecessary for the completion of the risk assessment. Additionally, a geophysical examination of bedrock topography is unlikely to provide any value-added information to this project.
105	Brady - Page 2 Paragraph 2	Since Unocal has concluded that contaminant migration is governed by bedrock drainage features, it seems reasonable to us to define bedrock topography and collect samples in the drainage features to evaluate contaminant distribution.	DEC agrees that bedrock drainage features will govern contaminant transport. However, major bedrock drainage features within the project appear to have been adequately identified and sampled.
106	Brady - Page 2 Paragraph 3	We did not find any evaluation of the underground utilities beneath Kogwanton Street. These utilities can act as a migration pathway. It appears that no samples were collected in the utility corridor. No direct observations of the utilities or the utility backfill material were made by Unocal.	DEC agrees that utility corridors can be significant contaminant transport pathways. Ground water is the only transport mechanism to move contaminants through utility backfill. The low upgradient hydrocarbon concentrations do not support the theory of ongoing contaminant transport through utility backfill. For the purposes of the risk assessment, the worst case scenario has been modeled. Low-level contaminated soil at the distal margins is marginal to the purpose of the risk assessment.
107	Brady - Page 2 Paragraph 4	We appreciate the efforts Unocal has made in characterizing the Tank Farm spill; however, we believe additional work is necessary to evaluate the extent of contamination. We believe that there is topographic data and contaminant data that suggests additional bedrock drainage features may be present directly down slope of the tank farm. Given the facility age, tank construction, storage volume, and large product throughput of the Unocal Tank Farm, it	The risk assessment is based on data gathered at the tank farm and immediately down gradient of the tank farm. Risk assessment results would be less conservative if additional information from the distal margins of the contaminant plume were to be used in the calculations.

Page/Section		Comment/Issue	Response
		seems reasonable to us to perform the additional work before moving forward with the risk assessment. The risk assessment process requires the site characterization to be complete in order to properly evaluate risk.	

ENVIRONMENTAL
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November 16, 2004

Bill Janes
Alaska Department of Environmental Conservation
Division of Spill Prevention and Response
Contaminated Sites Division
410 Willoughby Avenue, Suite 303
Juneau, AK 99801-1795

Re: Response to ADEC November 2003 Comments on the Final Risk Assessment Unocal Bulk Plant 0736

Dear Mr. Janes:

Please find attached (Table 1) responses to the comments from Lindsay Smith dated November 2003. For the most part, we agree with the comments and resolution of these issues will be incorporated in the final risk assessment revision.

We are presently preparing the final risk assessment revision and request that these comments be resolved as quickly as possible. I look forward to discussing these comments with you. If you have any questions or concerns, please contact me at (206) 842 -5398.

Sincerely,

Krista Graham
Senior Scientist

Max Schwenne
Vice President

Attachment: Comment Response Table

Sitka Unocal Tank Farm
Risk Assessment comments
Lindsay Smith
Nov 2003

Comment Number	Section	Page Number	Comment	Response
1	2.1.2	3	A single sediment sample is difficult to justify as adequate background. It is not clear if samples were tested for any COPCs besides PAHs (i.e. BTEX, DRO).	The “background” sample was collected purely for information. No contaminants of concern were eliminated by comparison to background samples.
2	3	4	Lead that is present from paint chips or other debris is still related to site activity and can still present a hazard. I was unable to find the data from the lead sampling, but evidence is needed that the one value above the screening level was truly an outlier. If it is the intention to remediate hotspots that should be made clear.	Unocal intends to remediate the lead contaminated soil described in the risk assessment as soon as approval is received from the landowner.
3	4	5	The appropriate hierarchy of toxicity values is IRIS, HEAST, NCEA. Although the regional office RBCs and PRGs follow this hierarchy, any values taken from those tables should be checked against the original sources to assure that no errors are propagated.	Values were checked against original sources and are correct in the November 2004 Final Risk Assessment.
4	5.3.2	10	The assumption that children spend 1 hour per day for 180 days per year playing in soil does not justify the use of 1 hour as the exposure time (ET). Exposure continues until soil is washed off. A more appropriate assumption for children’s exposure time range within 5-12 hours. (US EPA “Dermal Exposure	The exposure assumption of 1 hour per day should not have been included in the exposure assumption table. The value of one hour/day was not used in the calculations. The calculation from RAGS for absorbed dose for dermal contact with soil is provided below. These variables were used to calculate risk from dermal contact with soil.

Comment Number	Section	Page Number	Comment	Response
			Assessment: Principles and Applications ", and EPA RAGS E)	$$Dose = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$ Where: CS = Chemical concentration (mg/kg) CF = Conversion factor (10-6 kg/mg) SA = Skin surface area (cm2/event) AF = Soil to skin adherence factor (mg/cm2) ABS = Absorption factor (unitless) EF = Exposure frequency (events/year) ED = Exposure duration (years) BW = Body weight (kg) AT = Averaging time (days)
6	5.5.1	10	A reference for statement that COPCs will not experience plant uptake should be included.	Trapp, S. and C. McFarlane. 1995. *Plant contamination: Modeling and Stimulation of Organic Chemical Processes*. CRC Press, Inc.
7	6	13	A reference to support statement that increase in inhalation rate is proportionate to decrease in body weight should be included.	This statement has been removed from the risk assessment.
8	6.2.1	14	Cumulative HI for onsite worker for DRO is 0.07 not 0.05	Agree, this will be corrected.
9	7.2 and 10	15 and 18	Other pathways besides dermal exposure to groundwater contribute largely to the total risk and the uncertainty about this pathway can not be used to justify discounting risk. Most notably the risk to children offsite,	The uncertainty of estimating exposure to seeps by using groundwater data was eliminated by collecting seep data during April 2003. Nevertheless, it should still be noted that there are two assumptions/methods used in this risk

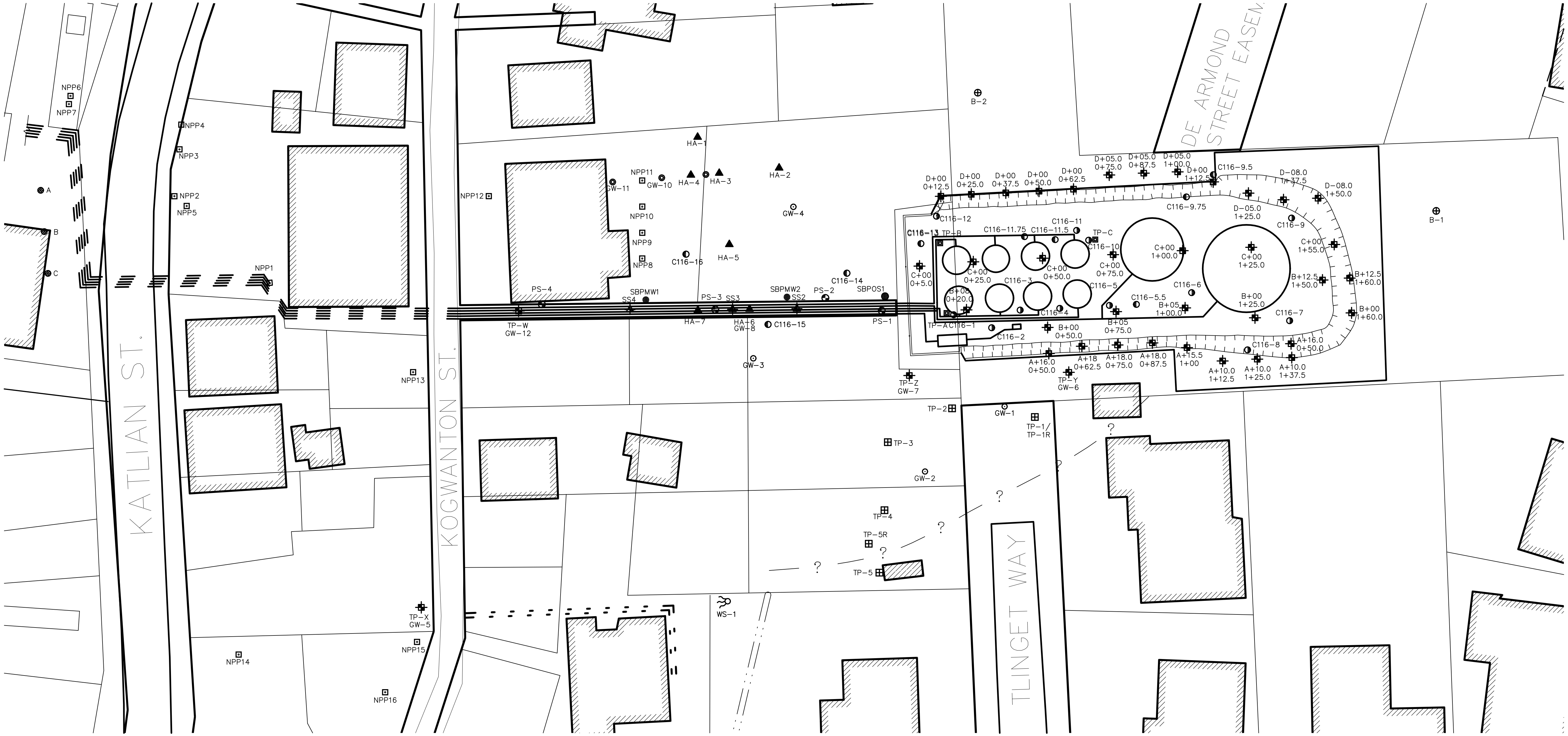
Comment Number	Section	Page Number	Comment	Response
			without considering the groundwater dermal pathway is 9E-06. Since the indoor air inhalation route was not evaluated for children, the risk to children is higher and most likely above the target risk level of 1E-05.	assessment that dramatically overestimate risk; making it unlikely that risk or hazard indices truly approach the risk values calculated in the risk assessment. 1. The use of the Johnson Ettinger Model to estimate risk from exposure to indoor air is very conservative. Use of the model at this site is even more conservative because homes in the vicinity are on pilings. The JE model assumes a direct pathway to indoor air. Consequently, the JE Model is overly conservative at this site. 2. No samples collected from shallow soil (<5 feet bgs) had concentrations of GRO or BETX above State cleanup levels (18 AAC 75 Table B). Most of the soil contamination at the site is subsurface, yet all the detected soil concentrations were used to calculate an exposure point concentration. This approach adds yet another layer of conservatism which overestimates risk to residential receptors from contact with contaminants in surface soil. Given the piling house construction and absence of contamination in surface soil calculating indoor air exposure is not realistic and not really possible using the JE Model. Conservative assumptions were used to bolster confidence in the assessment but it is necessary to use best

Sitka Unocal Tank Farm
Risk Assessment comments
Lindsay Smith
Nov 2003

Comment Number	Section	Page Number	Comment	Response
				professional judgment regarding exposure pathways if the risk values are to have any use.
11		Table 4	ABS_{GI} values do not seem to match those provided by RAIS, errors in the ABS_{GI} can affect the dermal CSFs and consequently the risk estimation.	The ABS_{GI} values used in the risk assessment match those provided in the RAIS; however, the ABS_{D} values for PAHs did not match the RAIS values. Risk will be recalculated in the November 2004 Final Risk Assessment using the current ABS_{D} RAIS values for PAHs.
12		Table 8	Risk to adult worker from Benzene should not be expressed as 0	Agree. Risks and hazard indices appear to be zero in several cells and tables because of excel number format limitations or because there are no detections of specific COPCs. Values will be put into scientific notation where the value is so small as to appear to be zero and assigned ND where the COPC has not been detected.
13	Appendix A	Table A2 and A3	The RBSL for naphthalene are incorrect in both of these tables.	RBSLs are not reported in Tables A2 or A3. The authors do not understand the comment.
14	Appendix C	EQUATION 9	Units in dermal exposure calculation do not compute. It appears that ED was left out. It appears that this was a typo and the error wasn't made in actual calculations.	Agree. Typographic error has been corrected in the November 2004 Final Risk Assessment.
15	Appendix D	Groundwater dermal table	nc notation should be included for benzene, as done in all the other tables in this appendix	Agree. Typographic error has been corrected in the November 2004 Final Risk Assessment.

Appendix H

Sample Location Figures from Previous Reports



EXPLANATION

Symbol	Description	Symbol	Description	Symbol	Description
C116-1	WATER SAMPLES BY PTI, OCTOBER 1990	TP-1	TEST PIT GEI, JANUARY 1998	A	SOIL SAMPLE BY GEI, FEBRUARY 2000
C116-13	SOIL SAMPLES BY PTI, OCTOBER 1990	PS-1	PIPELINE CORRIDOR SOIL SAMPLE BY GEI, JANUARY 1998	NPP13	SOIL SAMPLE BY BRADY, APRIL 2000
SBPMW1	MONITORING WELL	BS-1	BACKGROUND SOIL SAMPLE BY GEI, JANUARY 1998	A+10.0 1+12.5	TEST PIT BY GEI, DECEMBER 2000 OR MAY 2001
SBPOS1	EFFLUENT SAMPLE COLLECTION POINT FOR OIL/WATER SEPARATOR DISCHARGE	GW-1	GEOPROBE IMPLANT WELL BY GEI, INSTALLED JANUARY 1998	GW-9	GEOPROBE IMPLANT WELL, INSTALLED BY GEI, MAY 2001
TP-A	TEST PIT BY GEI, AUGUST 1992	WS-1	WATER SEEP SAMPLE BY GEI, JANUARY 1998	HA-1	HAND AUGER BY GEI, MAY 2001
SS2	SOIL SAMPLE BY SITKA TRIBE OF ALASKA, OCTOBER 1996	TP-1R	TEST PIT BY GEI, DECEMBER 1998		

Note:
The locations of all features shown are approximate.

References:

Drawing Entitled "PIPELINE EASEMENT, SITKA BULK PLANT, SITKA, ALASKA", By C.A. GOVE & ASSOCIATES, Dated 03/30/95.

Drawing Entitled "MASTER PROPERTY PLAT", By City of Sitka, Assessors Office, Dated 02/23/95.

Drawing Entitled "Site Plan, Tank Cleaning, Sitka Bulk Plant BPN 0736, Sitka, Alaska", By C.A. GOVE & ASSOCIATES, Dated 06/23/92.

USGS Topographic Map, Sitka (A-S) SE, Alaska, Dated 1987.

Report Entitled "Sitka Sound Bulk Plant Site Investigation Report" by PTI Environmental Services, Dated November 1990.

Report Entitled "Sitka Sound Seafoods, Initial Subsurface Investigation, Unocal Subsurface Hydrocarbon Release," dated May 14, 2000.

Field sketches by GeoEngineers, dated 09/25/96, 04/23/97, 01/29/98, 02/11/00, 12/06/00 and 05/15/01.

Address and topographic drawing provided by City of Sitka, dated 4/1/02.

N

0 40 80
APPROXIMATE SCALE IN FEET

UNOCAL BULK PLANT 0736
329 KATLIAN STREET
SITKA, ALASKA

GeoEngineers

SOIL AND GROUND WATER SAMPLE LOCATION MAP

FIGURE 5

UNOCAL BULK PLANT
329 KATLIAN STREET
SITKA, ALASKA

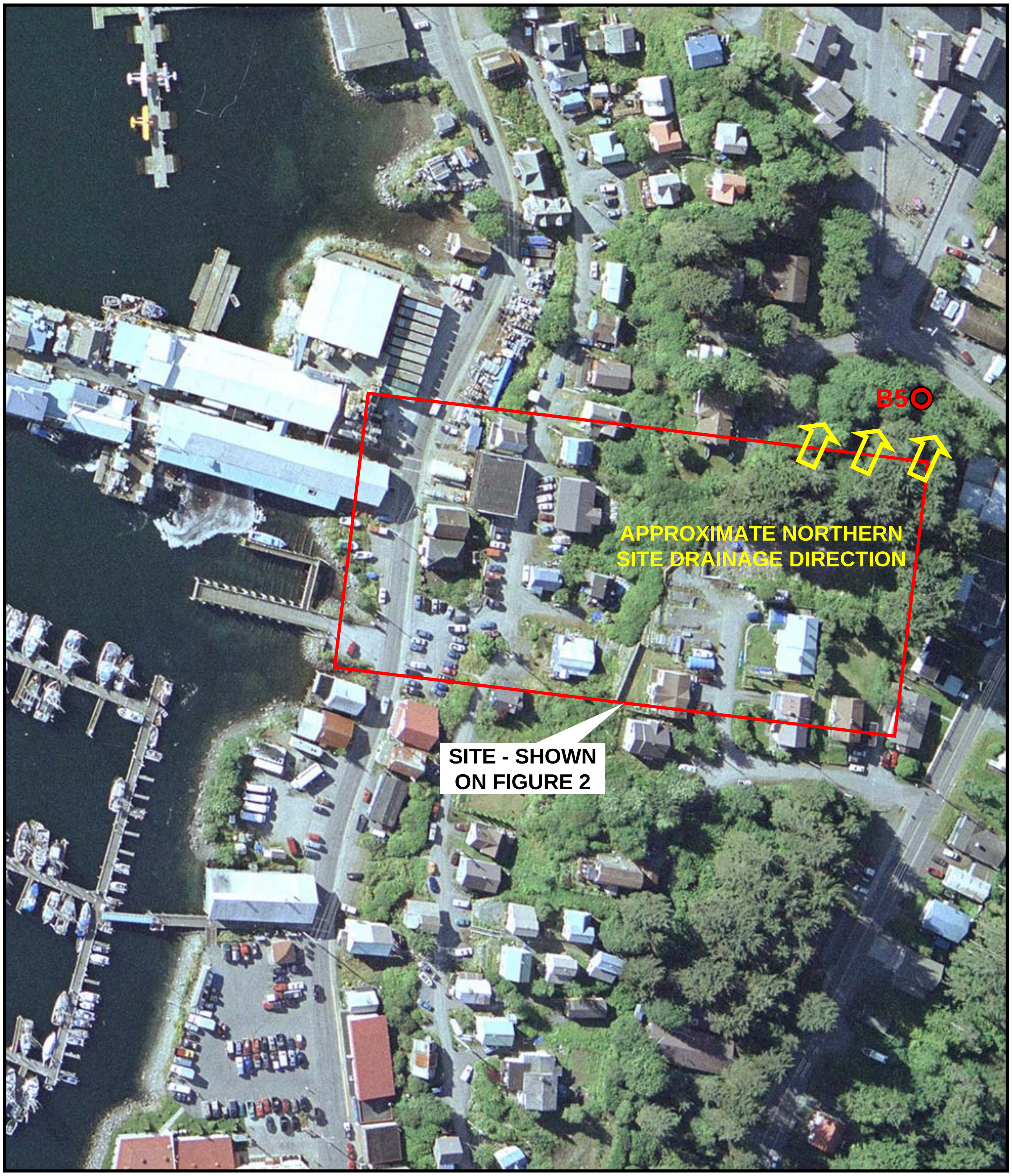
GEOENGINEERS

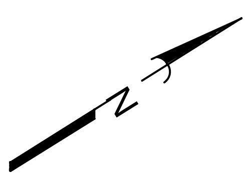
SEPTEMBER 1, 2004 BOREHOLE LOCATIONS

FIGURE 2

Reference: AeroMap U.S. Sitka, Alaska aerial photograph dated, 8/8/01.

0161-302-07 EJS:DKH 4/17/02 rev 10/11/04 (Figure 2.ppt)





Reference: AeroMap U.S. Sitka, Alaska aerial photograph dated, 8/8/01.

0 150 300
SCALE IN FEET

UNOCAL BULK PLANT
329 KATLIAN STREET
SITKA, ALASKA

GEOENGINEERS

SEPTEMBER 1, 2004 SITE INVESTIGATION

FIGURE 3

0161-302-07 EJS:DKR 5/14/02 rev 10/11/04 (Figure 3.ppt)