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RISK ASSESSMENT/ CLEANUP LEVEL ANALYSIS

PASCO LANDFILL
PASCO, WASHINGTON

September 1998

Prepared for:

PASCO LANDFILL PLP GROUP

Project 16078

Prepared by:

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October 2, 1998

TO: Rick Dawson, Benton-Franklin Health District
Anne Duffy, Washington State Department of Health
Beverly Gaines, United States Environmental Protection Agency

FROM: Guy J. Gregory, Washington Department of Ecology

SUBJECT: Transmittal of documents, Pasco Sanitary Landfill

Enclosed with this letter is the Risk Assessment/Cleanup Levels Development document for the Pasco Sanitary Landfill. This document, required under Order DE94TC-E103, and Amendment No. 1 to that order, details the contractors' position on risk causing chemicals at Pasco Sanitary Landfill, using the risk parameters of the Model Toxics Control Act cleanup regulation.

Copies of all documents are being forwarded to the information repository in Pasco. Public notice of the availability, and the formal comment period for this study will be conducted following receipt of the last major document due prior to remedy selection: the Feasibility Study.

Of course, input on these documents is welcome at any time. If you have questions, please contact me at (509) 456-6387, or via email at ggre461@ecy.wa.gov.

PHILIP SERVICES CORP.

September 11, 1998
Project No: 16078

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SEP 14 1998
DEPARTMENT OF ECOLOGY
EASTERN REGIONAL OFFICE

Mr. Guy Gregory
Washington Department of Ecology
N. 4601 Monroe, Suite 100
Spokane, Washington 99205-1295

SUBJECT: Pasco Landfill Risk Assessment and Cleanup Level Analysis Report

Dear Mr. Gregory:

Philip Services Corp. is pleased to submit the attached Risk Assessment and Cleanup Level Analysis report for the Pasco Landfill Site. This document has been prepared on behalf of the Pasco Landfill Potentially Liable Person Group (PLP Group) in accordance with the requirements of Enforcement Order No. DE 94TC-E103, Exhibit C. This report incorporates revisions in response to Ecology's comments, as previously discussed in the letter to Ecology dated August 31, 1998.

As you requested, four copies of the complete report and three copies of revised sections of the draft report are attached. The following replacement sections of the draft report are included:

- Report cover, main text and tables (replace all)
- Appendix A (add to existing information already in the appendix)
- Appendix B text and tables (retain 3 attachments already in the appendix)
- Appendix C (replace all)
- Appendix D (replace all)
- Appendix E (replace all)

Please contact me at (800) 765-6544 or Mo Azose at (425) 227-6161 with any questions.

Sincerely,

PHILIP SERVICES CORP.

Barrie Selcoe

Barrie C. Selcoe
Risk Assessment Group Leader

cc: PLP Group Technical Committee
Mo Azose

Attachments

EXECUTIVE SUMMARY

A risk assessment/cleanup level analysis (RA/CLA) was prepared for the Pasco Landfill Superfund Site in Pasco, Washington. The CLA is a tool that is used in the Remedial Investigation/Feasibility Study (RI/FS) process to:

- identify site-specific Indicator Hazardous Substances (IHSs);
- evaluate reasonable maximum exposures (RMEs) under current and future exposure scenarios; and
- develop site-specific risk-based cleanup levels for IHSs for use in the FS.

This document identifies IHSs for soil and groundwater by comparing detected concentrations to background and MTCA cleanup levels, evaluating frequency of detection, and relative contribution to site risk. The screening process used was sufficiently conservative to identify IHSs that contribute the majority of potential site-related risk. Site-specific cleanup levels for each IHS will be used in the FS to establish health-protective cleanup actions. The FS is being drafted and will be submitted to Ecology in December 1998.

Also, this document defines the RMEs for soil and groundwater. The site is, and will be, used for landfill support operations, and the RME scenario for soil is industrial land use. Because groundwater in the area is used for drinking water, the RME scenario for groundwater is drinking water.

Finally, this document proposes MTCA Method B cleanup levels for groundwater and Method C cleanup levels for soil. Soil cleanup levels are protective of direct contact exposures and consider potential cross-media transfer (soil-to-groundwater and soil-to-air). Cleanup levels meet the target risk goals in MTCA.

Risk assessments typically use conservative assumptions because of the uncertainty associated with the exact nature of exposure and human health effects of chemicals and chemical mixtures. This RA/CLA uses conservative assumptions in screening IHSs and developing cleanup levels. Groundwater cleanup levels consider simultaneous exposures to all groundwater IHSs in a drinking water well, although they have not all been detected in any one potable well. Because the conservative assumptions tend to overestimate potential site risk, if a detected concentration exceeds a risk-based cleanup level, it does not necessarily indicate that an actual health impact has or will occur. Rather, the exceedance indicates that the chemical may present an unacceptable risk and therefore warrants consideration in the FS for the determination of appropriate cleanup actions.

ACRONYM LIST

BRI	Basin Recycling Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CGI	Combustible gas indicator
CLA	Cleanup Level Analysis
CLARC	Cleanup Level and Risk Calculation
FS	Feasibility Study
HEAST	Health Effects Assessment Summary Tables
HI	Hazard index
HQ	Hazard quotient
IHS	Indicator hazardous substance
IRIS	Integrated Risk Information System
LSA	Landspread Area
MCL	Maximum Contaminant Level
MCPA	Methoxone
MTCA	Model Toxics Control Act
NCEA	National Center for Environmental Assessment
NWI	New Waste Inc.
PCB	Polychlorinated biphenyl
PP	Priority pollutant
PQL	Practical Quantitation Limit
QAPP	Quality Assurance Project Plan
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk-based concentration
RfD	Reference dose
RI	Remedial Investigation
RME	Reasonable maximum exposure
SF	Slope factor
SMA	Sludge Management Area
SMCL	Secondary Maximum Contaminant Level
SSL	Soil Screening Level
SVOC	Semivolatile organic compound
TCDD	Tetrachlorodibenzo-p-dioxin
TEF	Toxicity equivalency factor
VOC	Volatile organic compound
WAC	Washington Administrative Code

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RISK ASSESSMENT/CLEANUP LEVEL ANALYSIS

PASCO LANDFILL
PASCO, WASHINGTON

1 INTRODUCTION

1.1 Overview

This document presents a risk assessment/cleanup level analysis (RA/CLA) for the Pasco Landfill Superfund Site in Pasco, Washington (Figures 1 and 2). An ecological assessment was prepared separately (Philip, 1997). Indicator hazardous substances (IHSs) for soil and groundwater are identified, reasonable maximum exposures (RMEs) are evaluated, and cleanup levels are calculated for groundwater and soil. This report was prepared by Philip Services Corp. (Philip) (formerly Burlington Environmental, Inc.) for review by the Washington State Department of Ecology (Ecology).

The RA/CLA is based on a series of conservative assumptions specified in the Washington Model Toxics Control Act (MTCA) under WAC 173-340 for screening IHSs and developing cleanup levels. These assumptions are agency policy due to uncertainties regarding the nature of exposures and human health effects. The assumptions are conservative and tend to overestimate potential site risk. Exceedance of a risk-based cleanup level does not necessarily indicate that an actual health impact has occurred or will occur. Rather, the exceedance indicates that the chemical may present an unacceptable risk, and as a result it warrants consideration in the cleanup actions evaluated in the Feasibility Study (FS).

1.2 Site Background

The site is approximately 200 acres in size. Five buildings are present on-site:

1. transfer station building for household hazardous waste and municipal wastes (used by Basin Recycling Inc. [BRI]);
2. recycling building for household waste (used by BRI);
3. maintenance building (used by New Waste Inc.[NWI]);
4. well house (used by NWI); and
5. scale/guard house (used by NWI).

Site features are shown in Figure 3.

A complete description of historic site operations is presented in Section 3 of the Phase I RI Report (Burlington, 1994). In summary, landfilling operations began at the site in 1958. The municipal landfill was initially operated as an open burning facility. Refuse burning occurred in two or three trenched areas at the site during the 1960s and early 1970s. In addition, industrial wastes were disposed at the site beginning in April 1972, primarily in the form of bulk sludges and drummed wastes. Industrial wastes were segregated into five zones at the facility: Zones A, B, C, D, and E (as described below). Industrial waste disposal operations were halted in December 1974.

During the period of industrial waste disposal, other types of landfill operations continued, including disposal of various bulk liquids, septic tank wastes, sewage sludges, and animal fat emulsions. These wastes were disposed in lagoons or spread over ground surface areas at two locations on-site (Sludge Management Area [SMA] and Landspread Area [LSA]). At times, landspread wastes were mixed with soil for use as daily cover for the sanitary landfill. Another area of the site was used for the disposal of large quantities of baled refuse as part of the sanitary waste disposal operations. Landspreading of industrial wastewaters including animal fat emulsion coolants continued after the period of industrial waste disposal.

The following potential source areas were identified during the RI (Figure 3):

- **Zone A/North-South Burn Trench (BT-2)/Balefill** - disposal of solvents, paints, cleaners, and other industrial waste drums in Zone A, disposal and refuse burning in BT-2, and disposal of baled municipal waste in the Balefill Areas; Zone A is capped with polyethylene sheeting and a soil cover of approximately 2 feet (ft). The Burn Trench is currently covered with approximately 2 ft of native material. The Balefill Area is not covered and nothing has indicated that the Balefill Area is a potential source of contamination.

- **Zone B** - disposal of 2,4-D tar, MCPA bleed, and other herbicide waste drums; capped with polyethylene sheeting and a soil cover of approximately 2 ft.

- **Zones C and D and the East-West Burn Trenches (BT-1)** - disposal of bulk plywood resin waste, wood treatment and preservative waste, lime sludge, cutting oils, paint and solvent waste, and other bulk liquid waste in Zones C and D; disposal and burning of refuse in BT-1; Zones C and D are capped with polyethylene sheeting and a soil cover of approximately 2.8 ft. BT-1 is currently covered with approximately 2 ft of native material.

- **Zone E and Temporary Storage 1/Sewage Lagoon 1 (TS-1/SL-1)** - disposal of chlor-alkali waste in Zone E; temporary storage of chlor-alkali sludge and disposal of septic tank and chemical toilet pumpings in TS-1/SL-1; Zone E is capped with polyethylene sheeting and approximately 3 ft of soil. TS-1 and SL-1 are currently situated under native fill.

- **Zone U-1 and Temporary Storage 2 (TS-2)** - disposal of plywood resin waste, wood treatment and preservative waste, lime sludge, cutting oils, paint and solvent waste, and other bulk liquid waste in Zone U-1; off-loading and temporary storage of chlor-alkali sludge in TS-2; both areas are capped with 3 ft of native fill.

- **Sanitary Landfill** - refuse burning; disposal of septic, municipal, and agricultural wastes; dried sludges from former sewage lagoons SL-2 and SL-3; capped with at least 3 ft of native soil.

- **Sewage Lagoons 2 and 3 (SL-2 and SL-3)** - disposal of septic tank and chemical toilet pumpings; dried sludges were excavated and moved to the sanitary landfill. These areas are covered with approximately 2 ft of native fill.

- **SMA and LSA** - land spreading of sewage sludges and animal fat emulsion coolants.

During the RI, the following media were sampled:

- on-site surface and subsurface soil samples were collected in and adjacent to potential source areas and areas representing background;

- groundwater samples were collected from on-site and downgradient monitoring wells at two general depths (shallow and deep); samples were also collected from domestic wells downgradient of the site, and the on-site potable and dust suppression wells;

- air samples were collected from on-site building structures (for methane only); and

- soil gas samples were collected around the industrial waste areas and the sanitary landfill.

1.3 Scope of the Risk Assessment/Cleanup Level Analysis

This report identifies preliminary and final IHSs for soil and groundwater, RMEs for current and future site conditions, and identifies cleanup levels for groundwater and soil. In addition, potential physical hazards at the site are discussed. The risk assessment was prepared in accordance with Ecology's MTCA cleanup regulations, using the following guidance documents:

- Ecology's *The Model Toxics Control Act Cleanup Regulation, Chapter 173-340 WAC, Toxics Cleanup Program* (Ecology, 1996a);
- Ecology's *Statistical Guidance for Ecology Site Managers* (Ecology, 1992);
- Ecology's *Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-Detection Limit or Below-PQL Values* (Ecology, 1993);
- Ecology's *Cleanup Level and Risk Calculation (CLARC) Table* (Ecology, 1996b);
- USEPA's *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)* (1989a);
- USEPA memorandum entitled *Land Use in the CERCLA Remedy Selection Process* (USEPA, 1995a); and
- USEPA Region 10's *Supplemental Risk Assessment Guidance for Superfund* (USEPA, 1991).

1.4 Organization of the Report

In Section 2, sampling locations, analytical methods, quantitation limits, and background concentrations are presented. Available analytical data are evaluated, and preliminary IHSs are identified for soil and groundwater. In Section 3, RMEs to soil and groundwater are identified. Section 4 presents toxicity values identified for soil and groundwater preliminary IHSs. MTCA Method B cleanup levels for preliminary and final IHSs in groundwater and Method C cleanup levels for soil are presented in Section 5. Section 6 presents areas exceeding MTCA cleanup levels. Section 7 discusses the potential physical hazards at the site. Section 8 summarizes the conclusions of the RA/CLA.

2 INDICATOR HAZARDOUS SUBSTANCES

2.1 Introduction

According to WAC 173-340-708 (2)(a), when defining cleanup requirements at a site contaminated with several hazardous substances, those substances that contribute a small percentage of the overall threat to human health and the environment may be eliminated from consideration. The remaining hazardous substances serve as IHSs for purposes of defining site cleanup levels and selecting a cleanup action.

The factors to consider when selecting individual hazardous substances for further consideration include:

- the toxicity of the chemical relative to the concentration detected;
- its persistence in the environment;
- its mobility in the environment;
- natural background concentrations;
- thoroughness of testing for the chemical;
- frequency of detection; and
- degradation by-products.

2.2 Background Sampling

During the RI, background samples were collected from the following media and locations.

2.2.1 Groundwater

As discussed in the RI report, MW-21I, MW-25S, and MW-28S were installed to assess background groundwater concentrations. Samples collected during Phases I and II of the RI (through March 1997) were used to characterize background groundwater concentrations (Figure 4). These wells were used in the screening process to select preliminary inorganic IHSs in groundwater.

2.2.2 Soil

In December 1992, during the Phase I RI, 21 background surface soil samples (BK-01 to -21) were collected (Figure 5). These samples were used to characterize background soil concentrations, and were used in the

screening process to select preliminary IHSs for soil. Samples were collected at a depth of 6 inches and were analyzed for organochlorine pesticides/ polychlorinated biphenyls (PCBs), chlorinated herbicides, priority pollutant (PP) metals, and radionuclides.

During the Phase I RI, 22 samples were also collected from three background boreholes (2 from B-09, 10 from B-09R, and 10 from B-10) (Figure 5). These samples were used in the screening process to select preliminary IHSs for soil. Samples were collected at depths of 6 and 11 ft in B-09, and at 5-ft intervals from 5 to 50 ft in B-09R and B-10. Samples were analyzed for pesticides/PCBs, chlorinated herbicides, PP metals, and radionuclides. Samples from B-09 and B-10 were also analyzed for volatile organic compounds (VOCs).

In April and May 1995, during the Phase II RI, 20 samples (16 surface samples [BKG-01 to -16] and 4 subsurface samples [MW-25S]) were collected from background locations (Figure 6). These samples were also used in the screening process to select preliminary IHSs for soil. Surface soil samples were collected at a depth of 6 inches, while subsurface samples were collected at depths of 10, 20, 30, and 40 ft. Surface samples were collected in the agricultural field to the east of Zone B, while subsurface samples were collected during installation of off-site monitoring well MW-25S. Samples were analyzed for herbicides and dioxins/furans.

2.3 Data Evaluation

During all phases of the RI, the quality of the data was evaluated through the data validation process, where analytical methods, quantitation limits, qualifiers and codes, and field and laboratory contamination were reviewed for compliance with the Quality Assurance Project Plans (QAPPs). Data validation reports for Phase I and Phase II samples are included in Appendix A. Only data that were "R" (reject) qualified were excluded from the RA/CLA. The criteria for rejection are listed in USEPA Data Validation Functional Guidelines. Data excluded from the RA/CLA are tabulated by matrix and presented in Appendix A.

Data used in this RA/CLA were collected during the RI in accordance with the Ecology-approved Work Plans. Sample locations were selected based upon knowledge of historical operations at the site and samples were analyzed for parameters approved by Ecology. Detection limits were adequate for risk assessment purposes, and data were validated in accordance with USEPA guidelines. For these reasons, sufficient data meeting the data quality requirements were obtained to conduct this RA/CLA.

2.4 Screening Process Used to Select Preliminary Indicator Hazardous Substances

2.4.1 Groundwater

The screening process used to select preliminary and final IHSs in groundwater is consistent with MTCA (173-340-720[3]). A flowchart depicting the screening process is presented in Figure 7 and is described below.

- **Step 1** - Validated groundwater data not rejected in the data validation process were identified.

- **Step 2** - Detected inorganic concentrations were compared to background concentrations detected in the three background wells using MTCA*Stat* (Appendix B). Those inorganics that did not statistically exceed background were not considered site-related and were not selected as preliminary IHSs for groundwater. The remaining inorganics and all organic chemicals were evaluated further.

- **Step 3** – The frequency at which each chemical carried to Step 3 was detected in groundwater was evaluated. Chemicals detected at a frequency of 5 percent or less were not were selected as preliminary IHSs in groundwater.

- **Step 4** – Method B cleanup levels were calculated for chemicals carried to Step 4 (Appendix C). Those chemicals with site concentrations exceeding Method B levels were selected as preliminary IHSs for groundwater.

- **Step 5** – For chemicals carried to Step 5, the relative contribution of each chemical to the total site risk (cancer and non-cancer) was evaluated. A group of chemicals, which together pose less than 5 percent of the total site risk, were eliminated from further evaluation.

- **Step 6** – In this step, chemical data were analyzed in detail to determine whether the site is a source of a particular constituent. Chemicals remaining after this step were identified as final IHSs for groundwater.

2.4.2 Soil

The screening process used to select preliminary and final IHSs in soil is consistent with MTCA (173-340-745). A flowchart depicting the screening process is presented in Figure 8 and is described below.

- **Step 1** - Validated soil data not rejected in the data validation process were identified.

- **Step 2** – Detected inorganic concentrations were compared to background concentrations using MTCA*Stat* (Appendix B). Background was based on the samples identified in Section 2.2. Those inorganics that did not statistically exceed background were not considered site-related and were not selected as preliminary IHSs for soil. The remaining inorganics and all organics were evaluated further.

- **Step 3** - The frequency at which each chemical carried to Step 3 was detected in soil was evaluated. Chemicals detected at a frequency less than 5 percent were not selected as preliminary IHSs in soil.

- **Step 4** – Method C cleanup levels for industrial properties were calculated for chemicals carried to Step 4 (Appendix D). Levels protective of groundwater, direct contact, and inhalation were developed.

  - **<u>4A - Protection of Groundwater</u>** – Soil levels protective of groundwater were identified in a phased approach.
    - 1st - site concentrations were compared to 100 times the groundwater Method B levels. Chemicals with site concentrations exceeding these preliminary screening levels were evaluated further, while those below the preliminary screening levels were not evaluated further.
    - 2nd - site concentrations were compared to the generic USEPA soil screening levels (SSLs) for protection of groundwater (USEPA, 1996a). Chemicals with site concentrations exceeding these secondary screening values were evaluated further, while those below the secondary screening levels were not.
    - 3rd - site concentrations were compared to site-specific SSLs calculated in Appendix E. Chemicals with site concentrations exceeding the tertiary screening values were evaluated further, while those less than the screening levels were not.

  Subsequently, chemicals exceeding tertiary screening levels were evaluated with respect to whether they were final IHSs in groundwater. Those chemicals that were not final IHSs in groundwater were not

selected as IHSs in soil (for protection of groundwater), while those chemicals exceeding tertiary screening levels that were IHSs in groundwater were selected as preliminary IHSs in soil.

- **4B - Direct Contact** – Soil levels protective of direct contact exposures were obtained from Ecology's CLARC table (Ecology, 1996b). Chemicals with site concentrations less than Method C values for industrial exposures were not evaluated further, while those exceeding the Method C values were selected as preliminary IHSs for soil.

- **4C - Protection of Air (SMA and LSA)** – Soil levels protective of inhalation exposure in the SMA and LSA were identified in a phased approach.
  - 1st - site concentrations were compared to the generic USEPA SSLs for protection of air (USEPA, 1996a). Chemicals with site concentrations exceeding these primary screening levels (or without a screening level) were evaluated further, while those less than the screening levels were not.
  - 2nd - site concentrations were compared to other USEPA guidance values for protection of air exposures (USEPA, 1996b). Chemicals with site concentrations less than secondary screening levels were not selected as IHSs in soil (for protection of air), while those chemicals exceeding secondary screening levels were selected as preliminary soil IHSs.

2.5 IHSs in Groundwater

Groundwater samples were collected from the following wells during Phases I and II of the RI:

- on-site monitoring wells;
- the on-site potable well;
- the on-site dust suppression well;
- off-site monitoring wells; and,
- off-site domestic wells.

Numerous rounds of groundwater data were collected from shallow and deep wells during the RI. The following data sets were used in the risk assessment:

- 9 rounds of groundwater data (initial round in December 1992/January/February 1993, followed by eight quarterly sampling events in the second quarter of 1995 through the first quarter in 1997) collected from the following monitoring wells (Figures 4 and 9):

- #1 to #9 (all on-site);
- EE-2 to -8 (all on-site);
- MW-10S to -12S, -12I, -12ID, -13S to -17S, -17SR, -17DR, -17I, -18S to -20S, -21DR, -22S to -24S, -26S to -27S (all on-site); and,
- MW-29S to -42S (all downgradient of the site).

- the two samples collected from the on-site potable well on March 17, 1997; and,
- the sample collected from the on-site dust suppression well on May 8, 1997.

Data that were excluded from the RA/CLA due to "R" qualifiers are tabulated in Appendix A.

The groundwater sampling events listed above were consistent with Ecology-approved sampling plans for the RI and post-RI monitoring. Analytes included VOCs, semi-volatile organic compounds (SVOCs), herbicides, and Appendix I and II metals. The on-site potable well was analyzed for VOCs and metals, and the on-site dust suppression well was analyzed for VOCs only.

Step 1 - The first step in selecting IHSs for groundwater was to identify all detected chemicals concluded to be valid through the data validation process. As shown in Table 1, 39 VOCs, 24 SVOCs, four herbicides, and 21 inorganics were detected in the monitoring well samples.

Analytical results for the samples collected from the on-site potable well are presented in Table 2. No VOCs and 12 inorganics were detected in this well.

The on-site dust suppression well contained no detectable levels of VOCs.

Step 2 - The second step in selecting IHSs was to determine if detected inorganic concentrations in groundwater exceeded background concentrations. Statistical comparisons to background are presented in Appendix B and results are summarized in Table 3. As shown, site concentrations of 16 inorganics in monitoring wells exceed background and therefore were evaluated further. All organics were also given further evaluation.

As shown in Table 2, only barium exceeded background in the on-site potable well and therefore was evaluated further.

Step 3 - The third step was to determine the frequency at which chemicals carried to Step 3 were detected in groundwater samples. As shown in Table 4, 10 VOCs, 18 SVOCs, 4 pesticides/herbicides, and 2 metals were detected at a frequency of 5

percent or less and were not considered further. Chemicals detected at a frequency greater than 5 percent were evaluated further.

Step 4 - The fourth step was to calculate Method B levels for chemicals carried to Step 4 (Appendix C). Subsequently, site concentrations were compared to adjusted Method B levels (Table 5). As shown, site concentrations of 19 VOCs, one SVOC, and five metals exceeded Method B levels. These chemicals were identified as preliminary IHSs and were evaluated further.

Step 5 - The fifth step was to evaluate the relative contribution (of preliminary IHSs) to the overall site risk (cancer and non-cancer). As shown in Table 6, a group of nine chemicals was identified which poses 5 percent (total) of site non-cancer risk, and therefore these chemicals were not evaluated further. As shown in Table 7, a group of six chemicals poses less than 5 percent of the total site cancer risk, and these chemicals were also not evaluated further.

Step 6 - The sixth step was to further evaluate the chemicals remaining in the screening process. Two metals (antimony and lead) carried to Step 6 were targeted for evaluation.

Antimony - Antimony was detected in 42 of the 270 samples collected, with over 66% non-detects during the Phase I and II RI sampling. As described in Section 1.1 of Appendix B, an assessment of potential site contributions for analytes with greater than 50% non-detects is performed by first establishing site background concentrations through use of non-parametric statistical analyses and then comparing this number to the maximum concentration detected at the site. The site background concentration for antimony was concluded to be 11.44 µg/L (Table B-1 of Appendix B) using the non-parametric method. The maximum antimony concentration detected at the site was 15 µg/L (second quarter 1996 sample from well EE-3). This was the only sample that contained antimony above the site background concentration. Therefore, since only one exceedance of the calculated background concentration occurred out of 270 samples, antimony was not selected as a final IHS for groundwater.

Lead - As can be seen in the table below, of the 269 groundwater samples analyzed for lead as part of the Phase I and II monitoring activities, only two samples exceeded the MTCA Method B cleanup level of 15 ug/L. None of the wells exceeded the cleanup level on more than one occasion. The only exceedances occurred during the first quarter of groundwater sampling at the site. Based on these results, the appearance of lead in groundwater does not appear to be related to site activities, and therefore lead was not selected as a final IHS in groundwater.

Sampling Date	# of Detections	# Above MTCA Method B (15 ug/L)	Comments
Phase I RI (12/92 - 2/93)	10	2	22.3 ug/L in MW-15S and 17.1 ug/L in MW-17SR
2nd Q 1995	1	0	
3rd Q 1995	42	0	
4th Q 1995	0	0	
1st Q 1996	9	0	
2nd Q 1996	4	0	
3rd Q 1996	6	0	
4th Q 1996	1	0	
1st Q 1997	5	0	

The remaining 13 chemicals were identified as the IHSs for groundwater (Table 8). Together, these chemicals represent more than 95% of the risk from the RME for groundwater.

2.6 IHSs in Soil

Soil samples were collected from various areas during the Phase I and II investigations.

SMA & LSA - Soil samples were collected from the following locations in the SMA and LSA during the Phase I RI (Figure 10):

- SMA (SL-01 to SL-20); and
- LSA (LS-01 to LS-20).

Due to the type of waste management practices conducted in these areas (surface spreading), samples were collected from 0 to 6 inches. All samples were analyzed for SVOCs (USEPA Method 8270), pesticides/ PCBs (USEPA Method 8080), herbicides (USEPA Method 8150), PP Metals (USEPA Method 6010), and radionuclides (gross alpha-beta using USEPA Method 900.0 and gross gamma using USEPA Method 900.1).

Zone A/BT-2/Balefill - Because wastes in these areas are situated below approximately 2 ft of soil, only subsurface soil samples were collected. During the RI, four subsurface soil samples were collected from three locations adjacent to these areas: MW-12I, -13S, and -14S (Figure 4). Samples were collected from depths of 3.8, 45, 60, and 64.5 ft. All samples were analyzed for VOCs (USEPA Method 8240), SVOCs (USEPA Method 8270), pesticide/PCBs (USEPA Method 8080), and PP metals (USEPA Method 6010).

Zone B - Wastes in this zone are situated below approximately 2 ft of soil and a polyethylene cap; therefore, only subsurface soil samples were collected. During the Phase I and II RI, 24 subsurface soil samples were collected from six soil borings adjacent to Zone B (B-05, B-06, B-13, B-14, B-15, and MW-26S; Figures 11 and 12). Samples were collected from various depths ranging from 5 to 46 ft. Samples from B-05 and B-06 were analyzed for SVOCs (USEPA Method 8270) and PP metals (USEPA Method 6010). All samples were analyzed for chlorinated herbicides (USEPA Method 8150) and dioxins/furans.

Zones C & D & BT-1 - Wastes in this area are situated below approximately 2 ft of soil; therefore, only subsurface soil samples were collected. During the Phase I and II RI, 25 subsurface soil samples were collected from five soil borings in and adjacent to these areas (B-01, B-02, B-19, B-20, and MW-18S; Figures 4, 11, and 12). Samples were collected from various depths ranging from 5 to 70 ft. Nineteen samples were analyzed for VOCs (USEPA Method 8240 or 8260); in addition, nine samples from B-01, B-02, and MW-18S were analyzed for SVOCs (USEPA Method 8270) and PP metals (USEPA Method 6010). Soil from MW-18S was also analyzed for pesticides/PCBs (USEPA Method 8080).

Zone E & TS-1/SL-1 - Since wastes in this area are situated under approximately 2 ft of soil, only subsurface soil samples were collected. During the Phase I and II RI, 17 subsurface soil samples were collected from five soil borings adjacent to these areas (B-03, B-04, B-11, B-17, and B-18; Figures 11 and 12). It should be noted that subsurface soil samples associated with the LSA in the Phase I RI were subsequently allocated to Zone E and TS-1/SL-1 in the Phase II RI. Samples were collected from various depths ranging from 5 to 64 ft. Consistent with the approved Work Plan, four

samples (location B-11) were analyzed for VOCs (USEPA Method 8240), pesticides/PCBs (USEPA Method 8080), chlorinated herbicides (USEPA Method 8150), and radionuclides (USEPA Methods 900.0 and 900.1); 12 samples were analyzed for SVOCs (USEPA Method 8270) and PP metals (USEPA Method 6010), and eight samples (locations B-17 and B-18) were analyzed for hexavalent and total chromium.

SL-2 & SL-3 - Since potential waste sources in this area are situated below native fill, only subsurface soil samples were collected. During the Phase I RI, 12 subsurface soil samples were collected from three soil borings in and adjacent to these areas (B-07, B-08, and B-12; Figure 11). Samples were collected from various depths ranging from 11 to 61 ft. Eight samples (locations B-07 and B-12) were analyzed for VOCs (USEPA Method 8240), and 12 samples (all locations) were analyzed for SVOCs (USEPA Method 8270), pesticides/ PCBs (USEPA Method 8080), chlorinated herbicides (USEPA Method 8150), radionuclides (USEPA Methods 900.0 and 900.1), and PP metals (USEPA Method 6010).

Areas Not Immediately Adjacent to Designated Zones - During the RI, nine subsurface soil samples were collected from nine soil borings (MW-10S, MW-11S, MW-19S, MW-20S, MW-22S, MW-23S, M-24S, MW-27S, and MW-28S; Figure 4) installed on-site but outside of designated zones. Samples were collected from various depths ranging from 40 to 70 ft. Five samples were analyzed for VOCs (USEPA Method 8240), SVOCs (USEPA Method 8270), and pesticides/PCBs (USEPA Method 8080), two samples were analyzed for chlorinated herbicides (USEPA Method 8150), and all samples were analyzed for PP metals (USEPA Method 6010).

Step 1 - The first step in selecting IHSs for soil was to identify all detected chemicals concluded to be valid through the data validation process. Data that were excluded from the RA/CLA due to "R" qualifiers are tabulated in Appendix A.

SMA & LSA - Two SVOCs, 11 metals, and radionuclides (gross alpha, beta, and gamma) were detected in samples from the SMA (Table 9). One SVOC, 10 metals and radionuclides (gross alpha, beta, and gamma) were detected in samples collected from the LSA (Table 10).

Zone A/BT-2/Balefill - Three VOCs, two SVOCs, one pesticide (4,4'-DDT), and 10 metals were detected (Table 11).

Zone B - Three SVOCs, various dioxins/furans, and eight metals were detected (Table 12).

Zones C & D & BT-1 - Eight VOCs, three SVOCs, and 11 metals were detected (Table 13).

Zone E & TS-1/SL-1 - Three VOCs, four SVOCs, various radionuclides, and 10 metals were detected (Table 14).

SL-2 & SL-3 - Three VOCs, one SVOC (di-n-butylphthalate), various radionuclides, and 10 metals were detected (Table 15).

Areas Not Immediately Adjacent to Designated Zones - Seven VOCs, three SVOC, four pesticides, and 11 metals were detected (Table 16).

Step 2 - The second step in selecting IHSs was to determine if detected concentrations of inorganics in soil statistically exceeded background concentrations. Statistical comparisons to background are presented in Appendix B and results are summarized below.

SMA & LSA - Site concentrations exceeded background for eight metals in the SMA (Table 9) and three metals in the LSA (Table 10), and therefore were evaluated further. All organics were also evaluated further.

Zone A/BT-2/Balefill – Site concentrations exceeded background for two metals (Table 11), and therefore were evaluated further. All organics were also given further evaluation.

Zone B - Site concentrations of metals did not exceed background (Table 12). All organics were evaluated further.

Dioxins were detected in all background and Zone B samples (Table 3.30 and 3.31 of the Phase II Remedial Investigation Report [Philip, 1996]). Statistical evaluations were performed to assess whether dioxin concentrations in Zone B were statistically greater than site background concentrations.

Ecology's *Statistical Guidance for Ecology Site Managers* (Ecology 1992, 1993) was used to perform the tests. The evaluation consisted of three tests comparing dioxin concentrations in background with Zone B concentrations. In accordance with Ecology guidance, Zone B soil was concluded to exceed calculated site background values if at least one of the following was found to be true:

1. The one-sided 95 percent upper confidence limit (UCL) for the mean dioxin concentration in Zone B soil exceeded the calculated site background value;

2. More than 20 percent of Zone B dioxin concentrations exceeded the calculated site background value; or
3. The Zone B concentration exceeded twice the calculated site background value for a given congener.

The results of the Ecology tests indicate that 21 of the 24 dioxin congeners and congener totals detected in Zone B soil exceeded their respective calculated site background concentrations. It should be noted that although 20 background samples were submitted for analysis of dioxins, low surrogate recoveries for some of the congeners resulted in availability of only 16 values for use in calculating background concentrations.

Zones C & D & BT-1 – Site concentrations of five metals exceeded background (Table 13) and therefore were evaluated further. All organics were also evaluated further.

Zone E & TS-1/SL-1 – Site concentrations of six metals exceeded background (Table 14). As discussed in Section 5.3.4 of the Phase I RI Report (Burlington, 1994), radionuclide concentrations were within background levels. Therefore, the organics and six metals were evaluated further.

SL-2 & SL-3 – Site concentrations of three metals exceeded background (Table 15). As discussed in Section 5.3.4 of the Phase I RI Report (Burlington, 1994), radionuclide concentrations were within background levels. Therefore, the organics and three metals were evaluated further.

Areas Not Immediately Adjacent to Designated Zones – Site concentrations of three metals exceeded background (Table 16). Therefore, organics and the three metals were evaluated further.

Step 3 - The third step was to determine the frequency at which chemicals carried to Step 3 were detected in soil samples. As shown in Tables 9-16, thallium was the only chemical detected at a frequency of 5 percent or less in all areas. All other chemicals carried to this step were evaluated further.

Step 4 - The fourth step was to calculate Method C levels for chemicals carried to Step 4 (Appendix D). Three types of cleanup levels were calculated (protection of groundwater, direct contact, and protection of air). Subsequently, site concentrations were compared to Method C levels.

Protection of Groundwater – Maximum detected concentrations of three chemicals (acetone, arsenic and methylene chloride) exceeded Method C levels (site-specific SSLs) for protection of groundwater (Table 17). Since arsenic and methylene chloride are not groundwater IHSs, they were not

selected as IHSs in soil for protection of groundwater. However, acetone was identified as an IHS for soil.

Direct Contact – No maximum detected concentrations exceeded Method C levels for direct contact (Table 18).

Protection of Air – No maximum detected concentrations exceeded Method C levels for protection of air in the SMA and LSA (Table 19).

In summary, one soil IHS was identified for protection of groundwater, while no IHSs were identified for direct contact with soil or protection of air. The soil IHS is presented in Table 20.

Other Considerations

As stated in Section 1.2, on-site surface and subsurface soil samples were collected within, and /or adjacent to, potential source areas. In areas of general waste spreading activities (SMA and LSA), soil borings were completed within, and soil samples collected from, the areas of waste disposal activity. Similarly, subsurface samples were collected beneath Zones C and D. In other areas (Zones A, B, E, and the landfill), it was not feasible to conduct soil borings within the source areas due to potential hazards to human health or risks of spreading constituents to the underlying aquifer. For this reason, and consistent with the Ecology-approved investigation work plans, soil borings were typically completed immediately adjacent to, rather than directly beneath, these zones.

For most potential source areas at the site, the soil data set used in this RA/CLA does not reflect soil contamination, if any, directly beneath the zones. As a result, the RA/CLA concludes that there is only one IHS in soil. In light of the groundwater data and groundwater IHSs, and the soil vapor data, the FS will assume that soil below each zone with groundwater concentrations exceeding Method B levels requires some cleanup action.

3 EXPOSURE ASSESSMENT

3.1 Overview

According to WAC 173-340-708 (3), cleanup levels should be based on estimates of current and future resource uses and reasonable maximum exposures (RMEs) expected to occur under both current and future site use conditions.

The RME is defined as the highest exposure that is reasonably expected to occur at a site under current and potential future site use. RMEs for groundwater and soil are defined in WAC 173-340-720 and –740, respectively. The evaluation criteria in WAC 173-340-720 and –740 may be used to demonstrate that the RME scenarios specified in those sections are not appropriate for a particular site.

The following sections present an evaluation of future land uses and the appropriate RME scenarios for the site.

3.2 Future Land Use

The future land use was evaluated based on the following sources:

- Section 6.2.2 of USEPA's *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)* (1989a) (RAGS);
- USEPA memorandum entitled *Land Use in the CERCLA Remedy Selection Process* (USEPA, 1995a);
- conversations with the Franklin County Planning Director (Franklin County, 1997); and
- conversations with the city planner at the City of Pasco Planning Department (City of Pasco, 1997).

<u>USEPA Risk Assessment Guidance for Superfund (RAGS)</u>

Section 6.2.2 of RAGS (USEPA, 1989a) states that future land use should be determined based on available information and professional judgment. It indicates that pertinent information includes city projections of future land use and established land use trends in the general area (using local reports or general historical accounts of the area). RAGS also indicates that, at some sites, it may be most reasonable to assume that the land use will not change in the future.

USEPA Land Use Memorandum

This memorandum identifies two primary objectives:

1. promoting early discussions with local land use planning authorities, local officials, and the public regarding reasonably anticipated future uses of the property; and

2. promoting the use of that information to formulate realistic assumptions regarding future land use.

The memo identifies sources of information which should be considered in developing reasonable assumptions regarding future land use. It states that a visual inspection of the site and its surrounding areas is a good starting point. It then states that discussions with the local land use authorities and appropriate officials should follow. Another source of information is the public. It states:

> ***"Future land use assumptions allow the baseline risk assessment and the feasibility study to focus on the development of practicable and cost-effective remedial alternatives, leading to site activities which are consistent with the reasonably anticipated future land use".***

Franklin County Planning Department

The majority of the site is located outside of the City of Pasco limits and is within the jurisdiction of Franklin County. On June 24, 1997, Barrie Selcoe of Philip spoke with Dick German, the Planning Director for Franklin County (Franklin County, 1997). Mr. German discussed current and future land use designations, the county's new Comprehensive Plan (Franklin County, 1995), area growth trends, and the potential for future residential land use on-site.

Mr. German stated that the Comprehensive Plan designates the site as Agricultural, and the Plan will not be revised for approximately 30 years (an excerpt indicating the uses on Agricultural land is included as Appendix F). The site has a Conditional Use Permit for recycling centers (operated by BRI and NWI). The County allows special uses within Agricultural areas, such as agricultural packing and necessary facilities (e.g., sanitary landfills). He also said that the area near the site is growing towards commercial and agricultural packing, and there are onion processing sheds adjacent to the site and truck services in the vicinity.

When asked about the likelihood of future residential uses on-site, Mr. German indicated that all future residential growth will be to the west and northwest of the City. He also stated:

> ***"It is extremely unlikely that residential use would occur on-site based on the pattern of what's going on around the site. There's no foreseeable future residential use at the site."***

City of Pasco Planning Department

A small area along the western boundary of the site is located within City of Pasco limits. On June 24, 1997, Barrie Selcoe of Philip spoke with Dave McDonald, the City Planner for the City of Pasco (City of Pasco, 1997). McDonald discussed current and future land use designations, the City's new Comprehensive Plan (City of Pasco, 1995), area growth trends, and the potential for future residential land use on-site.

Mr. McDonald stated that the Comprehensive Plan designates the entire northeastern portion of the City (including the portion of the site within city limits) as Industrial, and the Plan will not be revised for approximately 30 years. The Industrial designation is conducive to various uses including:

- heavy equipment sales/service/repair;
- trucking facilities and storage;
- contractor storage;
- industrial supply;
- manufacturing;
- welding;
- auto assembly & repair; and
- office space.

An excerpt from the Comprehensive Plan indicating the uses on Agricultural land is included as Appendix G.

When asked about the likelihood of future residential uses on-site, Mr. McDonald indicated that residential growth is to the west of the City between Richland and Pasco, and there is ample room to expand westward for 40 or 50 years. In addition, the site is not suited for housing due to its proximity to the landfill and due to the surrounding areas being industrial and agricultural. He also stated:

> ***"It is not reasonable to assume future residential use on-site; you would have to rezone and change the Comprehensive Plan, and there's no compelling reason to do that. I don't foresee residential use at the site at all."***

Conclusions

Future land use was identified for the site and its vicinity using the four sources identified above.

The reasonable future on-site land use is agricultural and light industrial (landfill support operations). The reasonable future land uses immediately surrounding the site are agricultural and industrial (i.e., the same as present).

3.3 Reasonable Maximum Exposure Scenarios

3.3.1 Groundwater

According to WAC 173-340-720, groundwater cleanup levels are based on estimates of the highest beneficial use and the RME expected to occur under both current and future site use conditions. Drinking water is generally the beneficial use requiring the most protective cleanup levels, and exposures via ingestion and other domestic uses represent the RME unless the following can be demonstrated:

- The groundwater does not serve as a current source of drinking water;
- The groundwater is not a potential future source of drinking water; and,
- The department determines it is unlikely that hazardous substances will be transported from the contaminated groundwater to groundwater that is a current or potential future source of drinking water at concentrations that exceed groundwater quality criteria.

Because potable water is currently obtained from the aquifer, ingestion of drinking water was used as the RME for groundwater. Consequently, groundwater cleanup levels were based on use of groundwater for drinking water (Section 5).

3.3.2 Soil

WAC 173-340-740(1)(c) lists five criteria that must be met in order to establish soil cleanup levels other than residential:

1. the site is zoned or otherwise designated for industrial use;
2. the site is currently and historically used for industrial purposes;
3. adjacent properties are used or designated for industrial purposes;
4. the site is expected to be used for industrial purposes in the future due to zoning, statutory restrictions, adjacent land uses or "other relevant factors;" and,
5. institutional controls are imposed on the site.

1) Zoning - Most of the site and adjacent parcels are in Franklin County and zoned Agriculture or Light Industry (along Highway 12). Southwest of the site, and the extreme southwest corner of the site (between Dietrich Road and Highway 12) is within the City of Pasco and zoned Light Industry. Solid waste disposal and recycling are allowed in the Agriculture and Light Industry zones, but only with a conditional use permit (CUP). Solid waste activities at the site have been conducted under a CUP issued by the County since at least 1982. Although the site does not have an Industrial zone classification, the CUP is an official designation of the site as a solid waste disposal site. This designation will remain in place for as long as waste remains at the site.

2) Site Use - The current and historical use of the site (since the 1950s) is as a solid waste disposal facility. While a solid waste disposal facility may not be considered a "traditional" industrial use, it has several characteristics that are common to industrial activity. These characteristics are listed in WAC 173-340-745(1)(b)(i).

At a solid waste disposal facility, activities predominately involve heavy equipment, dust, and noise, and work is performed by adult employees. No one lives at the site, although at one time a caretaker resided on the site as part of the site security measures. The general public is not invited to the site except to dispose of solid waste. The access road is gated and locked when the landfill is closed. When the public is permitted to enter the site, it is only for waste disposal, they must have specific permission to enter, and they are directed to dispose of waste at the working face of the fill area and then leave. They are not free to wander around the site and must remain on the designated access roads. In addition, the PLP Group is in the process of installing security fences around some of the industrial waste zones, including Zones A and B. Finally, while food crops are normally grown in the Agriculture zone, they are not authorized at the site under the current CUP, and any attempt to undertake cultivation at the site would likely endanger the landfill cap and other containment systems. This is prohibited by WAC 173-351-500(2)(c) and the landfill closure permit.

3) Adjacent Properties - Adjacent properties are zoned Agriculture or Light Industry, and are used for agriculture or related industry. The primary crops are potatoes and alfalfa. Onion storage facilities were recently constructed to the southwest of the site. South of the site, the agricultural fields are used for irrigation/disposal of dairy wastewater, as well as for crops. An interchange for Highway 12 and Kahlotus Road was recently constructed to the south of the site. Industrial-type activity is allowed in the Agriculture zone if it is related to agriculture, such as potato or other food processing. Residential uses are not allowed in the Light Industry zone. Residential uses are allowed in the Agriculture zone, but the minimum lot size is very large (20+ acres). Commercial uses are allowed in the Agriculture zone if associated with an agricultural use, such as a fruit or vegetable stand. All areas of the site and adjacent parcels that are outside City limits are also outside the urban growth boundary.

Overall, the actual uses of adjacent properties cannot be characterized as residential or commercial. Like a solid waste landfill, large-scale agricultural activity is, by its nature, more like industrial activity than residential or commercial activity. The work is dominated by heavy machines and work performed by adult laborers. A variety of chemicals are used routinely on the fields. The general public is not invited to the property, and would be considered trespassers. Residences are sparse, and typically associated with an active farming operation.

4) Future Site Use - The site is expected to remain a solid waste disposal facility indefinitely.

5) Institutional Controls - Once the landfill cells are closed, they will be capped under applicable codes and permits. Post-closure restrictions prevent uses or activities that are not consistent with closure. For example, WAC 173-351-500(1)(i) requires a restrictive covenant on the site that cannot be removed unless all waste is removed from the site and approval is obtained from the local health department. The covenant provides notice that wastes are disposed at the site and that future use is restricted under WAC 173-351-500(2)(c), which prohibits any activity at the site which adversely affects the landfill cover, other containment systems, or the monitoring equipment.

These same limitations are incorporated into the closure permit issued to Pasco Sanitary Landfill for the closed landfill area, and similar limits will likely be imposed in a closure permit for the NWI facility to the north of the site. The Landfill Closure Plan for the site was approved by Ecology and incorporates the post-closure requirements of WAC 173-351. The Enforcement Order issued by Ecology for the site prohibits any sale or lease without prior notice to Ecology and prohibits any transfer unless there is an arrangement to maintain the remedial measures required by the Order, such as closure and post-closure actions at the

landfill. The conditional use permit for the site further limits the uses at the site to those associated with solid waste disposal.

Conclusions - Even if the site does not technically qualify as an "industrial" site under the criteria in WAC 173-340-740 and -745, MTCA still provides the flexibility to establish cleanup levels based on an industrial-type exposure scenario. For "industrial sites not qualifying under WAC 173-304-745", soil cleanup levels will be based on residential use "unless it can be demonstrated that this is clearly inappropriate" (WAC 173-340-740[1][c]). The criteria in 740(1)(c) are very similar to those in WAC 173-340-740(1)(a) and 745(1)(b), except that they allow commercial as well as industrial uses at the site and on adjacent properties.

WAC 173-340-740(d) further allows site-specific cleanup levels "for other non-residential site uses such as recreational and agricultural uses." Although the "hazard index and cancer risk" specified in Methods B and C cleanup levels apply, the exposure assumptions would be based on current and potential future site use and activity. Even if industrial cleanup levels are not applicable to the site (e.g., due to the nature of site zoning or the zoning and use at adjacent properties), MTCA still provides flexibility to set appropriate cleanup levels based on the future use of the site as a solid waste disposal facility. It is possible that such cleanup levels may be less stringent than industrial cleanup levels because the frequency and duration of exposure at a closed landfill are much less than those assumed for an active industrial complex.

Therefore, industrial land use is the appropriate RME at the site. Consequently, soil cleanup levels were based on either direct contact exposures by industrial workers or protection of groundwater, whichever is the lower value (Section 5). In addition, due to the presence of the two former surface zones (SMA and LSA), soil cleanup levels considered the potential for air exposures in these areas.

4 TOXICITY ASSESSMENT

Toxicity assessment is accomplished in two steps: hazard identification and dose-response assessment. Hazard identification is the process of determining whether exposure to a hazardous substance is associated with a particular adverse health effect. Hazard identification involves characterizing the nature and strength of the evidence of causation.

The dose-response assessment is the process of predicting a relationship between the dose received and the incidence of adverse health effects in the exposed population. From this quantitative dose-response relationship, toxicity values are derived that can be used to estimate the potential for adverse effects as a function of potential human exposure to the chemical.

4.1 Non-Carcinogenic Toxicity Values

Non-carcinogenic toxicity values (referred to as reference doses [RfDs]) are used in evaluating potential non-carcinogenic effects associated with exposure to chemicals. Consistent with USEPA guidance, the Integrated Risk Information System (IRIS) database (NLM, 1997) and Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997a) were respectively the primary and secondary references consulted for RfDs (USEPA, 1991). In addition, toxicity values obtained from the National Center for Environmental Assessment (NCEA, 1997) were used for chemicals with missing toxicity values in IRIS or HEAST.

Toxicity data for potential non-carcinogenic effects are presented in Table 21, and information obtained from NCEA is presented in Appendix H.

4.2 Carcinogenic Toxicity Values

Carcinogenic toxicity values (referred to as slope factors [SFs]) are used in evaluating potential carcinogenic effects associated with exposure to known, probable, or possible carcinogens having a USEPA weight-of-evidence classification of A, B, or C, respectively. SFs are described by USEPA as upper-bound estimates of the statistical probability of a response per unit intake of a chemical over a lifetime. SFs are used to estimate upper-bound lifetime statistical probabilities of a hypothetical individual developing cancer as a result of exposure to a particular level of a potential carcinogen.

Consistent with USEPA guidance, IRIS (NLM, 1997) and HEAST (USEPA, 1997a) were respectively the primary and secondary sources consulted for SFs for potential carcinogenic effects of IHSs. In addition, toxicity values obtained from the NCEA (1997) were used for chemicals with missing toxicity values in IRIS or HEAST. Toxicity data for potential carcinogenic effects are presented in Table 21, and toxicity information obtained from NCEA is presented in Appendix H.

5 DEVELOPMENT OF CLEANUP LEVELS

The MTCA cleanup levels for preliminary and final groundwater and soil IHSs were identified based on the process described below.

5.1 Groundwater

MTCA Method B cleanup levels were developed for preliminary and final IHSs in groundwater using the procedure presented in WAC 173-340-720 (3) (Appendix C).

The Method B cleanup levels for individual IHSs were adjusted downward, as necessary, to meet the total risk and hazard index (HI) goals for the combined IHSs. The HI cannot exceed one and the total excess cancer risk cannot exceed one in 100,000 (1×10^{-5}) (WAC 173-340-700 [3][b]). In the initial evaluation of preliminary IHSs, adjustments to Method B cleanup levels were necessary due to the number of preliminary IHSs. In addition, it was necessary to adjust the Method B cleanup levels for four final IHSs to meet the total risk and HI goals specified under MTCA.

5.2 Soil

MTCA Method C soil cleanup levels were developed for each preliminary IHS using the procedure presented in WAC 173-340-740 (4). Concentrations protective of three types of exposures (direct contact, leaching to groundwater, and air inhalation [SMA and LSA]) were identified (Appendix D).

In determining soil levels that are protective of groundwater, WAC 173-340-740 (4)(a)(ii)(A) indicates that concentrations that are equal to or less than 100 times the groundwater cleanup level should be used unless it can be demonstrated that a higher soil concentration is protective of groundwater. Soil leachate concentrations entering groundwater are dependent on many variables, including the amount of precipitation and subsequent infiltration in the area, soil-water partition coefficient for the chemical, the organic carbon content of the soil, and the depth to groundwater.

For those chemicals exceeding 100 times the groundwater cleanup level, generic USEPA soil screening levels (SSLs) for protection of groundwater were used as a secondary screening level. For those chemicals exceeding the generic SSL, site-specific SSLs were calculated (Appendix E).

Method C soil cleanup levels must be adjusted downward, if necessary, to meet the total risk and HI goals identified in WAC 173-340-740 (5)(a). The HI cannot exceed one and the total excess cancer risk cannot exceed one in 100,000 (1×10^{-5}) for the combined IHSs. However, since only one preliminary and final IHS (acetone) was identified for soil, no adjustments to the cleanup level were necessary.

6 COMPARISON OF MAXIMUM CONCENTRATIONS TO CLEANUP LEVELS

The maximum site concentration of each IHS was compared to MTCA cleanup levels to identify those chemicals and zones exceeding cleanup levels.

Maximum detected concentrations of final IHSs in monitoring wells were compared to Method B cleanup levels for groundwater. This comparison is presented in Table 22. As shown, all final IHSs except trans-1,2-dichloroethene exceed Method B levels for groundwater.

The same comparison was performed for soil. The maximum detected concentration in each potential source area was compared to the Method C levels for the soil IHS (acetone). This comparison is presented in Table 23. As shown, the maximum detected concentration in only one area (Zones C & D & BT-1) exceeds the Method C level for protection of groundwater. No areas exceed the Method C level for direct contact. Acetone was not detected in the areas where protection of air was a potential concern (SMA and LSA).

7 PHYSICAL HAZARDS

In this section of the risk assessment, the physical characteristics of the site are evaluated in order to identify potential or existing physical hazards. For purposes of this report, physical hazards were defined as explosion, drowning, slips/falls, and cuts/abrasions. The evaluation was based on site visits and monitoring conducted during the RI.

7.1 Potential for Explosion

Landfill gas probes were installed along the western and southern boundaries of the sanitary landfill during the RI. Landfill gas samples were collected quarterly. Monitoring parameters included oxygen, methane, percent lower explosive limit, hydrogen sulfide, hydrogen, carbon dioxide, and VOCs. Elevated concentrations of methane and carbon dioxide, accompanied by reduced levels of oxygen, were observed in all landfill gas probes.

Ecology Enforcement Order No. DE 94TC-E103 required a closure plan for the landfill, which includes a landfill gas control system. Until a landfill gas collection system is installed, the potential for explosion at the sanitary landfill cannot be eliminated. However, as the landfill continues to age, landfill gas generation rates will decline, and any associated risks will be reduced.

The potential for explosive atmospheres in site buildings was evaluated during the Phase II RI. A combustible gas indicator was used to monitor methane concentrations in the scale/guard house, well/pump house, and maintenance building. Samples were collected quarterly during the RI. No methane was detected in any on-site structure during the monitoring events.

7.2 Potential for Drowning

Because surface water is not present on-site, drowning is not a concern at the site.

7.3 Potential for Slips/Falls

Most of the site surface is flat. The soil is very sandy, and due to the climate, it is rarely wet from rain. Therefore, slips/falls are not expected from obstructions at the site surface. A few areas (Zone B and the sanitary landfill) have steeply sloped sides and workers may slip if walking up these slopes. However, the only workers expected to walk in these areas are workers involved in RI and remediation activities. Based on the results of the drum

characterization activities conducted during Phase II, the drums in Zones A and B are likely to be in poor condition. Therefore, there is a potential for subsidence in these zones. If someone were to walk across these zones following subsidence, they may slip or fall.

7.4 Potential for Cuts/Abrasions

Approximately 50 drums are present on the site surface in an area near the center of the site. The drums are empty and are stored on their sides. In addition, this area also contained approximately six automotive batteries and other scrap metal. This area is associated with the active NWI landfill, which is not a part of the site, and is enclosed by a 6-ft tall chain-link fence topped with barbed wire. The potential exists for workers in this area to be cut or scratched by materials in this area.

7.5 Subsidence

There are many discrete waste disposal zones at this site. For the purpose of the RI they were divided into nine zones (Section 1.2). A potential for subsidence exists where the contents of the waste zones may decompose, shift, or otherwise unevenly settle. Based on the findings of the RI, the potential for subsidence exists at the Municipal Landfill and at the drum waste zones Zone A and Zone B. Other zones at the site, such as the bulk waste disposal zones, are not likely to subside due to the nature of the material in the zone.

8 CONCLUSIONS

In conducting this RA/CLA, site-specific data collected during the remedial investigation were reviewed, IHSs were identified for soil and groundwater, RMEs were determined, and cleanup levels were calculated.

IHSs were identified for soil and groundwater using comparisons to background concentrations, frequency of detection, comparisons to adjusted MTCA levels, and relative contribution to site risk. The screening process was sufficiently conservative so that the identified IHSs contribute the majority of potential site-related risk. These IHSs will be used in the FS to establish health-protective cleanup actions.

Thirteen final groundwater IHSs were identified: acetone, benzene, chromium (assumed hexavalent at the direction of Ecology), 1,2-dichloroethane, 1,1-dichloroethene, cis- and trans-1,2-dichloroethene, tetrachloroethene, toluene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethene, and vinyl chloride. One final soil IHS (acetone) was identified. Due to the absence of soil data from directly beneath some of the potential source areas, and the presence of IHSs in groundwater in some of these zones, the FS will assume that soil beneath each zone with groundwater concentrations exceeding Method B levels requires some cleanup action.

Subsequently, RME scenarios for soil and groundwater were identified. Because the site is, and will be, used for landfill support operations, the RME scenario for soil is industrial land use. Because groundwater in the area is used for drinking water, the RME scenario for groundwater is drinking water. As a result, MTCA Method B cleanup levels were identified for groundwater, and Method C cleanup levels were identified for soil. Cleanup levels consider exposure to multiple chemicals. Maximum detected concentrations of all groundwater IHSs except trans-1,2-dichloroethene exceed the MTCA Method B cleanup levels. One potential source area (Zones C & D & BT-1) exceeds the MTCA Method C soil cleanup level for protection of groundwater. Soil concentrations in all areas are below Method C levels for direct contact exposures. Soil concentrations in the SMA and LSA are below Method C levels for cross-media protection of air.

Risk assessments typically use conservative assumptions because of the uncertainty associated with the nature of exposure and health effects of chemicals. This RA/CLA uses conservative assumptions in screening IHSs and developing cleanup levels. Because the conservative assumptions tend to overestimate potential site risk, if a detected concentration exceeds a risk-based cleanup level, it does not necessarily indicate that an actual health impact has occurred or will occur. Rather, the exceedance indicates that the chemical warrants consideration in the FS for additional cleanup actions.

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TABLES

TABLE 1
SUMMARY OF DETECTED ANALYTES - MONITORING WELLS

PASCO LANDFILL
PASCO, WASHINGTON

ANALYTE	FREQUENCY OF DETECTION	RANGE OF SAMPLE QUANTITATION LIMITS	RANGE OF DETECTED CONC.
VOCs			
1,1,1-Trichloroethane	118/320	0.05-610	0.032-950
1,1,2,2-Tetrachloroethane	1/320	0.05-50	0.044-0.044
1,1,2-Trichloroethane	20/320	0.05-50	0.057-3.6
1,1-Dichloroethane	196/320	0.1-100	0.033-770
1,1-Dichloroethene	155/320	0.01-50	0.01-75
1,2-Dichloroethane	107/320	0.05-50	0.052-83
1,2-Dichlorobenzene	39/436	0.05-10	0.045-6.3
1,2-Dichloroethene (total)	7/34	5-50	11-170
1,2-Dichloropropane	72/320	0.05-50	0.021-1.7
1,3-Dichlorobenzene	6/272	0.092-10	0.14-0.75
1,4-Dichlorobenzene	45/436	0.05-10	0.024-4.6
Acetone	59/320	0.1-250	0.046-5900
Acrylonitrile	7/286	0.05-10	0.029-0.85
Benzene	47/320	0.05-50	0.022-49
Carbon disulfide	20/320	0.05-50	0.021-1.1
Carbon tetrachloride	5/320	0.02-50	0.42-83
Chlorobenzene	21/320	0.05-50	0.039-2.2
Chloroethane	53/320	0.071-100	0.027-1.5
Chloroform	109/320	0.05-50	0.039-59
Chloromethane	32/320	0.1-100	0.018-1.2
Dibromochloromethane	2/320	0.05-50	6.2-16
Ethylbenzene	17/320	0.05-50	0.022-400
Methyl butyl ketone	25/320	0.1-50	0.037-4.89
Methylene chloride	82/320	0.05-50	0.049-35
Methyl ethyl ketone	16/320	0.1-250	0.24-1130
Methyl isobutyl ketone	11/320	0.1-50	0.84-1300
Tetrachloroethylene	253/320	0.05-50	0.035-33
Styrene	6/320	0.05-50	2.4-46
Trichloroethylene	240/320	0.05-60	0.048-270
Toluene	39/320	0.05-100	0.023-3200
Trichlorofluoromethane	77/286	0.1-10	0.022-44
Vinyl acetate	1/320	0.05-250	0.054-0.054
Vinyl chloride	96/320	0.02-100	0.01-28
cis-1,2-Dichloroethene	210/286	0.05-100	0.035-2600
cis-1,3-Dichloropropene	3/320	0.05-50	0.6-0.82
m,p-Xylene	20/320	0.05-100	0.021-1100
o-Xylene	17/286	0.05-50	0.058-350
trans-1,2-Dichloroethene	63/286	0.05-0.7	0.026-12
trans-1,3-Dichloropropene	1/320	0.05-50	33-33

TABLE 1 (continued)
SUMMARY OF DETECTED ANALYTES - MONITORING WELLS

PASCO LANDFILL
PASCO, WASHINGTON

ANALYTE	FREQUENCY OF DETECTION	RANGE OF SAMPLE QUANTITATION LIMITS	RANGE OF DETECTED CONC.
SVOCs			
1,2,4-Trichlorobenzene	4/145	0.092-10	0.084-0.21
2,4-Dimethylphenol	4/145	0.092-10	1.8-2.2
2,6-Dinitrotoluene	14/145	0.092-10	0.054-0.18
2-Chlorophenol	5/145	0.092-10	0.1-0.37
2-Methylnaphthalene	7/145	0.092-10	0.026-0.25
2-Methylphenol	6/145	0.092-10	0.076-17
2-Nitroaniline	2/145	0.46-49	0.022-0.037
4-Chloro-3-methylphenol	3/145	0.18-19	0.021-6.8
4-Methylphenol	6/145	0.092-10	0.21-36
Acenaphthene	1/145	0.092-10	0.13-0.13
Benzoic acid	8/145	0.46-49	0.11-4.6
Benzyl alcohol	4/145	0.18-19	0.034-0.36
Bis(2chloro-1-methylethyl)ether	1/145	0.092-10	0.68-0.68
Butyl benzyl phthalate	34/145	0.092-10	0.043-15
Di-n-butylphthalate	44/145	0.093-46	0.02-53
Di-n-octylphthalate	4/145	0.092-10	0.048-0.18
Diethyl phthalate	5/145	0.092-10	0.053-0.085
Dimethyl phthalate	16/145	0.05-10	0.021-1.2
Hexachloroethane	1/145	0.092-10	0.064-0.064
Isophorone	4/145	0.092-10	0.077-4.3
Naphthalene	15/145	0.092-10	0.031-2.9
Phenol	7/145	0.092-10	0.072-27
Pyrene	1/145	0.092-10	0.02-0.02
bis(2-Ethylhexyl)phthalate	7/145	0.093-10	2-4
Pesticides/Herbicides			
2,4,5-TP	1/129	0.03-0.3	0.024-0.024
2,4-D	2/129	0.019-0.3	0.01-0.8
Dicamba	1/129	0.015-0.3	0.9-0.9
MCPA	3/129	0.034-0.3	0.082-0.4

TABLE 1 (continued)
SUMMARY OF DETECTED ANALYTES - MONITORING WELLS

PASCO LANDFILL
PASCO, WASHINGTON

ANALYTE	FREQUENCY OF DETECTION	RANGE OF SAMPLE QUANTITATION LIMITS	RANGE OF DETECTED CONC.
Metals			
Antimony	91/270	0-102	1.1-15
Arsenic	241/270	0-6.3	1.1-8.9
Barium	202/203	0.2-3.5	39-251
Beryllium	30/270	0-1.8	0.01-1.1
Cadmium	11/270	0-5	4-12.5
Calcium	209/210	31.2-340	12700-136000
Chromium (total)	151/273	0-16	1-653
Cobalt	5/242	1-18	1.2-4
Copper	124/270	0-11.7	1-190
Iron	76/210	31.8-95	0.32-15800
Lead	75/270	0-7	0.35-22.3
Magnesium	209/210	2-200	15800-40400
Manganese	57/246	1-13.9	1.2-2680
Nickel	64/270	0-34.5	1.2-63
Potassium	209/210	363.7-440	4640-11000
Selenium	42/270	1-32	1.6-4
Silver	6/270	0-30	3.4-6
Sodium	209/210	400-635.1	22100-45900
Thallium	9/270	0-9.4	1-12
Vanadium	151/242	1-50.2	9.6-31.8
Zinc	112/270	0-20	1.8-286

Note: all concentrations in ug/l.

Table 2

SUMMARY OF DETECTED ANALYTES -
ON-SITE POTABLE WELL

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	Frequency of Detection	Range of Detected Site Concentrations	Background Concentration	Exceeds Bkgd ?
Metals				
Antimony	2/2	0.002-0.004	0.0114	N
Arsenic	2/2	0.0038-0.0045	0.0072	N
Barium	2/2	0.081-0.082	0.068	Y
Beryllium	2/2	0.00002	0.00090	N
Calcium	2/2	57.4-58.0	61.9	N
Chromium (total)	2/2	0.002	0.0078	N
Copper	2/2	0.005-0.008	0.073	N
Magnesium	2/2	22.9-23.2	24.5	N
Potassium	2/2	6.1-6.6	8.0	N
Sodium	2/2	34.9-35.0	35	N
Vanadium	2/2	0.014-0.015	0.021	N
Zinc	2/2	0.01-0.02	0.033	N

Concentrations presented in mg/L.
Based on samples PLF-DW0 and PLF-DW9 collected on March 17, 1997.
Background based on samples MW-21I, MW-25S, MW-28S, and NW-5;
background concentration calculations presented in Appendix B.

Table 3

SUMMARY OF SHALLOW GROUNDWATER STATISTICAL DATA

PASCO LANDFILL
PASCO, WASHINGTON

Chemical	Background Value	Site Concentration Value	Site Concentration Comment	Site Concentration Rationale	Exceeds Background?	
Antimony	11.4	15	MV	E	Y	
Arsenic	7.20	4.6	UCL	C	N	
Barium	68.1	83	UCL	A	Y	
Beryllium	0.90	1.1	MV	E	Y	
Cadmium	2.15	13	MV	E	Y	
Calcium	61,898	136,000	MV	B	Y	**
Chromium (total)	7.76	653	MV	B	Y	
Cobalt	9	4	MV	E	N	
Copper	73.43	190	MV	E	Y	
Iron	104	15,800	MV	E	Y	
Lead	4	22.3	MV	E	Y	
Magnesium	24,464	40,400	MV	B	Y	**
Manganese	6.95	2,680	MV	E	Y	
Nickel	17.25	63	MV	E	Y	
Potassium	7,967	11,000	MV	B	Y	**
Selenium	15	4	MV	E	N	
Silver	15	6	MV	E	N	
Sodium	34,713	45,900	MV	B	Y	**
Thallium	2.60	12	MV	E	Y	
Vanadium	21.04	16.54	UCL	C	N	**
Zinc	32.78	286	MV	E	Y	

Concentrations in ug/L

Background:
Shallow wells: MW-21I, MW-25S, MW-28S, NW-5 (Appendix B).
Source = S: site background; C: CLARCII value (from MTCA/CLARC II Table 2/96).

Site:
Based on samples #1 to #9, EE-2 to -8, MW-10S to -20S, MW-22S to -24S, MW-26S, MW-27S, MW-29S to MW-42S, and MW-17SR collected in Phases I and II of the Remedial Investigation (Appendix B).

Comments:
MV = Maximum value, UCL = 95% UCL.

Rationale for Selecting Concentration:
A - <15% non-detected on-site (ND as 1/2 MDL): use 95% UCL.
B - <15% non-detected on-site (ND as 1/2 MDL); log-normal and normal distributions rejected: use maximum value.
C - 15%-50% non-detected on-site with multiple detection limits: use 95% UCL (ND as 1/2 MDL).
D - 15%-50% non-detected on-site with multiple detection limits; log-normal and normal distributions rejected: use maximum values.
E - >50% non-detected on-site: use maximum value.

Exceeds Background = Comparison of site concentration (95% UCL or maximum value) vs 90th percentile background.
** - Comparing parametric with non-parametric results in site versus background.

Table 4

FREQUENCY OF DETECTION - MONITORING WELLS

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	Hits	Number of Samples	Percentage	Comments
VOCs				
Acetone	59	320	18.4	
Acrylonitrile	7	286	2.4	delete
Benzene	47	320	14.7	
Carbon disulfide	20	320	6.3	
Carbon tetrachloride	5	320	1.6	delete
Chlorobenzene	21	320	6.6	
Chloroethane	53	320	16.6	
Chloroform	109	320	34.1	
Chloromethane	32	320	10.0	
Dibromochloromethane	2	320	0.6	delete
1,2-Dichlorobenzene	39	436	8.9	
1,3-Dichlorobenzene	6	272	2.2	delete
1,4-Dichlorobenzene	45	436	10.3	
1,1-Dichloroethane	196	320	61.3	
1,2-Dichloroethane	107	320	33.4	
1,1-Dichloroethene	155	320	48.4	
1,2-Dichloroethene (total)	7	34	20.6	
1,2-Dichloroethene (cis)	210	286	73.4	
1,2-Dichloroethene (trans)	63	286	22.0	
1,2-Dichloropropane	72	320	22.5	
1,3-Dichloropropene (cis)	3	320	0.9	delete
1,3-Dichloropropene (trans)	1	320	0.3	delete
Ethylbenzene	17	320	5.3	
Methylene chloride	82	320	25.6	
Methyl butyl ketone	25	320	7.8	
Methyl ethyl ketone	16	320	5.0	
Methyl isobutyl ketone	11	320	3.4	delete
Styrene	6	320	1.9	delete
1,1,2,2-Tetrachloroethane	1	320	0.3	delete
Tetrachloroethene	253	320	79.1	
Toluene	39	320	12.2	
1,1,1-Trichloroethane	118	320	36.9	
1,1,2-Trichloroethane	20	320	6.3	
Trichloroethene	240	320	75.0	
Trichlorofluoromethane	77	286	26.9	
Vinyl acetate	1	320	0.3	delete
Vinyl chloride	96	320	30.0	
Xylene (o)	17	286	5.9	
Xylenes (m,p)	20	320	6.3	

Table 4

FREQUENCY OF DETECTION - MONITORING WELLS

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	Hits	Number of Samples	Percentage	Comments
SVOCs				
Acenaphthene	1	145	0.7	delete
Benzoic acid	8	145	5.5	
Benzyl alcohol	4	145	2.8	delete
Bis(2-chloro-1-methylethyl)ether	1	145	0.7	delete
Bis(2-ethylhexyl)phthalate	7	145	4.8	delete
Butyl benzyl phthalate	34	145	23.4	
4-Chloro-3-methylphenol	3	145	2.1	delete
2-Chlorophenol	5	145	3.4	delete
Di-n-butyl phthalate	44	145	30.3	
Di-n-octyl phthalate	4	145	2.8	delete
Diethyl phthalate	5	145	3.4	delete
2,4-Dimethylphenol	4	145	2.8	delete
Dimethyl phthalate	16	145	11.0	
2,6-Dinitrotoluene	14	145	9.7	
Hexachloroethane	1	145	0.7	delete
Isophorone	4	145	2.8	delete
2-Methylnaphthalene	7	145	4.8	delete
2-Methylphenol	6	145	4.1	delete
4-Methylphenol	6	145	4.1	delete
Naphthalene	15	145	10.3	
2-Nitroaniline	2	145	1.4	delete
Phenol	7	145	4.8	delete
Pyrene	1	145	0.7	delete
1,2,4-Trichlorobenzene	4	145	2.8	delete
Pesticides/Herbicides				
2,4-D	2	129	1.6	delete
Dicamba	1	129	0.8	delete
MCPA	3	129	2.3	delete
2,4,5-TP	1	129	0.8	delete

Table 4

FREQUENCY OF DETECTION - MONITORING WELLS

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	Hits	Number of Samples	Percentage	Comments
Metals				
Antimony	91	270	33.7	
Barium	202	203	99.5	
Beryllium	30	270	11.1	
Cadmium	11	270	4.1	delete
Calcium	209	210	99.5	
Chromium (total)	151	273	55.3	
Copper	124	270	45.9	
Iron	76	210	36.2	
Lead	75	270	27.8	
Magnesium	209	210	99.5	
Manganese	57	246	23.2	
Nickel	64	270	23.7	
Potassium	209	210	99.5	
Sodium	209	210	99.5	
Thallium	9	270	3.3	delete
Zinc	112	270	41.5	

Chemicals detected within background concentrations are not presented.

Table 5

COMPARISON TO METHOD B LEVELS - GROUNDWATER

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	Site Concentration	Adjusted Method B Level	Based on C/N	Comments
MONITORING WELLS				
VOCs				
Acetone	5.9	0.08	N	exceeds
Benzene	0.049	0.0008	C	exceeds
Carbon disulfide	0.0011	0.4	N	
Chlorobenzene	0.0022	0.008	N	
Chloroethane	0.0015	NA		
Chloroform	0.059	0.0007	C	exceeds
Chloromethane	0.0012	0.002	C	
1,2-Dichlorobenzene	0.0063	0.06	N	
1,4-Dichlorobenzene	0.0046	0.002	C	exceeds
1,1-Dichloroethane	0.77	0.08	N	exceeds
1,2-Dichloroethane	0.083	0.0005	C	exceeds
1,1-Dichloroethene	0.075	0.00007	C	exceeds
1,2-Dichloroethene (cis)	2.6	0.007	N	exceeds
1,2-Dichloroethene (trans)	0.012	0.010	N	exceeds
1,2-Dichloropropane	0.0017	0.0006	C	exceeds
Ethylbenzene	0.40	0.04	N	exceeds
Methylene chloride	0.035	0.0005	C	exceeds
Methyl butyl ketone	0.0049	NA		
Methyl ethyl ketone	1.1	2	N	
Tetrachloroethene	0.033	0.00008	C	exceeds
Toluene	3.2	0.1	N	exceeds
1,1,1-Trichloroethane	0.95	0.02	N	exceeds
1,1,2-Trichloroethane	0.0036	0.0008	C	exceeds
Trichloroethene	0.27	0.002	C	exceeds
Trichlorofluoromethane	0.044	0.2	N	
Vinyl chloride	0.028	0.00002	C	exceeds
Xylene (o)	0.35	1	N	
Xylenes (m,p)	1.1	1.0	N	exceeds
SVOCs				
Benzoic acid	0.0046	6	N	
Butyl benzyl phthalate	0.015	0.3	N	
Di-n-butyl phthalate	0.053	0.8	N	
Dimethyl phthalate	0.0012	8	N	
2,6-Dinitrotoluene	0.00018	0.00013	C	exceeds
Naphthalene	0.0029	0.06	N	

Table 5

COMPARISON TO METHOD B LEVELS - GROUNDWATER

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	Site Concentration	Adjusted Method B Level	Based on C/N	Comments
Metals				
Antimony	0.015	0.0006	N	exceeds
Barium	0.083	0.1	N	
Beryllium	0.0011	0.00002	C	exceeds
Calcium	136	NA		
Chromium (total)	0.65	0.04	N	exceeds
Copper	0.19	0.3	N	
Iron	16	NA		
Lead	0.022	0.015	N	exceeds
Magnesium	40	NA		
Manganese	2.7	0.05	N	exceeds
Nickel	0.063	0.2	N	
Potassium	11	NA		
Sodium	46	NA		
Zinc	0.29	0.5	N	
ON-SITE POTABLE WELL				
Metals				
Barium	0.082	0.1	N	

Concentrations presented in mg/L.
C/N - Carcinogenic / noncarcinogenic effects.
NA - Not available.

Chemicals exceeding background concentrations and detected at a frequency of 5% or more are presented.
Adjusted Method B level for chromium is for the hexavalent form (at the direction of Ecology).
Site concentrations calculated in Appendix B (for organics, maximum concentrations presented).
Adjusted Method B cleanup levels calculated in Appendix C.

Table 6

RELATIVE HAZARD INDEX OF PRELIMINARY IHSs - GROUNDWATER

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	Site Concentration (mg/l)	ICV	Intake (mg/kg-day)	Oral RfD (mg/kg-day)	HQ	HI	% of HI	% of HI to delete
Acetone	5.9	2	7.38E-01	0.100	7.375		10.30	
Benzene	0.049	2	6.13E-03	0.003	2.042		2.85	
Chloroform	0.059	2	7.38E-03	0.010	0.738		1.03	1.03
Dichlorobenzene (1,4)	0.0046	2	5.75E-04	0.200	0.003		0.004	0.004
Dichloroethane (1,1)	0.77	2	9.63E-02	0.100	0.963		1.34	1.34
Dichloroethane (1,2)	0.083	2	1.04E-02	0.030	0.346		0.48	
Dichloroethene (1,1)	0.075	2	9.38E-03	0.009	1.042		1.46	
Dichloroethene (cis-1,2)	2.6	2	3.25E-01	0.010	32.5		45.40	
Dichloroethene (trans-1,2)	0.012	2	1.50E-03	0.020	0.075		0.10	
Dichloropropane (1,2)	0.0017	2	2.13E-04	ND				
Ethylbenzene	0.40	2	5.00E-02	0.100	0.5		0.70	0.70
Methylene chloride	0.035	2	4.38E-03	0.060	0.073		0.10	0.10
Tetrachloroethene	0.033	2	4.13E-03	0.010	0.413		0.58	
Toluene	3.2	2	4.00E-01	0.200	2		2.79	
Trichloroethane (1,1,1)	0.95	2	1.19E-01	0.020	5.938		8.29	
Trichloroethane (1,1,2)	0.0036	2	4.50E-04	0.004	0.113		0.16	
Trichloroethene	0.27	2	3.38E-02	0.006	5.625		7.86	
Vinyl chloride	0.028	2	3.50E-03	0.070	0.05		0.07	
Xylenes (m,p)	1.1	2	1.38E-01	2.000	0.069		0.10	0.10
Dinitrotoluene (2,6)	0.00018	1	1.13E-05	0.001	0.011		0.02	0.02
Antimony	0.015	1	9.38E-04	0.0004	2.344		3.27	
Beryllium	0.0011	1	6.88E-05	0.005	0.014		0.02	0.02
Chromium (total)	0.65	1	4.08E-02	0.005	8.163		11.40	
Lead	0.022	1	1.38E-03	ND				
Manganese	2.7	1	1.68E-01	0.140	1.196		1.67	1.67
Totals						72	100.0	5.0

HI - Hazard Index (unitless).
HQ - Hazard Quotient (unitless).
ICV - Inhalation correction value.
ND - No data.

The oral RfD for chromium is based on the hexavalent form (at the direction of Ecology).

Equations:

$$\text{Intake} = \frac{(\text{Conc.})\,(1\ \text{L/day})(365\ \text{dys/yr})(6\ \text{yr})(\text{ICV})}{(16\ \text{kg})(2{,}190\ \text{dys})}$$

$$\text{HQ} = \frac{\text{Intake}}{\text{Oral RfD}}$$

$$\text{HI} = \text{Sum of HQs}$$

Table 7

RELATIVE RISK OF PRELIMINARY IHSs - GROUNDWATER

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	Site Concentration (mg/l)	ICV	Intake (mg/kg-day)	Oral SF $(mg/kg\text{-}day)^{-1}$	Risk	% of Risk	% of Risk to delete
VOCs							
Benzene	0.049	2	1.12E-03	2.9E-02	3.2E-05	1.2	
Chloroform	0.059	2	1.35E-03	6.1E-03	8.2E-06	0.3	0.3
Dichlorobenzene (1,4)	0.0046	2	1.05E-04	2.4E-02	2.5E-06	0.1	0.1
Dichloroethane (1,2)	0.083	2	1.90E-03	9.1E-02	1.7E-04	6.5	
Dichloroethene (1,1)	0.075	2	1.71E-03	6.0E-01	1.0E-03	39.0	
Dichloropropane (1,2)	0.0017	2	3.89E-05	6.8E-02	2.6E-06	0.1	0.1
Methylene chloride	0.035	2	8.00E-04	7.5E-03	6.0E-06	0.2	0.2
Tetrachloroethene	0.033	2	7.54E-04	5.2E-02	3.9E-05	1.5	
Trichloroethane (1,1,2)	0.0036	2	8.23E-05	5.7E-02	4.7E-06	0.2	
Trichloroethene	0.27	2	6.17E-03	1.1E-02	6.8E-05	2.6	
Vinyl chloride	0.028	2	6.40E-04	1.9E+00	1.2E-03	46.1	
SVOCs							
Dinitrotoluene (2,6)	0.00018	1	2.06E-06	6.8E-01	1.4E-06	0.1	0.1
Metals							
Beryllium	0.0011	1	1.26E-05	4.3E+00	5.4E-05	2.1	2.1
Totals					2.6E-03	100.0	2.8

Only those preliminary IHSs with oral carcinogenic toxicity values are presented.
ICV - Inhalation correction value.
IHS - Indicator Hazardous Substance.
SF - Slope factor.

Equations:

$$\text{Intake} = \frac{(\text{Conc.})\,(2\ \text{L/day})(365\ \text{dys/yr})(30\ \text{yr})(\text{ICV})}{(70\ \text{kg})(27375\ \text{dys})}$$

$$\text{Risk} = \text{Intake} \times \text{Oral SF}$$

Table 8

FINAL GROUNDWATER INDICATOR HAZARDOUS SUBSTANCES

PASCO LANDFILL
PASCO, WASHINGTON

Acetone
Benzene
Chromium (hexavalent)
Dichloroethane (1,2)
Dichloroethene (1,1)
Dichloroethene (cis-1,2)
Dichloroethene (trans-1,2)
Tetrachloroethene
Toluene
Trichloroethane (1,1,1)
Trichloroethane (1,1,2)
Trichloroethene
Vinyl chloride

Chromium in groundwater is assumed to be hexavalent at the direction of Ecology.

Table 9

SUMMARY OF DETECTED ANALYTES IN SOIL -
SLUDGE MANAGEMENT AREA

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	On-Site						Background Conc.	Exceeds Bkgd?
	Frequency of Detection	%	Range of Sample Quantitation Limits	Range of Detected Conc.	Site Conc.			
SVOCs (ug/kg)								
Butyl benzyl phthalate	6/20	30	340-390	58-930	---		---	---
Di-n-butyl phthalate	20/20	100		110-2,700	---		---	---
Metals (mg/kg)								
Antimony	8/20		1.1-1.5	1.7-3	3	M	3.28	N
Arsenic	20/20	100		6.2-12.2	9.84	U	7.88	Y
Cadmium	20/20	100		1.6-2.6	2.26	U	2.01	Y
Chromium (total)	20/20	100		5.1-21.9	21.9	M	6.78	Y
Copper	20/20	100		10.9-17.7	13.83	U	12.27	Y
Lead	20/20			6.1-10.6	8.19	U	8.5	N
Mercury	1/20	5	0.07-0.1	0.31	0.31	M	0.098	Y
Nickel	20/20	100		8-11.7	10.37	U	9.58	Y
Silver	20/20			0.91-1.8	1.4	U	1.5	N
Thallium	1/20	5	3-4	3.8	3.8	M	1.85	Y
Zinc	20/20	100		34.7-79.2	79.2	M	38.06	Y

M - Maximum.
U - Upper 95% confidence limit on the mean.

Based on samples SL-01 to SL-20.
Background based on samples BK-01 to BK-21.
Site and background concentration calculations presented in Appendix B.

% presented for all organics and metals exceeding background.

Table 10

SUMMARY OF DETECTED ANALYTES IN SOIL -
LANDSPREAD AREA

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	On-Site Frequency of Detection	%	Range of Sample Quantitation Limits	Range of Detected Conc.	Site Conc.		Background Conc.	Exceeds Bkgd ?
SVOCs (ug/kg)								
Di-n-butyl phthalate	20/20	100		130-1,600	---		---	---
Metals (mg/kg)								
Antimony	8/20		0.96-1.4	0.98-2.3	2.3	M	3.28	N
Arsenic	20/20			4.2-8.5	6.98	U	7.88	N
Cadmium	20/20			1-2	2	M	2.01	N
Chromium (total)	20/20			3.7-6.2	5.39	U	6.78	N
Copper	20/20	100		9.9-30.9	30.9	M	12.27	Y
Lead	20/20			5.7-11.3	8.01	U	8.5	N
Mercury	1/20	5	0.08-0.11	0.48	0.48	M	0.098	Y
Nickel	20/20			6.8-8.8	8.19	U	9.58	N
Silver	20/20			0.59-1.3	0.97	U	1.5	N
Zinc	20/20	100		28.2-54.9	38.61	U	38.06	Y

M - Maximum.
U - Upper 95% confidence limit on the mean.

Based on samples LS-01 to LS-20.
Background based on samples BK-01 to BK-21.
Site and background concentration calculations presented in Appendix B.

% presented for all organics and metals exceeding background.

Table 11

SUMMARY OF DETECTED ANALYTES IN SOIL -
ZONE A /BT-2/BALEFILL

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	On-Site Frequency of Detection	%	Range of Sample Quantitation Limits	Range of Detected Conc.	Site Conc.		Background Conc.	Exceeds Bkgd ?
VOCs (ug/kg)								
Acetone	3/3	100		59-2,200	--		--	--
Methylene Chloride	3/3	100		73-220	--		--	--
Toluene	2/3	67	140	3	--		--	--
SVOCs (ug/kg)								
Di-n-butyl phthalate	2/3	67	460	190-200	--		--	--
Di-n-octyl phthalate	1/3	33	350-380	110	--		--	--
Pesticides (ug/kg)								
4,4-DDT	1/3	33	3.4-3.57	8.9	--		--	--
Metals (mg/kg)								
Antimony	1/3		4.9-5.9	1.6	1.6	M	3	N
Arsenic	1/3		8.2-9.8	2.9	2.9	M	14.24	N
Barium	1/1			53.5	53.5	M	255	N
Cadmium	3/3			1.8-2.3	2.67	U	3.81	N
Chromium (total)	3/3	100		2.4-5	16.24	U	10.94	Y
Copper	3/3			11.6-12.3	12.7	U	19.52	N
Lead	3/3			4.5-5.7	6.49	U	13.33	N
Nickel	3/3			4.9-7.5	10.37	U	14.32	N
Silver	3/3	100		0.93-1.8	5.3	U	1.78	Y
Zinc	3/3			25.8-33.8	39.89	U	51.29	N

M - Maximum.
U - Upper 95% confidence limit on the mean.

Based on samples collected from MW-12I, MW-13S and MW-14S.
Background based on samples collected from B-09, B-09R, and B-10.
Site and background concentrations presented in Appendix B.

% presented for all organics and metals exceeding background.

Table 12

SUMMARY OF DETECTED ANALYTES IN SOIL - ZONE B

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	On-Site Frequency of Detection	%	Range of Sample Quantitation Limits	Range of Detected Conc.	Site Conc.	Background Conc.	Exceeds Bkgd ?
SVOCs (ug/kg)							
Bis(2-ethylhexyl)phthalate	4/8	50	340-360	80-150	--	--	--
Di-n-butyl phthalate	7/8	87.5	340-360	120-2,300	--	--	--
Di-n-octyl phthalate	1/8	12.5	340-360	110	--	--	--
Dioxins/Furans (pg/g)							
OCDD	11/16		0.79-14.0	1.42 -81	--	*	*
1,2,3,7,8,9-HxCDD	6/16		0.16-2.2	0.25-0.7	--	*	*
OCDF	9/16		0.17-5.1	0.17-2,600	--	*	*
1,2,3,4,7,8-HxCDD	1/16		0.17-2	0.18	--	*	*
2,3,7,8-TCDF	7/16		0.07-1.5	0.26-27.3	--	*	*
1,2,3,4,7,8,9-HpCDF	1/16		0.1-10	0.34	--	*	*
1,2,3,6,7,8-HxCDF	1/16		0.07-1.5	0.23	--	*	*
1,2,3,6,7,8-HxCDD	3/16		0.2-2.5	0.21-1.97	--	*	*
1,2,3,4,6,7,8-HpCDF	7/16		0.17-11	0.17-47	--	*	*
1,2,3,4,7,8-HxCDF	3/16		0.09-13	0.13-0.66	--	*	*
1,2,3,4,7,8,9-HpCDD	7/16		0.22-0.26	2.14-25.2	--	*	*
HpCDFs (total)	7/16		0.2-11	0.33-110	--	*	*
HpCDDs (total)	9/16		0.22-8.6	3.03-42.2	--	*	*
HxCDDs (total)	8/16		0.16-6.3	0.67-9.86	--	*	*
HxCDFs (total)	1/16		0.26-13	7.26	--	*	*
PeCDDs (total)	1/16		0.11-8.1	0.75	--	*	*
PeCDFs (total)	7/16		0.08-1.8	0.65-79.7	--	*	*
TCDDs (total)	4/16		0.07-2.1	0.48-11.4	--	*	*
TCDFs (total)	8/16		0.07-1.5	0.21-69.1	--	*	*
Metals (mg/kg)							
Arsenic	1/8		7.9-10.7	10.1	10.1 M	14.24	N
Cadmium	8/8			2.2-3.1	2.98 U	3.81	N
Chromium (total)	8/8			1.8-9.6	10.23 U	10.94	N
Copper	8/8			10.4-17.1	15.65 U	19.52	N
Lead	7/8		4.9-4.9	6-13.2	11.17 U	13.33	N
Nickel	8/8			7.5-15.1	13.46 U	14.32	N
Silver	8/8			0.77-1.7	1.44 U	1.78	N
Zinc	8/8			25.1-48.6	44.86 U	51.29	N

M - Maximum.
U - Upper 95% confidence limit on the mean.
* = See Section 2.6 (Step 2).

Based on samples B-05, B-06, B-13, B-14, B-15, and MW-26S.
Background based on samples collected from B-09, B-09R, B-10, and MW-25S.
Site and background concentration calculations presented in Appendix B.

% presented for all chemicals exceeding background or with no background values.

Table 13

SUMMARY OF DETECTED ANALYTES IN SOIL -
ZONES C & D & BT-1

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	On-Site Frequency of Detection	%	Range of Sample Quantitation Limits	Range of Detected Conc.	Site Conc.		Background Conc.	Exceeds Bkgd ?
VOCs (ug/kg)								
Acetone	18/19	94.7	25-240	63-630,000	--		--	--
Methyl butyl ketone	1/19	5.26	5-58	15	--		--	--
Methylene chloride	5/19	26.3	5.1-11	56-110	--		--	--
Methyl ethyl ketone	12/19	63.2	51-240	15-2,700	--		--	--
Methyl isobutyl ketone	5/19	26.3	51-58	15-1,100	--		--	--
Toluene	9/19	47.4	5-5.8	3-78	--		--	--
Xylene (m,p)	1/19	5.26	5.1-11	8.3	--		--	--
Xylene (o)	1/14	7.14	5.1-5.8	8.5	--		--	--
SVOCs (ug/kg)								
Di-n-butyl phthalate	8/9	88.9	350-1,700	37-840	--		--	--
Hexachlorobenzene	1/9	11.1	350-1,700	45	--		--	--
Hexachloroethane	1/9	11.1	350-1,700	55	--		--	--
Metals (mg/kg)								
Antimony	1/9	11.1	3.7-5.3	6	6	M	3	Y
Arsenic	5/9		2.8-10	4.3-6.2	5.27	U	14.24	N
Beryllium	3/9	33.3	0.01	0.04-0.08	0.08	M	0.01	Y
Cadmium	9/9			1.5-2.5	2.5	M	3.81	N
Chromium (total)	9/9			3.3-12.1	10.14	U	10.94	N
Copper	9/9			11.5-17.3	15.86	U	19.52	N
Lead	8/9		4.5	7-17.3	12.02	U	13.33	N
Mercury	8/9	88.9	0.04	0.09-0.12	0.12	M	0.028	Y
Nickel	9/9	100		7.3-15.7	14.98	U	14.32	Y
Silver	9/9	100		1.2-2.5	2.14	U	1.78	Y
Zinc	9/9			33.8-53.3	49.03	U	51.29	N

M - Maximum.
U - Upper 95% confidence limit on the mean.

Based on samples B-01, B-02, B-19, B-20, and MW-18S.
Background based on samples collected from B-09, B-09R, and B-10.
Site and background concentration calculations presented in Appendix B.

% presented for all organics and metals exceeding background.

Table 14

SUMMARY OF DETECTED ANALYTES IN SOIL -
ZONES E & TS-1/SL-1

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	On-Site Frequency of Detection	%	Range of Sample Quantitation Limits	Range of Detected Conc.	Site Conc.		Background Conc.	Exceeds Bkgd ?
VOCs (ug/kg)								
Acetone	4/4	100		43-400	--		--	--
Methylene Chloride	4/4	100		49-340	--		--	--
Toluene	1/4	25	200-220	3	--		--	--
SVOCs (ug/kg)								
BEHP	2/12	16.7	340-380	13-90	--		--	--
Di-n-butyl phthalate	12/12	100		120-630	--		--	--
Hexachlorobenzene	1/12	8.33	340-390	160	--		--	--
Hexachloroethane	2/12	16.7	340-390	66-85	--		--	--
Metals (mg/kg)								
Arsenic	7/12		3.1-6.5	3.1-11.8	10.76	U	14.24	N
Beryllium	8/12	66.7	0.01-0.01	0.04-0.46	0.46	M	0.01	Y
Cadmium	12/12			1.5-3.0	2.66	U	3.81	N
Chromium (total)	12/12			3.4-12.1	8.46	U	10.94	N
Copper	12/12	100		14.2-33.3	21.88	U	19.52	Y
Lead	12/12	100		5.5-26.8	14.48	U	13.33	Y
Mercury	9/12	75	0.04-0.4	0.1-180	4690.45	U	0.028	Y
Nickel	12/12			9.0-15.4	13.44	U	14.32	N
Silver	12/12	100		1.2-2.5	1.91	U	1.78	Y
Zinc	12/12	100		39.3-66.6	52.91	U	51.29	Y
Radionuclides (pci/g)							Range	
Gross Alpha	4/4			7.7-20	--		3-23	*
Beta & Photon	4/4			15-26	--		8.7-26	*
K-40	3/4		1.7-1.7	8.9-18	--		7.8-25	*
Ac-228	1/4		0.1-0.3	1.4	--		0.46-1.3	*
Bi-214	2/4		0.1-0.2	0.8-1.4	--		0.29-1.4	*
Tl-208	2/4		0.03-0.1	0.4-0.6	--		0.15-0.44	*
Th-234	1/4		0.1-0.4	3	--		NA	*
Pb-214	4/4			0.4-1.3	--		0.41-1.7	*
Pb-212	3/4		0.3	1.1-1.4	--		0.47-1.4	*

BEHP - Bis(2-ethylhexyl)phthalate.
M - Maximum.
NA - Not analyzed
U - Upper 95% confidence limit on the mean.

Based on samples B-03, B-04, B-11, B-17, and B-18.
Background based on samples collected from B-09, B-09R, and B-10.
Site and background concentration calculations presented in Appendix B.
* - See Section 2.6 (Step 2).
% presented for all organics and metals exceeding background.

Table 15

SUMMARY OF DETECTED ANALYTES IN SOIL -
SL-2 & SL-3

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	On-Site Frequency of Detection	%	Range of Sample Quantitation Limits	Range of Detected Conc.	Site Conc.		Background Conc.	Exceeds Blgd ?
VOCs (ug/kg)								
Acetone	8/8	100		37-1500	--		--	--
Methylene chloride	8/8	100		76-100	--		--	--
Toluene	8/8	100		3-5	--		--	--
SVOCs (ug/kg)								
Di-n-butyl phthalate	9/12	75	350-360	76-240	--		--	--
Metals (mg/kg)								
Arsenic	9/12		3.6-9.1	3.1-12.6	9.33	U	14.24	N
Beryllium	2/12	16.7	0.01-0.01	0.06-0.21	0.21	M	0.01	Y
Cadmium	12/12			2-2.6	2.5	U	3.81	N
Chromium (total)	12/12			4.2-9.7	9.7	M	10.94	N
Copper	12/12			11.4-19.1	15.24	U	19.52	N
Lead	12/12			6.9-15	11.55	U	13.33	N
Mercury	2/12	16.7	0.4-0.5	0.1-0.96	0.96	M	0.028	Y
Nickel	12/12			8.3-15.1	12.88	U	14.32	N
Silver	12/12	100		1.3-2.4	1.9	U	1.78	Y
Zinc	12/12			37.6-50.5	44.85	U	51.29	N
Radionuclides (pci/g)							Range	
Gross Alpha	12/12			10-26	--		3-23	*
Beta & photon	12/12			14-22	--		8.7-26	*
K-40	5/12			13-19	--		7.8-25	*
Ac-228	1/12			0.8	--		0.46-1.3	*
Bi-214	1/12			0.7	--		0.29-1.4	*
Tl- 208	2/12			0.2	--		0.15-0.44	*
Pb-214	5/12			0.3-1.1	--		0.41-1.7	*
Pb-212	4/12			0.8-1.1	--		0.47-1.4	*

M - Maximum.
U - Upper 95% confidence limit on the mean.

Based on samples B-07, B-08, and B-12.
Background based on samples collected from B-09, B-09R, and B-10.
Site and background concentration calculations presented in Appendix B.

* - See Section 2.6 (Step 2).
% presented for all organics and metals exceeding background.

Table 16

SUMMARY OF DETECTED ANALYTES IN SOIL -
AREAS NOT IMMEDIATELY ADJACENT TO DESIGNATED ZONES

PASCO LANDFILL
PASCO, WASHINGTON

	On-Site							
Analyte	Frequency of Detection	%	Range of Sample Quantitation Limits	Range of Detected Conc.	Site Conc.		Background Conc.	Exceeds Bkgd ?
VOCs (ug/kg)								
Acetone	4/5	80	26-1,100	36-2,300	---		---	---
Chloroform	1/5	20	5-230	1	---		---	---
Ethylbenzene	1/5	20	5-230	0.5	---		---	---
Methylene chloride	5/5	100	5-450	83-2,300	---		---	---
Methyl ethyl ketone	1/5	20	26-1,100	6	---		---	---
Toluene	3/5	60	5-230	2-5	---		---	---
Xylene (m,p)	1/5	20	10-450	1	---		---	---
SVOCs (ug/kg)								
Bis(2-ethylhexyl)phthalate	4/5	80	380-810	86-520	---		---	---
Di-n-butyl phthalate	5/5	100	380-810	70-3,000	---		---	---
Di-n-octyl phthalate	1/5	20	380-810	160	---		---	---
Pesticides (ug/kg)								
4,4'-DDT	1/5	20	3-3.91	30.3	---		---	---
Endrin	1/5	20	3.6-3.91	41.8	---		---	---
Endrin aldehyde	1/5	20	3.6-3.91	5.04	---		---	---
Endrin ketone	1/5	20	3.6-3.91	3.79	---		---	---
Metals (mg/kg)								
Arsenic	5/9		0.1-9.9	9.7	12.12	U	14.24	N
Barium	1/1		---	50.9	50.9	M	255	N
Beryllium	4/9	44.4	0.01-0.49	0.12-0.16	0.13	M	0.01	Y
Cadmium	6/9		0.1	0.14-3.8	3.8	M	3.81	N
Chromium (total)	9/9		0.2	2.8-9.8	9.8	M	10.94	N
Copper	9/9		0.1	9.5-17.5	14.93	U	19.52	N
Lead	7/9		0.1-4.7	2.1-11.1	11.10	M	13.33	N
Nickel	9/9		0.1	4.7-12	9	U	14.32	N
Selenium	1/9	11.1	0.1-14.2	13	13	M	7.48	Y
Silver	6/9	66.7	0.1-0.74	0.079-2.5	46.85	U	1.78	Y
Zinc	9/9		0.2	24.8-54.8	49.12	U	51.29	N

M - Maximum.
U - Upper 95% confidence limit on the mean.
Based on samples MW-10S, MW-11S, MW-19S, MW20S, MW22S, MW-23S, MW-24S, MW-27S and MW-28S.
Background based on samples B-09, B-09R, and B-10.
Site and background concentration calculations presented in Appendix B.

% presented for all organics and metals exceeding background.

Table 17

UNADJUSTED METHOD C CLEANUP LEVELS FOR PRELIMINARY IHSs IN SOIL - PROTECTION OF GROUNDWATER

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	Maximum Detected Conc. (mg/kg)	Adjusted Method B GW Level (mg/L)	*Protection of Groundwater* Step #1 (100 x GW Level) (mg/kg)	Site Conc. Exceeds?	Step #2 Generic SSL (mg/kg)	Site Conc. Exceeds?	Step #3 Site-Specific SSL (mg/kg)	Site Conc. Exceeds?	Groundwater IHS? If yes, Soil IHS
VOCs									
Acetone	630.00	0.08	8	yes	0.8	yes	80	yes	yes
Chloroform	0.001	0.0007	0.07	no	--	--	--	--	
Ethylbenzene	0.0005	0.04	3.5	no	--	--	--	--	
Methylene chloride	2.30	0.0005	0.05	yes	0.001	yes	0.2	yes	no
Methyl butyl ketone	0.015	NA	NA	no	--	--	--	--	
Methyl ethyl ketone	2.70	2	240	no	--	--	--	--	
Methyl isobutyl ketone	1.10	0.03	3	no	--	--	--	--	
Toluene	0.078	0.1	10	no	--	--	--	--	
Xylenes	0.0085	1	100	no	--	--	--	--	
SVOCs									
Bis(2-ethylhexyl)phthalate	0.52	0.006	0.6	no	--	--	--	--	
Butyl benzyl phthalate	0.93	0.3	32	no	--	--	--	--	
Di-n-butyl phthalate	3.00	0.8	80	no	--	--	--	--	
Di-n-octyl phthalate	0.16	0.01	1	no	--	--	--	--	
Hexachlorobenzene	0.160	0.00005	0.005	yes	0.1	yes	6	no	
Hexachloroethane	0.085	0.006	0.6	no	--	--	--	--	
Pesticides									
4,4-DDT	0.0303	0.00003	0.003	yes	2	no	--	--	
Endrin	0.0418	0.0002	0.02	yes	0.05	no	--	--	
Endrin aldehyde	0.00504	NA	NA	no	--	--	--	--	
Endrin ketone	0.00379	NA	NA	no	--	--	--	--	
Dioxins/Furans									
2,3,7,8-TCDD Equivalents	6.25E-06	6E-10	6E-08	yes	NA	--	0.003	no	

Table 17

UNADJUSTED METHOD C CLEANUP LEVELS FOR PRELIMINARY IHSs IN SOIL - PROTECTION OF GROUNDWATER

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	Maximum Detected Conc. (mg/kg)	Adjusted Method B GW Level (mg/L)	*Protection of Groundwater* Step #1 (100 x GW Level) (mg/kg)	Site Conc. Exceeds?	Step #2 Generic SSL (mg/kg)	Site Conc. Exceeds?	Step #3 Site-Specific SSL (mg/kg)	Site Conc. Exceeds?	Groundwater IHS? If yes, Soil IHS
Metals									
Antimony	6.0	0.0006	0.1	yes	0.3	yes	126	no	
Arsenic	12.6	0.00006	0.006	yes	1	yes	3	yes	no
Beryllium	0.46	0.00002	0.002	yes	3	no	--	--	
Cadmium	3.8	0.0005	0.05	yes	0.4	yes	3,769	no	
Chromium (total)	21.9	0.04	4	yes	2	yes	997	no	
Copper	33.3	0.3	30	yes	NA	--	59,017	no	
Lead	26.8	0.015	1.5	yes	400	no	--	--	
Mercury	180.0	0.001	0.1	yes	0.1	yes	351	no	
Nickel	15.7	0.16	16	no	--	--	--	--	
Selenium	13.0	0.05	5	yes	0.3	yes	560	no	
Silver	2.5	0.008	0.8	yes	2	yes	1547	no	
Zinc	79.2	0.5	48	yes	620	no	--	--	

Chemicals exceeding background in at least one area at a frequency >5% are presented.
IHS - Indicator Hazardous Substance.
GW - Groundwater.
NA - Not available.
SSL - Soil Screening Level.

Adjusted Method B GW levels from Table C-4.
Generic SSLs obtained from Table A-1 in *Soil Screening Guidance: Technical Background Document* (USEPA, 1996a).
Site-specific SSLs calculated in Appendix E.
Groundwater IHSs obtained from Table 8.
Adjusted Method B GW Level and Protection of Groundwater Levels for chromium are for the hexavalent form (at the direction of Ecology).

Table 18

UNADJUSTED METHOD C CLEANUP LEVELS FOR PRELIMINARY IHSs
IN SOIL - DIRECT CONTACT

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	Max. Detected	Unadjusted Method C Cleanup Level - Direct Contact	Maximum Conc. Exceeds?
VOCs			
Acetone	630.00	350,000	no
Chloroform	0.001	21,500	no
Ethylbenzene	0.00050	350,000	no
Methylene chloride	2.3	17,500	no
Methyl butyl ketone	0.015	NA	--
Methyl ethyl ketone	2.7	2,100,000	no
Methyl isobutyl ketone	1.10	280,000	no
Toluene	0.078	700,000	no
Xylenes	0.0085	7,000,000	no
SVOCs			
Bis(2-ethylhexyl)phthalate	0.52	9,380	no
Butyl benzyl phthalate	0.93	700,000	no
Di-n-butyl phthalate	3.0	350,000	no
Di-n-octyl phthalate	0.16	70,000	no
Hexachlorobenzene	0.16	82	no
Hexachloroethane	0.085	3,500	no
Pesticides			
4,4-DDT	0.030	386	no
Endrin	0.042	1,050	no
Endrin aldehyde	0.0050	NA	--
Endrin ketone	0.0038	NA	--
Dioxins/Furans			
2,3,7,8-TCDD	6E-06	8.75E-04	no
Metals			
Antimony	6.0	1,400	no
Arsenic	12.6	219	no
Beryllium	0.46	31	no
Cadmium	3.8	3,500	no
Chromium (total)	21.9	3,500,000	no
Copper	33.3	130,000	no
Lead	26.8	NA	--
Mercury	180	1,050	no
Nickel	15.7	70,000	no
Selenium	13	17,500	no
Silver	2.5	17,500	no
Zinc	79.2	1,050,000	no

Concentrations presented in mg/kg.
IHS - Indicator hazardous substance.
NA - Not available.
Method C Soil levels from Ecology's CLARC Table.

Table 19

UNADJUSTED METHOD C CLEANUP LEVELS FOR PRELIMINARY IHSs
IN SMA AND LSA - PROTECTION OF AIR

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	Maximum Detected Conc.	*Protection of Air*			
		Step #1 Generic SSL (Residential)	Max. Conc. Exceeds?	Step #2 EPA Region 6 MSL (Industrial)	Max. Conc. Exceeds?
SVOCs					
Butyl benzyl phthalate	0.93	930	no	--	--
Di-n-butyl phthalate	2.7	2,300	no	--	--
Metals					
Arsenic	12.2	750	no	--	--
Cadmium	2.6	1,800	no	--	--
Chromium (total)	21.9	270	no	--	--
Copper	30.9	NA	--	63,000	no
Mercury	0.48	10	no	--	--
Nickel	11.7	13,000	no	--	--
Zinc	79.2	NA	--	>saturation	no

Concentrations presented in mg/kg.
Chemicals exceeding background in the SMA or LSA and detected at a frequency of >5% are presented.
IHS - Indicator Hazardous Substance.
MSL - Media-specific Level.
NA - Not available.
SSL - Soil Screening Level.

Generic SSLs obtained from Table A-1 in *Soil Screening Guidance: Technical Background Document* (USEPA, 1996a).
EPA Region 6 MSL obtained from EPA Region 6 Human Health Media-Specific Screening Levels (USEPA, 1996b).

Table 20

FINAL SOIL INDICATOR HAZARDOUS SUBSTANCE

PASCO LANDFILL
PASCO, WASHINGTON

Acetone

Table 21

TOXICITY INFORMATION FOR
CLEANUP LEVEL CALCULATIONS

PASCO LANDFILL
PASCO, WASHINGTON

Hazardous Substance	Carcinogenic Toxicity Data				Non-carcinogenic Toxicity Data				
	Oral SF	Source	WOE	Tumor Type	Oral RfD	Source	Confidence Level	Target Organ/System or Critical Effect	UF/ MF
VOCs									
Acetone	ND				1.0E-01	I	Low	Liver & Kidney	1000
Benzene	2.9E-02	I	A	Leukemia	3.0E-03	N	Medium	Circulatory & Immune	3000
Carbon disulfide	ND				1.0E-01	I	Medium	Developmental	100
Chlorobenzene	ND				2.0E-02	I	Medium	Liver	1000
Chloroethane	ND				ND				
Chloroform	6.1E-03	I	B2		1.0E-02	I	Medium	Liver	1000
Chloromethane	1.3E-02	H7	C		ND				
1,2-Dichlorobenzene	ND				9.0E-02	I	Low	Liver	1000
1,4-Dichlorobenzene	2.4E-02	H7	C		2.0E-01	N	Medium	Kidney	1000
1,1-Dichloroethane	ND				1.0E-01	H7	NA	Kidney	NA
1,2-Dichloroethane	9.1E-02	I	B2		3.0E-02	N	Low	Lung	1000
1,1-Dichloroethene	6.0E-01	I	C		9.0E-03	I	Medium	Liver	1000
1,2-Dichloroethene (cis)	ND				1.0E-02	H7	NA	Circulatory	3000
1,2-Dichloroethene (trans)	ND				2.0E-02	I	Low	Circulatory	1000
1,2-Dichloropropane	6.8E-02	H7	B2		ND				
Ethylbenzene	ND				1.0E-01	I	Low	Liver & kidney	1000
Methyl butyl ketone	ND				ND				
Methylene chloride	7.5E-03	I	B2		6.0E-02	I	Medium	Liver	100
Methyl ethyl ketone	ND				6.0E-01	I	Low	Developmental	3000
Methyl isobutyl ketone	ND				8.0E-02	H7	NA	Liver & Kidney	3000
Tetrachloroethene	5.2E-02	N	C-B2		1.0E-02	I	Medium	Liver	1000
Toluene	ND				2.0E-01	I	Medium	Liver & Kidney	1000
1,1,1-Trichloroethane	ND				2.0E-02	N	Medium/Low	CNS	3000
1,1,2-Trichloroethane	5.7E-02	I	C		4.0E-03	I	Medium	Liver & Circulatory	1000
Trichloroethene	1.1E-02	N	C-B2		6.0E-03	N	Low	Liver & Kidney	3000
Trichlorofluoromethane	ND				3.0E-01	I	Medium	Lung & Circulatory	1000
Vinyl chloride	1.9E+00	H7	A	Lung & Liver	7.0E-02	U	NA	Liver	30
Xylenes	ND				2.0E+00	I	Medium	CNS	100

Table 21

TOXICITY INFORMATION FOR
CLEANUP LEVEL CALCULATIONS

PASCO LANDFILL
PASCO, WASHINGTON

Hazardous Substance	*Carcinogenic Toxicity Data*				*Non-carcinogenic Toxicity Data*				
	Oral SF	Source	WOE	Tumor Type	Oral RfD	Source	Confidence Level	Target Organ/System or Critical Effect	UF/ MF
SVOCs									
Benzoic acid	ND				4.0E+00	I	Medium	Growth rate	1
Bis(2-ethylhexyl) phthalate	1.4E-02	I	B2		2.0E-02	I	Medium	Growth rate	1000
Butyl benzyl phthalate	ND				2.0E-01	I	Low	Growth rate	1000
Di-n-butyl phthalate	ND				1.0E-01	I	Low	Mortality	1000
Di-n-octyl phthalate	ND				2.0E-02	H7	NA	Liver	1000
Dimethylphthalate	ND				1.0E+00	H3	NA	CNS & Gastrointestinal	NA
2,6-Dinitrotoluene	6.8E-01	I	B2		1.0E-03	H7	NA	CNS, Circulatory & Kidney	3000
Hexachlorobenzene	1.6E+00	I	B2		8.0E-04	I	Medium	Liver	100
Hexachloroethane	1.4E-02	I	C		1.0E-03	I	Medium	Kidney	1000
Naphthalene	ND				4.0E-02	N	NA	Circulatory & Lung	1000
Pesticides									
4,4'-DDT	3.4E-01	I	B2		5.0E-04	I	Medium	Liver	100
Endrin	ND				3.0E-04	I	Medium	Liver	100
Endrin aldehyde	ND				ND				
Endrin ketone	ND				ND				
Dioxins/Furans									
2,3,7,8-TCDD	1.5E+05	H7	B2		ND				
Metals									
Antimony	ND				4.0E-04	I	Low	Circulatory	1000
Arsenic	1.5E+00	I	A	Liver, Kidney & Lung	3.0E-04	I	Medium	Skin	3

Table 21

TOXICITY INFORMATION FOR
CLEANUP LEVEL CALCULATIONS

PASCO LANDFILL
PASCO, WASHINGTON

Hazardous Substance	*Carcinogenic Toxicity Data*				*Non-carcinogenic Toxicity Data*				
	Oral SF	Source	WOE	Tumor Type	Oral RfD	Source	Confidence Level	Target Organ/System or Critical Effect	UF/ MF
Barium	ND				7.0E-02	I	Medium	Circulatory	3
Beryllium	4.3E+00	I	B2		5.0E-03	I	Low	Musculoskeletal	100
Cadmium	ND				5.0E-04	I	High	Kidney	10
Calcium	ND				ND				
Chromium (III)	ND				1.0E+00	I	Low	Reproductive	100
Chromium (VI)	ND				5.0E-03	I	Low	Reproductive	500
Copper	ND				4.0E-02	D		Gastrointestinal	
Iron	ND				ND				
Lead	ND	I	B2		ND				
Magnesium	ND				ND				
Manganese	ND				1.4E-01	I	Medium	CNS	1
Mercury	ND				3.0E-04			CNS	
Nickel	ND				2.0E-02	I	Medium	Growth rate	300
Potassium	ND				ND				
Selenium	ND				NA	I	High	Skin	3
Sodium	ND				ND				
Silver	ND				5.0E-03	I	Low	Skin	3
Thallium	ND				7.0E-05	H1	NA	Liver & Circulatory	
Zinc	ND				3.0E-01	I	Medium	Circulatory	3

CNS - Central nervous system.
NA - Not available.
ND - No data.
RfD - Reference dose (mg/kg-day).
SF - Slope factor $(mg/kg\text{-}day)^{-1}$.
UF/MF - Uncertainty factor/modifying factor.
WOE - Weight-of-evidence.

Sources:
H1 - HEAST (USEPA, 1991); H3 - HEAST (USEPA, 1993); H7 - HEAST (USEPA, 1997)
I - IRIS (USEPA, 1997a).
N - National Center for Environmental Assessment (NCEA, 1997).
P - Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons (USEPA, 1993).
U - USEPA Headquarters (USEPA, 1997b).
D - USEPA Drinking Water Criteria.

Table 22

FINAL GROUNDWATER INDICATOR HAZARDOUS SUBSTANCES -
COMPARISON TO FINAL METHOD B LEVELS

PASCO LANDFILL
PASCO, WASHINGTON

Analyte	Maximum Concentration	Final Method B Level	Comment
Acetone	5.9	0.4	Exceeds
Benzene	0.049	0.002	Exceeds
Chromium (hexavalent)	0.65	0.08	Exceeds
1,2-Dichloroethane	0.083	0.0005	Exceeds
1,1-Dichloroethene	0.075	0.00007	Exceeds
1,2-Dichloroethene (cis)	2.6	0.04	Exceeds
1,2-Dichloroethene (trans)	0.012	0.05	
Tetrachloroethene	0.033	0.0008	Exceeds
Toluene	3.2	0.5	Exceeds
1,1,1-Trichloroethane	0.95	0.2	Exceeds
1,1,2-Trichloroethane	0.0036	0.0008	Exceeds
Trichloroethene	0.27	0.004	Exceeds
Vinyl chloride	0.028	0.00002	Exceeds

Concentrations in mg/L.

Maximum concentrations from Table 1.
Method B values presented in Table C-19 of Appendix C.

Chromium in solution is assumed to be hexavalent (at the direction of Ecology).

Table 23

FINAL SOIL INDICATOR HAZARDOUS SUBSTANCE -
COMPARISON TO FINAL METHOD C LEVELS FOR ACETONE

PASCO LANDFILL
PASCO, WASHINGTON

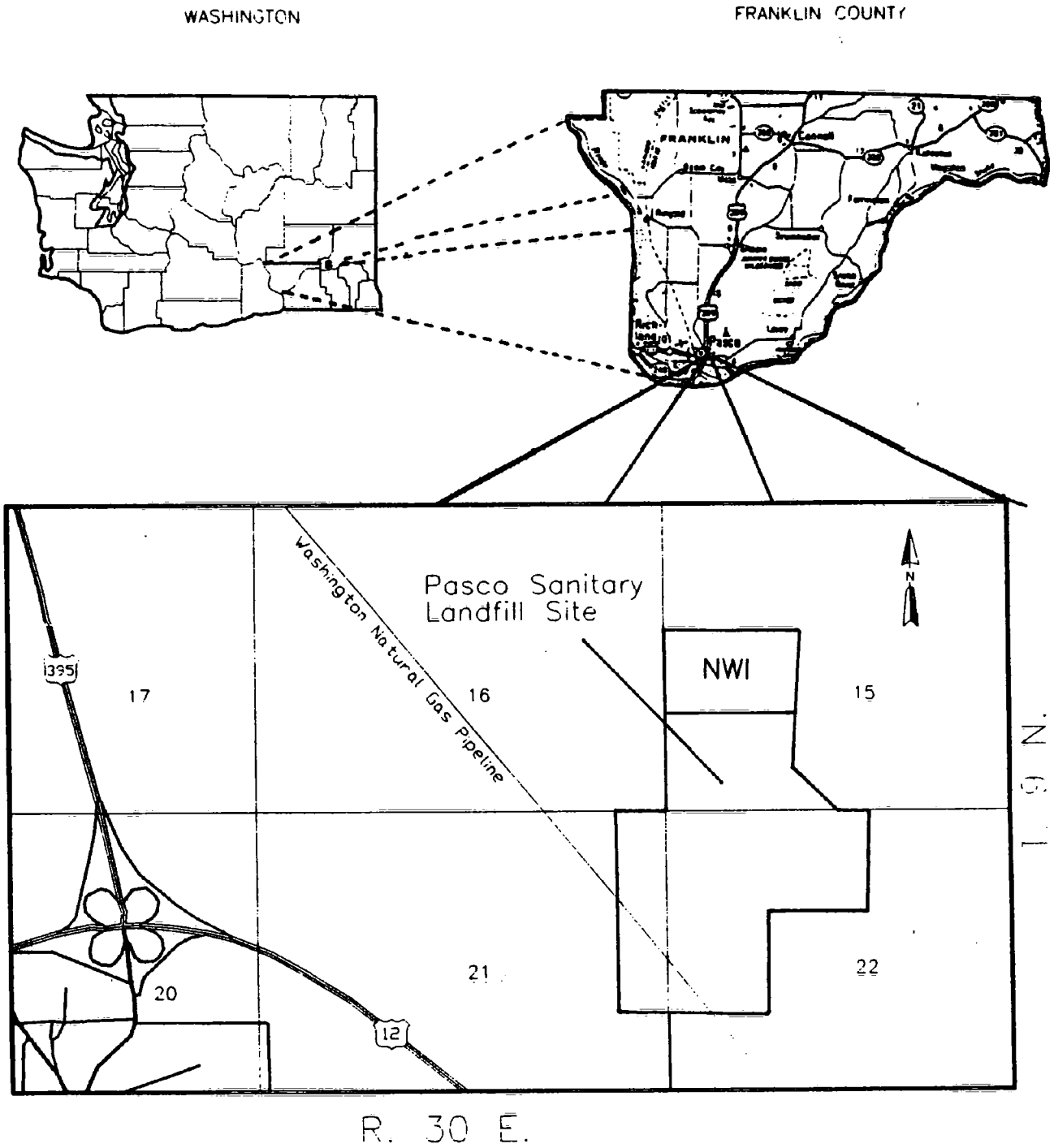
Zone/Area	Maximum Concentration	Method C Levels		
		Protection of Groundwater 80,310 ug/kg	Direct Contact 350,000,000 ug/kg	Protection of Air
SMA	ND	----	----	----
LSA	ND	----	----	----
Zone A/BT-2/Balefill	2,200	within	within	NA
Zone B	ND	----	----	NA
Zones C & D & BT-1	630,000	**exceeds**	within	NA
Zones E & TS-1/SL-1	400	within	within	NA
SL-2 & SL-3	1,500	within	within	NA
Not Immediately Adjacent	2,300	within	within	NA

Concentrations in ug/kg.
The Method C level for protection of air was not identified since acetone was not detected in the SMA or LSA.

Maximum concentrations from Tables 9-16.
Method C levels presented in Appendix D.

NA - Not applicable.
ND - Not detected.

FIGURES



Modified from U.S. Geological Survey Glade and Pasco, Washington quadrangles, photorevised 1992

Scale is variable

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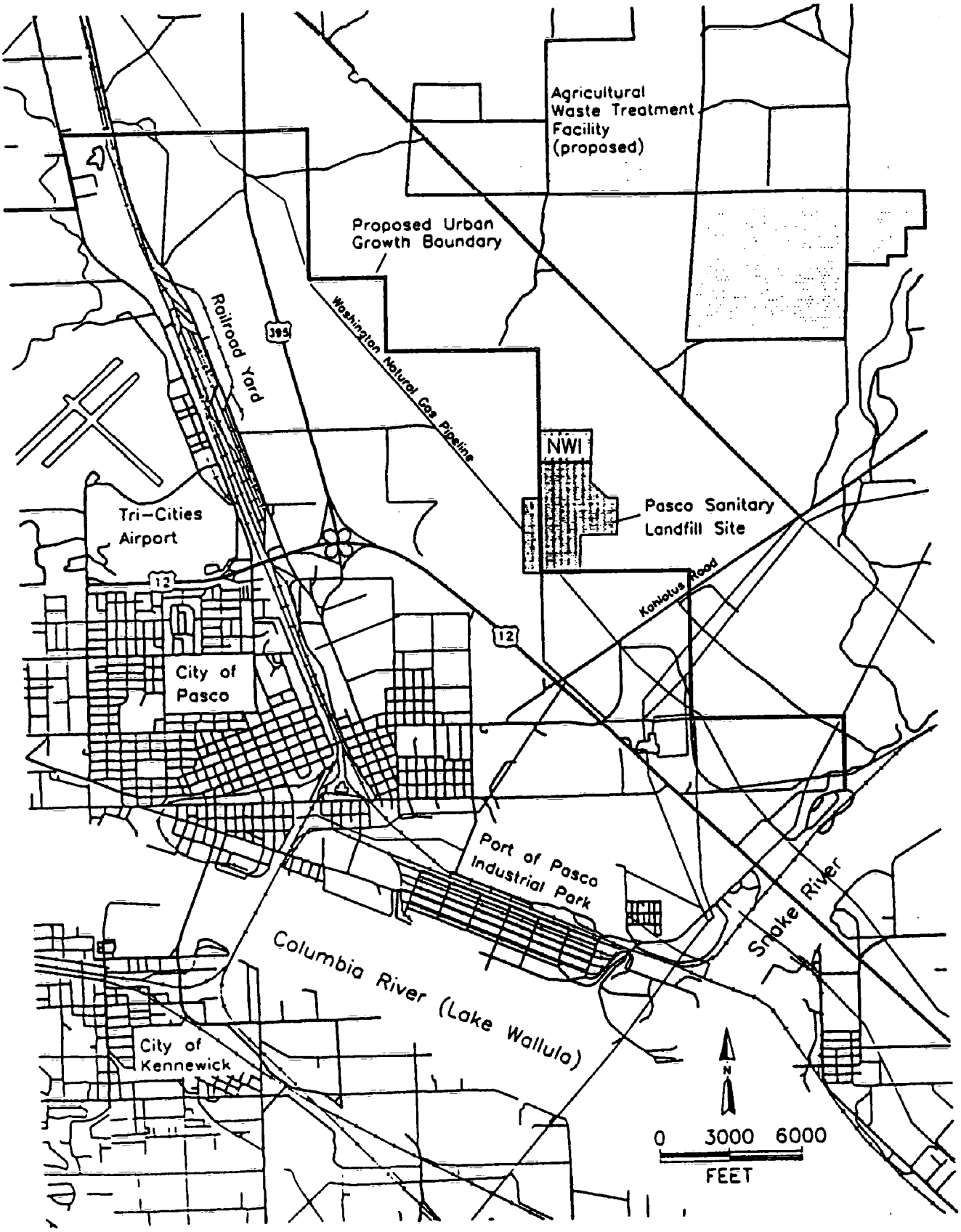
DR. _____ DATE _____
CH. _____ DATE _____
APP. _____ DATE _____

PHILIP SERVICES CORP.
Four Gateway Center
12th floor
Pittsburgh, PA 15222
phone: 412-765-3843
fax: 412-765-0905

TITLE PASCO LANDFILL - PASCO, WA
SITE LOCATION

PROJECT NO.	DRAWING NO.	REV.
16078	FIGURE 1	A



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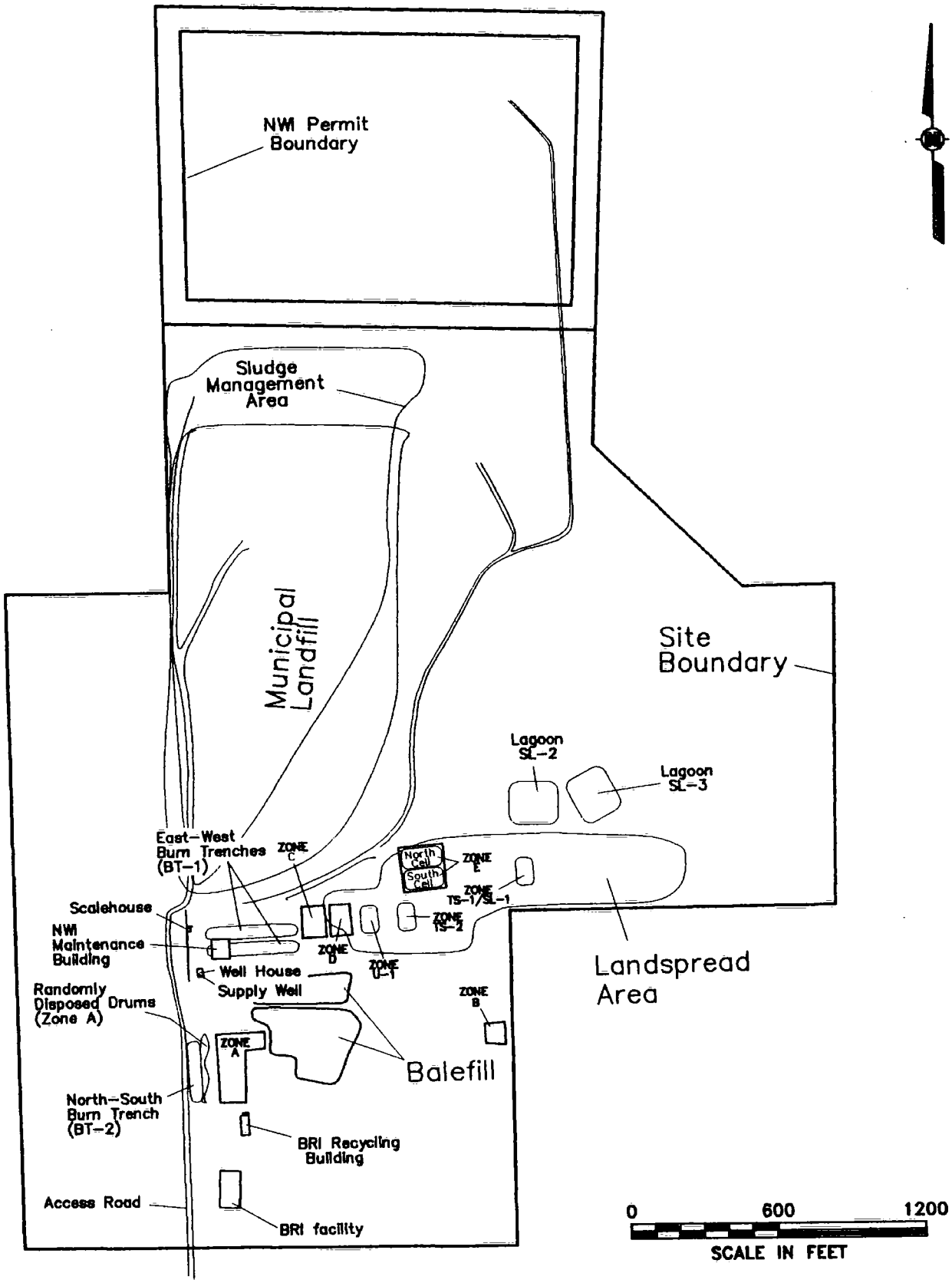
TITLE PASCO LANDFILL - PASCO, WA
SITE VICINITY

PROJECT NO.	DRAWING NO.	REV.
16078	FIGURE 2	A



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CH. _____ DATE _____
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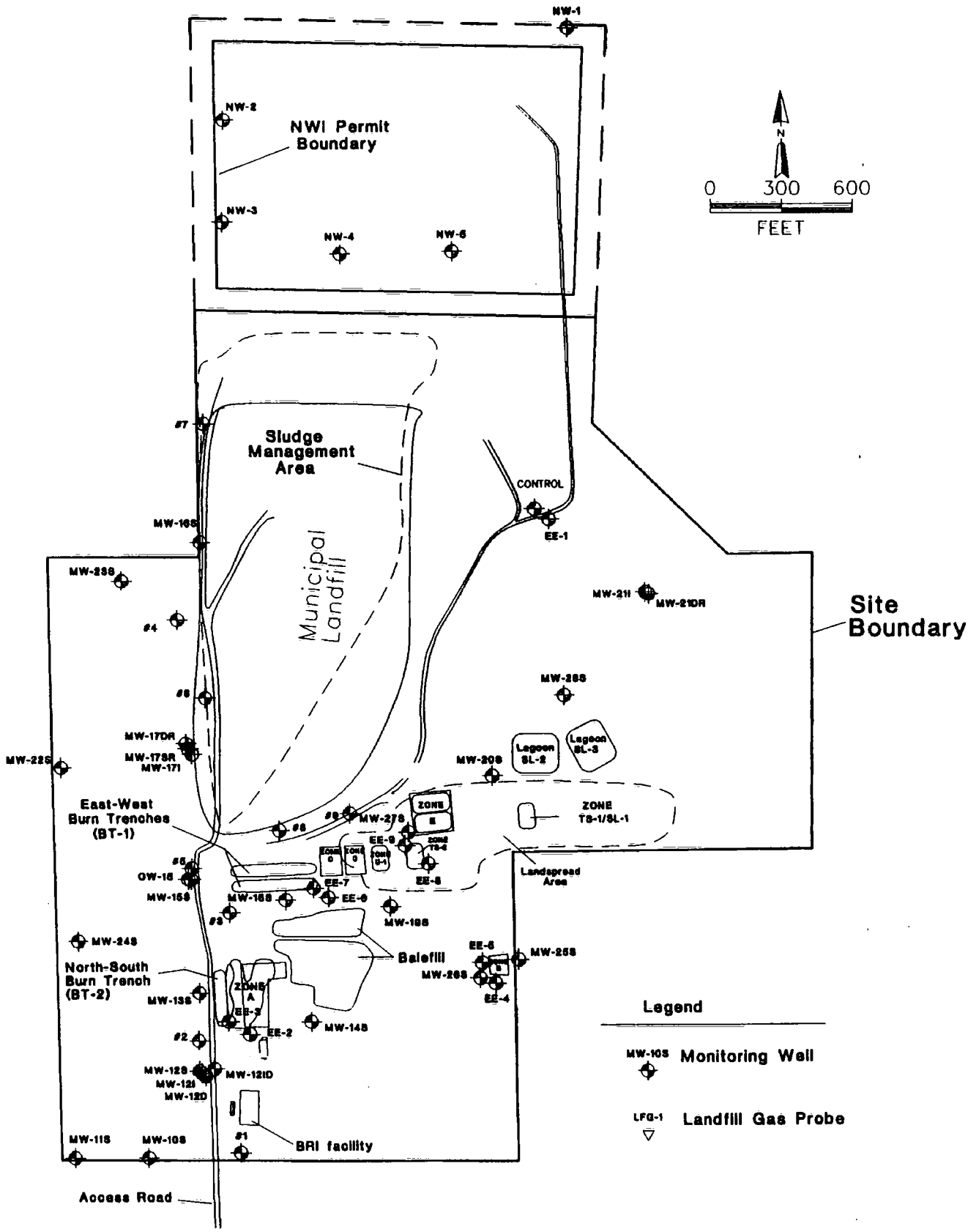
TITLE PASCO LANDFILL - PASCO, WA
SITE FEATURES

PROJECT NO.	DRAWING NO.	REV.
16078	FIGURE 3	A



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CH. _____ DATE _____
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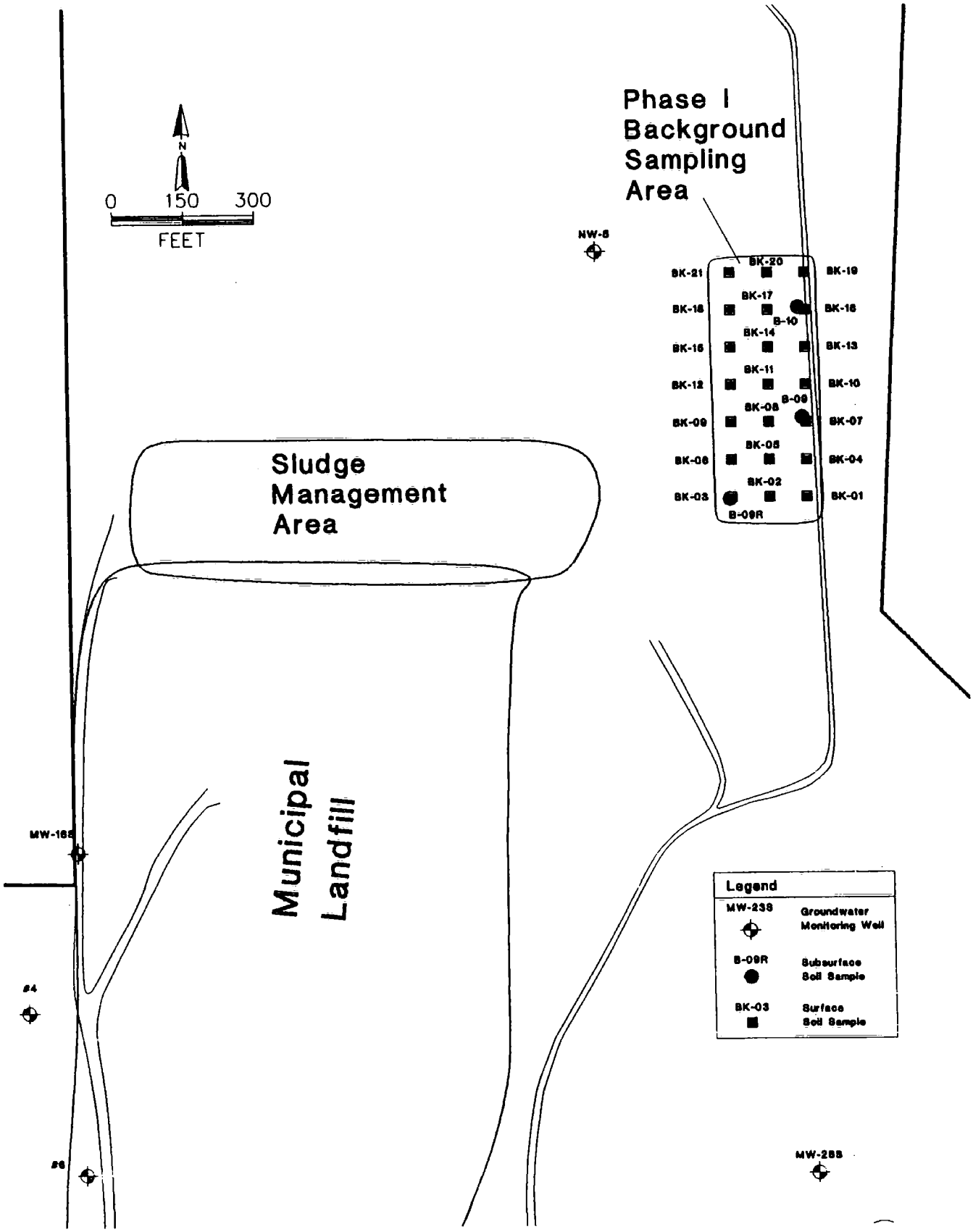
PHILIP SERVICES CORP.

Four Gateway Center
12th floor
Pittsburgh, PA 15222
phone: 412-765-3643
fax: 412-765-0905

TITLE PASCO LANDFILL - PASCO, WA
ON-SITE GROUNDWATER MONITORING WELLS

PROJECT NO.	DRAWING NO.	REV.
16078	FIGURE 4	A



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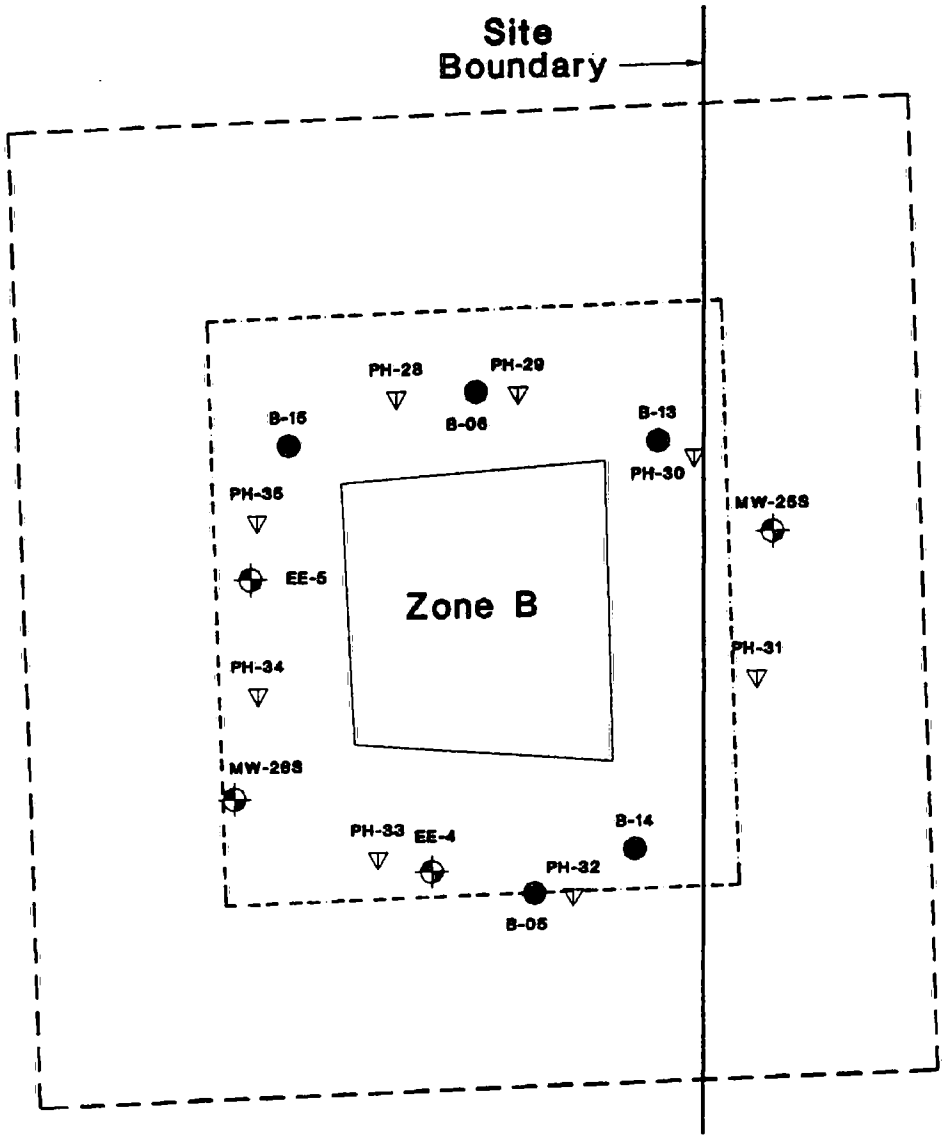
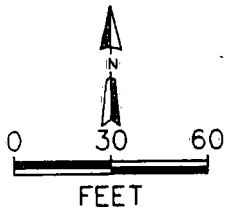
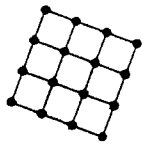
TITLE PASCO LANDFILL - PASCO, WA
PHASE 1
BACKGROUND SOIL
SAMPLING LOCATIONS

PROJECT NO.	DRAWING NO.	REV.
16078	FIGURE 5	A





Background Sampling Grid



Legend

- Phase I RI Geophysical Survey Area
- Phase II RI Geophysical Survey Area
- Exploratory Trench
- MW-20S — Monitoring Well
- B-07 — Soil Boring
- PH-31 — Soil-Gas Probehole

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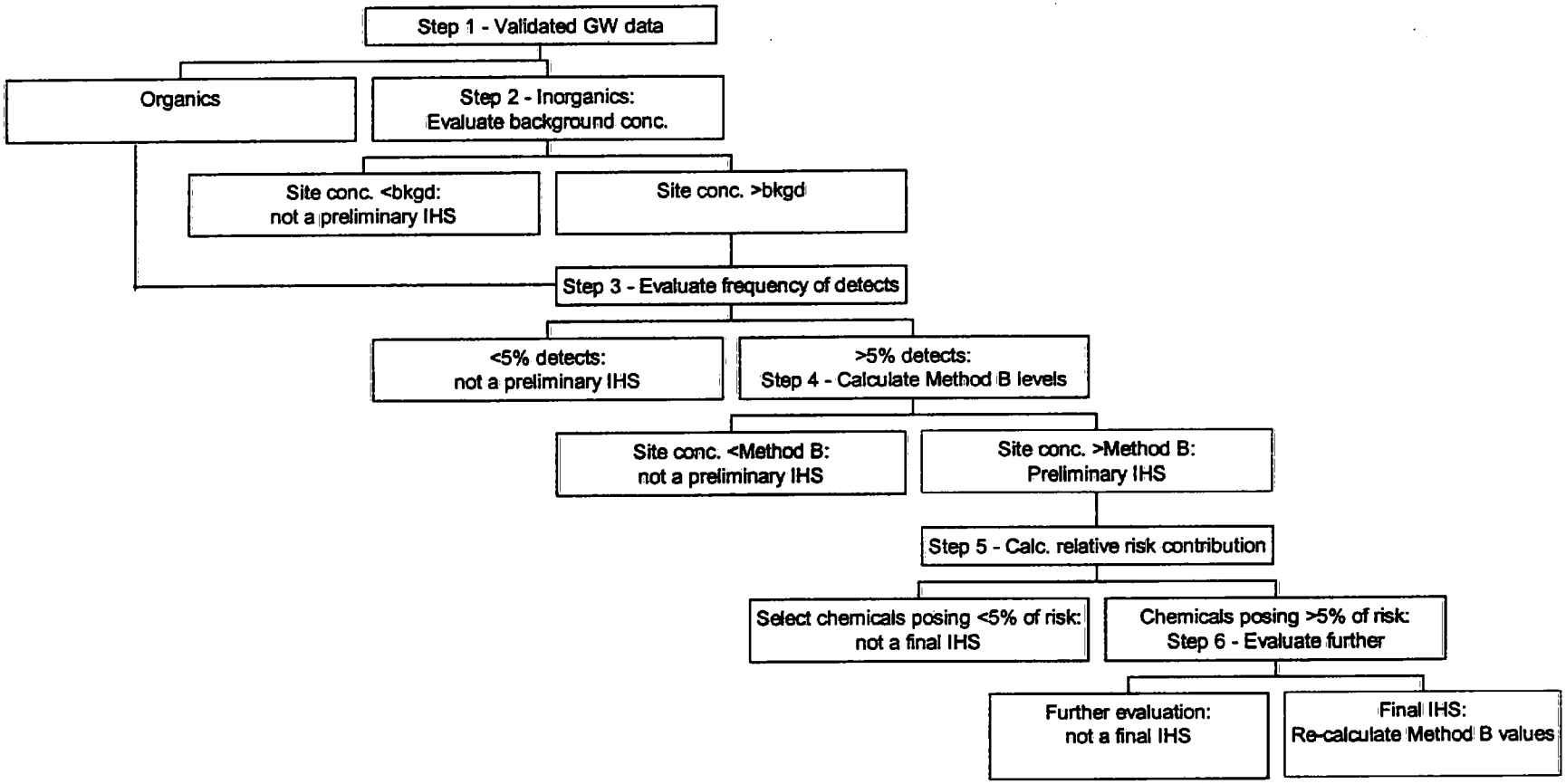
TITLE: PASCO LANDFILL - PASCO, WA
PHASE 2
BACKGROUND SOIL
SAMPLING LOCATIONS

PROJECT NO.	DRAWING NO.	REV.
16078	FIGURE 6	A



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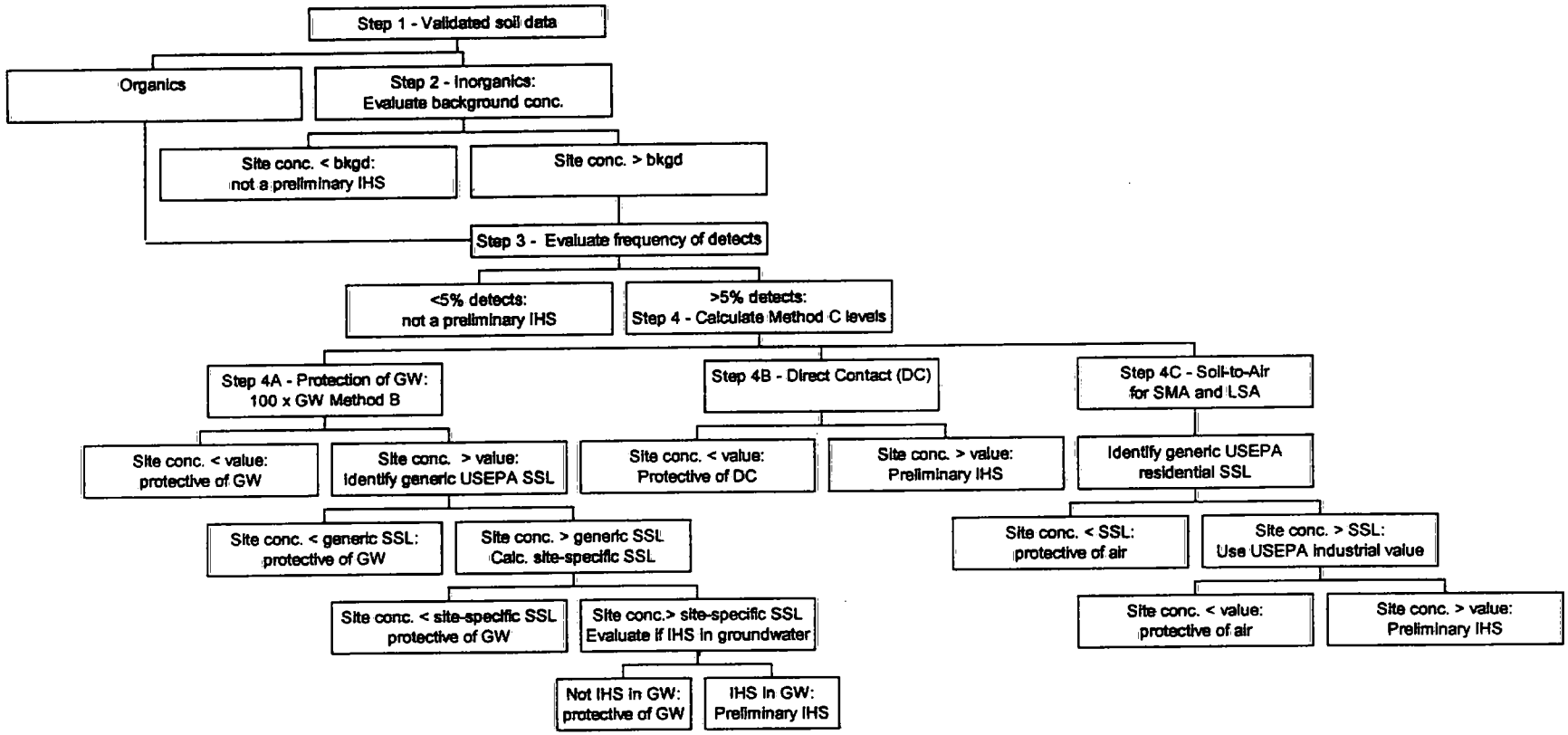
TITLE PASCO LANDFILL - PASCO, WA
SELECTION OF IHSs IN GROUNDWATER

PROJECT NO.	DRAWING NO.	REV.
16078	FIGURE 7	A



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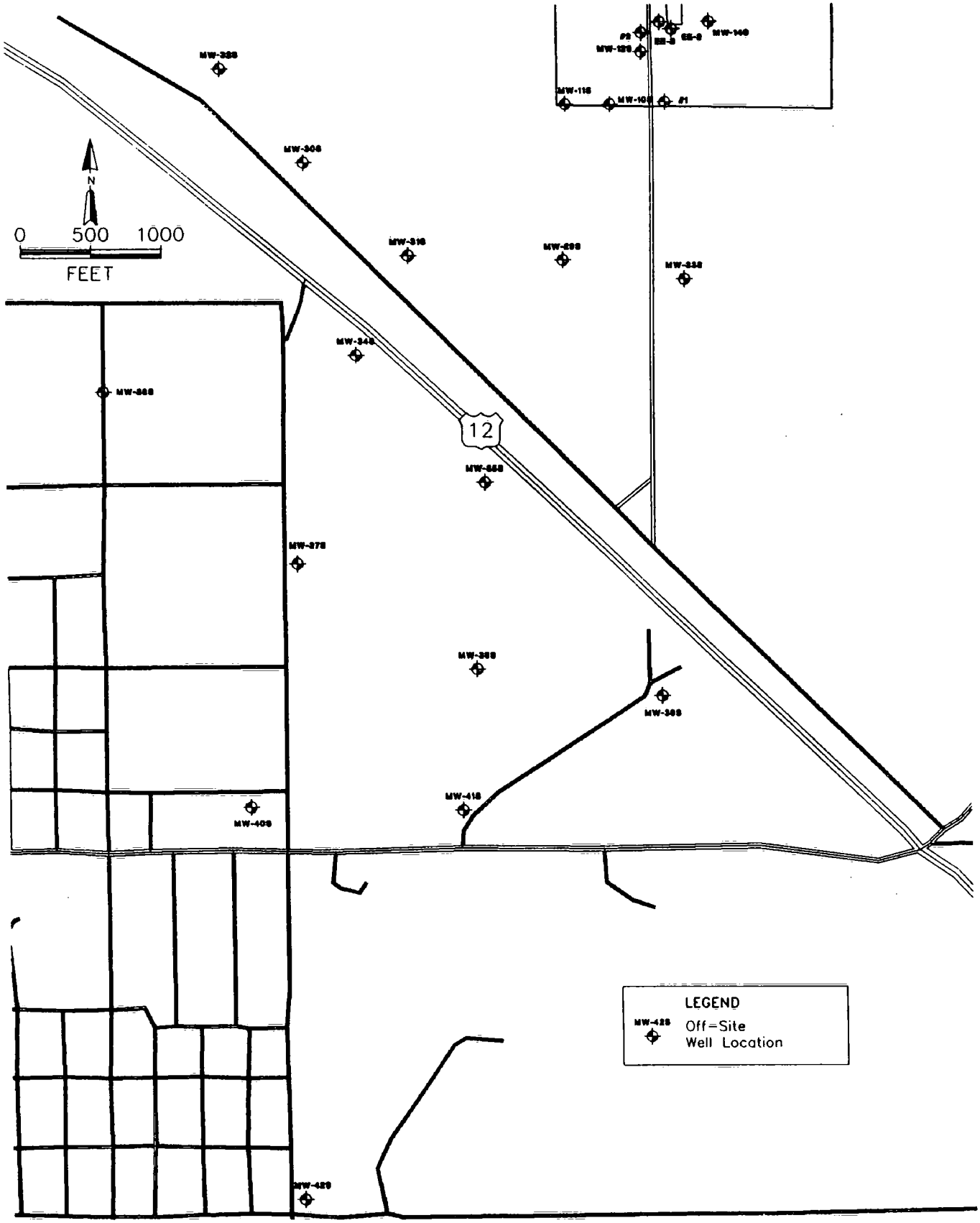
phone: 412-765-3643
fax: 412-765-0905

TITLE PASCO LANDFILL - PASCO, WA
SELECTION OF IHSs IN SOIL

PROJECT NO.	DRAWING NO.	REV.
16078	FIGURE 8	A



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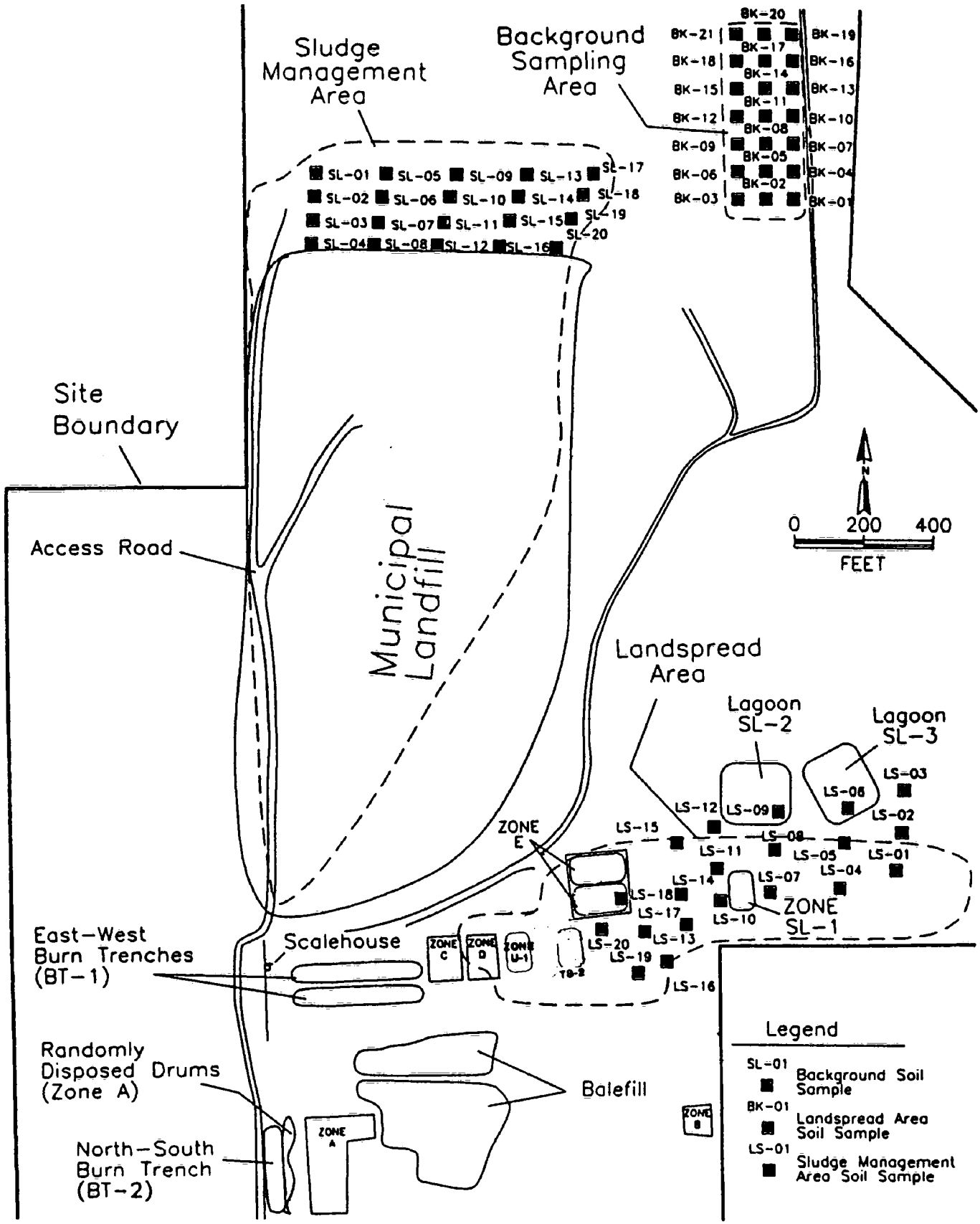
fax: 412-765-0905

TITLE PASCO LANDFILL - PASCO, WA
OFF-SITE GROUNDWATER
MONITORING WELLS

PROJECT NO.	DRAWING NO.	REV.
16078	FIGURE 9	A



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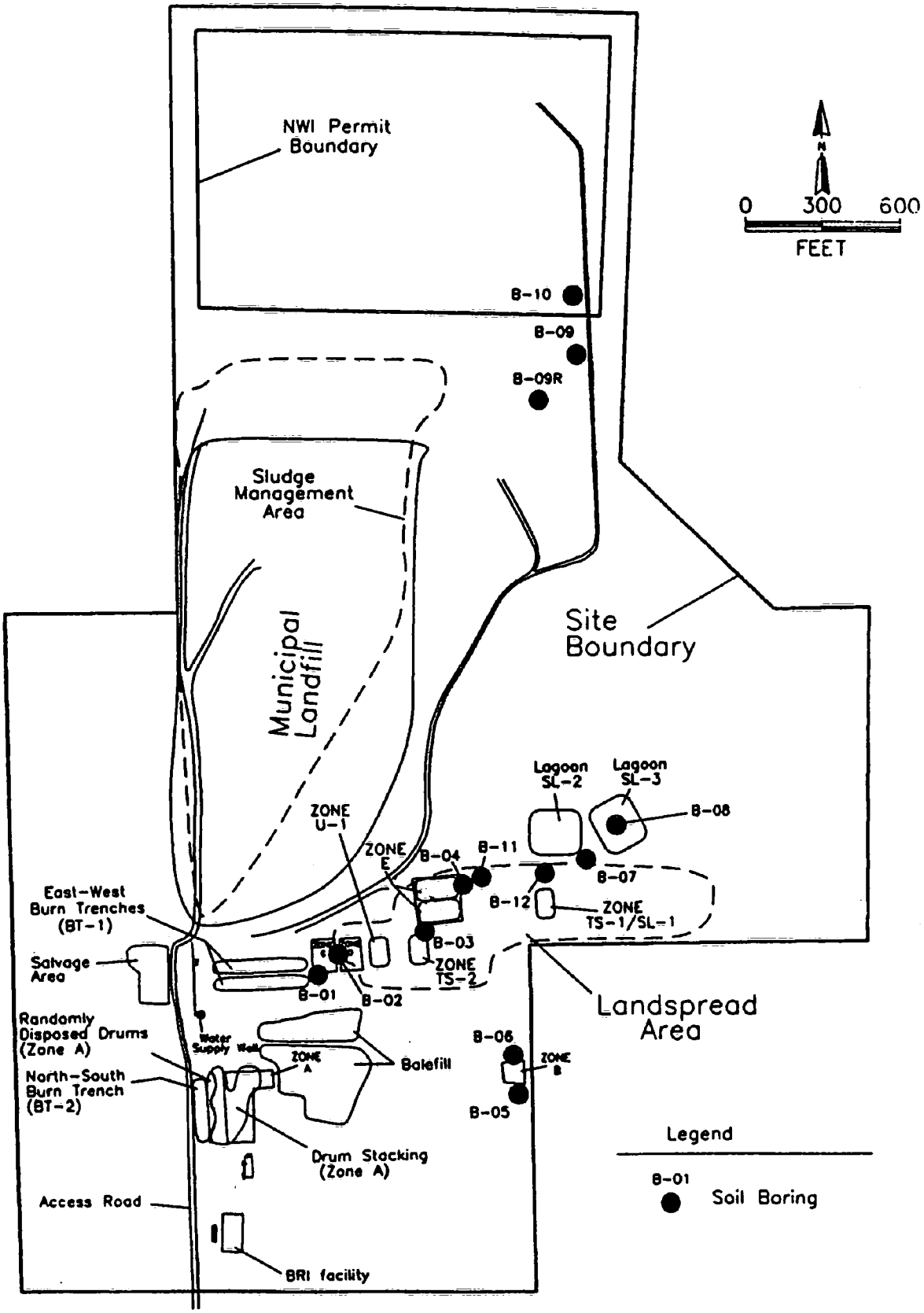
TITLE PASCO LANDFILL - PASCO, WA
SURFACE SOIL SAMPLING LOCATIONS
PHASE 1 R1

PROJECT NO.	DRAWING NO.	REV.
16078	FIGURE 10	A



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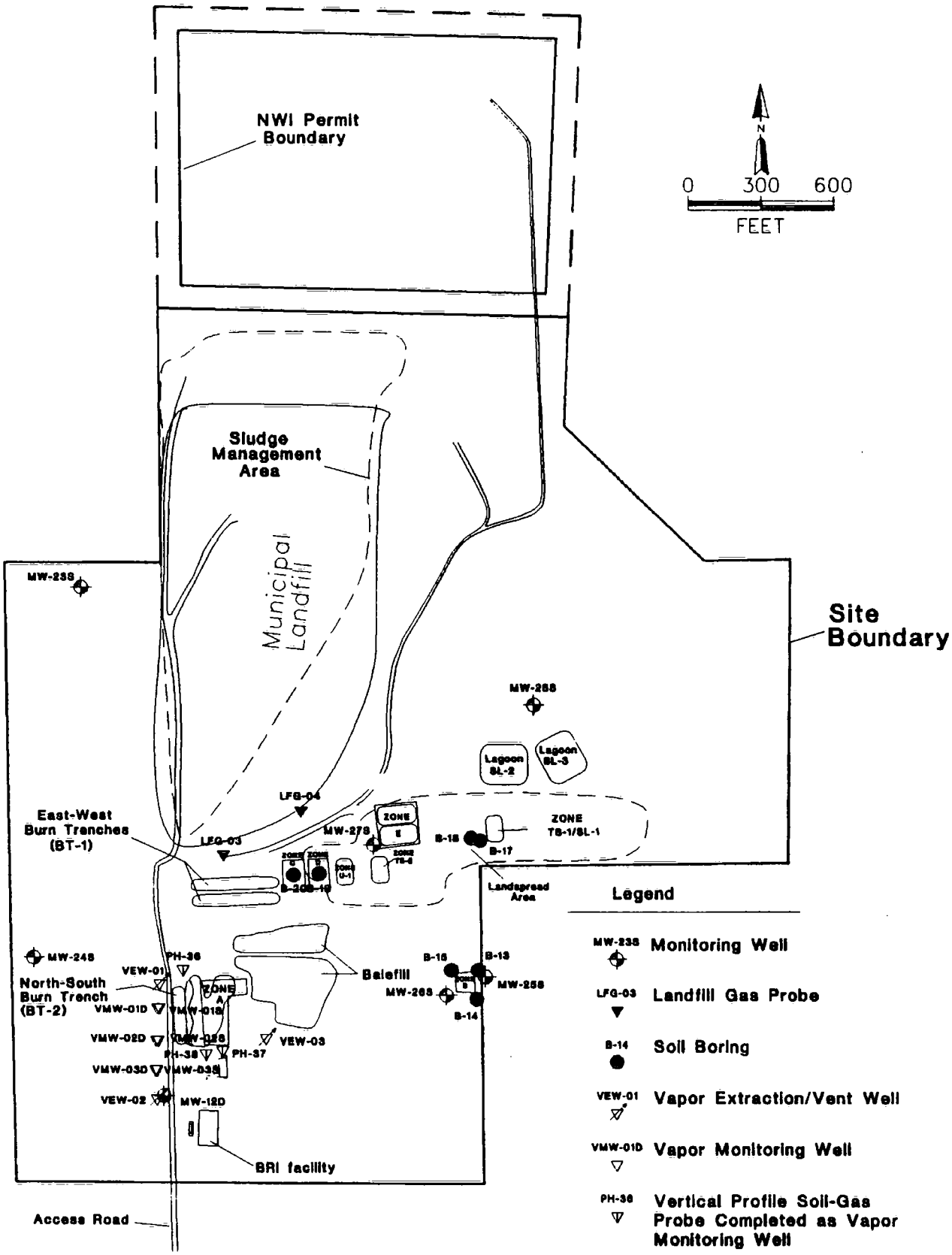
TITLE PASCO LANDFILL - PASCO, WA
SOIL BORING LOCATIONS
PHASE 1 R1

PROJECT NO.	DRAWING NO.	REV.
16078	FIGURE 11	A



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CH. _____ DATE _____
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Pittsburgh, PA 15222
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fax: 412-765-0905

TITLE PASCO LANDFILL - PASCO, WA
MONITORING WELLS AND SOIL BORINGS
PHASE 2 R1

PROJECT NO.	DRAWING NO.	REV.
16078	FIGURE 12	A

A

APPENDIX A

DATA VALIDATION REPORTS AND SUMMARY TABLES

DATA VALIDATION REPORTS IN APPENDIX

Report Date	Media / Data Set No.	Sample Collection Data
Mar 05, 1993	Soil / 1B	Oct 26-31, 1992
Mar 05, 1993	Soil / 2A	Oct 26-31, 1992
Mar 05, 1993	Soil / 2D	Oct 26-31, 1992
Mar 05, 1993	Soil / 2C	Dec 02, 1992
Mar 05, 1993	Soil / 3A	Dec 05, 1992
Mar 05, 1993	Soil / 3C	Dec 05, 1992
Mar 05, 1993	Soil / 3D	Dec 05, 1992
Mar 05, 1993	Subsurface soil / 5A	Jan 23-24, 1993
Mar 05, 1993	Water / 1C	Jan 26 and Feb 11, 1993
Mar 16, 1993	Water / 6E	Jan 26, 1993
Mar 19, 1993	Soil / 5B	Oct 26-31, 1992
Mar 19, 1993	Soil / 2B	Dec 02-03, 1992
Mar 19, 1993	Soil / 1A	Dec 02-08, 1992
Mar 19, 1993	Water / 4A-4E	Dec 08 and Dec 12, 1992
Mar 19, 1993	Water / 6A-6E2	Dec 08, 1992 and Jan 26, 1993
Mar 19, 1993	Soil / 5C	Jan 04, 1993
Mar 19, 1993	Soil and water / 5A.2	Jan 26-27, 1993
Mar 22, 1993	Soil / 3B	Dec 05, 1992
Mar 30, 1993	Soil / 8B	Jan 22-24, 1993
Mar 30, 1993	Soil / 8D	Jan 22-24, 1993
Mar 30, 1993	Water / 8F	Feb 10-11, 1993
Apr 02, 1993	Soil / 7A-7D	Dec 20, 1992-Jan 05, 1993
Apr 02, 1993	Soil / 8C	Jan 22-24, 1993
Apr 02, 1993	Soil / 7E	Feb 03, 1993
Apr 13, 1993	Water / 10A-10F	Feb 11, 1993
Apr 19, 1993	Water / 12A-12E	Jan 25-26, 1993
Apr 21, 1993	Soil / 9A-9D	Jan 10-21, 1993
Apr 23, 1993	Soil / 8E	Jan 22-24, 1993
Apr 23, 1993	Water / 13A-13E	Feb 02, 1993
May 07, 1993	Water / 15A-15F	Feb 09, 1993
May 07, 1993	Water / 11A-11F	Feb 10, 1993
May 07, 1993	Water / 14A-14E	Feb 12, 1993
May 07, 1993	Soil gas / 17A	Mar 22, 1993
May 19, 1993	Water / 16A-16E	Feb 02-04, 1993
Jun 07, 1993	Soil / 8A	Jan 22-24, 1993

DATA VALIDATION REPORTS IN APPENDIX
(Continued)

Report Date	Media	Sample Collection Date
Sep 09, 1993	Groundwater	Dec 16, 1992-Feb 13, 1993
Sep 09, 1993	Subsurface soil	Dec 06, 1992-Feb 04, 1993
Sep 09, 1993	Surface soil	Dec 02-05, 1992
Sep 09, 1993	Landfill gas	Mar 3, 1993
Sep 09, 1993	Soil gas	Oct 26-31, 1992
Jul 17, 1995	Soil	Apr 1995
Jul 17, 1995	Soil	Apr 1995
Jul 17, 1995	Soil	Apr 1995
Jul 17, 1995	Soil	Apr 1995
Jul 17, 1995	Soil	May 01, 1995
Jul 17, 1995	Soil	May 01, 1995
Jul 17, 1995	Soil and groundwater	May 02, 05, 06, 1995
Jul 17, 1995	Air	May 04, 1995
Jul 17, 1995	Water	May 09,1995
Jul 17, 1995	Water	May 10, 1995
Aug 31, 1995	Soil	May 30, 1995
Sep 05, 1995	Soil	May 30, 1995
Sep 13, 1995	Soil and water	Apr 27-May 10, 1995
Oct 22, 1996	Groundwater	Jul 24-30, 1996
Feb 26, 1997	Groundwater	Sep 17-21, 1996
Feb 26, 1997	Groundwater	Dec 05-11, 1996
May 09, 1997	Groundwater	Feb 26-Mar 01, 1997
May 28, 1997	Drinking water	Mar 17, 1997
June 15, 1998	Groundwater	Feb 1993
September 2, 1998	Groundwater	Dec 06, 1996

Summary of Soil Data
Rejected through Data Validation
Pasco Landfill

Boring Number	Sample Date	Sample Depth	Analyte	Reported Value (ng/kg)
BKG-01	4/27/95	0.500	1,2,3,4,6,7,8-HpCDF	< 0.21 R
BKG-01	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.29 R
BKG-01	4/27/95	0.500	HpCDFs (total)	< 0.2 R
BKG-01	4/27/95	0.500	HxCDFs (total)	< 0.29 R
BKG-01	4/27/95	0.500	OCDF	< 0.25 R
BKG-02	4/27/95	0.500	1,2,3,4,6,7,8-HpCDF	< 0.21 R
BKG-02	4/27/95	0.500	1,2,3,4,7,8,9-HpCDD	< 0.22 R
BKG-02	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.29 R
BKG-02	4/27/95	0.500	HpCDDs (total)	< 0.22 R
BKG-02	4/27/95	0.500	HpCDFs (total)	< 0.2 R
BKG-02	4/27/95	0.500	HxCDFs (total)	< 0.29 R
BKG-02	4/27/95	0.500	OCDD	< 0.79 R
BKG-02	4/27/95	0.500	OCDF	< 0.25 R
BKG-03	4/27/95	0.500	1,2,3,4,7,8,9-HpCDD	< 0.22 R
BKG-03	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.19 R
BKG-03	4/27/95	0.500	HpCDDs (total)	< 0.22 R
BKG-03	4/27/95	0.500	HxCDFs (total)	< 0.29 R
BKG-03	4/27/95	0.500	OCDD	< 0.79 R
BKG-03	4/27/95	0.500	OCDF	< 0.11 R
BKG-04	4/27/95	0.500	1,2,3,4,6,7,8-HpCDF	< 0.21 R
BKG-04	4/27/95	0.500	1,2,3,4,7,8,9-HpCDD	< 0.22 R
BKG-04	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.29 R
BKG-04	4/27/95	0.500	HpCDFs (total)	< 0.2 R
BKG-04	4/27/95	0.500	HxCDFs (total)	< 0.29 R
BKG-04	4/27/95	0.500	OCDF	< 0.25 R
BKG-05	4/27/95	0.500	1,2,3,4,6,7,8-HpCDF	< 0.21 R
BKG-05	4/27/95	0.500	1,2,3,4,7,8,9-HpCDD	< 0.22 R
BKG-05	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.29 R
BKG-05	4/27/95	0.500	HpCDFs (total)	< 0.2 R
BKG-05	4/27/95	0.500	HxCDFs (total)	< 0.29 R
BKG-05	4/27/95	0.500	OCDF	< 0.25 R
BKG-06	4/27/95	0.500	1,2,3,4,7,8,9-HpCDF	< 0.22 R
BKG-06	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.29 R
BKG-06	4/27/95	0.500	OCDF	< 0.25 R
BKG-07	4/27/95	0.500	1,2,3,4,7,8,9-HpCDD	< 0.22 R
BKG-07	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.29 R
BKG-07	4/27/95	0.500	HpCDDs (total)	< 0.22 R
BKG-07	4/27/95	0.500	HxCDFs (total)	< 0.29 R
BKG-07	4/27/95	0.500	OCDD	< 0.79 R
BKG-07	4/27/95	0.500	OCDF	< 0.23 R
BKG-08	4/27/95	0.500	1,2,3,4,6,7,8-HpCDF	< 0.21 R
BKG-08	4/27/95	0.500	1,2,3,4,7,8,9-HpCDD	< 0.22 R
BKG-08	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.29 R
BKG-08	4/27/95	0.500	HpCDFs (total)	< 0.2 R

Summary of Soil Data
Rejected through Data Validation
Pasco Landfill

Boring Number	Sample Date	Sample Depth	Analyte	Reported Value (ng/kg)
BKG-08	4/27/95	0.500	HxCDFs (total)	< 0.29 R
BKG-08	4/27/95	0.500	OCDF	< 0.25 R
BKG-09	4/27/95	0.500	1,2,3,4,6,7,8-HpCDF	< 0.21 R
BKG-09	4/27/95	0.500	1,2,3,4,7,8,9-HpCDD	< 0.22 R
BKG-09	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.23 R
BKG-09	4/27/95	0.500	HpCDFs (total)	< 0.2 R
BKG-09	4/27/95	0.500	HxCDFs (total)	< 0.23 R
BKG-09	4/27/95	0.500	OCDF	< 0.25 R
BKG-10	4/27/95	0.500	1,2,3,4,7,8,9-HpCDF	< 0.22 R
BKG-10	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.29 R
BKG-10	4/27/95	0.500	OCDF	< 0.25 R
BKG-11	4/27/95	0.500	1,2,3,4,7,8,9-HpCDD	< 0.22 R
BKG-11	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.29 R
BKG-11	4/27/95	0.500	HpCDDs (total)	< 0.22 R
BKG-11	4/27/95	0.500	HxCDFs (total)	< 0.29 R
BKG-11	4/27/95	0.500	OCDD	< 0.79 R
BKG-12	4/27/95	0.500	1,2,3,4,7,8,9-HpCDD	< 0.22 R
BKG-12	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.29 R
BKG-12	4/27/95	0.500	HpCDDs (total)	< 0.22 R
BKG-12	4/27/95	0.500	HpCDFs (total)	< 0.2 R
BKG-12	4/27/95	0.500	HxCDFs (total)	< 0.29 R
BKG-12	4/27/95	0.500	OCDF	< 0.25 R
BKG-13	4/27/95	0.500	1,2,3,4,6,7,8-HpCDF	< 0.21 R
BKG-13	4/27/95	0.500	1,2,3,4,7,8,9-HpCDD	< 0.22 R
BKG-13	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.29 R
BKG-13	4/27/95	0.500	HpCDFs (total)	< 0.2 R
BKG-13	4/27/95	0.500	HxCDFs (total)	< 0.29 R
BKG-13	4/27/95	0.500	OCDD	< 0.79 R
BKG-13	4/27/95	0.500	OCDF	< 0.25 R
BKG-14	4/27/95	0.500	1,2,3,4,7,8,9-HpCDF	< 0.22 R
BKG-14	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.29 R
BKG-14	4/27/95	0.500	OCDF	< 0.25 R
BKG-15	4/27/95	0.500	1,2,3,4,6,7,8-HpCDF	< 0.12 R
BKG-15	4/27/95	0.500	1,2,3,4,7,8,9-HpCDD	< 0.22 R
BKG-15	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.23 R
BKG-15	4/27/95	0.500	HpCDDs (total)	< 0.22 R
BKG-15	4/27/95	0.500	HpCDFs (total)	< 0.2 R
BKG-15	4/27/95	0.500	HxCDFs (total)	< 0.23 R
BKG-15	4/27/95	0.500	OCDD	< 0.79 R
BKG-15	4/27/95	0.500	OCDF	< 0.21 R
BKG-16	4/27/95	0.500	1,2,3,4,6,7,8-HpCDF	< 0.21 R
BKG-16	4/27/95	0.500	1,2,3,4,7,8,9-HpCDD	< 0.22 R
BKG-16	4/27/95	0.500	2,3,4,6,7,8-HxCDF	< 0.29 R
BKG-16	4/27/95	0.500	HpCDDs (total)	< 0.22 R

Summary of Soil Data
Rejected through Data Validation
Pasco Landfill

Boring Number	Sample Date	Sample Depth	Analyte	Reported Value (ng/kg)
BKG-16	4/27/95	0.500	HpCDFs (total)	< 0.2 R
BKG-16	4/27/95	0.500	HxCDFs (total)	< 0.29 R
BKG-16	4/27/95	0.500	OCDD	< 0.79 R
BKG-16	4/27/95	0.500	OCDF	< 0.25 R
B-13	5/1/95	10.000	2,3,4,6,7,8-HxCDF	< 0.29 R
B-13	5/1/95	20.000	2,3,4,6,7,8-HxCDF	< 0.25 R
B-13	5/1/95	20.000	HxCDFs (total)	< 0.29 R
B-13	5/1/95	10.000	HxCDFs (total)	< 0.29 R
B-14	5/1/95	20.000	2,3,4,6,7,8-HxCDF	< 0.29 R
B-14	5/1/95	10.000	2,3,4,6,7,8-HxCDF	< 0.28 R
B-14	5/1/95	20.000	HxCDFs (total)	< 0.29 R
B-14	5/1/95	10.000	HxCDFs (total)	< 0.28 R
B-15	5/1/95	20.000	2,3,4,6,7,8-HxCDF	< 0.26 R
B-15	5/1/95	10.000	2,3,4,6,7,8-HxCDF	< 0.29 R
B-15	5/1/95	10.000	HxCDFs (total)	< 0.29 R
B-15	5/1/95	20.000	HxCDFs (total)	< 0.26 R
MW-25S	5/1/95	10.000	2,3,4,6,7,8-HxCDF	< 0.29 R
MW-25S	5/1/95	40.000	2,3,4,6,7,8-HxCDF	< 0.22 R
MW-25S	5/1/95	20.000	2,3,4,6,7,8-HxCDF	< 0.29 R
MW-25S	5/1/95	30.000	2,3,4,6,7,8-HxCDF	< 0.28 R
MW-25S	5/1/95	10.000	HxCDFs (total)	< 0.29 R
MW-25S	5/1/95	40.000	HxCDFs (total)	< 0.29 R
MW-25S	5/1/95	30.000	HxCDFs (total)	< 0.28 R
MW-25S	5/1/95	40.000	OCDD	< 0.79 R
MW-26S	5/1/95	15.500	2,3,4,6,7,8-HxCDF	< 0.29 R
MW-26S	5/1/95	5.000	2,3,4,6,7,8-HxCDF	< 0.29 R
MW-26S	5/1/95	15.500	HxCDFs (total)	< 0.29 R

R = Data rejected by validator. Low surrogate recovery

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Well Number	Sample Date	CAS Number	Analyte	Reported Value
EE-2	05/31/95	78-93-3	2-Butanone	< 0.1 R
EE-2	05/31/95	95-48-7	2-Methylphenol	< 0.47 R
EE-2	05/31/95	95-48-7	2-Methylphenol	< 0.47 R
EE-2	05/31/95	95-48-7	2-Methylphenol	< 0.47 R
EE-2	05/31/95	95-48-7	2-Methylphenol	< 0.5 R
EE-2	05/31/95	95-48-7	2-Methylphenol	< 0.51 R
EE-2	05/31/95	108-39-4	3-Methylphenol	< 0.47 R
EE-2	05/31/95	108-39-4	3-Methylphenol	< 0.47 R
EE-2	05/31/95	108-39-4	3-Methylphenol	< 0.47 R
EE-2	05/31/95	108-39-4	3-Methylphenol	< 0.5 R
EE-2	05/31/95	108-39-4	3-Methylphenol	< 0.51 R
EE-2	05/31/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
EE-2	05/31/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
EE-2	05/31/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
EE-2	05/31/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
EE-2	05/31/95	108-95-2	Phenol	< 0.47 R
EE-2	05/31/95	108-95-2	Phenol	< 0.47 R
EE-2	05/31/95	108-95-2	Phenol	< 0.47 R
EE-2	05/31/95	108-95-2	Phenol	< 0.5 R
EE-2	05/31/95	108-95-2	Phenol	< 0.51 R
MW-13S	05/31/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-13S	05/31/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-13S	05/31/95	107-13-1	Acrylonitrile	< 0.1 R
MW-20S	05/31/95	96-18-4	1,2,3-Trichloropropane	< 0.2 R
MW-20S	05/31/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.2 R
MW-20S	05/31/95	108-10-1	4-Methyl-2-pentanone	< 0.2 R
MW-20S	05/31/95	75-00-3	Chloroethane	< 0.2 R
MW-25S	05/31/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-25S	05/31/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-25S	05/31/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-25S	05/31/95	107-13-1	Acrylonitrile	< 0.1 R
MW-25S	05/31/95	118-74-1	Hexachlorobenzene	< 0.092 R
MW-28S	05/31/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-28S	05/31/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-28S	05/31/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-28S	05/31/95	107-13-1	Acrylonitrile	< 0.1 R
MW-28S	05/31/95	118-74-1	Hexachlorobenzene	< 0.1 R
#4	06/01/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
#4	06/01/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
#4	06/01/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
#4	06/01/95	107-13-1	Acrylonitrile	< 0.1 R
#4	06/01/95	75-00-3	Chloroethane	< 0.1 R
#5	06/01/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
#5	06/01/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
#5	06/01/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R

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Well Number	Sample Date	CAS Number	Analyte	Reported Value
#5	06/01/95	107-13-1	Acrylonitrile	< 0.1 R
#5	06/01/95	65-85-0	Benzoic acid	< 0.47 R
#5	06/01/95	118-74-1	Hexachlorobenzene	< 0.093 R
#6	06/01/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
#6	06/01/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
#6	06/01/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
#6	06/01/95	107-13-1	Acrylonitrile	< 0.1 R
#6	06/01/95	75-00-3	Chloroethane	< 0.1 R
MW-16S	06/01/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-16S	06/01/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-16S	06/01/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-16S	06/01/95	107-13-1	Acrylonitrile	< 0.1 R
#1	06/02/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
#1	06/02/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
#1	06/02/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
#1	06/02/95	107-13-1	Acrylonitrile	< 0.1 R
#1	06/02/95	75-00-3	Chloroethane	< 0.1 R
#1	06/02/95	118-74-1	Hexachlorobenzene	< 0.096 R
#2	06/02/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
#2	06/02/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
#2	06/02/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
#2	06/02/95	107-13-1	Acrylonitrile	< 0.1 R
#2	06/02/95	118-74-1	Hexachlorobenzene	< 0.093 R
#8	06/02/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
#8	06/02/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
#8	06/02/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
#8	06/02/95	107-13-1	Acrylonitrile	< 0.1 R
#8	06/02/95	75-00-3	Chloroethane	< 0.1 R
MW-10S	06/02/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-10S	06/02/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-10S	06/02/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-10S	06/02/95	107-13-1	Acrylonitrile	< 0.1 R
MW-10S	06/02/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-11S	06/02/95	96-18-4	1,2,3-Trichloropropane	< 0.2 R
MW-11S	06/02/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.2 R
MW-11S	06/02/95	591-78-6	2-Hexanone	< 0.2 R
MW-11S	06/02/95	108-10-1	4-Methyl-2-pentanone	< 0.2 R
MW-11S	06/02/95	107-13-1	Acrylonitrile	< 0.2 R
MW-11S	06/02/95	75-25-2	Bromoform	< 0.2 R
MW-11S	06/02/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-17SR	06/02/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-17SR	06/02/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-17SR	06/02/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-17SR	06/02/95	107-13-1	Acrylonitrile	< 0.1 R
MW-18S	06/02/95	96-18-4	1,2,3-Trichloropropane	< 0.2 R

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MW-18S	06/02/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.2 R
MW-18S	06/02/95	591-78-6	2-Hexanone	< 0.2 R
MW-18S	06/02/95	108-10-1	4-Methyl-2-pentanone	< 0.2 R
MW-18S	06/02/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-19S	06/02/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-19S	06/02/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-19S	06/02/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-19S	06/02/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-22S	06/02/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-22S	06/02/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-22S	06/02/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-22S	06/02/95	107-13-1	Acrylonitrile	< 0.1 R
MW-23S	06/02/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-23S	06/02/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-23S	06/02/95	107-13-1	Acrylonitrile	< 0.1 R
MW-27S	06/02/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-27S	06/02/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-27S	06/02/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-27S	06/02/95	107-13-1	Acrylonitrile	< 0.1 R
MW-27S	06/02/95	118-74-1	Hexachlorobenzene	< 0.092 R
#9	06/03/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
#9	06/03/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
#9	06/03/95	78-93-3	2-Butanone	< 0.1 R
#9	06/03/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
#9	06/03/95	107-13-1	Acrylonitrile	< 0.1 R
#9	06/03/95	75-00-3	Chloroethane	< 0.1 R
EE-2	06/03/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
EE-2	06/03/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
EE-2	06/03/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
EE-2	06/03/95	118-74-1	Hexachlorobenzene	< 0.093 R
EE-3	06/03/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
EE-3	06/03/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
EE-3	06/03/95	78-93-3	2-Butanone	< 0.1 R
EE-3	06/03/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
EE-3	06/03/95	107-13-1	Acrylonitrile	< 0.1 R
EE-3	06/03/95	118-74-1	Hexachlorobenzene	< 0.47 R
EE-4	06/03/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
EE-4	06/03/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
EE-4	06/03/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
EE-4	06/03/95	107-13-1	Acrylonitrile	< 0.1 R
EE-4	06/03/95	75-00-3	Chloroethane	< 0.1 R
EE-4	06/03/95	118-74-1	Hexachlorobenzene	< 0.093 R
EE-5	06/03/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
EE-5	06/03/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
EE-5	06/03/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R

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Well Number	Sample Date	CAS Number	Analyte	Reported Value
EE-5	06/03/95	75-00-3	Chloroethane	< 0.1 R
EE-5	06/03/95	118-74-1	Hexachlorobenzene	< 0.093 R
EE-6	06/03/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
EE-6	06/03/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
EE-6	06/03/95	78-93-3	2-Butanone	< 0.1 R
EE-6	06/03/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
EE-6	06/03/95	107-13-1	Acrylonitrile	< 0.1 R
EE-6	06/03/95	75-00-3	Chloroethane	< 0.1 R
EE-6	06/03/95	118-74-1	Hexachlorobenzene	< 0.093 R
EE-7	06/03/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
EE-7	06/03/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
EE-7	06/03/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
EE-7	06/03/95	67-64-1	Acetone	< 0.1 R
EE-7	06/03/95	107-13-1	Acrylonitrile	< 0.1 R
EE-7	06/03/95	75-00-3	Chloroethane	< 0.1 R
EE-7	06/03/95	118-74-1	Hexachlorobenzene	< 0.096 R
EE-8	06/03/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
EE-8	06/03/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
EE-8	06/03/95	78-93-3	2-Butanone	< 0.1 R
EE-8	06/03/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
EE-8	06/03/95	107-13-1	Acrylonitrile	< 0.1 R
EE-8	06/03/95	75-00-3	Chloroethane	< 0.1 R
EE-8	06/03/95	118-74-1	Hexachlorobenzene	< 0.1 R
MW-12I	06/03/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-12I	06/03/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-12I	06/03/95	78-93-3	2-Butanone	< 0.1 R
MW-12I	06/03/95	67-64-1	Acetone	< 0.1 R
MW-12I	06/03/95	107-13-1	Acrylonitrile	< 0.1 R
MW-12I	06/03/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-12I	06/03/95	108-05-4	Vinyl acetate	< 0.1 R
MW-12S	06/03/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-12S	06/03/95	78-93-3	2-Butanone	< 0.1 R
MW-12S	06/03/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-12S	06/03/95	107-13-1	Acrylonitrile	< 0.1 R
MW-12S	06/03/95	75-00-3	Chloroethane	< 0.1 R
MW-12S	06/03/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-14S	06/03/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-14S	06/03/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-14S	06/03/95	78-93-3	2-Butanone	< 0.1 R
MW-14S	06/03/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-14S	06/03/95	107-13-1	Acrylonitrile	< 0.1 R
MW-14S	06/03/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-26S	06/03/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-26S	06/03/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-26S	06/03/95	78-93-3	2-Butanone	< 0.1 R

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MW-26S	06/03/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-26S	06/03/95	107-13-1	Acrylonitrile	< 0.1 R
MW-26S	06/03/95	75-00-3	Chloroethane	< 0.1 R
MW-26S	06/03/95	118-74-1	Hexachlorobenzene	< 0.1 R
NW-5	06/03/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
NW-5	06/03/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
NW-5	06/03/95	78-93-3	2-Butanone	< 0.1 R
NW-5	06/03/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
NW-5	06/03/95	107-13-1	Acrylonitrile	< 0.1 R
MW-15S	06/04/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-15S	06/04/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-15S	06/04/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-24S	06/04/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-24S	06/04/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-24S	06/04/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-24S	06/04/95	107-13-1	Acrylonitrile	< 0.1 R
MW-29S	06/04/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-29S	06/04/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-29S	06/04/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-29S	06/04/95	107-13-1	Acrylonitrile	< 0.1 R
MW-30S	06/04/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-30S	06/04/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-30S	06/04/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-30S	06/04/95	67-64-1	Acetone	< 0.1 R
MW-30S	06/04/95	107-13-1	Acrylonitrile	< 0.1 R
MW-30S	06/04/95	75-00-3	Chloroethane	< 0.1 R
MW-31S	06/04/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-31S	06/04/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-31S	06/04/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-31S	06/04/95	107-13-1	Acrylonitrile	< 0.1 R
MW-32S	06/04/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
MW-32S	06/04/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
MW-32S	06/04/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
MW-32S	06/04/95	107-13-1	Acrylonitrile	< 0.1 R
#3	06/05/95	96-18-4	1,2,3-Trichloropropane	< 0.1 R
#3	06/05/95	96-12-8	1,2-Dibromo-3-chloropropane	< 0.1 R
#3	06/05/95	108-10-1	4-Methyl-2-pentanone	< 0.1 R
#3	06/05/95	67-64-1	Acetone	< 0.1 R
#3	06/05/95	107-13-1	Acrylonitrile	< 0.1 R
MW-12I	09/21/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-12S	09/21/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-13S	09/21/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-24S	09/21/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-29S	09/21/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-30S	09/21/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R

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Well Number	Sample Date	CAS Number	Analyte	Reported Value
MW-31S	09/21/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-32S	09/21/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-14S	09/22/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-15S	09/22/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-18S	09/22/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-19S	09/22/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-20S	09/22/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-25S	09/22/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-26S	09/22/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-27S	09/22/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#9	09/23/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#9	09/23/95	7439-96-5	Manganese	< 13.9 R
EE-4	09/23/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
EE-4	09/23/95	7439-96-5	Manganese	< 13.9 R
EE-5	09/23/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
EE-5	09/23/95	7439-96-5	Manganese	< 13.9 R
MW-11S	09/23/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-11S	09/23/95	7439-96-5	Manganese	< 13.9 R
MW-17DR	09/23/95	7439-96-5	Manganese	< 13.9 R
MW-17I	09/23/95	7439-96-5	Manganese	< 13.9 R
MW-17SR	09/23/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-17SR	09/23/95	67-64-1	Acetone	< 0.5 R
MW-17SR	09/23/95	7439-96-5	Manganese	< 13.9 R
MW-21I	09/23/95	7439-96-5	Manganese	< 13.9 R
MW-22S	09/23/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-22S	09/23/95	7439-96-5	Manganese	< 13.9 R
#1	09/24/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#2	09/24/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#3	09/24/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#4	09/24/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#5	09/24/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#6	09/24/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
EE-2	09/24/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-16S	09/24/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
NW-5	09/24/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
EE-6	09/26/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
EE-7	09/26/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
EE-8	09/26/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-10S	09/26/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-23S	09/26/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-28S	09/26/95	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-33S	10/26/95	534-52-1	4,6-Dinitro-2-methylphenol	< 0.5 R
MW-33S	10/26/95	107-13-1	Acrylonitrile	< 0.5 R
MW-34S	10/26/95	534-52-1	4,6-Dinitro-2-methylphenol	< 0.5 R
MW-34S	10/26/95	107-13-1	Acrylonitrile	< 0.5 R

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Well Number	Sample Date	CAS Number	Analyte	Reported Value
MW-35S	10/26/95	107-13-1	Acrylonitrile	< 0.5 R
MW-12I	12/07/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-12S	12/07/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-18S	12/07/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-27S	12/07/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-29S	12/07/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-30S	12/07/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-31S	12/07/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-32S	12/07/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-33S	12/07/95	118-74-1	Hexachlorobenzene	< 0.093 R
#5	12/08/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-34S	12/08/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-35S	12/08/95	118-74-1	Hexachlorobenzene	< 0.093 R
#1	12/09/95	118-74-1	Hexachlorobenzene	< 0.093 R
#2	12/09/95	118-74-1	Hexachlorobenzene	< 0.093 R
#3	12/09/95	118-74-1	Hexachlorobenzene	< 0.093 R
EE-2	12/10/95	118-74-1	Hexachlorobenzene	< 0.093 R
EE-3	12/10/95	118-74-1	Hexachlorobenzene	< 0.093 R
EE-6	12/10/95	118-74-1	Hexachlorobenzene	< 0.093 R
EE-7	12/10/95	118-74-1	Hexachlorobenzene	< 0.094 R
EE-8	12/10/95	118-74-1	Hexachlorobenzene	< 0.093 R
MW-15S	03/20/96	78-93-3	2-Butanone	< 0.5 R
MW-15S	03/20/96	591-78-6	2-Hexanone	< 0.5 R
MW-15S	03/20/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-15S	03/20/96	67-64-1	Acetone	< 0.5 R
MW-15S	03/20/96	107-13-1	Acrylonitrile	< 1 R
MW-15S	03/20/96	75-00-3	Chloroethane	< 0.1 R
MW-15S	03/20/96	7440-22-4	Silver	< 4.5 R
MW-24S	03/20/96	78-93-3	2-Butanone	< 0.5 R
MW-24S	03/20/96	591-78-6	2-Hexanone	< 0.5 R
MW-24S	03/20/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-24S	03/20/96	67-64-1	Acetone	< 0.5 R
MW-24S	03/20/96	107-13-1	Acrylonitrile	< 1 R
MW-24S	03/20/96	75-00-3	Chloroethane	< 0.1 R
MW-24S	03/20/96	7440-22-4	Silver	< 4.5 R
MW-29S	03/20/96	7440-22-4	Silver	< 4.5 R
MW-30S	03/20/96	78-93-3	2-Butanone	< 0.5 R
MW-30S	03/20/96	591-78-6	2-Hexanone	< 0.5 R
MW-30S	03/20/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-30S	03/20/96	67-64-1	Acetone	< 0.5 R
MW-30S	03/20/96	107-13-1	Acrylonitrile	< 0.5 R
MW-30S	03/20/96	75-00-3	Chloroethane	< 0.1 R
MW-30S	03/20/96	7440-22-4	Silver	< 4.5 R
MW-31S	03/20/96	78-93-3	2-Butanone	< 0.5 R
MW-31S	03/20/96	591-78-6	2-Hexanone	< 0.5 R

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Well Number	Sample Date	CAS Number	Analyte	Reported Value
MW-31S	03/20/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-31S	03/20/96	67-64-1	Acetone	< 0.5 R
MW-31S	03/20/96	107-13-1	Acrylonitrile	< 0.5 R
MW-31S	03/20/96	75-00-3	Chloroethane	< 0.1 R
MW-31S	03/20/96	7440-22-4	Silver	< 4.5 R
MW-32S	03/20/96	78-93-3	2-Butanone	< 0.5 R
MW-32S	03/20/96	591-78-6	2-Hexanone	< 0.5 R
MW-32S	03/20/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-32S	03/20/96	67-64-1	Acetone	< 0.5 R
MW-32S	03/20/96	107-13-1	Acrylonitrile	< 0.5 R
MW-32S	03/20/96	75-00-3	Chloroethane	< 0.1 R
MW-32S	03/20/96	7440-22-4	Silver	< 4.5 R
MW-33S	03/20/96	75-00-3	Chloroethane	< 0.1 R
MW-33S	03/20/96	7440-22-4	Silver	< 4.5 R
MW-34S	03/20/96	78-93-3	2-Butanone	< 0.5 R
MW-34S	03/20/96	591-78-6	2-Hexanone	< 0.5 R
MW-34S	03/20/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-34S	03/20/96	67-64-1	Acetone	< 0.5 R
MW-34S	03/20/96	107-13-1	Acrylonitrile	< 1 R
MW-34S	03/20/96	75-00-3	Chloroethane	< 0.1 R
MW-34S	03/20/96	7440-22-4	Silver	< 4.5 R
MW-35S	03/20/96	7440-22-4	Silver	< 4.5 R
#1	03/21/96	78-93-3	2-Butanone	< 0.5 R
#1	03/21/96	591-78-6	2-Hexanone	< 0.5 R
#1	03/21/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#1	03/21/96	67-64-1	Acetone	< 0.5 R
#1	03/21/96	107-13-1	Acrylonitrile	< 1 R
#1	03/21/96	75-00-3	Chloroethane	< 0.1 R
MW-16S	03/21/96	108-10-1	4-Methyl-2-pentanone	< 5 R
MW-22S	03/21/96	78-93-3	2-Butanone	< 0.5 R
MW-22S	03/21/96	591-78-6	2-Hexanone	< 0.5 R
MW-22S	03/21/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-22S	03/21/96	67-64-1	Acetone	< 0.5 R
MW-22S	03/21/96	107-13-1	Acrylonitrile	< 1 R
MW-22S	03/21/96	75-00-3	Chloroethane	< 0.1 R
MW-23S	03/21/96	108-10-1	4-Methyl-2-pentanone	< 5 R
MW-28S	03/21/96	78-93-3	2-Butanone	< 0.5 R
MW-28S	03/21/96	591-78-6	2-Hexanone	< 0.5 R
MW-28S	03/21/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-28S	03/21/96	67-64-1	Acetone	< 0.5 R
MW-28S	03/21/96	107-13-1	Acrylonitrile	< 1 R
MW-28S	03/21/96	75-00-3	Chloroethane	< 0.1 R
NW-5	03/21/96	78-93-3	2-Butanone	< 0.5 R
NW-5	03/21/96	591-78-6	2-Hexanone	< 0.5 R
NW-5	03/21/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R

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Well Number	Sample Date	CAS Number	Analyte	Reported Value
NW-5	03/21/96	67-64-1	Acetone	< 0.5 R
NW-5	03/21/96	107-13-1	Acrylonitrile	< 1 R
NW-5	03/21/96	75-00-3	Chloroethane	< 0.1 R
#2	03/22/96	96-12-8	1,2-Dibromo-3-chloropropane	< 0.5 R
#2	03/22/96	78-93-3	2-Butanone	< 0.5 R
#2	03/22/96	591-78-6	2-Hexanone	< 0.5 R
#2	03/22/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#2	03/22/96	67-64-1	Acetone	< 0.5 R
#2	03/22/96	7440-22-4	Silver	< 4.5 R
#3	03/22/96	78-93-3	2-Butanone	< 0.5 R
#3	03/22/96	591-78-6	2-Hexanone	< 0.5 R
#3	03/22/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#3	03/22/96	67-64-1	Acetone	< 0.5 R
#3	03/22/96	107-13-1	Acrylonitrile	< 1 R
#3	03/22/96	75-00-3	Chloroethane	< 0.1 R
#3	03/22/96	7440-22-4	Silver	< 4.5 R
#4	03/22/96	108-10-1	4-Methyl-2-pentanone	< 5 R
#4	03/22/96	7440-22-4	Silver	< 4.5 R
#5	03/22/96	78-93-3	2-Butanone	< 0.5 R
#5	03/22/96	591-78-6	2-Hexanone	< 0.5 R
#5	03/22/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#5	03/22/96	67-64-1	Acetone	< 2 R
#5	03/22/96	107-13-1	Acrylonitrile	< 1 R
#5	03/22/96	7440-22-4	Silver	< 4.5 R
#6	03/22/96	78-93-3	2-Butanone	< 0.5 R
#6	03/22/96	591-78-6	2-Hexanone	< 0.5 R
#6	03/22/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#6	03/22/96	67-64-1	Acetone	< 0.74 R
#6	03/22/96	107-13-1	Acrylonitrile	< 1 R
#6	03/22/96	75-00-3	Chloroethane	< 0.1 R
#6	03/22/96	7440-22-4	Silver	< 4.5 R
#8	03/22/96	78-93-3	2-Butanone	< 0.5 R
#8	03/22/96	591-78-6	2-Hexanone	< 0.5 R
#8	03/22/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#8	03/22/96	67-64-1	Acetone	< 0.5 R
#8	03/22/96	107-13-1	Acrylonitrile	< 1 R
#8	03/22/96	75-00-3	Chloroethane	< 0.1 R
#8	03/22/96	7440-22-4	Silver	< 4.5 R
MW-17SR	03/22/96	108-10-1	4-Methyl-2-pentanone	< 5 R
MW-17SR	03/22/96	7440-22-4	Silver	< 4.5 R
EE-4	03/23/96	78-93-3	2-Butanone	< 0.5 R
EE-4	03/23/96	591-78-6	2-Hexanone	< 0.5 R
EE-4	03/23/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
EE-4	03/23/96	67-64-1	Acetone	< 0.5 R
EE-4	03/23/96	107-13-1	Acrylonitrile	< 1 R

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Well Number	Sample Date	CAS Number	Analyte	Reported Value
EE-4	03/23/96	75-00-3	Chloroethane	< 0.1 R
EE-5	03/23/96	78-93-3	2-Butanone	< 0.5 R
EE-5	03/23/96	591-78-6	2-Hexanone	< 0.5 R
EE-5	03/23/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
EE-5	03/23/96	67-64-1	Acetone	< 0.5 R
EE-5	03/23/96	107-13-1	Acrylonitrile	< 1 R
EE-5	03/23/96	75-00-3	Chloroethane	< 0.1 R
EE-6	03/23/96	78-93-3	2-Butanone	< 0.5 R
EE-6	03/23/96	591-78-6	2-Hexanone	< 0.5 R
EE-6	03/23/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
EE-6	03/23/96	67-64-1	Acetone	< 0.5 R
EE-6	03/23/96	107-13-1	Acrylonitrile	< 1 R
EE-6	03/23/96	75-00-3	Chloroethane	< 0.1 R
EE-7	03/23/96	78-93-3	2-Butanone	< 0.5 R
EE-7	03/23/96	591-78-6	2-Hexanone	< 0.5 R
EE-7	03/23/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
EE-7	03/23/96	67-64-1	Acetone	< 0.5 R
EE-7	03/23/96	107-13-1	Acrylonitrile	< 1 R
EE-7	03/23/96	75-00-3	Chloroethane	< 0.1 R
MW-14S	03/23/96	78-93-3	2-Butanone	< 0.5 R
MW-14S	03/23/96	591-78-6	2-Hexanone	< 0.5 R
MW-14S	03/23/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-14S	03/23/96	67-64-1	Acetone	< 0.5 R
MW-14S	03/23/96	107-13-1	Acrylonitrile	< 1 R
MW-25S	03/23/96	78-93-3	2-Butanone	< 0.5 R
MW-25S	03/23/96	591-78-6	2-Hexanone	< 0.5 R
MW-25S	03/23/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-25S	03/23/96	67-64-1	Acetone	< 0.5 R
MW-25S	03/23/96	107-13-1	Acrylonitrile	< 1 R
MW-25S	03/23/96	75-00-3	Chloroethane	< 0.1 R
MW-26S	03/23/96	78-93-3	2-Butanone	< 0.5 R
MW-26S	03/23/96	591-78-6	2-Hexanone	< 0.5 R
MW-26S	03/23/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-26S	03/23/96	67-64-1	Acetone	< 0.5 R
MW-26S	03/23/96	107-13-1	Acrylonitrile	< 1 R
MW-26S	03/23/96	75-00-3	Chloroethane	< 0.1 R
#9	03/24/96	78-93-3	2-Butanone	< 0.5 R
#9	03/24/96	591-78-6	2-Hexanone	< 0.5 R
#9	03/24/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
#9	03/24/96	67-64-1	Acetone	< 0.5 R
#9	03/24/96	107-13-1	Acrylonitrile	< 1 R
MW-11S	03/24/96	78-93-3	2-Butanone	< 0.5 R
MW-11S	03/24/96	591-78-6	2-Hexanone	< 0.5 R
MW-11S	03/24/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-11S	03/24/96	107-13-1	Acrylonitrile	< 1 R

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Well Number	Sample Date	CAS Number	Analyte	Reported Value
MW-11S	03/24/96	75-00-3	Chloroethane	< 0.1 R
MW-18S	03/24/96	78-93-3	2-Butanone	< 0.5 R
MW-18S	03/24/96	591-78-6	2-Hexanone	< 0.5 R
MW-18S	03/24/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-18S	03/24/96	67-64-1	Acetone	< 0.5 R
MW-18S	03/24/96	107-13-1	Acrylonitrile	< 1 R
MW-18S	03/24/96	75-00-3	Chloroethane	< 0.1 R
MW-20S	03/24/96	78-93-3	2-Butanone	< 0.5 R
MW-20S	03/24/96	591-78-6	2-Hexanone	< 0.5 R
MW-20S	03/24/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-20S	03/24/96	67-64-1	Acetone	< 0.5 R
MW-20S	03/24/96	107-13-1	Acrylonitrile	< 1 R
MW-20S	03/24/96	75-00-3	Chloroethane	< 0.1 R
MW-27S	03/24/96	78-93-3	2-Butanone	< 0.5 R
MW-27S	03/24/96	591-78-6	2-Hexanone	< 0.5 R
MW-27S	03/24/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-27S	03/24/96	67-64-1	Acetone	< 0.5 R
MW-27S	03/24/96	107-13-1	Acrylonitrile	< 1 R
MW-27S	03/24/96	75-00-3	Chloroethane	< 0.1 R
EE-8	03/25/96	78-93-3	2-Butanone	< 0.5 R
EE-8	03/25/96	591-78-6	2-Hexanone	< 0.5 R
EE-8	03/25/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
EE-8	03/25/96	67-64-1	Acetone	< 0.5 R
EE-8	03/25/96	107-13-1	Acrylonitrile	< 1 R
EE-8	03/25/96	75-00-3	Chloroethane	< 0.1 R
MW-12D	03/25/96	78-93-3	2-Butanone	< 0.5 R
MW-12D	03/25/96	591-78-6	2-Hexanone	< 0.5 R
MW-12D	03/25/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-12D	03/25/96	67-64-1	Acetone	< 0.5 R
MW-12D	03/25/96	107-13-1	Acrylonitrile	< 1 R
MW-12D	03/25/96	75-00-3	Chloroethane	< 0.1 R
MW-19S	03/25/96	78-93-3	2-Butanone	< 0.5 R
MW-19S	03/25/96	591-78-6	2-Hexanone	< 0.5 R
MW-19S	03/25/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-19S	03/25/96	67-64-1	Acetone	< 0.5 R
MW-19S	03/25/96	107-13-1	Acrylonitrile	< 1 R
MW-19S	03/25/96	75-00-3	Chloroethane	< 0.1 R
MW-36S	04/16/96	78-93-3	2-Butanone	< 0.5 R
MW-36S	04/16/96	591-78-6	2-Hexanone	< 0.5 R
MW-36S	04/16/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-36S	04/16/96	67-64-1	Acetone	< 0.5 R
MW-36S	04/16/96	107-13-1	Acrylonitrile	< 1 R
MW-36S	04/16/96	75-00-3	Chloroethane	< 0.1 R
MW-36S	04/16/96	67-66-3	Chloroform	< 0.23 R
MW-37S	04/16/96	78-93-3	2-Butanone	< 0.5 R

Summary of Groundwater Data
Rejected through Data Validation
Pasco Landfill

Well Number	Sample Date	CAS Number	Analyte	Reported Value
MW-37S	04/16/96	591-78-6	2-Hexanone	< 0.5 R
MW-37S	04/16/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-37S	04/16/96	67-64-1	Acetone	< 0.5 R
MW-37S	04/16/96	107-13-1	Acrylonitrile	< 1 R
MW-37S	04/16/96	75-00-3	Chloroethane	< 0.1 R
MW-38S	04/16/96	78-93-3	2-Butanone	< 0.5 R
MW-38S	04/16/96	591-78-6	2-Hexanone	< 0.5 R
MW-38S	04/16/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-38S	04/16/96	67-64-1	Acetone	< 5 R
MW-38S	04/16/96	107-13-1	Acrylonitrile	< 1 R
MW-38S	04/16/96	75-00-3	Chloroethane	< 0.1 R
MW-39S	04/16/96	78-93-3	2-Butanone	< 0.5 R
MW-39S	04/16/96	108-10-1	4-Methyl-2-pentanone	< 0.5 R
MW-39S	04/16/96	67-64-1	Acetone	< 0.5 R
MW-39S	04/16/96	107-13-1	Acrylonitrile	< 1 R
MW-39S	04/16/96	75-00-3	Chloroethane	< 0.1 R
MW-32S	07/24/96	78-93-3	2-Butanone	< 3 R
MW-33S	07/24/96	78-93-3	2-Butanone	< 3 R
MW-35S	07/24/96	78-93-3	2-Butanone	< 3 R
MW-36S	07/24/96	78-93-3	2-Butanone	< 3 R
MW-37S	07/24/96	78-93-3	2-Butanone	< 3 R
MW-38S	07/24/96	78-93-3	2-Butanone	< 3 R
MW-39S	07/24/96	78-93-3	2-Butanone	< 3 R
MW-19S	07/25/96	78-93-3	2-Butanone	< 3 R
MW-20S	07/25/96	78-93-3	2-Butanone	< 3 R
MW-22S	07/25/96	78-93-3	2-Butanone	< 3 R
MW-27S	07/25/96	78-93-3	2-Butanone	< 3 R
MW-28S	07/25/96	78-93-3	2-Butanone	< 3 R
#4	07/26/96	78-93-3	2-Butanone	< 3 R
#6	07/26/96	78-93-3	2-Butanone	< 3 R
#8	07/26/96	78-93-3	2-Butanone	< 3 R
EE-7	07/26/96	78-93-3	2-Butanone	< 3 R
EE-8	07/26/96	78-93-3	2-Butanone	< 3 R
MW-25S	07/26/96	78-93-3	2-Butanone	< 3 R
MW-26S	07/26/96	78-93-3	2-Butanone	< 5 R
#5	07/27/96	78-93-3	2-Butanone	< 3 R
MW-13S	07/27/96	78-93-3	2-Butanone	< 3 R
MW-16S	07/27/96	78-93-3	2-Butanone	< 3 R
MW-17SR	07/27/96	78-93-3	2-Butanone	< 3 R
MW-23S	07/27/96	78-93-3	2-Butanone	< 3 R
MW-24S	07/27/96	78-93-3	2-Butanone	< 3 R
MW-29S	07/27/96	78-93-3	2-Butanone	< 3 R
EE-2	07/29/96	78-93-3	2-Butanone	< 3 R
EE-3	07/29/96	78-93-3	2-Butanone	< 3 R
MW-10S	07/29/96	78-93-3	2-Butanone	< 3 R

Summary of Groundwater Data
Rejected through Data Validation
Pasco Landfill

Well Number	Sample Date	CAS Number	Analyte	Reported Value
MW-11S	07/29/96	78-93-3	2-Butanone	< 3 R
MW-12ID	07/29/96	78-93-3	2-Butanone	< 3 R
MW-12S	07/29/96	78-93-3	2-Butanone	< 3 R
MW-40S	07/30/96	78-93-3	2-Butanone	< 3 R
MW-41S	07/30/96	78-93-3	2-Butanone	< 3 R
MW-42S	07/30/96	78-93-3	2-Butanone	< 3 R
MW-26S	09/18/96	65-85-0	Benzoic acid	< 10 R
MW-26S	06/20/97	120-82-1	1,2,4-Trichlorobenzene	< 0.6 R
MW-26S	06/20/97	95-95-4	2,4,5-Trichlorophenol	< 0.7 R
MW-26S	06/20/97	88-06-2	2,4,6-Trichlorophenol	< 0.7 R
MW-26S	06/20/97	120-83-2	2,4-Dichlorophenol	< 0.7 R
MW-26S	06/20/97	105-67-9	2,4-Dimethylphenol	< 0.3 R
MW-26S	06/20/97	51-28-5	2,4-Dinitrophenol	< 2.1 R
MW-26S	06/20/97	121-14-2	2,4-Dinitrotoluene	< 0.2 R
MW-26S	06/20/97	606-20-2	2,6-Dinitrotoluene	< 0.5 R
MW-26S	06/20/97	91-58-7	2-Chloronaphthalene	< 2 R
MW-26S	06/20/97	95-57-8	2-Chlorophenol	< 0.4 R
MW-26S	06/20/97	534-52-1	2-Methyl-4,6-dinitrophenol	< 3 R
MW-26S	06/20/97	91-57-6	2-Methylnaphthalene	< 2 R
MW-26S	06/20/97	95-48-7	2-Methylphenol	< 1 R
MW-26S	06/20/97	88-74-4	2-Nitroaniline	< 1 R
MW-26S	06/20/97	88-75-5	2-Nitrophenol	< 0.5 R
MW-26S	06/20/97	99-09-2	3-Nitroaniline	< 1 R
MW-26S	06/20/97	101-55-3	4-Bromophenyl phenyl ether	< 0.6 R
MW-26S	06/20/97	59-50-7	4-Chloro-3-methylphenol	< 0.7 R
MW-26S	06/20/97	106-47-8	4-Chloroaniline	< 1 R
MW-26S	06/20/97	7005-72-3	4-Chlorophenyl phenyl ether	< 0.7 R
MW-26S	06/20/97	106-44-5	4-Methylphenol	< 1 R
MW-26S	06/20/97	100-01-6	4-Nitroaniline	< 1 R
MW-26S	06/20/97	100-02-7	4-Nitrophenol	< 2 R
MW-26S	06/20/97	83-32-9	Acenaphthene	< 0.9 R
MW-26S	06/20/97	208-96-8	Acenaphthylene	< 0.9 R
MW-26S	06/20/97	120-12-7	Anthracene	< 0.8 R
MW-26S	06/20/97	191-24-2	Benzo(g,h,i)perylene	< 0.8 R
MW-26S	06/20/97	65-85-0	Benzoic acid	< 10 R
MW-26S	06/20/97	100-51-6	Benzyl alcohol	< 10 R
MW-26S	06/20/97	111-91-1	Bis(2-chloroethoxy)methane	< 0.8 R
MW-26S	06/20/97	111-44-4	Bis(2-chloroethyl)ether	< 0.6 R
MW-26S	06/20/97	39638-32-9	Bis(2-chloroisopropyl)ether	< 1 R
MW-26S	06/20/97	117-81-7	bis(2-Ethylhexyl)phthalate	< 3.3 R
MW-26S	06/20/97	85-68-7	Butyl benzyl phthalate	< 3.2 R
MW-26S	06/20/97	132-64-9	Dibenzofuran	< 2 R
MW-26S	06/20/97	84-66-2	Diethyl phthalate	< 0.9 R
MW-26S	06/20/97	131-11-3	Dimethyl phthalate	< 0.7 R
MW-26S	06/20/97	84-74-2	Di-n-butyl phthalate	< 0.7 R

Summary of Groundwater Data
Rejected through Data Validation
Pasco Landfill

Well Number	Sample Date	CAS Number	Analyte	Reported Value
MW-26S	06/20/97	117-84-0	Di-n-octyl phthalate	< 3 R
MW-26S	06/20/97	88-85-7	Dinoseb	< 2 R
MW-26S	06/20/97	206-44-0	Fluoranthene	< 0.8 R
MW-26S	06/20/97	86-73-7	Fluorene	< 0.9 R
MW-26S	06/20/97	87-68-3	Hexachlorobutadiene	< 0.5 R
MW-26S	06/20/97	77-47-4	Hexachlorocyclopentadiene	< 2.3 R
MW-26S	06/20/97	67-72-1	Hexachloroethane	< 0.6 R
MW-26S	06/20/97	78-59-1	Isophorone	< 0.6 R
MW-26S	06/20/97	91-20-3	Naphthalene	< 0.7 R
MW-26S	06/20/97	98-95-3	Nitrobenzene	< 0.7 R
MW-26S	06/20/97	86-30-6	N-Nitrosodiphenylamine	< 0.8 R
MW-26S	06/20/97	87-86-5	Pentachlorophenol	< 0.2 R
MW-26S	06/20/97	85-01-8	Phenanthrene	< 0.8 R
MW-26S	06/20/97	108-95-2	Phenol	< 0.6 R
MW-26S	06/20/97	129-00-0	Pyrene	< 0.8 R
#6	06/23/97	71-55-6	1,1,1-Trichloroethane	< 0.7 R
#6	06/23/97	79-34-5	1,1,2,2-Tetrachloroethane	< 0.07 R
#6	06/23/97	75-34-3	1,1-DCA	< 0.7 R
#6	06/23/97	75-35-4	1,1-DCE	< 0.07 R
#6	06/23/97	107-06-2	1,2-DCA	< 0.5 R
#6	06/23/97	108-10-1	4-Methyl-2-pentanone	< 2 R
#6	06/23/97	67-64-1	Acetone	< 6 R
#6	06/23/97	156-59-2	cis-1,2-DCE	< 6.3 R
#6	06/23/97	100-41-4	Ethylbenzene	< 0.5 R
#6	06/23/97	1330-20-7	m,p-Xylene	< 0.5 R
#6	06/23/97	95-47-6	o-Xylene	< 0.5 R
#6	06/23/97	127-18-4	PCE	< 4.2 R
#6	06/23/97	79-01-6	TCE	< 2.6 R
#6	06/23/97	108-88-3	Toluene	< 0.5 R
#6	06/23/97	75-01-4	Vinyl chloride	< 0.05 R
MW-25S	09/26/97	93-76-5	2,4,5-T	< 0.3 R
MW-25S	09/26/97	93-72-1	2,4,5-TP	< 0.2 R
MW-25S	09/26/97	94-75-7	2,4-D	< 0.6 R
MW-25S	09/26/97	94-82-6	2,4-DB	< 0.6 R
MW-25S	09/26/97	51-28-5	2,4-Dinitrophenol	< 2.1 R
MW-25S	09/26/97	65-85-0	Benzoic acid	< 14 R
MW-25S	09/26/97	75-99-0	Dalapon	< 0.4 R
MW-25S	09/26/97	1918-00-9	Dicamba	< 0.2 R
MW-25S	09/26/97	120-36-5	Dichlorprop	< 0.3 R
MW-25S	09/26/97	88-85-7	Dinoseb	< 2 R
MW-25S	09/26/97	94-74-6	MCPA	< 2 R
MW-25S	09/26/97	93-65-2	MCPP	< 3 R
MW-26S	09/26/97	51-28-5	2,4-Dinitrophenol	< 2.1 R
MW-26S	09/26/97	65-85-0	Benzoic acid	< 14 R
MW-26S	09/26/97	88-85-7	Dinoseb	< 2 R

Summary of Groundwater Data
Rejected through Data Validation
Pasco Landfill

Well Number	Sample Date	CAS Number	Analyte	Reported Value
MW-25S	12/05/97	105-67-9	2,4-Dimethylphenol	< 0.3 R
MW-25S	12/05/97	65-85-0	Benzoic acid	< 14 R
MW-25S	12/05/97	77-47-4	Hexachlorocyclopentadiene	< 2.3 R
MW-26S	12/05/97	91-94-1	3,3'-Dichlorobenzidine	< 0.01 R
MW-26S	12/05/97	65-85-0	Benzoic acid	< 14 R
MW-26S	12/05/97	77-47-4	Hexachlorocyclopentadiene	< 2.3 R

R = Data rejected by validator. Low surrogate recovery

Table I-1
Sample Identification

SITE ID	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE MATRIX	SHIP DATE	SAMPLE DATE	CHAIN of CUSTODY
GROUNDWATER						
#1	PLF-GW-024	NA	W	2/9/93	2/9/93	5336
#1	PLF-GW-024	NA	W	2/9/93	2/9/93	5334
#1	PLF-GW-024	NA	W	2/9/93	2/9/93	5336
#2	PLF-GW-046	NA	W	2/11/93	2/11/93	5341
#2	PLF-GW-046	NA	W	2/11/93	2/11/93	5340
#3	PLF-GW-048	NA	W	2/11/93	2/11/93	5341
#3	PLF-GW-048	NA	W	2/11/93	2/11/93	5340
#4	PLF-GW-033	NA	W	2/10/93	2/10/93	5339
#4	PLF-GW-033	NA	W	2/10/93	2/10/93	5337
#4	PLF-GW-033	NA	W	2/12/93	2/10/93	5338
#5	PLF-GW-032	NA	W	2/10/93	2/10/93	5339
#5	PLF-GW-032	NA	W	2/10/93	2/10/93	5337
#5	PLF-GW-032	NA	W	2/12/93	2/10/93	5338
#6	PLF-GW-038	NA	W	2/10/93	2/10/93	5339
#6	PLF-GW-038	NA	W	2/10/93	2/10/93	5337
#6	PLF-GW-038	NA	W	2/12/93	2/10/93	5338
#7	PLF-GW-036	NA	W	2/10/93	2/10/93	5339
#7	PLF-GW-036	NA	W	2/10/93	2/10/93	5337
#8	PLF-GW-039	NA	W	2/10/93	2/10/93	5339
#8	PLF-GW-039	NA	W	2/10/93	2/10/93	5337
#8	PLF-GW-039	NA	W	2/12/93	2/10/93	5338
#9	PLF-GW-042	NA	W	2/11/93	2/11/93	5341
#9	PLF-GW-042	NA	W	2/11/93	2/11/93	5340
#9	PLF-GW-042	NA	W	2/12/93	2/11/93	5338
EE-2	PLF-GW-029	NA	W	2/9/93	2/9/93	5336
EE-2	PLF-GW-029	NA	W	2/9/93	2/9/93	5335
EE-2	PLF-GW-029	NA	W	2/9/93	2/9/93	5336
EE-2	PLF-GW-053	NA	W	2/16/93	2/13/93	5343
EE-3	PLF-GW-027	NA	W	2/9/93	2/9/93	5336
EE-3	PLF-GW-027	NA	W	2/9/93	2/9/93	5334
EE-3	PLF-GW-027	NA	W	2/9/93	2/9/93	5336
EE-4	PLF-GW-050	NA	W	2/16/93	2/12/93	5343
EE-4	PLF-GW-050	NA	W	2/16/93	2/12/93	5343
EE-4	PLF-GW-050	NA	W	2/16/93	2/12/93	5343
EE-5	PLF-GW-051	NA	W	2/16/93	2/12/93	5343
EE-6	PLF-GW-018	NA	W	2/8/93	2/8/93	5332
EE-7	PLF-GW-019	NA	W	2/8/93	2/8/93	5332
EE-8	PLF-GW-021	NA	W	2/8/93	2/8/93	5332

SITE ID	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE MATRIX	SHIP DATE	SAMPLE DATE	CHAIN of CUSTODY
MW-10S	PLF-GW-015	NA	W	2/8/93	2/8/93	5332
MW-10S	PLF-GW-015	NA	W	2/8/93	2/8/93	5333
MW-10S	PLF-GW-015	NA	W	2/8/93	2/8/93	5332
MW-11S	PLF-GW-017	NA	W	2/8/93	2/8/93	5332
MW-11S	PLF-GW-017	NA	W	2/8/93	2/8/93	5333
MW-11S	PLF-GW-017	NA	W	2/8/93	2/8/93	5332
MW-11S	PLF-GW-017	NA	W	2/8/93	2/8/93	5332
MW-11S	PLF-GW-017	NA	W	2/8/93	2/8/93	5333
MW-11S	PLF-GW-017	NA	W	2/8/93	2/8/93	5332
MW-11S	PLF-GW-017	NA	W	2/8/93	2/8/93	5332
MW-11S	PLF-GW-017	NA	W	2/8/93	2/8/93	5333
MW-11S	PLF-GW-017	NA	W	2/8/93	2/8/93	5332
MW-12D	PLF-GW-045	NA	W	2/11/93	2/11/93	5341
MW-12D	PLF-GW-045	NA	W	2/11/93	2/11/93	5340
MW-12I	PLF-GW-044	NA	W	2/11/93	2/11/93	5341
MW-12I	PLF-GW-044	NA	W	2/11/93	2/11/93	5340
MW-12S	PLF-GW-043	NA	W	2/11/93	2/11/93	5341
MW-12S	PLF-GW-043	NA	W	2/11/93	2/11/93	5340
MW-13S	PLF-GW-022	NA	W	2/9/93	2/9/93	5336
MW-13S	PLF-GW-022	NA	W	2/9/93	2/9/93	5334
MW-13S	PLF-GW-022	NA	W	2/9/93	2/9/93	5336
MW-13S	PLF-GW-022	NA	W	2/9/93	2/9/93	5336
MW-13S	PLF-GW-022	NA	W	2/9/93	2/9/93	5334
MW-13S	PLF-GW-022	NA	W	2/9/93	2/9/93	5336
MW-13S	PLF-GW-022	NA	W	2/9/93	2/9/93	5336
MW-13S	PLF-GW-022	NA	W	2/9/93	2/9/93	5334
MW-13S	PLF-GW-022	NA	W	2/9/93	2/9/93	5336
MW-14S	PLF-GW-023	NA	W	2/9/93	2/9/93	5336
MW-14S	PLF-GW-023	NA	W	2/9/93	2/9/93	5334
MW-14S	PLF-GW-023	NA	W	2/9/93	2/9/93	5336
MW-15S	PLF-GW-002	NA	W	1/26/93	1/26/93	5297
MW-15S	PLF-GW-002	NA	W	1/27/93	1/26/93	5298
MW-15S	PLF-GW-002	NA	W	1/27/93	1/26/93	5299
MW-15S	PLF-GW-002	NA	W	1/26/93	1/26/93	5297
MW-15S	PLF-GW-002	NA	W	1/27/93	1/26/93	5298
MW-15S	PLF-GW-002	NA	W	1/27/93	1/26/93	5299
MW-15S	PLF-GW-002	NA	W	1/26/93	1/26/93	5297
MW-15S	PLF-GW-002	NA	W	1/27/93	1/26/93	5298
MW-15S	PLF-GW-002	NA	W	1/27/93	1/26/93	5299

Site ID:

#1	= JUB Well #1	OW-15	= Observation Well No. 15
EE-2	= Ecology and Environmental Well No. 2	LFG-1	= Landfill Gas Probe No. 1
MW-12S	= Burlington Shallow Well No. 12	PH-01	= RECON Probe Hole No. 1
MW - 12I	= Burlington Intermediate Well No. 12	BK-01	= Background Surface Soil Sample No. 1
MW-12D	= Burlington Deep Well No. 12	LS-01	= Landspread Surface Soil Sample No. 1
B-01	= Boring No. 1	SL-01	= Sludge Spread Surface Soil Sample No. 1
		NA	= Not Applicable

Blank Type:
SB = System Blank
ER = Equipment Rinse
TB = Trip Blank
FB = Field Blank

Sample Matrix:
W = Water
S = Surface or Subsurface Soil
A = Landfill / Soil Gas
G = Air
N = Nitrogen

Table I-1
Sample Identification

SITE ID	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE MATRIX	SHIP DATE	SAMPLE DATE	CHAIN of CUSTODY
MW-15S	PLF-GW-002	NA	W	1/27/93	1/26/93	5300
MW-15S	PLF-GW-003	NA	W	1/26/93	1/26/93	5297
MW-15S	PLF-GW-003	NA	W	1/27/93	1/26/93	5298
MW-15S	PLF-GW-003	NA	W	1/27/93	1/26/93	5299
MW-15S	PLF-GW-003	NA	W	1/27/93	1/26/93	5300
MW-16S	PLF-GW-030	NA	W	2/10/93	2/10/93	5339
MW-16S	PLF-GW-030	NA	W	2/10/93	2/10/93	5337
MW-16S	PLF-GW-030	NA	W	2/10/93	2/10/93	5339
MW-16S	PLF-GW-030	NA	W	2/10/93	2/10/93	5337
MW-16S	PLF-GW-030	NA	W	2/10/93	2/10/93	5339
MW-16S	PLF-GW-030	NA	W	2/10/93	2/10/93	5337
MW-16S	PLF-GW-030	NA	W	2/12/93	2/10/93	5338
MW-16S	PLF-GW-030	NA	W	2/12/93	2/10/93	5338
MW-16S	PLF-GW-030	NA	W	2/12/93	2/10/93	5338
MW-17DR	PLF-GW-07	NA	W	1/27/93	1/27/93	5305
MW-17DR	PLF-GW-07	NA	W	1/27/93	1/27/93	5306
MW-17I	PLF-GW-06	NA	W	1/27/93	1/27/93	5305
MW-17I	PLF-GW-06	NA	W	1/27/93	1/27/93	5306
MW-17S	PLF-GW-001	NA	W	12/16/92	12/16/92	5281
MW-17SR	PLF-GW-004	NA	W	1/26/93	1/26/93	5297
MW-17SR	PLF-GW-004	NA	W	1/27/93	1/26/93	5298
MW-17SR	PLF-GW-004	NA	W	1/27/93	1/26/93	5299
MW-17SR	PLF-GW-004	NA	W	1/27/93	1/26/93	5300
MW-18S	PLF-GW-034	NA	W	2/10/93	2/10/93	5339
MW-18S	PLF-GW-034	NA	W	2/10/93	2/10/93	5337
MW-18S	PLF-GW-034	NA	W	2/12/93	2/10/93	5338
MW-18S	PLF-GW-035	NA	W	2/10/93	2/10/93	5339
MW-18S	PLF-GW-035	NA	W	2/10/93	2/10/93	5337
MW-19S	PLF-GW-028	NA	W	2/9/93	2/9/93	5336
MW-19S	PLF-GW-028	NA	W	2/9/93	2/9/93	5334
MW-19S	PLF-GW-028	NA	W	2/9/93	2/9/93	5336
MW-20S	PLF-GW-026	NA	W	2/9/93	2/9/93	5336
MW-20S	PLF-GW-026	NA	W	2/9/93	2/9/93	5334
MW-20S	PLF-GW-026	NA	W	2/9/93	2/9/93	5336
MW-21DR	PLF-GW-020	NA	W	2/8/93	2/8/93	5332
MW-21DR	PLF-GW-020	NA	W	2/8/93	2/8/93	5333
MW-21DR	PLF-GW-020	NA	W	2/8/93	2/8/93	5332
MW-21I	PLF-GW-037	NA	W	2/10/93	2/10/93	5339
MW-21I	PLF-GW-037	NA	W	2/10/93	2/10/93	5337
MW-22S	PLF-GW-040	NA	W	2/11/93	2/11/93	5341
MW-22S	PLF-GW-040	NA	W	2/11/93	2/11/93	5341
MW-22S	PLF-GW-040	NA	W	2/11/93	2/11/93	5341
MW-22S	PLF-GW-040	NA	W	2/11/93	2/11/93	5340
MW-22S	PLF-GW-040	NA	W	2/11/93	2/11/93	5340
MW-22S	PLF-GW-040	NA	W	2/11/93	2/11/93	5340
MW-22S	PLF-GW-040	NA	W	2/12/93	2/11/93	5338
MW-22S	PLF-GW-040	NA	W	2/11/93	2/11/93	5338
MW-22S	PLF-GW-040	NA	W	2/11/93	2/11/93	5338
SUBSURFACE SOIL						
B-01	PLF-SBS-256	11.0	S	1/27/93	1/25/93	5301
B-01	PLF-SBS-257	26.0	S	1/27/93	1/25/93	5301
B-01	PLF-SBS-258	41.0	S	1/27/93	1/25/93	5301
B-01	PLF-SBS-259	60.0	S	1/27/93	1/25/93	5301
B-02	PLF-SBS-261	11.0	S	1/27/93	1/26/93	5301
B-02	PLF-SBS-262	26.0	S	1/27/93	1/26/93	5301
B-02	PLF-SBS-263	41.0	S	1/27/93	1/26/93	5301
B-02	PLF-SBS-264	50.0	S	1/27/93	1/26/93	5301
B-03	PLF-SBS-232	11.0	S	1/25/93	1/22/93	5295
B-03	PLF-SBS-233	26.0	S	1/25/93	1/22/93	5295
B-03	PLF-SBS-234	41.0	S	1/25/93	1/22/93	5295
B-03	PLF-SBS-235	61.0	S	1/25/93	1/22/93	5295
B-03	PLF-SBS-237	8.8	S	1/25/93	1/22/93	5295
B-04	PLF-SBS-238	11.0	S	1/25/93	1/22/93	5295
B-04	PLF-SBS-239	26.0	S	1/25/93	1/22/93	5295
B-04	PLF-SBS-240	46.0	S	1/25/93	1/22/93	5295
B-04	PLF-SBS-241	64.0	S	1/25/93	1/22/93	5295
B-05	PLF-SBS-297	11.0	S	2/8/93	2/4/93	5312
B-05	PLF-SBS-297	11.0	S	2/8/93	2/4/93	5330
B-05	PLF-SBS-298	21.0	S	2/8/93	2/4/93	5312
B-05	PLF-SBS-298	21.0	S	2/8/93	2/4/93	5330
B-05	PLF-SBS-299	31.0	S	2/8/93	2/4/93	5312
B-05	PLF-SBS-299	31.0	S	2/8/93	2/4/93	5330
B-05	PLF-SBS-300	41.0	S	2/8/93	2/4/93	5312
B-05	PLF-SBS-300	41.0	S	2/8/93	2/4/93	5330
B-05	PLF-SBS-301	41.0	S	2/8/93	2/4/93	5312
B-05	PLF-SBS-301	41.0	S	2/8/93	2/4/93	5330

Site ID:			
#1	= JUB Well #1	OW-15	= Observation Well No. 15
EE-2	= Ecology and Environmental Well No. 2	LFG-1	= Landfill Gas Probe No. 1
MW-12S	= Burlington Shallow Well No. 12	PH-01	= RECON Probe Hole No. 1
MW - 12I	= Burlington Intermediate Well No. 12	BK-01	= Background Surface Soil Sample No. 1
MW-12D	= Burlington Deep Well No. 12	LS-01	= Landspread Surface Soil Sample No. 1
B-01	= Boring No. 1	SL-01	= Sludge Spread Surface Soil Sample No. 1
		NA	= Not Applicable

Blank Type:
SB = System Blank
ER = Equipment Rinse
TB = Trip Blank
FB = Field Blank

Sample Matrix:
W = Water
S = Surface or Subsurface Soil
A = Landfill / Soil Gas
G = Air
N = Nitrogen

Table I-1
Sample Identification

SITE ID	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE MATRIX	SHIP DATE	SAMPLE DATE	CHAIN of CUSTODY
B-06	PLF-SBS-302	11.0	S	2/8/93	2/4/93	5312
B-06	PLF-SBS-302	11.0	S	2/8/93	2/4/93	5330
B-06	PLF-SBS-303	21.0	S	2/8/93	2/4/93	5312
B-06	PLF-SBS-303	21.0	S	2/8/93	2/4/93	5330
B-06	PLF-SBS-304	31.0	S	2/8/93	2/4/93	5312
B-06	PLF-SBS-304	31.0	S	2/8/93	2/4/93	5330
B-06	PLF-SBS-305	46.0	S	2/8/93	2/4/93	5312
B-06	PLF-SBS-305	46.0	S	2/8/93	2/4/93	5330
B-07	PLF-SBS-250	11.0	S	1/25/93	1/24/93	5296
B-07	PLF-SBS-250	11.0	S	1/25/93	1/24/93	5294
B-07	PLF-SBS-251	26.0	S	1/25/93	1/24/93	5296
B-07	PLF-SBS-251	26.0	S	1/25/93	1/24/93	5294
B-07	PLF-SBS-252	41.0	S	1/25/93	1/24/93	5296
B-07	PLF-SBS-252	41.0	S	1/25/93	1/24/93	5294
B-07	PLF-SBS-253	60.0	S	1/25/93	1/24/93	5296
B-07	PLF-SBS-253	60.0	S	1/25/93	1/24/93	5294
B-07	PLF-SBS-254	60.0	S	1/25/93	1/24/93	5296
B-07	PLF-SBS-254	60.0	S	1/25/93	1/24/93	5294
B-08	PLF-SBS-246	11.0	S	1/25/93	1/23/93	5295
B-08	PLF-SBS-246	11.0	S	1/25/93	1/23/93	5294
B-08	PLF-SBS-247	26.0	S	1/25/93	1/23/93	5296
B-08	PLF-SBS-247	26.0	S	1/25/93	1/23/93	5294
B-08	PLF-SBS-248	41.0	S	1/25/93	1/23/93	5296
B-08	PLF-SBS-248	41.0	S	1/25/93	1/23/93	5294
B-08	PLF-SBS-249	55.0	S	1/25/93	1/23/93	5296
B-08	PLF-SBS-249	55.0	S	1/25/93	1/23/93	5294
B-09	PLF-SBS-274	6.0	S	2/8/93	2/3/93	5308
B-09	PLF-SBS-274	6.0	S	2/8/93	2/3/93	5309
B-09	PLF-SBS-275	11.0	S	2/8/93	2/3/93	5308
B-09	PLF-SBS-275	11.0	S	2/8/93	2/3/93	5309
B-09R	PLF-SBS-285	5.0	S	2/8/93	2/3/93	5308
B-09R	PLF-SBS-285	5.0	S	2/8/93	2/3/93	5309
B-09R	PLF-SBS-286	10.0	S	2/8/93	2/3/93	5308
B-09R	PLF-SBS-286	10.0	S	2/8/93	2/3/93	5309
B-09R	PLF-SBS-287	15.0	S	2/8/93	2/3/93	5308
B-09R	PLF-SBS-287	15.0	S	2/8/93	2/3/93	5309
B-09R	PLF-SBS-288	20.0	S	2/8/93	2/3/93	5310
B-09R	PLF-SBS-288	20.0	S	2/8/93	2/3/93	5311

SITE ID	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE MATRIX	SHIP DATE	SAMPLE DATE	CHAIN of CUSTODY
B-09R	PLF-SBS-289	25.0	S	2/8/93	2/3/93	5310
B-09R	PLF-SBS-289	25.0	S	2/8/93	2/3/93	5311
B-09R	PLF-SBS-290	30.0	S	2/8/93	2/3/93	5310
B-09R	PLF-SBS-290	30.0	S	2/8/93	2/3/93	5311
B-09R	PLF-SBS-291	35.0	S	2/8/93	2/3/93	5310
B-09R	PLF-SBS-291	35.0	S	2/8/93	2/3/93	5311
B-09R	PLF-SBS-292	40.0	S	2/8/93	2/3/93	5310
B-09R	PLF-SBS-292	40.0	S	2/8/93	2/3/93	5311
B-09R	PLF-SBS-293	45.0	S	2/8/93	2/3/93	5310
B-09R	PLF-SBS-293	45.0	S	2/8/93	2/3/93	5311
B-09R	PLF-SBS-294	50.0	S	2/8/93	2/3/93	5310
B-09R	PLF-SBS-294	50.0	S	2/8/93	2/3/93	5311
B-09R	PLF-SBS-295	50.0	S	2/8/93	2/3/93	5310
B-09R	PLF-SBS-295	50.0	S	2/8/93	2/3/93	5311
B-10	PLF-SBS-276	5.0	S	2/8/93	2/3/93	5308
B-10	PLF-SBS-276	5.0	S	2/8/93	2/3/93	5309
B-10	PLF-SBS-277	10.0	S	2/8/93	2/3/93	5308
B-10	PLF-SBS-277	10.0	S	2/8/93	2/3/93	5309
B-10	PLF-SBS-278	15.0	S	2/8/93	2/3/93	5308
B-10	PLF-SBS-278	15.0	S	2/8/93	2/3/93	5309
B-10	PLF-SBS-279	20.0	S	2/8/93	2/3/93	5308
B-10	PLF-SBS-279	20.0	S	2/8/93	2/3/93	5309
B-10	PLF-SBS-280	25.0	S	2/8/93	2/3/93	5308
B-10	PLF-SBS-280	25.0	S	2/8/93	2/3/93	5309
B-10	PLF-SBS-281	30.0	S	2/8/93	2/3/93	5308
B-10	PLF-SBS-281	30.0	S	2/8/93	2/3/93	5309
B-10	PLF-SBS-282	35.0	S	2/8/93	2/3/93	5308
B-10	PLF-SBS-282	35.0	S	2/8/93	2/3/93	5309
B-10	PLF-SBS-283	45.0	S	2/8/93	2/3/93	5308
B-10	PLF-SBS-283	45.0	S	2/8/93	2/3/93	5309
B-10	PLF-SBS-284	50.0	S	2/8/93	2/3/93	5308
B-10	PLF-SBS-284	50.0	S	2/8/93	2/3/93	5309
B-10	PLF-SBS-296	40.0	S	2/8/93	2/3/93	5310
B-10	PLF-SBS-296	40.0	S	2/8/93	2/3/93	5311
B-11	PLF-SBS-265	11.0	S	1/27/93	1/26/93	5301
B-11	PLF-SBS-265	11.0	S	1/27/93	1/26/93	5302
B-11	PLF-SBS-266	26.0	S	1/27/93	1/26/93	5301
B-11	PLF-SBS-266	26.0	S	1/27/93	1/26/93	5302

Site ID:

#1	= JUB Well #1	OW-15	= Observation Well No. 15
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MW-12S	= Burlington Shallow Well No. 12	PH-01	= RECON Probe Hole No. 1
MW - 12I	= Burlington Intermediate Well No. 12	BK-01	= Background Surface Soil Sample No. 1
MW-12D	= Burlington Deep Well No. 12	LS-01	= Landspread Surface Soil Sample No. 1
B-01	= Boring No. 1	SL-01	= Sludge Spread Surface Soil Sample No. 1
		NA	= Not Applicable

Blank Type:
SB = System Blank
ER = Equipment Rinse
TB = Trip Blank
FB = Field Blank

Sample Matrix:
W = Water
S = Surface or Subsurface Soil
A = Landfill / Soil Gas
G = Air
N = Nitrogen

Table I-1
Sample Identification

SITE ID	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE MATRIX	SHIP DATE	SAMPLE DATE	CHAIN of CUSTODY
B-11	PLF-SBS-267	41.0	S	1/27/93	1/26/93	5301
B-11	PLF-SBS-267	41.0	S	1/27/93	1/26/93	5302
B-11	PLF-SBS-268	61.0	S	1/27/93	1/26/93	5301
B-11	PLF-SBS-268	61.0	S	1/27/93	1/26/93	5302
B-11	PLF-SBS-269	61.0	S	1/27/93	1/26/93	5301
B-11	PLF-SBS-269	61.0	S	1/27/93	1/26/93	5302
B-12	PLF-SBS-242	11.0	S	1/25/93	1/23/93	5295
B-12	PLF-SBS-242	11.0	S	1/25/93	1/23/93	5294
B-12	PLF-SBS-243	26.0	S	1/25/93	1/23/93	5295
B-12	PLF-SBS-243	26.0	S	1/25/93	1/23/93	5294
B-12	PLF-SBS-244	41.0	S	1/25/93	1/23/93	5295
B-12	PLF-SBS-244	41.0	S	1/25/93	1/23/93	5294
B-12	PLF-SBS-245	61.0	S	1/25/93	1/23/93	5295
B-12	PLF-SBS-245	61.0	S	1/25/93	1/23/93	5294
MW-10S	PLF-SBS-107	69.0	S	12/29/92	12/29/92	5285
MW-11S	PLF-SBS-110	70.0	S	1/5/93	1/5/93	5287
MW-12I	PLF-SBS-099	64.5	S	12/21/92	12/20/92	5284
MW-12I	PLF-SBS-100	72.0	S	12/21/92	12/19/92	5282
MW-12I	PLF-SBS-101	78.0	S	12/21/92	12/20/92	5282
MW-13S	PLF-SBS-206	14.8	S	1/25/93	1/20/93	5290
MW-13S	PLF-SBS-207	15.3	S	1/25/93	1/20/93	5290
MW-13S	PLF-SBS-208	15.8	S	1/25/93	1/20/93	5290
MW-13S	PLF-SBS-210	16.8	S	1/25/93	1/20/93	5290
MW-13S	PLF-SBS-211	17.3	S	1/25/93	1/20/93	5290
MW-13S	PLF-SBS-212	17.8	S	1/25/93	1/20/93	5290
MW-13S	PLF-SBS-213	60.0	S	1/21/93	1/21/93	5289
MW-13S	PLF-SBS-215	64.8	S	1/25/93	1/21/93	5291
MW-13S	PLF-SBS-215	64.8	S	1/25/93	1/21/93	5292
MW-13S	PLF-SBS-216	65.3	S	1/25/93	1/21/93	5293
MW-13S	PLF-SBS-217	65.8	S	1/25/93	1/21/93	5293
MW-13S	PLF-SBS-219	66.8	S	1/25/93	1/21/93	5293
MW-13S	PLF-SBS-220	67.3	S	1/25/93	1/21/93	5293
MW-13S	PLF-SBS-221	67.8	S	1/25/93	1/21/93	5293
MW-14S	PLF-SBS-169	3.8	S	1/25/93	1/19/93	5291
MW-14S	PLF-SBS-169	3.8	S	1/25/93	1/19/93	5292
MW-14S	PLF-SBS-170	4.3	S	1/25/93	1/19/93	5290
MW-14S	PLF-SBS-171	4.8	S	1/25/93	1/19/93	5290
MW-14S	PLF-SBS-174	6.3	S	1/25/93	1/19/93	5290
MW-14S	PLF-SBS-175	6.8	S	1/25/93	1/19/93	5290
MW-14S	PLF-SBS-176	7.3	S	1/25/93	1/19/93	5290
MW-14S	PLF-SBS-177	7.8	S	1/25/93	1/19/93	5290
MW-14S	PLF-SBS-178	8.3	S	1/25/93	1/19/93	5290
MW-14S	PLF-SBS-179	8.8	S	1/25/93	1/19/93	5290
MW-14S	PLF-SBS-180	45.0	S	1/21/93	1/20/93	5289
MW-18S	PLF-SBS-167	70.0	S	1/21/93	1/18/93	5289
MW-19S	PLF-SBS-128	58.5	S	1/12/93	1/10/93	5288
MW-20S	PLF-SBS-150	74.0	S	1/12/93	1/12/93	5288
MW-22S	PLF-SBS-273	60.0	S	2/8/93	2/2/93	5307
OW-15	PLF-SBS-003	69.3	S	12/7/92	12/6/92	5278
SURFACE SOIL						
BK-01	PLF-SS-025	0.5	S	12/7/92	12/3/92	5270
BK-01	PLF-SS-025	0.5	S	12/4/92	12/3/92	5272
BK-02	PLF-SS-026	0.5	S	12/7/92	12/3/92	5270
BK-02	PLF-SS-026	0.5	S	12/4/92	12/3/92	5272
BK-03	PLF-SS-027	0.5	S	12/7/92	12/3/92	5270
BK-03	PLF-SS-027	0.5	S	12/4/92	12/3/92	5272
BK-04	PLF-SS-028	0.5	S	12/7/92	12/3/92	5270
BK-04	PLF-SS-028	0.5	S	12/4/92	12/3/92	5272
BK-05	PLF-SS-029	0.5	S	12/7/92	12/3/92	5270
BK-05	PLF-SS-029	0.5	S	12/4/92	12/3/92	5272
BK-06	PLF-SS-030	0.5	S	12/7/92	12/3/92	5270
BK-06	PLF-SS-030	0.5	S	12/4/92	12/3/92	5272
BK-07	PLF-SS-031	0.5	S	12/7/92	12/3/92	5270
BK-07	PLF-SS-031	0.5	S	12/4/92	12/3/92	5272
BK-08	PLF-SS-032	0.5	S	12/7/92	12/3/92	5270
BK-08	PLF-SS-032	0.5	S	12/4/92	12/3/92	5272
BK-09	PLF-SS-033	0.5	S	12/7/92	12/3/92	5270
BK-09	PLF-SS-033	0.5	S	12/4/92	12/3/92	5272
BK-10	PLF-SS-034	0.5	S	12/7/92	12/3/92	5270
BK-10	PLF-SS-034	0.5	S	12/4/92	12/3/92	5272
BK-11	PLF-SS-035	0.5	S	12/7/92	12/3/92	5270
BK-11	PLF-SS-035	0.5	S	12/4/92	12/3/92	5272
BK-12	PLF-SS-036	0.5	S	12/7/92	12/3/92	5270
BK-12	PLF-SS-036	0.5	S	12/4/92	12/3/92	5272
BK-13	PLF-SS-037	0.5	S	12/7/92	12/3/92	5270
BK-13	PLF-SS-037	0.5	S	12/4/92	12/3/92	5272

Site ID:

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MW - 12I	= Burlington Intermediate Well No. 12	BK-01	= Background Surface Soil Sample No. 1
MW-12D	= Burlington Deep Well No. 12	LS-01	= Landspread Surface Soil Sample No. 1
B-01	= Boring No. 1	SL-01	= Sludge Spread Surface Soil Sample No. 1
		NA	= Not Applicable

Blank Type:
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Sample Matrix:
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Table I-1
Sample Identification

SITE ID	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE MATRIX	SHIP DATE	SAMPLE DATE	CHAIN of CUSTODY
BK-14	PLF-SS-038	0.5	S	12/7/92	12/3/92	5270
BK-14	PLF-SS-038	0.5	S	12/4/92	12/3/92	5272
BK-15	PLF-SS-039	0.5	S	12/7/92	12/3/92	5271
BK-15	PLF-SS-039	0.5	S	12/4/92	12/3/92	5273
BK-16	PLF-SS-040	0.5	S	12/7/92	12/3/92	5271
BK-16	PLF-SS-040	0.5	S	12/4/92	12/3/92	5273
BK-17	PLF-SS-041	0.5	S	12/7/92	12/3/92	5271
BK-17	PLF-SS-041	0.5	S	12/4/92	12/3/92	5273
BK-18	PLF-SS-042	0.5	S	12/7/92	12/3/92	5271
BK-18	PLF-SS-042	0.5	S	12/4/92	12/3/92	5273
BK-19	PLF-SS-043	0.5	S	12/7/92	12/3/92	5271
BK-19	PLF-SS-043	0.5	S	12/4/92	12/3/92	5273
BK-20	PLF-SS-044	0.5	S	12/7/92	12/3/92	5271
BK-20	PLF-SS-044	0.5	S	12/4/92	12/3/92	5273
BK-20	PLF-SS-046	0.5	S	12/7/92	12/3/92	5271
BK-20	PLF-SS-046	0.5	S	12/4/92	12/3/92	5273
BK-21	PLF-SS-045	0.5	S	12/7/92	12/3/92	5271
BK-21	PLF-SS-045	0.5	S	12/4/92	12/3/92	5273
LS-01	PLF-SS-047	0.5	S	12/7/92	12/5/92	5274
LS-01	PLF-SS-047	0.5	S	12/7/92	12/5/92	5276
LS-02	PLF-SS-048	0.5	S	12/7/92	12/5/92	5274
LS-02	PLF-SS-048	0.5	S	12/7/92	12/5/92	5276
LS-02	PLF-SS-067	0.5	S	12/7/92	12/5/92	5275
LS-02	PLF-SS-067	0.5	S	12/7/92	12/5/92	5277
LS-03	PLF-SS-049	0.5	S	12/7/92	12/5/92	5274
LS-03	PLF-SS-049	0.5	S	12/7/92	12/5/92	5276
LS-04	PLF-SS-050	0.5	S	12/7/92	12/5/92	5274
LS-04	PLF-SS-050	0.5	S	12/7/92	12/5/92	5276
LS-05	PLF-SS-051	0.5	S	12/7/92	12/5/92	5274
LS-05	PLF-SS-051	0.5	S	12/7/92	12/5/92	5276
LS-06	PLF-SS-052	0.5	S	12/7/92	12/5/92	5274
LS-06	PLF-SS-052	0.5	S	12/7/92	12/5/92	5276
LS-07	PLF-SS-053	0.5	S	12/7/92	12/5/92	5274
LS-07	PLF-SS-053	0.5	S	12/7/92	12/5/92	5276
LS-08	PLF-SS-054	0.5	S	12/7/92	12/5/92	5274
LS-08	PLF-SS-054	0.5	S	12/7/92	12/5/92	5276
LS-09	PLF-SS-055	0.5	S	12/7/92	12/5/92	5274
LS-09	PLF-SS-055	0.5	S	12/7/92	12/5/92	5276

SITE ID	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE MATRIX	SHIP DATE	SAMPLE DATE	CHAIN of CUSTODY
LS-10	PLF-SS-056	0.5	S	12/7/92	12/5/92	5274
LS-10	PLF-SS-056	0.5	S	12/7/92	12/5/92	5276
LS-11	PLF-SS-057	0.5	S	12/7/92	12/5/92	5274
LS-11	PLF-SS-057	0.5	S	12/7/92	12/5/92	5276
LS-12	PLF-SS-058	0.5	S	12/7/92	12/5/92	5274
LS-12	PLF-SS-058	0.5	S	12/7/92	12/5/92	5276
LS-13	PLF-SS-059	0.5	S	12/7/92	12/5/92	5274
LS-13	PLF-SS-059	0.5	S	12/7/92	12/5/92	5276
LS-14	PLF-SS-060	0.5	S	12/7/92	12/5/92	5274
LS-14	PLF-SS-060	0.5	S	12/7/92	12/5/92	5276
LS-15	PLF-SS-061	0.5	S	12/7/92	12/5/92	5275
LS-15	PLF-SS-061	0.5	S	12/7/92	12/5/92	5277
LS-16	PLF-SS-062	0.5	S	12/7/92	12/5/92	5275
LS-16	PLF-SS-062	0.5	S	12/7/92	12/5/92	5277
LS-17	PLF-SS-063	0.5	S	12/7/92	12/5/92	5275
LS-17	PLF-SS-063	0.5	S	12/7/92	12/5/92	5277
LS-18	PLF-SS-064	0.5	S	12/7/92	12/5/92	5275
LS-18	PLF-SS-064	0.5	S	12/7/92	12/5/92	5277
LS-19	PLF-SS-065	0.5	S	12/7/92	12/5/92	5275
LS-19	PLF-SS-065	0.5	S	12/7/92	12/5/92	5277
LS-20	PLF-SS-066	0.5	S	12/7/92	12/5/92	5275
LS-20	PLF-SS-066	0.5	S	12/7/92	12/5/92	5277
SL-01	PLF-SS-001	0.5	S	12/7/92	12/2/92	5266
SL-01	PLF-SS-001	0.5	S	12/4/92	12/2/92	5268
SL-02	PLF-SS-002	0.5	S	12/7/92	12/2/92	5266
SL-02	PLF-SS-002	0.5	S	12/4/92	12/2/92	5268
SL-03	PLF-SS-003	0.5	S	12/7/92	12/2/92	5266
SL-03	PLF-SS-003	0.5	S	12/4/92	12/2/92	5268
SL-04	PLF-SS-004	0.5	S	12/7/92	12/2/92	5266
SL-04	PLF-SS-004	0.5	S	12/4/92	12/2/92	5268
SL-05	PLF-SS-005	0.5	S	12/7/92	12/2/92	5266
SL-05	PLF-SS-005	0.5	S	12/4/92	12/2/92	5268
SL-06	PLF-SS-006	0.5	S	12/7/92	12/2/92	5266
SL-06	PLF-SS-006	0.5	S	12/4/92	12/2/92	5268
SL-07	PLF-SS-007	0.5	S	12/7/92	12/2/92	5266
SL-07	PLF-SS-007	0.5	S	12/4/92	12/2/92	5268
SL-08	PLF-SS-008	0.5	S	12/7/92	12/2/92	5266
SL-08	PLF-SS-008	0.5	S	12/4/92	12/2/92	5268

Site ID:

#1	= JUB Well #1
EE-2	= Ecology and Environmental Well No. 2
MW-12S	= Burlington Shallow Well No. 12
MW - 12I	= Burlington Intermediate Well No. 12
MW-12D	= Burlington Deep Well No. 12
B-01	= Boring No. 1
OW-15	= Observation Well No. 15
LFG-1	= Landfill Gas Probe No. 1
PH-01	= RECON Probe Hole No. 1
BK-01	= Background Surface Soil Sample No. 1
LS-01	= Landspread Surface Soil Sample No. 1
SL-01	= Sludge Spread Surface Soil Sample No. 1
NA	= Not Applicable

Blank Type:

SB = System Blank
ER = Equipment Rinse
TB = Trip Blank
FB = Field Blank

Sample Matrix:

W = Water
S = Surface or Subsurface Soil
A = Landfill / Soil Gas
G = Air
N = Nitrogen

Table I-1
Sample Identification

SITE ID	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE MATRIX	SHIP DATE	SAMPLE DATE	CHAIN of CUSTODY
SL-09	PLF-SS-009	0 5	S	12/7/92	12/2/92	5266
SL-09	PLF-SS-009	0 5	S	12/4/92	12/2/92	5268
SL-10	PLF-SS-010	0 5	S	12/7/92	12/2/92	5266
SL-10	PLF-SS-010	0 5	S	12/4/92	12/2/92	5268
SL-10	PLF-SS-021	0 5	S	12/7/92	12/2/92	5267
SL-10	PLF-SS-021	0 5	S	12/4/92	12/2/92	5269
SL-11	PLF-SS-011	0 5	S	12/7/92	12/2/92	5266
SL-11	PLF-SS-011	0 5	S	12/4/92	12/2/92	5268
SL-12	PLF-SS-012	0 5	S	12/7/92	12/2/92	5266
SL-12	PLF-SS-012	0 5	S	12/4/92	12/2/92	5268
SL-13	PLF-SS-013	0 5	S	12/7/92	12/2/92	5266
SL-13	PLF-SS-013	0 5	S	12/4/92	12/2/92	5268
SL-14	PLF-SS-014	0 5	S	12/7/92	12/2/92	5266
SL-14	PLF-SS-014	0 5	S	12/4/92	12/2/92	5268
SL-15	PLF-SS-015	0 5	S	12/7/92	12/2/92	5267
SL-15	PLF-SS-015	0 5	S	12/4/92	12/2/92	5269
SL-16	PLF-SS-016	0 5	S	12/7/92	12/2/92	5267
SL-16	PLF-SS-016	0 5	S	12/4/92	12/2/92	5269
SL-17	PLF-SS-017	0 5	S	12/7/92	12/2/92	5267
SL-17	PLF-SS-017	0 5	S	12/4/92	12/2/92	5269
SL-18	PLF-SS-018	0 5	S	12/7/92	12/2/92	5267
SL-18	PLF-SS-018	0 5	S	12/4/92	12/2/92	5269
SL-19	PLF-SS-019	0 5	S	12/7/92	12/2/92	5267
SL-19	PLF-SS-019	0 5	S	12/4/92	12/2/92	5269
SL-20	PLF-SS-020	0 5	S	12/7/92	12/2/92	5267
SL-20	PLF-SS-020	0 5	S	12/4/92	12/2/92	5269
LANDFILL GAS						
LFG-1	GPS001	42 5	A	3/22/93	3/22/93	5289
LFG-1	GPS002	30 5	A	3/22/93	3/22/93	5289
LFG-1	GPS003	13.5	A	3/22/93	3/22/93	5289
LFG-2	GPS004	20.5	A	3/22/93	3/22/93	5289
LFG-2	GPS006	6.5	A	3/22/93	3/22/93	5289
SOIL GAS						
PH-01	PLF-SG-003	30	A	NA	10/26/92	5263
PH-02	PLF-SG-005	5	A	10/27/92	10/26/92	NA
PH-03	PLF-SG-006	12	A	NA	10/26/92	NA
PH-04	PLF-SG-007	30	A	NA	10/26/92	NA
PH-04	PLF-SG-007-D	30	A	NA	10/26/92	NA
PH-04	PLF-SG-008	5	A	10/27/92	10/26/92	5263

SITE ID	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE MATRIX	SHIP DATE	SAMPLE DATE	CHAIN of CUSTODY
PH-05	PLF-SG-014	30	A	NA	10/28/92	NA
PH-05	PLF-SG-015	5	A	10/29/92	10/28/92	5264
PH-06	PLF-SG-016	33	A	NA	10/28/92	NA
PH-06	PLF-SG-017	5	A	10/29/92	10/28/92	5264
PH-06	PLF-SG-018	5	A	10/29/92	10/28/92	5264
PH-07	PLF-SG-019	27	A	NA	10/28/92	NA
PH-07	PLF-SG-020	5	A	10/29/92	10/28/92	5264
PH-08	PLF-SG-021	45	A	NA	10/28/92	NA
PH-08	PLF-SG-021-D	45	A	NA	10/28/92	NA
PH-09	PLF-SG-026	30	A	NA	10/29/92	NA
PH-09	PLF-SG-027	5	A	10/29/92	10/29/92	5264
PH-10	PLF-SG-028	30	A	NA	10/29/92	NA
PH-11	PLF-SG-029	40	A	NA	10/29/92	NA
PH-12	PLF-SG-030	27	A	NA	10/29/92	NA
PH-13	PLF-SG-032	40	A	NA	10/29/92	NA
PH-14	PLF-SG-034	30	A	NA	10/29/92	NA
PH-15	PLF-SG-035	40	A	NA	10/29/92	NA
PH-16	PLF-SG-036	30	A	NA	10/29/92	NA
PH-16	PLF-SG-036-D	30	A	NA	10/29/92	NA
PH-17	PLF-SG-041	40	A	NA	10/30/92	NA
PH-17	PLF-SG-042	5	A	11/2/92	10/30/92	5265
PH-18	PLF-SG-043	5	A	11/2/92	10/30/92	5265
PH-19	PLF-SG-044	40	A	NA	10/30/92	NA
PH-20	PLF-SG-045	40	A	NA	10/30/92	NA
PH-21	PLF-SG-046	30	A	NA	10/30/92	NA
PH-21	PLF-SG-047	5	A	11/2/92	10/30/92	5265
PH-22	PLF-SG-048	40	A	NA	10/30/92	NA
PH-23	PLF-SG-049	42	A	NA	10/30/92	NA
PH-24	PLF-SG-050	40	A	NA	10/30/92	NA
PH-08	PLF-SG-051	30	A	NA	10/30/92	NA
PH-08	PLF-SG-052	15	A	NA	10/30/92	NA
PH-08	PLF-SG-052-D	15	A	NA	10/30/92	NA
PH-25	PLF-SG-057	40	A	NA	10/31/92	NA
PH-26	PLF-SG-058	40	A	NA	10/31/92	NA
PH-26	PLF-SG-058-D	40	A	NA	10/31/92	NA
PH-27	PLF-SG-060	5	A	11/2/92	10/31/92	5265

Site ID:			
#1	= JUB Well #1	OW-15	= Observation Well No. 15
EE-2	= Ecology and Environmental Well No. 2	LFG-1	= Landfill Gas Probe No. 1
MW-12S	= Burlington Shallow Well No. 12	PH-01	= RECON Probe Hole No. 1
MW - 12I	= Burlington Intermediate Well No. 12	BK-01	= Background Surface Soil Sample No. 1
MW-12D	= Burlington Deep Well No. 12	LS-01	= Landspread Surface Soil Sample No. 1
B-01	= Boring No. 1	SL-01	= Sludge Spread Surface Soil Sample No. 1
		NA	= Not Applicable

Blank Type:
SB = System Blank
ER = Equipment Rinse
TB = Trip Blank
FB = Field Blank

Sample Matrix:
W = Water
S = Surface or Subsurface Soil
A = Landfill / Soil Gas
G = Air
N = Nitrogen

Table I-1
Sample Identification

BLANK TYPE	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE MATRIX	SHIP DATE	SAMPLE DATE	CHAIN of CUSTODY
EQUIPMENT RINSE / FIELD BLANK / TRIP BLANK						
ER	PLF-ER-001	NA	W	12/7/92	12/7/92	5279
ER	PLF-ER-001	NA	W	12/7/92	12/7/92	5280
ER	PLF-ER-002	NA	W	12/7/92	12/7/92	5279
ER	PLF-ER-002	NA	W	12/7/92	12/7/92	5280
ER	PLF-ER-003	NA	W	12/7/92	12/7/92	5279
ER	PLF-ER-003	NA	W	12/7/92	12/7/92	5280
ER	PLF-ER-004	NA	W	12/21/92	12/21/92	5283
ER	PLF-ER-005	NA	W	12/29/92	12/29/92	5286
ER	PLF-ER-006	NA	W	1/27/93	1/27/93	5303
ER	PLF-ER-006	NA	W	1/27/93	1/27/93	5304
ER	PLF-ER-007	NA	W	2/11/93	2/11/93	5341
ER	PLF-ER-007	NA	W	2/11/93	2/11/93	5338
ER	PLF-ER-008	NA	W	2/11/93	2/11/93	5341
ER	PLF-ER-008	NA	W	2/11/93	2/11/93	5338
TB	PLF-GW-005	NA	W	1/27/93	1/26/93	5299
FB	PLF-GW-008	NA	W	2/8/93	2/2/93	5307
TB	PLF-GW-009	NA	W	2/8/93	2/2/93	5307
FB	PLF-GW-010	NA	W	2/8/93	2/3/93	5310
TB	PLF-GW-011	NA	W	2/8/93	2/3/93	5310
FB	PLF-GW-012	NA	W	2/8/93	2/3/93	5310
FB	PLF-GW-013	NA	W	2/8/93	2/4/93	5310
FB	PLF-GW-014	NA	W	2/8/93	2/4/93	5310
TB	PLF-GW-016	NA	W	2/8/93	2/8/93	5332
TB	PLF-GW-025	NA	W	2/9/93	2/9/93	5336
TB	PLF-GW-031	NA	W	2/10/93	2/10/93	5339
TB	PLF-GW-041	NA	W	2/11/93	2/11/93	5341
ER	PLF-GW-047	NA	W	2/11/93	2/11/93	5341
ER	PLF-GW-049	NA	W	2/11/93	2/11/93	5341
ER	PLF-GW-049	NA	W	2/11/93	2/11/93	5340
ER	PLF-GW-052	NA	W	2/16/93	2/12/93	5343
SB	PLF-SG-001	NA	G	NA	10/26/92	NA
SB	PLF-SG-002	NA	G	NA	10/26/92	NA
SB	PLF-SG-004	NA	G	NA	10/26/92	NA
SB	PLF-SG-009	NA	G	NA	10/26/92	NA
TB	PLF-SG-010	NA	N	10/27/92	10/26/92	5263
SB	PLF-SG-011	NA	G	NA	10/27/92	NA
SB	PLF-SG-012	NA	G	NA	10/27/92	NA

BLANK TYPE	SAMPLE NUMBER	SAMPLE DEPTH	SAMPLE MATRIX	SHIP DATE	SAMPLE DATE	CHAIN of CUSTODY
ER	PLF-SG-013	NA	G	NA	10/27/92	NA
SB	PLF-SG-022	NA	G	NA	10/27/92	NA
SB	PLF-SG-023	NA	G	NA	10/29/92	NA
SB	PLF-SG-024	NA	G	NA	10/29/92	NA
ER	PLF-SG-025	NA	G	NA	10/29/92	NA
TB	PLF-SG-031	NA	N	10/29/92	10/29/92	5264
SB	PLF-SG-033	NA	G	NA	10/29/92	NA
SB	PLF-SG-037	NA	G	NA	10/29/92	NA
SB	PLF-SG-038	NA	G	NA	10/30/92	NA
SB	PLF-SG-039	NA	G	NA	10/30/92	NA
ER	PLF-SG-040	NA	G	NA	10/30/92	NA
SB	PLF-SG-053	NA	G	NA	10/30/92	NA
SB	PLF-SG-054	NA	G	NA	10/31/92	NA
SB	PLF-SG-055	NA	G	NA	10/31/92	NA
ER	PLF-SG-056	NA	G	NA	10/31/92	NA
SB	PLF-SG-059	NA	G	NA	10/31/92	NA
TB	PLF-SG-061	NA	N	11/2/92	10/31/92	5265

Site ID:			
#1	= JUB Well #1	OW-15	= Observation Well No. 15
EE-2	= Ecology and Environmental Well No. 2	LFG-1	= Landfill Gas Probe No. 1
MW-12S	= Burlington Shallow Well No. 12	PH-01	= RECON Probe Hole No. 1
MW - 12I	= Burlington Intermediate Well No. 12	BK-01	= Background Surface Soil Sample No. 1
MW-12D	= Burlington Deep Well No. 12	LS-01	= Landspread Surface Soil Sample No. 1
B-01	= Boring No. 1	SL-01	= Sludge Spread Surface Soil Sample No. 1
		NA	= Not Applicable

Blank Type:
SB = System Blank
ER = Equipment Rinse
TB = Trip Blank
FB = Field Blank

Sample Matrix:
W = Water
S = Surface or Subsurface Soil
A = Landfill / Soil Gas
G = Air
N = Nitrogen

Table I-2

SAMPLE LISTINGS

PASCO LANDFILL
PASCO, WASHINGTON

Appendix I Subsection	Analysis Type	Sample Group
GROUNDWATER		
I1.1	Coliforms	PLF-GW-002 to PLF-GW-049
I1.2	VOCs, SVOCs, Chlorinated Herbicides, Metals, Pest./PCBs	PLF-GW-001; PLF-ER-001 to PLF-ER-003
I1.3	VOCs, SVOCs, Pest./PCBs, Metals, MFS, Chlorinated Herbicides	PLF-GW-002 to PLF-GW-007; PLF-ER-004 to PLF-ER-006
I1.4	Chlorinated Herbicides, MFS	PLF-GW-002 to PLF-GW-007, PLF-ER-006
I1.5	Radiochemical	PLF-GW-030 to PLF-GW-034; PLF-GW-038 to PLF-GW-042; PLF-ER-007, PLF-ER-008
I1.6	VOCs, SVOCs, Pest./PCBs, Chlorinated Herbicides, Metals, MFS	PLF-GW-040 to PLF-GW-049; PLF-ER-007, PLF-ER-008
I1.7	VOCs, SVOCs, Pest./PCBs, Chlorinated Herbicides, Metals, MFS	PLF-GW-030 to PLF-GW-039
I1.8	VOCs, SVOCs, Pest./PCBs, Metals, MFS	PLF-GW-015 to PLF-GW-021
I1.9	VOCs	PLF-GW-008 to PLF-GW-014
I1.10	VOCs, SVOCs, Pest./PCBs, Chlorinated Herbicides, Metals, MFS	PLF-GW-022 to PLF-GW-029
I1.11	VOCs, SVOCs, Pest./PCBs, Chlorinated Herbicides, Metals	PLF-GW-050 to PLF-GW-053
SURFACE SOILS		
I2.1	Radiochemical	PLF-SS-001 to PLF-SS-021; PLF-SS-025 to PLF-SS-067; PLF-ER-001 to PLF-ER-003
I2.2	TOC, Chlorinated Herbicides	PLF-SS-001 to PLF-SS-021; PLF-SS-025 to PLF-SS-046
I2.3	SVOCs	PLF-SS-001 to PLF-SS-021; PLF-SS-025 to PLF-SS-046
I2.4	Pest./PCBs	PLF-SS-01 to PLF-SS-021; PLF-SS-025 to PLF-SS-046

Table I-2, Continued

SAMPLE LISTINGS

PASCO LANDFILL
PASCO, WASHINGTON

Appendix I Subsection	Analysis Type	Sample Group
SURFACE SOILS, Continued		
I2.5	Metals	PLF-SS-01 to PLF-SS-021; PLF-SS-025 to PLF-SS-046
I2.6	TOC, Chlorinated Herbicides	PLF-SS-047 to PLF-SS-067
I2.7	SVOCs	PLF-SS-047 to PLF-SS-067
I2.8	Metals	PLF-SS-047 to PLF-SS-067
I2.9	Pest./PCBs	PLF-SS-047 to PLF-SS-067
SUBSURFACE SOILS		
I3.1	Radiochemical	PLF-SBS-242 to PLF-SBS-254
I3.2	Radiochemical	PLF-SBS-265 to PLF-SBS-269; PLF-GW-002 to PLF-GW-004, PLF-ER-006
I3.3	TOC and CEC	PLF-SBS-169 and PLF-SBS-215
I3.4	Dioxins and Dibenzofurans	PLF-SBS-297 to PLF-SBS-305
I3.5	VOCs, SVOCs, Pest./PCBs, Metals	PLF-SBS-099, PLF-SBS-107, PLF-SBS-110
I3.6	Radiochemical	PLF-SBS-274 to PLF-SBS-296
I3.7	VOCs	PLF-SBS-242 to PLF-SBS-245; PLF-SBS-250 to PLF-SBS-254
I3.8	SVOCs	PLF-SBS-233 to PLF-SBS-235; PLF-SBS-237 to PLF-SBS-254
I3.9	Chlorinated Herbicides	PLF-SBS-242 to PLF-SBS-254
I3.10	Pest./PCBs	PLF-SBS-242 to PLF-SBS-254
I3.11	Metals	PLF-SBS-233 to PLF-SBS-235; PLF-SBS-237 to PLF-SBS-254
I3.12	VOCs, SVOCs, Metals, Pest./PCBs	PLF-SBS-128, PLF-SBS-150, PLF-SBS-167, PLF-SBS-180, PLF-SBS-213
I3.13	VOCs, SVOCs, Chlorinated Herbicides, Pest./PCBs, Metals	PLF-SBS-256 to PLF-SBS-259; PLF-SBS-261 to PLF-SBS-269; PLF-SBS-273 to PLF-SBS-305

Table I-2, Continued

SAMPLE LISTINGS

PASCO LANDFILL
PASCO, WASHINGTON

Appendix I Subsection	Analysis Type	Sample Group
SOIL-GAS		
I4.1	VOCs	PLF-SG-005, PLF-SG-008, PLF-SG-010, PLF-SG-015, PLF-SG-017, PLF-SG-018, PLF-SG-020, PLF-SG-027, PLF-SG-031, PLF-SG-042, PLF-SG-043, PLF-SG-047, PLF-SG-060, PLF-SG-061
I4.2	VOCs	PLF-SG-001 to PLF-SG-004, PLF-SG-006, PLF-SG-007, PLF-SG-009, PLF-SG-011 to PLF-SG-014, PLF-SG-016, PLF-SG-019, PLF-SG-021 to PLF-SG-026, PLF-SG-028 to PLF-SG-030, PLF-SG-032 to PLF-SG-041, PLF-SG-044 to PLF-SG-046, PLF-SG-048 to PLF-SG-059
LANDFILL GAS		
I5.1	VOCs	GPS-001 to GPS-008

MEMORANDUM

DATE: March 5, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 1B

During the period of October 26 - 31, 1992, fourteen soil-gas samples were collected by Burlington Environmental Inc. (Burlington). Their sample identification numbers are as follows:

PLF-SG-005	PLF-SG-018	PLF-SG-043
PLF-SG-008	PLF-SG-020	PLF-SG-047
PLF-SG-010	PLF-SG-027	PLF-SG-060
PLF-SG-~~1~~0 15 NBC	PLF-SG-031	PLF-SG-061
PLF-SG-017	PLF-SG-042	

These samples were then submitted to Sound Analytical of Tacoma, Washington (work orders 28072, 28178, and 28186), for volatile organic compound analysis (USEPA SW-846, Method 8240). I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number 0LM01.0. These guidelines are normally used for water and soil monitoring. However, this document was relied upon for proper guidance in the soil-gas data validation, since no CLP guidance documents for soil-gas analysis are published.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. The samples received the requested analyses, and all holding, extraction, and analysis times met the required guidelines. All duplicate analyses displayed precision within acceptable quality control (QC) limits.

Surrogate compound recoveries met within expected QC limits with the exception of the third surrogate compound (1,2-dichloromethane-d4) for samples PLF-SG-005, PLF-SG-008, and PLF-SG-010. As such, data from these samples should be considered as estimated values.

Requisite instrument tuning check with bromofluorobenzene documented performance of gas chromatograph/mass spectral analyses. Initial and continuing calibration checks met the required minimum relative response factors for all detected compounds. Internal standards displayed area response and retention times all within required limits. Additional QC was supplied in the form of the raw lab data, gas chromatograms, and mass spectral data for the samples, method blanks, method spikes, and calibration standards. Data consistency was demonstrated throughout.

Proper data qualifier flags accompanied the analytical results as needed with advisement of the previously-noted exception. Overall, the data quality guidelines as advised in the CLP Statement of Work are met. Accordingly, this data can be considered valid for its intended use.

RECOMMENDATIONS

Data reported for samples PLF-SG-005, PLF-SG-008, and PLF-SG-010, should be considered estimates appended with "J" data qualifier flags.

NC/rlk/b43:2046b.mem

MEMORANDUM

DATE: March 5, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 2A

During the period of October 26 - 31, 1992, forty-three soil samples were collected by Burlington Environmental Inc. (Burlington). Their sample identification numbers are as follows:

-SS-001	PLF-SS-007	PLF-SS-013	PLF-SS-019	PLF-SS-028	PLF-SS-034	PLF-SS-040
PLF-SS-002	PLF-SS-008	PLF-SS-014	PLF-SS-020	PLF-SS-029	PLF-SS-035	PLF-SS-041
PLF-SS-003	PLF-SS-009	PLF-SS-015	PLF-SS-021	PLF-SS-030	PLF-SS-036	PLF-SS-042
PLF-SS-004	PLF-SS-010	PLF-SS-016	PLF-SS-025	PLF-SS-031	PLF-SS-037	PLF-SS-043
PLF-SS-005	PLF-SS-011	PLF-SS-017	PLF-SS-026	PLF-SS-032	PLF-SS-038	PLF-SS-044
PLF-SS-006	PLF-SS-012	PLF-SS-018	PLF-SS-027	PLF-SS-033	PLF-SS-039	PLF-SS-045
						PLF-SS-046

These samples were then submitted to Sound Analytical Services (SAS), of Tacoma, Washington (work order 28850), for chlorinated herbicides (USEPA SW-846, Method 8150) and total organic carbon (TOC) per SAS laboratory protocol. I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number 0LM01.0. These guidelines are normally used for water and soil monitoring of specific target compounds. However, this document was also relied upon for proper guidance in the above analyses, because there are no criteria currently available for chlorinated herbicides and total organic carbon analysis.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. The samples received the requested analyses, and all holding, extraction, and analysis times met the required guidelines. Duplicate analyses performed for TOC analysis, displayed acceptable precision between results. Matrix spike/matrix spike duplicate recoveries displayed accuracy within advisory quality control (QC) limits. While there are no surrogate compounds as part of TOC analysis, analytical check standards provided additional evidence of data precision. Elevated method blank values were found for TOC analysis. However, raw data worksheet calculations indicate that the reported sample values have been corrected to reflect this elevated blank value.

Due to insufficient sample volume, a laboratory duplicate analysis was not run for detection of herbicides. This does not affect the completeness of the data as field duplicates indicate the appropriate data precision; PLF-SS-021 is a duplicate of PLF-SS-01 and PLF-SS-046 is a duplicate of PLF-SS-044. All matrix spike/matrix spike duplicate recoveries displayed accuracy within advisory QC limits, with the exception of dalapon, dicamba, MCPA, 2,4-D, and dinoseb. Since these compounds were not detected in the samples, no data qualifier flags are used.

Surrogate compound recoveries for all chlorinated herbicide analyses met within acceptable QC limits. Requisite instrument tuning check with decafluorotriphenylphosphine was reported to document performance of gas chromatograms/mass spectral (GC/MS) analyses. Initial and continuing calibration checks displayed area response, response factors, and retention times within advisory QC limits for all target compounds, as well as internal standards of acenaphthene-D8 and phenanthrene-D10.

Additional QC was supplied in the form of the raw lab data, GC/MS data for the samples, method blanks, method spikes, and calibration standards. Data consistency was demonstrated throughout. Proper data qualifier flags accompanied the analytical results as needed. Overall, the data quality guidelines as advised in the CLP Statement of Work are met. Accordingly, this data can be considered valid for its intended use.

RECOMMENDATIONS

No modifications to the data set are required.

NC/rlk/b44:2051b.mem

MEMORANDUM

DATE: March 5, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist BC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 2D

During the period of October 26 - 31, 1992, forty-three soil samples were collected by Burlington Environmental Inc. (Burlington). Their sample identification numbers are as follows:

PLF-SS-001	PLF-SS-007	PLF-SS-013	PLF-SS-019	PLF-SS-028	PLF-SS-034	PLF-SS-040
PLF-SS-002	PLF-SS-008	PLF-SS-014	PLF-SS-020	PLF-SS-029	PLF-SS-035	PLF-SS-041
PLF-SS-003	PLF-SS-009	PLF-SS-015	PLF-SS-021	PLF-SS-030	PLF-SS-036	PLF-SS-042
PLF-SS-004	PLF-SS-010	PLF-SS-016	PLF-SS-025	PLF-SS-031	PLF-SS-037	PLF-SS-043
PLF-SS-005	PLF-SS-011	PLF-SS-017	PLF-SS-026	PLF-SS-032	PLF-SS-038	PLF-SS-044
PLF-SS-006	PLF-SS-012	PLF-SS-018	PLF-SS-027	PLF-SS-033	PLF-SS-039	PLF-SS-045
						PLF-SS-046

These samples were then submitted to Sound Analytical Services (SAS), of Tacoma, Washington (work order 28850), for priority pollutant metals (PPM) analysis (USEPA SW-846, Method 6010). I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM02.0.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines. All metal analyses were performed by inductively coupled plasma (ICP) analysis with the exception of mercury, which received cold vapor atomic absorption (CVAA) analysis.

All sample spike recoveries met required quality control (QC) limits with the exception of mercury in one out of six sample spikes. All target analytes from serial dilutions were within CLPQC directives with the exception of zinc. For duplicate analyses, eight out of thirteen analytes (flagged *) had relative percent differences exceeding QC limits. This does not reflect overall analytical precision as much as it is an indication of soil sample heterogeneity. All target analytes from laboratory control samples were within required QC limits with the exception of antimony. As such, all reported antimony values should be considered as estimates.

Initial and continuing calibration verification, method blanks, interference checks, ICP correction factors, line calibration data, and calibration check standards all met within required QC limits. Supporting documentation was supplied in the form of raw sample data. Data consistent with reported summary information was demonstrated. Overall, the data quality objectives outlined by the CLP Statement of Work were followed. Accordingly, this data can be considered useful for its intended purpose, with inclusions of the qualifier listed under Recommendations.

RECOMMENDATIONS

All reported values of antimony should be considered as estimates appended with the CLP data qualifier flag "E". No further modifications to the data set are required.

B
NSC 5/18/93

NC/rlk/b44:2061b.mem

MEMORANDUM

DATE: March 5, 1993

TO: Ted Wall, Environmental Engineer JW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 2C

On December 2, 1992, forty-three soil samples were collected by Burlington field personnel. Their sample identification numbers are as follows:

PLF-SS-001	PLF-SS-007	PLF-SS-013	PLF-SS-019	PLF-SS-028	PLF-SS-034	PLF-SS-040
PLF-SS-002	PLF-SS-008	PLF-SS-014	PLF-SS-020	PLF-SS-029	PLF-SS-035	PLF-SS-041
PLF-SS-003	PLF-SS-009	PLF-SS-015	PLF-SS-021	PLF-SS-030	PLF-SS-036	PLF-SS-042
PLF-SS-004	PLF-SS-010	PLF-SS-016	PLF-SS-025	PLF-SS-031	PLF-SS-037	PLF-SS-043
PLF-SS-005	PLF-SS-011	PLF-SS-017	PLF-SS-026	PLF-SS-032	PLF-SS-038	PLF-SS-044
PLF-SS-006	PLF-SS-012	PLF-SS-018	PLF-SS-027	PLF-SS-033	PLF-SS-039	PLF-SS-045
						PLF-SS-046

These samples were then submitted to Sound Analytical Services (SAS), of Tacoma, Washington (work order 28850). Data Set 2C represents results from pesticide/PCB analyses (USEPA SW-846, Method 8080). I have completed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number 0LM01.0. My findings are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines. Dual column analysis/confirmation (columns DB-608 and DB-5), was performed for all samples as required according to CLP directives.

A transcription error was noted for sample PLF-SS-036. Specifically, the analyte 4,4'-DDD is reported for this sample. Examination of the sample chromatograms and raw data clearly indicate that 4,4'-DDE is the target compound that should be reported.

Surrogate compound recoveries for all samples met advisory quality control (QC) limits with the exception of column DB-608 samples PLF-SS-019, PLF-SS-021, and laboratory duplicate for PLF-SS-035. Surrogate compound retention times for all samples met QC limits with the exception of column DB-5 samples PLF-SS-035, PLF-SS-035 (Matrix Spike Duplicate), PLF-SS-044, PLF-SS-044 (duplicate), PLF-SS-044 (matrix spike), PLF-SS-45, and method blank #3. Per CLP protocol, since no target analytes were detected in these samples, no data qualifier flags are used.

Matrix spike/matrix spike duplicate data met required QC limits for data set accuracy with advisement of the above surrogate issue. Duplicate data met advisory QC limits for overall data set precision with advisement of the above surrogate issue. Method blank analyses required no corrections and contained no laboratory contaminants.

Initial and continuing calibration standards were performed and met required QC limits with the following exceptions: 1) The initial calibration QC criteria for breakdown of 4,4'-DDT and Endrin was exceeded by both analytical columns. This is noteworthy as 4,4'-DDE is a breakdown product of 4,4'-DDT. 4,4'-DDE was reported in samples PLF-SS-029 (4.4 parts per billion (ppb)) and PLF-SS-036 (3.8 ppb), and these values are very close to the practical quantitation limit of 3.5 ppb. 2) The initial calibration of single target analytes for column DB-5 had several calibration factors outside QC limits. This applies to target analytes d-benzenehexachloride, *4,4'-DDE*, endosulfan II, and endosulfan sulfate. Furthermore, results between dual column confirmation of these samples vary by more than 50 percent, bringing into question the analytical precision.

Pesticide analyte resolution and calibration verification summaries were included for both columns and analytical sequence forms clearly displayed analytical performance. Additional QC was supplied in the form of the raw laboratory worksheets and dual column chromatograms for all samples, matrix spikes, duplicates, and calibration standards. Data consistent with reported summary information was evident.

Overall, the data quality guidelines required by the CLP statement of work were followed. Due to the additive nature of QC issues involving the reported 4,4'-DDE values, the absence of a "J" data qualifier flag cannot be supported; otherwise, this data can be considered valid for its intended use.

RECOMMENDATIONS

A "J" data qualifier flag should be added to all reported 4,4'- DDE values.

NC/rlk/b44:2060b.mem

MEMORANDUM

DATE: March 5, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 3A

On December 5, 1992, twenty-one soil samples were collected by Burlington field personnel. Their sample identification numbers are listed below.

PLF-SS-047	PLF-SS-051	PLF-SS-055	PLF-SS-059	PLF-SS-063
PLF-SS-048	PLF-SS-052	PLF-SS-056	PLF-SS-060	PLF-SS-064
PLF-SS-049	PLF-SS-053	PLF-SS-057	PLF-SS-061	PLF-SS-065
PLF-SS-050	PLF-SS-054	PLF-SS-058	PLF-SS-062	PLF-SS-066
				PLF-SS-067

These samples were then submitted to Sound Analytical Services (SAS), of Tacoma, Washington (work order 28878), for chlorinated herbicides (USEPA SW-846, Method 8150) and total organic carbon (TOC) per SAS laboratory protocol. I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number 0LM01.0. These guidelines are normally used for water and soil monitoring of specific target compounds. However, this document was also relied upon for proper guidance in the above analyses, because no CLP guidelines have been published for chlorinated herbicides and total organic carbon analysis.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. The samples received the requested analyses, and all holding, extraction, and analysis times met the required guidelines. Duplicate analyses performed for TOC analysis, displayed acceptable precision between results. Matrix spike/matrix spike duplicate recoveries displayed accuracy within advisory quality control (QC) limits. While there are no surrogate compounds as part of TOC analysis, analytical check standards provided additional evidence of data precision. An elevated method blank value was found for TOC analysis. As agreed upon by SAS, the two reported TOC values (samples PLF-SS-053 and PLF-SS-063) should be adjusted 40 mg/kg downward to baseline.

Laboratory duplicates analysis were not run for detection of herbicides. However, field duplicate pair PLF-SS-048 and PLF-SS-067 indicate appropriate analytical precision. All matrix spike/matrix spike duplicate recoveries displayed accuracy within advisory QC limits, with the exception of dalapon, and dicamba. Per CLP protocol, since these compounds were not detected in the samples, no data qualifier flags are used.

Surrogate compound recoveries for all chlorinated herbicide analyses met within expected QC limits. Requisite instrument tuning check with decafluorotriphenylphosphine was reported to document performance of gas chromatograms/mass spectral (GC/MS) analyses. Initial and continuing calibration checks displayed area response, response factors, and retention times within advisory QC limits for all target compounds, as well as those for internal standards.

Additional QC was supplied in the form of the raw lab data, GC/MS data for the samples, method blanks, method spikes, and calibration standards. Data consistency was demonstrated throughout. Proper data qualifier flags accompanied the analytical results as needed. Overall, the data quality guidelines as advised in the CLP Statement of Work are met. Accordingly, this data can be considered valid for its intended use.

RECOMMENDATIONS

All reported TOC values should be adjusted 40 mg/kg less than stated.

MEMORANDUM

DATE: March 5, 1993

TO: Ted Wall, Environmental Engineer JW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 3C

On December 5, 1992, twenty-one soil samples were collected by Burlington field personnel. Their sample identification numbers are as follows:

PLF-SS-047	PLF-SS-050	PLF-SS-053	PLF-SS-056	PLF-SS-059	PLF-SS-062	PLF-SS-065
PLF-SS-048	PLF-SS-051	PLF-SS-054	PLF-SS-057	PLF-SS-060	PLF-SS-063	PLF-SS-066
PLF-SS-049	PLF-SS-052	PLF-SS-055	PLF-SS-058	PLF-SS-061	PLF-SS-064	PLF-SS-067

These samples were then submitted to Sound Analytical Services (SAS), of Tacoma, Washington (work order 28878), for priority pollutant metals (PPM) analysis (USEPA SW-846, Method 6010). I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM02.0.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines. All metal analyses were performed by inductively coupled plasma (ICP) analysis with the exception of mercury, which received cold vapor atomic absorption (CVAA) analysis.

All sample spike recoveries met required quality control (QC) limits with the exception of antimony and thallium. All target analytes from serial dilutions were within CLP QC directives with the exception of zinc. For duplicate analyses, seven out of thirteen analytes (flagged *) had relative percent differences exceeding QC limits. This does not reflect overall

analytical precision as much as it is an indication of soil sample heterogeneity. All target analytes from laboratory control samples were within required QC limits with the exception of antimony. As such, all reported antimony values should be considered as estimates.

Initial and continuing calibration verification, method blanks, interference checks, ICP correction factors, line calibration data, and calibration check standards all met within required QC limits. Supporting documentation was supplied in the form of raw sample data. Data consistent with reported summary information was demonstrated. Overall, the data quality objectives outlined by the CLP Statement of Work were followed. Accordingly, these data can be considered useful for their intended purpose, with inclusions of qualifiers listed under Recommendations.

RECOMMENDATIONS

All reported values of antimony should be considered as estimates appended with the CLP data qualifier flag "~~E~~ B". 5/18/93

NC/rlk/b44:2070b.mem

MEMORANDUM

DATE: March 5, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 3D

On December 5, 1992, twenty-one soil samples were collected by Burlington field personnel. Their sample identification numbers are as follows:

PLF-SS-047	PLF-SS-050	PLF-SS-053	PLF-SS-056	PLF-SS-059	PLF-SS-062	PLF-SS-065
PLF-SS-048	PLF-SS-051	PLF-SS-054	PLF-SS-057	PLF-SS-060	PLF-SS-063	PLF-SS-066
PLF-SS-049	PLF-SS-052	PLF-SS-055	PLF-SS-058	PLF-SS-061	PLF-SS-064	PLF-SS-067

These samples were then submitted to Sound Analytical Services, of Tacoma, Washington (work order 28878). Data Set 3D represents results from pesticide/PCB analysis (USEPA SW-846, Method 8080). I have completed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number 0LM01.0. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines. Dual column analysis/confirmation (columns DB-608 and DB-5), was performed for all samples as required according to CLP directives.

A transcription error was noted for performance evaluation of the above columns. Specifically, the combined percent breakdown of 4,4'-DDT and Endrin reported is lower than the correctly calculated breakdown value. Regardless, the higher corrected value remains within the CLP acceptance criteria. The correct calculations are in the project file (Section 19.14, Lab QA/QC Data).

Surrogate compound recoveries for all samples met advisory quality control (QC) limits with the exception of tetrachloro-m-xylene recovery for samples PLF-SS-047 and PLF-SS-057. Performance evaluation compound retention times met QC limits with the exception of 4,4'-DDD, 4,4'-DDT, Endosulfan II, α-chlordane, and γ-chlordane for column DB-5. However, no target analytes were detected in the samples. Per CLP protocol, no data qualifier flags were needed.

Matrix spike/matrix spike duplicate data met required QC limits for data set accuracy. Duplicate data met advisory QC limits for overall data set precision. Method blank analyses required no corrections and contained no laboratory contaminants. Initial and continuing calibration standards were performed and met most required QC limits with the exceptions noted above regarding compound retention times and recoveries.

Pesticide/PCB analyte resolution and calibration verification summaries were included for both columns and analytical sequence forms further described analytical performance. Additional QC was supplied in the form of the raw laboratory worksheets and dual column chromatograms for all samples, matrix spikes, duplicates, and calibration standards. Examination of this material reveals that analyte values for all matrix spikes, duplicates, and samples, were quantitated from the average response factors found during calibration. The chromatograms have been annotated to reflect this change, and data consistent with reported summary information was evident.

Overall, the data quality guidelines required by the CLP statement of work were followed. Accordingly, this data can be considered useful for its intended purpose.

RECOMMENDATION

No modification of the data are required.

MEMORANDUM

DATE: March 5, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NC

SUBJECT: DATA VALIDATION OF RADIOCHEMICAL ANALYSIS FORM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 5A

During the period of January 23-24, 1993, thirteen subsurface soil samples were collected by Burlington Environmental Inc. (Burlington). Their sample identification numbers are as follows:

PLF-SBS-242	PLF-SBS-246	PLF-SBS-249	PLF-SBS-252
PLF-SBS-243	PLF-SBS-247	PLF-SBS-250	PLF-SBS-253
PLF-SBS-244	PLF-SBS-248	PLF-SBS-251	PLF-SBS-254
PLF-SBS-245			

These samples were then submitted to Barringer Laboratories, Golden, Colorado (job number 936161E), for alpha, beta, and gamma radiation analysis (USEPA Methods 900 and 901.1). As there are no Contract Laboratory Program (CLP) guidelines for radiochemical analysis, I performed a data quality review of the analytical results in accordance with the USEPA Handbook for Analytical Quality Control in Radioanalytical Laboratories (EPA 600/7-77-088). This document was relied upon for proper guidance in the radiochemical data validation, as it is no less stringent in its data quality requirements than CLP criteria.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly preserved and received in good condition. The samples received the requested analyses, and all holding, extraction, and analysis times met the required guidelines. Method blanks displayed spike recoveries well within quality control (QC) criteria, and no blank corrections were required. All duplicate analyses displayed precision within acceptable QC limits. Matrix spike/matrix spike duplicates, and continuing calibration data displayed required analytical accuracy. A ninety-five percent confidence level is reported for all results, including appropriate standard deviations.

Alpha and beta analysis were supplied with additional data quality assurance in the form of USEPA sample intercomparison records, particle background records, laboratory worksheets, and sample run logs. Gamma analysis included supporting documentation of certified calibration standards (traceable to the National Institute of Standards and Technology), instrument

background checks, instrument efficiency and control checks, and laboratory sample logs. Data consistent with reported summary information was demonstrated.

Overall, the data quality objectives as required by USEPA directives are met. Accordingly, this data set can be considered valid for its intended use.

RECOMMENDATIONS

No modifications of the data are required.

NC/rlk/b45:2096b.mem

MEMORANDUM

DATE: March 5, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF WATER QUALITY ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION PROJECT 624419, DATA SET 1C

Between January 26 and February 11, 1993, forty-two water samples were collected by Burlington field personnel. The sample identification numbers are as follows.

PLF-GW-002	PLF-GW-015	PLF-GW-022MSD	PLF-GW-030	PLF-GW-036	PLF-GW-042
PLF-GW-002MS	PLF-GW-017	PLF-GW-023	PLF-GW-030MS	PLF-GW-037	PLF-GW-043
PLF-GW-002MSD	PLF-GW-017MS	PLF-GW-024	PLF-GW-030MSD	PLF-GW-038	PLF-GW-044
PLF-GW-003	PLF-GW-017MSD	PLF-GW-026	PLF-GW-032	PLF-GW-039	PLF-GW-045
PLF-GW-004	PLF-GW-020	PLF-GW-027	PLF-GW-033	PLF-GW-040	PLF-GW-046
PLF-GW-006	PLF-GW-022	PLF-GW-028	PLF-GW-034	PLF-GW-040MS	PLF-GW-048
PLF-GW-007	PLF-GW-022MS	PLF-GW-029	PLF-GW-035	PLF-GW-040 MSD	PLF-GW-049

These samples were then submitted for coliform analyses to the Benton-Franklin Health Department, Richland, Washington. These samples were analyzed for the presence of coliform bacteria by the multiple-tube fermentation technique, giving sample results calculated from the most probable number table (Recommended Procedures for Examination of Water, 1970, American Public Health Association, Washington, D.C.). I performed a data quality evaluation of the microbiological results in accordance with USEPA Contract Laboratory Program (CLP) Document #0LM01.0. These guidelines are normally used for the chemical evaluation of water samples. However, this document was relied upon for advisory guidance in microbiological data validation, since no CLP guidance documents for coliform analysis are published.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly preserved and received in good condition. Samples received the requested analysis with all holding, processing, and analysis times meeting the required guidelines. Replicates were performed for PLF-GW-002, PLF-GW-022, PLF-GW-030, and PLF-GW-040; data precision is clearly evident.

Supporting documentation consisted of test media age, pH, and sterility verification. Analytical controls were run on test media to insure that desired organisms produced appropriate results and non-coliforms did not interfere. Additional controls were also run on sterilizers, balances, and the equipment used in processing of samples and reagents. Copies of raw lab data will remain on file with the Benton-Franklin Health Department and are available upon request. The data quality objectives as advised by CLP guidelines are met. Accordingly, this data can be considered valid for its intended use.

RECOMMENDATIONS

No modifications to the data are required.

NC/rlk/b44:2084b.mem

MEMORANDUM

DATE: March 16, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 6E

On January 26, 1993, four water samples were collected by Burlington field personnel. The sample identification numbers and associated analyses are listed below.

Samples	Chlorinated Herbicides 8150	Minimal Functional Standards: Chemical Oxygen Demand, Total Organic Carbon, Ammonia
PLF-GW-002	X	X
PLF-GW-003	X	X
PLF-GW-004	X	X
PLF-ER-006	X	
PLF-GW-006		X
PLF-GW-007		X

These samples were then submitted to Sound Analytical Services (SAS), of Tacoma, Washington (work order 29839). I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number 0LM01.0. These guidelines are normally used for water and soil monitoring of specific target compounds. However, this document was also relied upon for proper guidance in the above analyses, because no CLP guidelines have been published for chlorinated herbicides and Minimal Functional Standards (MFS) analysis.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. The samples received the requested analyses, and all holding, extraction,

and analysis times met the required guidelines. Duplicate analyses performed for MFS analysis, displayed acceptable precision between results. Matrix spike/matrix spike duplicate recoveries displayed accuracy within advisory quality control (QC) limits. While there are no surrogate compounds as part of MFS analysis, analytical check standards provided additional evidence of data precision. Additional instrument calibration was provided and sample results within linearity criteria are evident.

Laboratory duplicates analysis were not run for detection of herbicides. However, field duplicate pair PLF-GW-002 and PLF-GW-003 indicate significant analytical precision. All matrix spike/matrix spike duplicate recoveries displayed accuracy within advisory QC limits, with the exception of dalapon. Per CLP protocol, since this compound was not detected in the samples, no data qualifier flag is used. Surrogate compound recoveries for all chlorinated herbicide analyses met within expected QC limits. Requisite instrument tuning check with decafluorotriphenylphosphine was reported to document performance of gas chromatograms/mass spectral (GC/MS) analyses. Initial and continuing calibration checks displayed area response, response factors, and retention times within advisory QC limits for all target compounds, as well as those for internal standards.

Additional QC was supplied in the form of the raw lab data, GC/MS data for the samples, method blanks, method spikes, and calibration standards. Data consistency was demonstrated throughout. Proper data qualifier flags accompanied the analytical results as needed. Overall, the data quality guidelines as advised in the CLP Statement of Work are met. Accordingly, this data can be considered valid for its intended use.

RECOMMENDATIONS

No modifications to this data set are required.

NC/rlk/b45:2124b.mem

MEMORANDUM

DATE: March 19, 1993

TO: Ted Wall, Environmental Engineer JW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 5B

During the period of October 26 - 31, 1992, two soil samples were collected by Burlington Environmental personnel. The sample identification numbers are PLF-SBS-169 and PLF-SBS-215.

These samples were then submitted to Sound Analytical Services (SAS), of Tacoma, Washington (work order 29774), for analysis of cation exchange capacity (CEC) per USEPA SW-846 Method 9080 and total organic carbon (TOC) per Puget Sound protocol. I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number 0LM01.0. These guidelines are normally used for water and soil monitoring of specific target compounds. However, this document was also relied upon for proper guidance in the above analyses, because there are no criteria currently available for cation exchange capacity and total organic carbon analysis.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. The samples received the requested analyses, and all holding, extraction, and analysis times met the required guidelines. All duplicate analyses displayed acceptable precision between results. Matrix spike/matrix spike duplicate recoveries displayed accuracy within advisory quality control (QC) limits. While there are no surrogate compounds as part of these analyses, analytical check standards provided additional evidence of data precision. Calibration standards provided for CEC analysis displayed linearity within advisory criteria. An elevated method blank value was found for TOC analysis. However, raw data worksheet calculations indicate that the reported sample values have been corrected to reflect this elevated blank value.

Additional QC was supplied in the form of the raw lab data, and data consistency was demonstrated throughout. Overall, the data quality guidelines as advised in the CLP Statement of Work are met. Accordingly, this data can be considered valid for its intended use.

RECOMMENDATIONS

No modifications to the data set are required.

NC/rlk/b45:2121b.mem

MEMORANDUM

DATE: March 19, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 2B

During the period of December 2 and 3, 1992, forty-three soil samples were collected by Burlington field personnel. Their sample identification numbers are as follows:

PLF-SS-001	PLF-SS-007	PLF-SS-013	PLF-SS-019	PLF-SS-028	PLF-SS-034	PLF-SS-040
PLF-SS-002	PLF-SS-008	PLF-SS-014	PLF-SS-020	PLF-SS-029	PLF-SS-035	PLF-SS-041
PLF-SS-003	PLF-SS-009	PLF-SS-015	PLF-SS-021	PLF-SS-030	PLF-SS-036	PLF-SS-042
PLF-SS-004	PLF-SS-010	PLF-SS-016	PLF-SS-025	PLF-SS-031	PLF-SS-037	PLF-SS-043
PLF-SS-005	PLF-SS-011	PLF-SS-017	PLF-SS-026	PLF-SS-032	PLF-SS-038	PLF-SS-044
PLF-SS-006	PLF-SS-012	PLF-SS-018	PLF-SS-027	PLF-SS-033	PLF-SS-039	PLF-SS-045
						PLF-SS-046

These samples were then submitted to Sound Analytical Services (SAS), of Tacoma, Washington (work order 28850) for semivolatile compound analyses (USEPA SW-846, Method 8270). I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number 0LM01.0.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Samples received the requested analyses, with holding, extraction, and analysis times for all samples meeting the required guidelines.

Surrogate compound recoveries met within expected quality control (QC) limits for all samples, method blanks, and matrix spikes. Matrix spike/matrix spike duplicates displayed analytical accuracy within required QC limits. Method blank data indicates lab contaminant of di-n-butylphthalate and related sample data received the appropriate qualifier flag.

Requisite instrument tuning check with decafluorotriphenylphosphine was reported to document performance of gas chromatograph/mass spectral analyses. Initial and continuing calibration checks all met required minimum relative response factors. Internal standards displayed area response and retention times all within required limits. A search for tentatively-identified compounds (TIC) was performed and several compounds were found. Per CLP protocol, they

received the appropriate "J" data qualifier flags. Laboratory duplicates were not run for these analyses. However, field duplicate pairs PLF-SS-010/PLF-SS-021 and PLF-SS-044/PLF-SS-046 indicate the appropriate analytical precision. Additional QC was supplied in the form of the raw lab data and gas chromatographic/ion mass spectral data for the samples, method blanks, method spikes, and calibration standards. Data consistency was demonstrated throughout.

Proper data qualifier flags accompanied the analytical results as needed. Overall, the data quality guidelines as required in the CLP Statement of Work are met. Accordingly, this data can be considered valid for its intended use.

RECOMMENDATIONS

No modifications to this data set are required.

MEMORANDUM

DATE: March 19, 1993

TO: Ted Wall, Environmental Engineer JW

FROM: Nels Cone, Chemist NC

SUBJECT: DATA VALIDATION OF RADIOCHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 1A

During the period of December 2-8, 1992, sixty-four soil and three equipment rinsate samples were collected by Burlington Environmental Inc. (Burlington). Their sample identification numbers are as follows:

PLF-SS-001	PLF-SS-011	PLF-SS-021	PLF-SS-034	PLF-SS-044	PLF-SS-054	PLF-SS-064
PLF-SS-002	PLF-SS-012	PLF-SS-025	PLF-SS-035	PLF-SS-045	PLF-SS-055	PLF-SS-065
PLF-SS-003	PLF-SS-013	PLF-SS-026	PLF-SS-036	PLF-SS-046	PLF-SS-056	PLF-SS-066
PLF-SS-004	PLF-SS-014	PLF-SS-027	PLF-SS-037	PLF-SS-047	PLF-SS-057	PLF-SS-067
PLF-SS-005	PLF-SS-015	PLF-SS-028	PLF-SS-038	PLF-SS-048	PLF-SS-058	PLF-ER-001
PLF-SS-006	PLF-SS-016	PLF-SS-029	PLF-SS-039	PLF-SS-049	PLF-SS-059	PLF-ER-002
PLF-SS-007	PLF-SS-017	PLF-SS-030	PLF-SS-040	PLF-SS-050	PLF-SS-060	PLF-ER-003
PLF-SS-008	PLF-SS-018	PLF-SS-031	PLF-SS-041	PLF-SS-051	PLF-SS-061	
PLF-SS-009	PLF-SS-019	PLF-SS-032	PLF-SS-042	PLF-SS-052	PLF-SS-062	
PLF-SS-010	PLF-SS-020	PLF-SS-033	PLF-SS-043	PLF-SS-053	PLF-SS-063	

These samples were then submitted to Barringer Laboratories, Golden, Colorado (job numbers 925680E and 925694E), for alpha, beta, and gamma radiation analysis (USEPA Methods 900.0 and 901.1). As there are no Contract Laboratory Program (CLP) guidelines for radiochemical analysis, I performed a data quality review of the analytical results in accordance with the USEPA Handbook for Analytical Quality Control in Radioanalytical Laboratories (EPA 600/7-77-088). This document was relied upon for proper guidance in the radiochemical data validation, as it is no less stringent in its data quality requirements than CLP criteria.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly preserved and received in good condition. The samples received the requested analyses, and all holding, extraction, and analysis times met the required guidelines. Method blanks displayed spike recoveries well within quality control (QC) criteria, and no blank corrections were required. All duplicate analyses displayed precision within acceptable QC limits. Matrix spike/matrix spike duplicates,

and continuing calibration data displayed required analytical accuracy. A ninety-five percent confidence level is reported for all results, including appropriate standard deviations.

Alpha and beta analysis were supplied with additional data quality assurance in the form of USEPA sample intercomparison records, particle background records, laboratory worksheets, and sample run logs. Gamma analysis included supporting documentation of certified calibration standards (traceable to the National Institute of Standards and Technology), instrument background checks, instrument efficiency and control checks, and laboratory sample logs. Data consistent with reported summary information was demonstrated.

Overall, the data quality objectives as required by USEPA directives are met. Accordingly, this data set can be considered valid for its intended use.

RECOMMENDATIONS

No modifications of the data are required.

MEMORANDUM

DATE: March 19, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 4A - 4E

On December 8, 1992, three water samples were collected by Burlington field personnel. On December 12, one water sample was also collected. The identification numbers of these samples are as follows:

PLF-GW-001 PLF-ER-001 PLF-ER-002 PLF-ER-003

These samples were then submitted to Sound Analytical Services, of Tacoma, Washington. Work order 29107 was assigned to the first sample, and work order 28916 for the remaining three. I performed a data quality review of the analytical results receiving priority pollutant metals (PPM) analysis (USEPA SW-846, Method 6010) in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM02.0. I performed a data quality review of the analytical results from pesticide/PCB (USEPA SW-846, Method 8080), semivolatile compound (Method 8270), and volatile compound (Method 8240) analysis, in accordance with the USEPA CLP Document Number 0LM01.0. There are no CLP documents specific for evaluation of chlorinated herbicides. However, the documents were also relied upon for general guidance in the herbicide analysis. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, and all samples received the requested analyses.

4A:

For volatile compound analysis of PLF-GW-001, methylene chloride was detected in the method blank; results received the appropriate data qualifier flag. Surrogate compound recoveries, as well as system monitoring compound recoveries, met CLP-required quality control (QC) limits for the sample, the accompanying method blank and method spikes. Requisite instrument tuning check with bromofluorobenzene documented gas

chromatograph/mass spectra (GC/MS) performance. All internal standards' retention times met required QC limits. Initial calibration and continuing calibration verification displayed several target compounds outside advisory QC limits. These compounds were not detected in the sample. Per CLP protocol, no data qualifier flags were needed. Additional QC was supplied in the form of the laboratory worksheets, and GC/MS printouts for the sample method blank, method spikes, and calibration standards. Data consistency was demonstrated throughout.

4B:

For samples receiving chlorinated herbicide analysis, surrogate recoveries were within expected QC limits for the samples, method blank, and method spike. The method blank required no corrections and contained no laboratory contaminants. Requisite instrument tuning checks with decafluorotriphenylphosphine (DFTPP) documented GC/MS performance. Initial and continuing calibration checks displayed retention times, area response, and response factors within advisory QC limits for all analytical standards. Supporting GC/MS printouts for the samples, method blank, and method spike, appear consistent with summary information.

4C:

Semivolatile analysis displayed surrogate recoveries within required QC limits for all samples, method blank, and method spike. Method spike recoveries had four out of eleven compounds outside QC limits. However, no target analytes were detected in the samples, and no data qualifier flags were needed, per CLP protocol. The method blank contained no laboratory contaminants and required no corrections. Requisite instrument tuning check with DFTPP documented GC/MS performance. Initial and continuing calibration checks met minimum relative response factors. Internal calibration standards met all QC criteria for retention times and area response. A search for tentatively-identified compounds (TIC) was performed and none were found. Supporting chromatograms demonstrated data consistency for all samples, method blank, and method spike.

4D:

All metal analyses were performed by inductively coupled plasma (ICP) analysis, except mercury, which received cold vapor atomic absorption (CVAA) analysis. Duplicate analyses met QC limits required for precision evaluation. All target analytes from the laboratory control sample met expected QC limits. Initial and continuing calibration verification, method

blanks, ICP correction factors, line calibration data, and check standards all met within required QC limits. Supporting documentation was supplied in the form of raw sample data consistent with reported summary information.

4E:

All pesticide/PCB analyses were performed using dual column confirmation (columns DB-608 and DB-5) as required by CLP protocol. A transcription error is noted for performance evaluation of these columns. Specifically, the combined percent breakdown of 4,4'-DDT and Endrin reported is lower than the correctly calculated breakdown value. Regardless, the higher corrected value remains within the CLP acceptance criteria.

Surrogate compound recoveries for all analyses met required QC limits with the exception of the method blank. Regardless, the overall data precision remains unaffected. Method blank analyses required no corrections and contained no laboratory contaminants. Method spike analyses met required QC limits for analytical accuracy. Initial calibration standards displayed analytical performance within CLP criteria. Dual column chromatograms were included for all samples, the method blank, method spike, and calibration standards. The chromatograms have been annotated with quantitation values calculated from the average response factors as needed by the laboratory. The reported summary information appears consistent with this data.

RECOMMENDATIONS

Overall, the data guidelines as described in the CLP Statement of Work were met. Accordingly, this data can be considered valid for its intended use.

No modifications to this data are required.

NC/rlk/b45:2147b.mem

MEMORANDUM

DATE: March 19, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 6A - 6E2

During the period of December 8, 1992, and January 26, 1993, nine water samples were collected by Burlington field personnel. The sample identification numbers and associated EPA SW-846 analyses are listed below.

Sample I.D.	Volatiles 8240	Semivolatiles 8270	Pesticide/PCB 8080	Priority Metals 6010	Minimal Functional Standards: Conductance, Chloride, Sulfate	Minimal Functional Standards: Nitrite/Nitrate
PLF-GW-002	X	X	X	X		X
PLF-GW-003	X	X	X	X		X
PLF-GW-004	X	X	X	X		X
PLF-GW-005	X					
PLF-GW-006	X	X			X	X
PLF-GW-007	X	X			X	X
[illegible]F-ER-004	X	X	X	X		
[illegible]-ER-005	X	X	X	X		
PLF-ER-006	X	X	X	X		

These samples were then submitted to Sound Analytical Services, of Tacoma, Washington (work orders 29194, 29302, and 29839). I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Numbers ILM02.0 and ILM01.0. There are no CLP documents specific for evaluation of Minimal Functional Standards (MFS). However, these documents were also relied upon for general guidance for the MFS analyses. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, and all samples received the requested analyses.

6A:

For volatile compound analysis, acetone and methylene chloride were detected in some of the method blanks; results received the appropriate data qualifier flag. Surrogate compound recoveries, as well as system monitoring compound recoveries, met CLP-required quality control (QC) limits for the samples, the accompanying method blanks, and matrix spike analyses. Tentatively-identified compound (TIC) data was supplied and none were found. Requisite instrument tuning check with bromofluorobenzene documented gas chromatograph/mass spectra (GC/MS) performance. All internal standards' retention times met QC limits. Several compounds were found outside QC limits of the initial calibration (xylenes), and continuing

calibration (carbon tetrachloride, dibromochloromethane) checks. These compounds were not detected in the samples and, per CLP protocol, no data qualifier flags are needed. Additional QC was supplied in the form of the laboratory worksheets, and GC/MS printouts for the sample method blank, matrix spikes, and calibration standards. Data consistency was demonstrated throughout.

6B:

Semivolatile analysis displayed surrogate recoveries within required QC limits for all samples, and method blanks, with the exception of 2-fluorobiphenyl recovery in sample PLF-ER-005. Additionally, the matrix spike recoveries for 1,4-dichlorobenzene, acenaphthene, and 1,2,4-trichlorobenzene associated with sample PLF-ER-005 were below QC limits. However, initial and continuing calibration checks shows these compounds responding within required QC limits. These analytes were not detected in the sample and, per CLP protocol, no data qualifier flag is needed. Several compounds were found outside QC limits for the continuing calibration check: benzo(k)fluoroanthene, nitrobenzene, and 2,4,5-trichlorophenol. These compounds were not detected in the samples and no data qualifier flags are used, as per CLP protocol. Requisite instrument tuning check with DFTPP documented GC/MS performance. A search for tentatively-identified compounds (TIC) was performed, and several compounds were found. Per CLP protocol, they received the appropriate "J" data qualifier flags. Di-n-butylphthalate was detected in several of the method blanks; results received the appropriate "B" data qualifier flag. Internal calibration standards met all QC criteria for retention times and area response. Supporting chromatograms demonstrated data consistency for all samples, method blank, and matrix spikes.

6C:

All metal analyses were performed by inductively coupled plasma (ICP) analysis, except mercury, which received cold vapor atomic absorption (CVAA) analysis. Duplicate analyses met QC limits required for precision evaluation with the exception of zinc analysis for sample PLF-ER-005. This result received the appropriate "*" flag and no further action is needed. All spiked sample analyses met expected QC limits with the exception of compound results that were qualified with the appropriate "W" flag. Further QC issues involved these same "W" flagged compounds. Specifically, for thallium, the continuing calibration verification for sample PLF-ER-004 was outside QC limits. Furthermore, arsenic and thallium laboratory control sample recoveries associated with samples PLF-GW-002, PLF-GW-003, PLF-GW-004, and PLF-ER-006 are outside QC limits. These analytes are not found in the samples and, per CLP protocol, no further CLP qualifications are made. Remaining initial and continuing calibration verification, laboratory control samples, line calibration data, and check standards all met within required QC limits. Blank results met expected QC limits. However, a transcription error involving the Lead (Pb) analytical blank used in samples PLF-GW-002, PLF-GW-003, PLF-GW-004, and PLF-ER-006 is noted. Specifically, the blank reporting form shows an incorrect blank

value of 5.965 mg/L. Examination of the raw data worksheets and run logs reveal that value to be of a rinse sample and the correct value should be <1.0 mg/L. The reporting form has been corrected to the true value, otherwise, consistency with report summary information is evident.

6D:

All pesticide/PCB analyses were performed using dual column confirmation (columns db-608 and db-5) as required by CLP protocol. Transcription errors are noted for performance evaluation of these columns for samples PLF-ER-004 and PLF-ER-005. Specifically, the combined percent breakdown of 4,4'-DDT and Endrin reported is lower than the correctly calculated breakdown values. The reporting forms have been corrected to the true values and they remain within the CLP acceptance criteria. Surrogate compound recoveries for the samples, method blanks, and matrix spikes, met required QC limits. Method blank analyses required no corrections and contained no laboratory contaminants. Method spike analyses met required QC limits for analytical accuracy. Initial calibration standards displayed analytical performance within CLP criteria except for endosulfan II, endrin ketone, and α-chlordane calibration criteria (column db-608) for PLF-GW-002, PLF-GW-003, PLF-GW-004, and PLF-ER-006 analyses. However, all the retention times and peak resolution for these analytes on column db-608 met required QC limits and these analytes were not found in any samples. Hence, no CLP qualifications are necessary. Dual column chromatograms were included for all samples, the method blank, method spike, and calibration standards. The chromatograms have been annotated with quantitation values calculated from the average response factors as needed, by the laboratory. The reported summary information appears consistent with this data.

6E2:

Duplicate analyses performed for MFS displayed acceptable precision between results as when matrix spike analyses were performed, the appropriate accuracy is evident. Iron, zinc, and manganese requirements were reported in previous metals (6010) analyses. Additional QC documentation consisting of laboratory worksheets, control standard analyses, sample run logs, and instrument calibration evidence was supplied. Overall, the data guidelines as described in the CLP Statement of Work were met.

RECOMMENDATIONS

This data can be considered valid for its intended use. No further modifications to this data set are required.

MEMORANDUM

DATE: March 19, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 5C

On January 4, 1993, nine soil samples were collected by Burlington field personnel. Their sample identification numbers are as follows:

PLF-SBS-297	PLF-SBS-300	PLF-SBS-303
PLF-SBS-298	PLF-SBS-301	PLF-SBS-304
PLF-SBS-299	PLF-SBS-302	PLF-SBS-305

These samples were then submitted to Enseco of West Sacramento, California (lab order 068049). Data Set 5C represents results from dioxin analysis (USEPA SW-846, Method 8290). I have completed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number DFLM01.0 (1991). My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines. Although the laboratory report came with adequate raw data needed for validation, CLP reporting format was not used.

USEPA specific data qualifier flags were not used. In the case of sample PLF-SBS-303, a "@" flag is used in place of a standard "J" data qualifier flag. According to ancillary information supplied by the lab, the "@" flag has the same meaning as the "J" flag. Results are reported on a dry weight basis with percent moisture reported as a separate value. Detection limits are then reported on a sample-specific basis. Surrogate compound recoveries for all samples, matrix spikes, and method blank, met required quality control (QC) limits. Matrix spike/matrix spike duplicate data met required QC limits for data set accuracy. Laboratory duplicates were not run for these analytes. However, field duplicate pair PLF-SBS-300 and PLF-SBS-301 indicate required QC criteria for overall data set precision. Method blank analyses required no corrections and contained no laboratory contaminants. Initial and continuing

calibration data were supplied and met required relative response factor QC limits with the exception of surrogates 13C-1,2,3,7,8-PeCDD and 13C-1,2,3,6,7,8-HxCDD. Regardless, the overall accuracy of the data is not affected.

Supporting QC was provided in the form of the sample run logs, spectral performance profiles, and chromatograms for all samples, matrix spikes, and calibration standards. As a result of CLP reporting summaries not being supplied, the computerized data handling system of the gas chromatograph/mass spectroscopy instrument (I.D. #VG-4) was exclusively relied upon for compound match interpretation. Based upon the information provided, the reported summary information appears consistent with the data.

Other than non CLP-standard use of data qualification flags, the data quality guidelines required by the CLP statement of work appeared to have been followed. Accordingly, this data can be considered useful for its intended purpose.

RECOMMENDATION

OCDD results reported for sample PLF-SBS-303 should receive a "J" data qualifier flag instead of a "@" flag.

MEMORANDUM

DATE: March 19, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF RADIOCHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 5A.2

During the period of January 26-27, 1993, a total of five soil samples and six water samples were collected by Burlington Environmental Inc. personnel. The sample identification numbers are as follows:

PLF-SBS-265	PLF-SBS-267	PLF-SBS-269	PLF-GW-002MS	PLF-GW-003	PLF-ER-006
PLF-SBS-266	PLF-SBS-268	PLF-GW-002	PLF-GW-002MSD	PLF-GW-004	

These samples were then submitted to Barringer Laboratories, Golden, Colorado (job numbers 936181E, and 936182E), for alpha, beta, and gamma radiation analysis (USEPA Methods 900.0 and 901.1). As there are no Contract Laboratory Program (CLP) guidelines for radiochemical analysis, I performed a data quality review of the analytical results in accordance with the USEPA Handbook for Analytical Quality Control in Radioanalytical Laboratories (EPA 600/7-77-088). This document was relied upon for proper guidance in the radiochemical data validation, as it is no less stringent in its data quality requirements than CLP criteria.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly preserved and received in good condition. The samples received the requested analyses, and all holding, extraction, and analysis times met the required guidelines. Method blanks displayed spike recoveries well within quality control (QC) criteria, and no blank corrections were required. All duplicate analyses displayed precision within acceptable QC limits. Matrix spike/matrix spike duplicates, and continuing calibration data displayed required analytical accuracy. A ninety-five percent confidence level is reported for all results, including appropriate standard deviations.

Alpha and beta analysis were supplied with additional data quality assurance in the form of USEPA sample intercomparison records, particle background records, laboratory worksheets, and sample run logs. Gamma analysis included supporting documentation of certified calibration standards (traceable to the National Institute of Standards and Technology), instrument background checks, instrument efficiency and control checks, and laboratory sample logs. Data consistent with reported summary information was demonstrated.

Overall, the data quality objectives as required by USEPA directives are met. Accordingly, this data set can be considered valid for its intended use.

RECOMMENDATIONS

No modifications of the data are required.

NC/rlk/b45:2116b.mem

MEMORANDUM

DATE: March 22, 1993

TO: Ted Wall, Environmental Engineer JW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 3B

On December 5, 1992, twenty-one soil samples were collected by Burlington field personnel. Their sample identification numbers are as follows:

PLF-SS-047	PLF-SS-050	PLF-SS-053	PLF-SS-056	PLF-SS-059	PLF-SS-062	PLF-SS-065
PLF-SS-048	PLF-SS-051	PLF-SS-054	PLF-SS-057	PLF-SS-060	PLF-SS-063	PLF-SS-066
PLF-SS-049	PLF-SS-052	PLF-SS-055	PLF-SS-058	PLF-SS-061	PLF-SS-064	PLF-SS-067

These samples were then submitted to Sound Analytical Services of Tacoma, Washington (work order 28878), for semivolatile compound analysis (USEPA SW-846, Method 8270). I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number 0LM01.0.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been iced and received in good condition. Samples received the requested analyses, with extraction, holding, and analysis times for all samples meeting the required guidelines.

Surrogate compound recoveries met within acceptable quality control (QC) limits for all samples, method blanks, and matrix spikes. Method blank data indicates lab contaminant of di-n-butylphthalate and related sample data received the appropriate qualifier flag. For matrix spike/matrix spike duplicate recoveries, four out of eleven were outside required QC criteria (1,4-dichlorobenzene, nitroso-di-n-propylamine, 1,2,4-trichlorobenzene, acenaphthene). Per CLP protocol, since no samples contained these compounds, no data qualifier flags were needed. Furthermore, initial and continuous calibration checks for all target compounds (including the four above), met required minimum relative response factors.

Requisite instrument tuning check with decafluorotriphenylphosphine was reported to document performance of gas chromatograph/mass spectral analyses. Internal standards displayed area response and retention times all within required limits. A search for tentatively-identified compounds (TIC) was performed and several were found. Per CLP protocol, they received the appropriate "J" data qualifier flag.

Laboratory duplicates were not run for these analyses. However, field duplicate pair PLF-SS-048 and PLF-SS-067 indicate the appropriate analytical precision. Additional QC was supplied in the form of gas chromatographic/ion mass spectral data for the samples, method blanks, method spikes, and calibration standards. Data consistency was demonstrated throughout.

Proper data qualifier flags accompanied the analytical results as needed. Overall, the data quality guidelines as required in the CLP Statement of Work are met. Accordingly, this data can be considered valid for its intended use.

RECOMMENDATIONS

No modifications of the data are required.

MEMORANDUM

DATE: March 30, 1993

TO: Ted Wall, Environmental Engineer JW

FROM: Nels Cone, Chemist NC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 8B

During the period of January 22 - 24, 1993, twenty-two soil samples were collected by Burlington field personnel. The sample identification numbers are listed below.

PLF-SBS-232	PLF-SBS-237	PLF-SBS-241	PLF-SBS-245	PLF-SBS-249	PLF-SBS-253
PLF-SBS-233	PLF-SBS-238	PLF-SBS-242	PLF-SBS-246	PLF-SBS-250	PLF-SBS-254
PLF-SBS-234	PLF-SBS-239	PLF-SBS-243	PLF-SBS-247	PLF-SBS-251	
PLF-SBS-235	PLF-SBS-240	PLF-SBS-244	PLF-SBS-248	PLF-SBS-252	

These samples were then submitted to Sound Analytical Services of Tacoma, Washington (work order 29777). Data Set 8B represents results from semivolatile compound analysis (USEPA SW-846, Method 8270). I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM01.0. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, and all samples received the requested analyses.

Semivolatile analysis displayed surrogate recoveries within required QC limits for all samples, and method blanks. All matrix spike/matrix spike duplicate recoveries met required QC limits with the exception of 1,4-dichlorobenzene and 1,2,4-trichlorobenzene. However, initial and continuing calibration checks shows these compounds responding within required QC limits. These analytes were not detected in the sample and, per CLP protocol, no data qualifier flag is needed. Requisite instrument tuning check with DFTPP documented GC/MS performance. A search for tentatively-identified compounds (TIC) was performed, and several compounds were found. Per CLP protocol, they received the appropriate "J" data qualifier flags.

Di-n-butylphthalate was detected in several of the method blanks; results received the appropriate "B" qualifier flag. Internal calibration standards met QC criteria for retention times and area response. Supporting chromatograms have been annotated with quantitation values

calculated as needed, by the laboratory. These chromatograms appear to demonstrate data consistency for all samples, method blanks, and matrix spikes.

RECOMMENDATIONS

Overall, the data quality guidelines as described in the CLP Statement of Work are met. This data can be considered valid for its intended use, and no modifications are required.

MEMORANDUM

DATE: March 30, 1993

TO: Ted Wall, Environmental Engineer

FROM: Nels Cone, Chemist

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 8D

During the period of January 22 - 24, 1993, twenty-two soil samples were collected by Burlington field personnel. The sample identification numbers are listed below.

PLF-SBS-232	PLF-SBS-237	PLF-SBS-241	PLF-SBS-245	PLF-SBS-249	PLF-SBS-253
PLF-SBS-233	PLF-SBS-238	PLF-SBS-242	PLF-SBS-246	PLF-SBS-250	PLF-SBS-254
PLF-SBS-234	PLF-SBS-239	PLF-SBS-243	PLF-SBS-247	PLF-SBS-251	
PLF-SBS-235	PLF-SBS-240	PLF-SBS-244	PLF-SBS-248	PLF-SBS-252	

These samples were then submitted to Sound Analytical Services of Tacoma, Washington (work order 29777). Data set 8D represents results from pesticide/PCB analysis (USEPA SW-846, Method 8080). I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM01.0. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, and all samples received the requested analyses.

All pesticide/PCB analyses were performed using dual column confirmation (columns db-608 and db-5) as required by CLP protocol. Surrogate compound recoveries for the samples, method blanks, and matrix spikes, met required QC limits. Method blank analyses required no corrections and contained no laboratory contaminants. Method spike analyses met required QC limits for analytical accuracy. Initial calibration standards displayed analytical performance within CLP criteria except for endosulfan II, endrin ketone, and α-chlordane calibration criteria (column db-608). However, all the retention times and peak resolution for these analytes on column db-608 met required QC limits and these analytes were not found in any samples. Hence, no CLP qualifications are necessary. Dual column chromatograms were included for all samples, the method blank, method spike, and calibration standards. The chromatograms have been annotated with quantitation values calculated from the average response factors as needed, by the laboratory. The reported summary information appears consistent with this data.

RECOMMENDATIONS

Overall, the data guidelines as described in the CLP Statement of Work are met. This data can be considered valid for its intended use, and no modifications to it are required.

NC/rlk/b46:2175b.mem

MEMORANDUM

DATE: March 30, 1993

TO: Ted Wall, Environmental Engineer

FROM: Nels Cone, Chemist

SUBJECT: DATA VALIDATION OF RADIOCHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 8F

During the period of February 10-11, 1993, a total of fourteen water samples were collected by Burlington Environmental Inc. personnel. The sample identification numbers are as follows:

PLF-GW-030	PLF-GW-030MSD	PLF-GW-033	PLF-GW-038	PLF-GW-040	PLF-GW-040MSD	PLF-ER-007
PLF-GW-030MS	PLF-GW-032	PLF-GW-034	PLF-GW-039	PLF-GW-040MS	PLF-GW-042	PLF-ER-008

These samples were then submitted to Barringer Laboratories, Golden, Colorado (job number 936319E), for alpha, beta, and gamma radiation analysis (USEPA Methods 900.0 and 901.1). As there are no Contract Laboratory Program (CLP) guidelines for radiochemical analysis, I performed a data quality review of the analytical results in accordance with the USEPA Handbook for Analytical Quality Control in Radioanalytical Laboratories (EPA 600/7-77-088). This document was relied upon for proper guidance in the radiochemical data validation, as it is no less stringent in its data quality requirements than CLP criteria.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly preserved and received in good condition. The samples received the requested analyses, and all holding, extraction, and analysis times met the required guidelines. Method blanks displayed spike recoveries well within quality control (QC) criteria, and no blank corrections were required. All duplicate analyses displayed precision within acceptable QC limits. Matrix spike/matrix spike duplicates, and continuing calibration data displayed required analytical accuracy. A ninety-five percent confidence level is reported for all results, including appropriate standard deviations.

Alpha and beta analysis were supplied with additional data quality assurance in the form of USEPA sample intercomparison records, particle background records, laboratory worksheets, and sample run logs. Gamma analysis included supporting documentation of certified calibration standards (traceable to the National Institute of Standards and Technology), instrument

background checks, instrument efficiency and control checks, and laboratory sample logs. Data consistent with reported summary information was demonstrated.

Overall, the data quality objectives as required by USEPA directives are met. Accordingly, this data set can be considered valid for its intended use.

RECOMMENDATIONS

No modifications of the data are required.

NC/rlk/b46:2176b.mem

MEMORANDUM

DATE: April 2, 1993

TO: Ted Wall, Environmental Engineer JW

FROM: Nels Cone, Chemist

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 7A - 7D

During the period of December 20, 1992, to January 5, 1993, three soil samples were collected by Burlington field personnel. The identification numbers of these samples are as follows:

PLF-SBS-099 PLF-SBS-107 PLF-SBS-110

These samples were then submitted to Sound Analytical Services, of Tacoma, Washington (Work orders 29195, 29304, and 29391). I performed a data quality review of the analytical results receiving priority pollutant metals (PPM) analysis (USEPA SW-846, Method 6010) in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM02.0. I performed a data quality review of the analytical results from pesticide/PCB (USEPA SW-846, Method 8080), semivolatile compound (Method 8270), and volatile compound (Method 8240) analysis, in accordance with the USEPA CLP Document Number 0LM01.0. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, and all samples received the requested analyses.

7A:

For volatile compound analysis, methylene chloride and acetone and/or toluene were detected in the method blanks; results received the appropriate "B" data qualifier flag to indicate this. Surrogate compound recoveries, as well as system monitoring compound recoveries, met CLP-required quality control (QC) limits for the sample, the accompanying method blank and method spikes. A search for tentatively-identified compounds (TIC) was performed, and several were found. Per CLP protocol, they received the appropriate "J data qualifier flag. Requisite instrument tuning check with bromofluorobenzene documented gas chromatograph/mass spectra (GC/MS) performance. All internal standards' retention times

met required QC limits. Initial calibration and continuing calibration verification displayed several target compounds outside advisory QC limits. These compounds were not detected in the samples. Per CLP protocol, no data qualifier flags were needed. Additional QC was supplied in the form of the laboratory worksheets, and GC/MS printouts for the sample method blank, method spikes, and calibration standards. Data consistency was demonstrated throughout.

7B:

Semivolatile analysis displayed surrogate recoveries within required QC limits for all samples, method blank, and method spike. Matrix spike recoveries had two out of eleven compounds outside QC limits. However, these compounds were not detected in the samples, and no data qualifier flags were needed, per CLP protocol. Method blanks contained several species of phthalates; results received the appropriate "B" data qualifier flag. Requisite instrument tuning check with DFTPP documented GC/MS performance. Initial calibration checks met minimum relative response factors. Continuing calibration checks were outside advisory QC limits for several compounds. However, they were not detected in the samples and no data qualifier flag is needed. Internal calibration standards met all QC criteria for retention times and area response. A search for tentatively-identified compounds (TIC) was performed and several were found. Per CLP protocol, they received the appropriate "J" data qualifier flag. Supporting chromatograms demonstrated data consistency for all samples, method blank, and method spike.

7C:

All metal analyses were performed by inductively coupled plasma (ICP) analysis, except mercury, which received cold vapor atomic absorption (CVAA) analysis. Duplicate analyses did not meet QC limits required for several analytes; results received the appropriate CLP data qualifier flag. All target analytes from the laboratory control samples (LCS) met expected QC limits except antimony, chromium, and selenium, and the sample results for these analytes can only be considered estimated at best. All spiked sample recoveries met required QC limits with the exception of selenium (in addition to estimated LCS results) and thallium for sample PLF-SBS-099; results received the appropriate CLP data qualifier flag. Initial and continuing calibration verification, method blanks, ICP correction factors and line calibration data all met within required QC limits. Supporting documentation was supplied in the form of raw sample data consistent with reported summary information.

7D:

All pesticide/PCB analyses were performed using dual column confirmation (columns DB-608 and DB-5) as required by CLP protocol. Transcription errors are noted in supporting documentation for performance evaluation of these columns. Specifically, the combined percent breakdown of 4,4'-DDT and Endrin reported is lower than the correctly calculated breakdown values. The reporting forms have been corrected to the true values and they remain within the CLP acceptance criteria. Surrogate compound recoveries for all analyses met required QC limits with the exception of tetrachloro-m-xylene in sample PLF-SBS-107. Regardless, the overall data accuracy remains unaffected. Method blank analyses contained 4,4'-DDT and results received appropriate "B" flags to indicate this. Method spike analyses met required QC limits for analytical accuracy. Initial calibration of columns DB-608 displayed appropriate analytical performance. Initial calibration of column DB-5 displays several compounds out of QC limits: α-BHC, δ-BHC, lindane, heptaclor, dieldrin, 4,4'-DDE, endrin, endosulfan II, 4,4'-DDD, endosulfan sulfate, 4,4'-DDT, methoxychlor, and endrin aldehyde. These compounds were not detected in the samples using either column, and no data qualifier flags are used. Dual column chromatograms were included for all samples, the method blank, method spike, and calibration standards. The chromatograms have been annotated with quantitation values calculated from the average response factors as needed by the laboratory. The reported summary information appears consistent with this data.

RECOMMENDATIONS

Antimony results for samples PLF-SBS-107 and PLF-SBS-110 should be appended with a "B" data qualifier flag. Chromium and selenium results for sample PLF-SBS-099 should also be appended with a "B" data qualifier flag, as results for these analytes can be considered as concentration estimates only.

NC/rlk/b47:2160b.mem

MEMORANDUM

DATE: April 2, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 8C

During the period of January 22 - 24, 1993, twenty-two soil samples were collected by Burlington field personnel. The sample identification numbers are listed below.

PLF-SBS-232	PLF-SBS-237	PLF-SBS-241	PLF-SBS-245	PLF-SBS-249	PLF-SBS-253
PLF-SBS-233	PLF-SBS-238	PLF-SBS-242	PLF-SBS-246	PLF-SBS-250	PLF-SBS-254
PLF-SBS-234	PLF-SBS-239	PLF-SBS-243	PLF-SBS-247	PLF-SBS-251	
PLF-SBS-235	PLF-SBS-240	PLF-SBS-244	PLF-SBS-248	PLF-SBS-252	

These samples were then submitted to Sound Analytical Services of Tacoma, Washington (work order 29777). Data set 8C represents results of analysis for chlorinated herbicides (USEPA SW-846, Method 8150). I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM01.0. These guidelines are normally used for water and soil monitoring of specific compounds. However, this document was also relied upon for proper guidance in the above herbicide analyses, because no CLP guidelines have been published specific to them.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. The samples received the requested analyses, and all holding, extraction, and analysis times met the required guidelines.

Laboratory duplicates analysis were not run for detection of herbicides. However, field duplicate pair PLF-SBS-253 and PLF-SBS-254 indicate appropriate analytical precision. Eight out of ten matrix spike/matrix spike duplicate recoveries did not display accuracy within advisory QC limits. However, these compounds were not detected in the samples, and no data qualifier flags are used. Furthermore, surrogate compound recoveries for all chlorinated herbicide analyses met expected QC limits.

Additional QC was supplied in the form of the GC/MS data for the samples, initial and continuing calibration checks, DFTPP tuning check, matrix spikes, and calibration standards. Data consistency was demonstrated throughout. Proper data qualifier flags accompanied the analytical results as needed.

RECOMMENDATIONS

Overall, the data quality guidelines as advised in the CLP Statement of Work are met. Accordingly, this data can be considered valid for its intended use, with no modifications required.

MEMORANDUM

DATE: April 2, 1993

TO: Ted Wall, Environmental Engineer

FROM: Nels Cone, Chemist

SUBJECT: DATA VALIDATION OF RADIOCHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 7E

On February 3, 1993, a total of twenty-three soil samples were collected by Burlington Environmental Inc. personnel. The sample identification numbers are as follows:

PLF-SBS-274	PLF-SBS-279	PLF-SBS-284	PLF-SBS-289	PLF-SBS-294
PLF-SBS-275	PLF-SBS-280	PLF-SBS-285	PLF-SBS-290	PLF-SBS-295
PLF-SBS-276	PLF-SBS-281	PLF-SBS-286	PLF-SBS-291	PLF-SBS-296
PLF-SBS-277	PLF-SBS-282	PLF-SBS-287	PLF-SBS-292	
PLF-SBS-278	PLF-SBS-283	PLF-SBS-288	PLF-SBS-293	

These samples were then submitted to Barringer Laboratories, Golden, Colorado (job numbers 936258E), for alpha, beta, and gamma radiation analysis (USEPA Methods 900.0 and 901.1). As there are no Contract Laboratory Program (CLP) guidelines for radiochemical analysis, I performed a data quality review of the analytical results in accordance with the USEPA Handbook for Analytical Quality Control in Radioanalytical Laboratories (EPA 600/7-77-088). This document was relied upon for proper guidance in the radiochemical data validation, as it is no less stringent in its data quality requirements than CLP criteria.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly preserved and received in good condition. The samples received the requested analyses, and all holding, extraction, and analysis times met the required guidelines. Method blanks displayed spike recoveries well within quality control (QC) criteria, and no blank corrections were required. All duplicate analyses displayed precision within acceptable QC limits. Matrix spike/matrix spike duplicates, and continuing calibration data displayed required analytical accuracy. A ninety-five percent confidence level is reported for all results, including appropriate standard deviations.

Alpha and beta analysis were supplied with additional data quality assurance in the form of USEPA sample intercomparison records, particle background records, laboratory worksheets, and sample run logs. Gamma analysis included supporting documentation of certified calibration standards (traceable to the National Institute of Standards and Technology), instrument background checks, instrument efficiency and control checks, and laboratory sample logs. Data consistent with reported summary information was demonstrated.

Overall, the data quality objectives as required by USEPA directives are met. Accordingly, this data set can be considered valid for its intended use.

RECOMMENDATIONS

No modifications of the data are required.

MEMORANDUM

DATE: April 13, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 10A-10F

On February 11, 1993, fourteen water samples were collected by Burlington field personnel. The identification numbers of these samples are listed below:

PLF-GW-040	PLF-GW-040MSD	PLF-GW-042	PLF-GW-044	PLF-GW-046	PLF-GW-048	PLF-ER-007
PLF-GW-040MS	PLF-GW-041	PLF-GW-043	PLF-GW-045	PLF-GW-047	PLF-GW-049	PLF-ER-008

These samples were then submitted to Sound Analytical Services, of Tacoma, Washington (Work order 30171). I performed a data quality review of the analytical results receiving priority pollutant metals (PPM) analysis (USEPA SW-846, Method 6010) in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM02.0. I performed a data quality review of the analytical results from pesticide/PCB (USEPA SW-846, Method 8080), semivolatile compound (Method 8270), and volatile compound (Method 8240) analysis, in accordance with the USEPA CLP Document Number 0LM01.0. There are no CLP documents specific for evaluation of chlorinated herbicides (Method 8150) and Minimal Functional Standards (MFS). However, CLP documents were also relied upon for advisory guidance for these analyses. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, and all samples received the requested analyses.

10A:

For volatile compound analysis, methylene chloride and acetone were detected in the method blanks; results received the appropriate "B" data qualifier flag to indicate this. Surrogate compound recoveries, as well as system monitoring compound recoveries, met CLP-required quality control (QC) limits for the sample, the accompanying method blank and method spikes. A search for tentatively-identified compounds (TIC) was performed, and several were found.

Per CLP protocol, they received the appropriate "J data qualifier flag. Requisite instrument tuning check with bromofluorobenzene (BFB) documented gas chromatograph/mass spectra (GC/MS) performance. All internal standards' retention times met required QC limits. Initial calibration data displays all analytes within required QC limits. Continuing calibration verification displays all compounds within advisory QC limits, with the exception of xylene. This compound was not detected in the samples. Per CLP protocol, no data qualifier flags are needed. Additional QC was supplied in the form of the laboratory worksheets, and GC/MS printouts for the samples method blank, method spikes, and calibration standards. Data consistency was demonstrated throughout.

10B:

Semivolatile analysis displayed surrogate recoveries within required QC limits for all samples, method blanks, and method spikes. Matrix spike recoveries met required QC limits. Method blanks contained several species of phthalates; results did not always receive the appropriate "B" data qualifier flag. Requisite instrument tuning check with DFTPP documented GC/MS performance. Initial calibration checks met minimum relative response factors. Continuing calibration checks met advisory QC limits for all compounds. Internal calibration standards met all QC criteria for retention times and area response. A search for tentatively-identified compounds (TIC) was performed and several were found. Per CLP protocol, they received the appropriate "J" data qualifier flag. Supporting chromatograms demonstrated data consistency for all samples, method blank, and method spike.

10C:

All pesticide/PCB analyses were performed using dual column confirmation (columns DB-608 and DB-5) as required by CLP protocol. Surrogate compound recoveries for the analyses met required QC limits with the exception of decachlorobiphenyl in samples PLF-GW-049 and PLF-ER-007. Regardless, the overall data accuracy remains unaffected. Method blank analyses contained no contaminants and no corrections were required. A matrix spike duplicate analysis was not able to be performed, therefore analytical accuracy cannot be fully determined per CLP guidelines. Initial calibration of columns DB-5 displayed appropriate analytical performance. Initial calibration data of column DB-608 displays 4,4'-DDT and methoxychlor are out of QC limits. Additionally, continuing calibration verification met expected QC limits with the exception of δ-BHC on both columns. 4,4'-DDT, methoxychlor, and δ-BHC were not detected in the samples using either column, and no data qualifier flags are used. Dual column chromatograms were included for all samples, the method blank, method spike, and calibration standards. The chromatograms have been annotated with

quantitation values calculated from the average response factors as needed by the laboratory. The reported summary information appears consistent with this data.

10D

The chlorinated herbicide method blank contained no contaminants and no corrections were used. Surrogate compound recoveries met advisory QC limits for all analyses. Matrix spike/matrix spike duplicate results indicate all required QC limits were met with exception of the compound dalapon. However, this analyte was not detected in the samples and no data qualifier flags were are used. Additional QC was supplied in the form of GC/MS data for the samples, matrix spike, initial and continuing calibration data, and DFTPP tuning check. Proper data qualifier flags accompanied the analytical results as needed.

10E:

All metal analyses were performed by inductively coupled plasma (ICP) analysis, except mercury, which received cold vapor atomic absorption (CVAA) analysis. Duplicate analyses did not meet QC limits required for zinc; results received the appropriate CLP "*" data qualifier flag. All target analytes from the laboratory control samples (LCS) met expected QC limits. Arsenic, mercury, lead, thallium, and zinc were found in the method blank; per CLP protocol, no further qualifications are made. Zinc results do not meet required spike recovery QC criteria, nor did zinc meet required QC limits for serial dilution. Post-digestion spike samples recoveries met required QC limits with the exception of selenium, lead, and arsenic; results received the appropriate CLP "W" data qualifier flag. Taking all QC issues into account, and per CLP protocol, the values reported for arsenic and lead can only be considered as estimates. Due to the additive nature of QC issues regarding zinc analyses, all results from this analyte are unacceptable. Initial and continuing calibration verification, check standards, ICP correction factors and line calibration data all met within required QC limits. Supporting documentation was supplied in the form of raw sample data consistent with reported summary information.

10F:

Duplicate analyses performed for MFS displayed acceptable precision between results. When matrix spike analyses were performed, the appropriate accuracy is evident. Blank analysis met required QC limits. Iron, zinc, and manganese requirements were reported in previous metals (6010) analyses. Additional QC documentation consisting of laboratory worksheets, check

standard analyses, sample run logs, raw data, and instrument calibration data was supplied. Data consistency was demonstrated throughout.

RECOMMENDATIONS

All reported detections of various phthalate species in these samples must be appended with a "B" data qualifier flag. All sample results of arsenic and lead analysis must receive the CLP metals data qualifier flag "B", denoting that they are useful as estimates only. All sample results from zinc analysis must be appended with a "R" data qualifier flag, and rejected. The samples should be re-analyzed for zinc, and the re-analysis results should replace the rejected data.

MEMORANDUM

DATE: May 21, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NC

SUBJECT: PROJECT 624419 DATA VALIDATION ADDENDUM TO DATA SET 10E

Original zinc values reported with this data set (lab work order 30171) were rejected (See April 13, 1993 memorandum). Since the holding times had not been exceeded for the samples, they were re-analyzed. The re-analyzed results meet the data quality objectives as defined by CLP protocol and overall results are valid for their intended use. Subsequently, these re-analyzed results have been made part of the original data set.

NC/rlk/b47:2297b.mem

MEMORANDUM

DATE: April 19, 1993

TO: Ted Wall, Environmental Engineer JW

FROM: Nels Cone, Chemist

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 12A-12E NBC

On January 25 and 26, 1993, thirteen water samples were collected by Burlington field personnel. The identification numbers of these samples are listed below:

PLF-SBS-256	PLF-SBS-259	PLF-SBS-263	PLF-SBS-266	PLF-SBS-269
PLF-SBS-257	PLF-SBS-261	PLF-SBS-264	PLF-SBS-267	
PLF-SBS-258	PLF-SBS-262	PLF-SBS-265	PLF-SBS-268	

These samples were then submitted to Sound Analytical Services, of Tacoma, Washington (Work order 29845). I performed a data quality review of the analytical results receiving priority pollutant metals (PPM) analysis (USEPA SW-846, Method 6010) in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM02.0. I performed a data quality review of the analytical results from pesticide/PCB (USEPA SW-846, Method 8080), semivolatile compound (Method 8270), and volatile compound (Method 8240) analysis, in accordance with the USEPA CLP Document Number 0LM01.0. There are no CLP documents specific for evaluation of chlorinated herbicides (Method 8150). However, CLP documents were also relied upon for advisory guidance for these analyses. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, and all samples received the requested analyses. The numbering system for this data set was out of order. However, a thorough examination of the paperwork reveals that the needed pages are present.

12A:

For volatile compound analysis, methylene chloride, acetone, and toluene were detected in the method blanks; results did not always receive the appropriate "B" data qualifier flag to indicate this. Surrogate compound recoveries, as well as system monitoring compound recoveries, met CLP-required quality control (QC) limits for the sample, the accompanying method blank and matrix spikes. Matrix spike/matrix spike duplicate analyses met required QC limits with the exception of 1,1-dichloroethane. However, overall data set accuracy remains unaffected. A search for tentatively-identified compounds (TIC) was performed, and several were found. Per CLP protocol, they received the appropriate "J data qualifier flag. Requisite instrument tuning check with bromofluorobenzene (BFB) documented gas chromatograph/mass spectra (GC/MS) performance. All internal standards' retention times met required QC limits. Initial calibration data displays all analytes within required QC limits. Continuing calibration verification displays all compounds within advisory QC limits, with the exception of bromoform, bromomethane, bromofluorobenzene, and xylene. These compounds were not detected in the samples. Per CLP protocol, no data qualifier flags are needed. Additional QC was supplied in the form of the laboratory worksheets, and GC/MS printouts for the samples, method blank, matrix spikes, and calibration standards. Data consistency was demonstrated throughout.

12B:

Semivolatile analyses displayed surrogate recoveries within required QC limits for all samples, method blank, and matrix spikes. Matrix spike/matrix spike duplicate recoveries met required QC limits, with the exception of 1,4-dichlorobenzene. This does not affect overall analytical accuracy. Method blanks contained di-n-butylphthalate, and results did not receive the appropriate "B" data qualifier flag. Di-n-butylphthalate presence was only confirmed by close examination of the appropriate chromatographic peaks of the samples and method blanks. Requisite instrument tuning check with DFTPP documented GC/MS performance. Initial calibration checks met minimum relative response factors. Continuing calibration checks met advisory QC limits for all compounds, with the exception of benzo(k)fluoranthene. Overall data precision remains unaffected. Internal calibration standards met all QC criteria for retention times and area response. A search for tentatively-identified compounds (TIC) was performed and several were found. Per CLP protocol, they received the appropriate "J" data qualifier flag. Supporting chromatograms demonstrated data consistency for all samples, method blank, and matrix spikes.

12C:

All pesticide/PCB analyses were performed using dual column confirmation (columns DB-608 and DB-5) as required by CLP protocol. Surrogate compound recoveries for the analyses met required QC limits. Method blank analyses contained no contaminants and no corrections were required. Matrix spike/matrix spike duplicate analyses met required QC limits for analytical accuracy. Initial calibration of columns DB-5 displayed appropriate analytical performance. Initial calibration data of column DB-608 displays endosulfan II, endrin, ketone, and α-chlordane are out of QC limits. These compounds were not detected in the samples using either column, and no data qualifier flags are used. Analyte resolution and continuing calibration verification met expected QC limits for both columns. Dual column chromatograms were included for all samples, the method blank, matrix spikes, and calibration standards. The chromatograms have been annotated with quantitation values calculated from the average response factors as needed by the laboratory. The reported summary information appears consistent with this data.

12D

The chlorinated herbicide method blank contained no contaminants and no corrections were used. Surrogate compound recoveries met advisory QC limits for all analyses. Matrix spike/matrix spike duplicate recovery results indicate that all spike compounds did not meet required QC limits were not met and cannot be relied upon to indicate data accuracy. However, these analytes (dalapon, dicamba, MCPP, MCPA, dichloroprop, 2,4-D, 2,4-DB, 2,4,5-T, dinoseb, and silvex) were not detected in the samples and overall this sample data is still useful. Additional QC was supplied in the form of GC/MS data for the samples, matrix spike, initial and continuing calibration data, and DFTPP tuning check. Consistent dilution factors and proper data qualifier flags accompanied the analytical results as needed.

12E:

All metal analyses were performed by inductively coupled plasma (ICP) analysis, except mercury, which received cold vapor atomic absorption (CVAA) analysis. Duplicate analyses did not meet QC limits required for arsenic and cadmium; results received the appropriate CLP "*" data qualifier flag. All target analytes from the laboratory control samples (LCS) met expected QC limits. Zinc was found in the method blank; per CLP protocol, no further qualifications are made. Serial dilution data met required QC parameters. Matrix spike sample recoveries met required QC limits with the exception of antimony; results received the appropriate CLP "N" data qualifier flag. Post-digest spike recoveries met expected QC

criteria. Initial and continuing calibration verification, check standards, ICP correction factors and line calibration data all met within required QC limits. Supporting documentation was supplied in the form of raw sample data consistent with reported summary information.

RECOMMENDATIONS

All reported detections of acetone, methylene chloride, toluene, and di-n-butylphthalate in these samples must be appended with a "B" data qualifier flag.

NC/rlk/b46:2229b.mem

MEMORANDUM

DATE: April 21, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 9A - 9D

During the period of January 10 - 21, 1993, five soil samples were collected by Burlington field personnel. The identification numbers of these samples are as follows:

PLF-SBS-128 PLF-SBS-150 PLF-SBS-167 PLF-SBS-180 PLF-SBS-213

These samples were then submitted to Sound Analytical Services, of Tacoma, Washington (Work orders 29551 and 29728). I performed a data quality review of the analytical results receiving priority pollutant metals (PPM) analysis (USEPA SW-846, Method 6010) in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM02.0. I performed a data quality review of the analytical results from pesticide/PCB (USEPA SW-846, Method 8080), semivolatile compound (Method 8270), and volatile compound (Method 8240) analysis, in accordance with the USEPA CLP Document Number 0LM01.0. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition, with the exceptions described for samples by specific analysis. Holding, extraction, and analysis times for the samples met the required guidelines, with exceptions described for samples by specific analysis. All samples received the requested analyses.

9A:

For volatile compound analysis, methylene chloride and acetone and toluene were detected in the method blanks; results did not always receive the appropriate "B" data qualifier flag to indicate this. Surrogate compound recoveries, as well as system monitoring compound recoveries, met CLP-required quality control (QC) limits for the sample, the accompanying method blank and method spikes. A search for tentatively-identified compounds (TIC) was performed, and several were found. Per CLP protocol, they received the appropriate "J data qualifier flag. Requisite instrument tuning check with bromofluorobenzene documented gas chromatograph/mass spectra (GC/MS) performance. All internal standards' retention times

met required QC limits. Initial calibration data displayed all analytes within advisory QC limits, with the exception of xylenes. Continuing calibration verification displayed bromomethane, 1,1,2-trichloroethylene, vinyl chloride, 1,1,2,2-tetrachloroethylene, and xylenes outside advisory QC limits. These compounds were not detected in the samples. Per CLP protocol, no data qualifier flags were needed. Additional QC was supplied in the form of the laboratory worksheets, and GC/MS printouts for the sample method blank, method spikes, and calibration standards. Data consistency was demonstrated throughout.

9B:

Semivolatile analysis displayed surrogate recoveries within required QC limits for all samples, method blank, and method spike. Matrix spike recoveries had four out of twenty-two compounds outside QC limits. However, these compounds were not detected in the samples, and no data qualifier flags were needed, per CLP protocol. Method blanks contained several species of phthalates; results did not always receive the appropriate "B" data qualifier flag. Requisite instrument tuning check with DFTPP documented GC/MS performance. Initial calibration checks met minimum relative response factors. Continuing calibration checks were outside advisory QC limits for several compounds. However, they were not detected in the samples and no data qualifier flag is needed. Internal calibration standards met all QC criteria for retention times and area response with the exception of perylene-d12 in sample PLF-SBS-180. Additionally, the holding time for this sample is three days past the CLP requirement. However, no related analytes were detected in the sample, and no further action is required. A search for tentatively-identified compounds (TIC) was performed and several were found. Per CLP protocol, they received the appropriate "J" data qualifier flag. Supporting chromatograms demonstrated data consistency for all samples, method blank, and method spike.

9C:

All metal analyses were performed by inductively coupled plasma (ICP) analysis, except mercury, which received cold vapor atomic absorption (CVAA) analysis. Duplicate analyses did not meet QC limits required for cadmium and lead; results received the appropriate CLP "*" data qualifier flag. All target analytes from the laboratory control samples (LCS) met expected QC limits. Selenium, thallium and antimony do not meet the spike recovery QC criteria; results received the appropriate CLP "N" data qualifier flag. All post-digestion spiked sample recoveries met required QC limits. Serial dilution QC criteria for zinc and

copper were not met and results received the appropriate CLP data qualifier flag. Initial and continuing verification, method blanks, check standards, and line calibration data all met within required QC limits. Supporting documentation was supplied in the form of raw sample data consistent with reported summary information.

9D:

All pesticide/PCB analyses were performed using dual column confirmation (columns DB-608 and DB-5) as required by CLP protocol. Analyte resolution for both columns displayed performance within acceptable QC limits. Surrogate compound recoveries for all analyses met required QC limits. Method blank analyses contained no contaminants and required no corrections. Method spike analyses met required QC limits for analytical accuracy. The holding times for samples PLF-SBS-128 and PLF-SBS-150 were six days past the CLP requirements making the reported results unacceptable. Initial calibration of columns DB-5 displayed appropriate analytical performance. Initial calibration data of column DB-608 displays several compounds out of QC limits: endosulfan II, α-chlordane, and endrin ketone. However, these compounds were not detected in any of the samples using either column; hence no data qualifier flags are required. Dual column chromatograms were included for all samples, the method blank, method spike, and calibration standards. The chromatograms have been annotated with quantitation values calculated from the average response factors as needed by the laboratory. The reported summary information appears consistent with this data.

RECOMMENDATIONS

All detections of acetone, methylene chloride, toluene, and various species of phthalates in the samples should be appended with "B" data qualifier flags. Pesticide/PCB analyses for PLF-SBS-128 and PLF-SBS-150 must be rejected due to holding time exceedance.

NC/rlk/b46:2212b.mem

MEMORANDUM

DATE: April 23, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 8E

During the period of January 22 - 24, 1993, twenty-two soil samples were collected by Burlington field personnel. The identification numbers of these samples are as follows:

PLF-SBS-232	PLF-SBS-237	PLF-SBS-241	PLF-SBS-245	PLF-SBS-249	PLF-SBS-253
PLF-SBS-233	PLF-SBS-238	PLF-SBS-242	PLF-SBS-246	PLF-SBS-250	PLF-SBS-254
PLF-SBS-234	PLF-SBS-239	PLF-SBS-243	PLF-SBS-247	PLF-SBS-251	
PLF-SBS-235	PLF-SBS-240	PLF-SBS-244	PLF-SBS-248	PLF-SBS-252	

These samples were then submitted to Sound Analytical Services, of Tacoma, Washington (Work order 29777). Data set 8E represents results from Priority Pollutant Metals (PPM) analysis (USEPA SW-846, Method 6010). I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM02.0. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, and all samples received the requested analyses.

All metal analyses were performed by inductively coupled plasma (ICP) analysis, except mercury, which received cold vapor atomic absorption (CVAA) analysis. Duplicate analyses met QC limits required for precision evaluation, with the exception of arsenic, lead, and mercury analysis; results received the appropriate CLP "*" data qualifier flag. Several analytes were found in the method blank at levels below USEPA contract-required detection limits. As per CLP protocol, no correction or qualification of the sample results is performed. All spiked sample recoveries, including post-digestion spikes, met required QC limits with the exception of antimony; results received the appropriate CLP "N" data qualifier flag. Initial and continuing calibration verification, laboratory control of samples, ICP correction factors and line calibration data all met within required QC limits. Supporting documentation was

supplied in the form of raw sample data. Consistency with reported summary information appears to be evident.

RECOMMENDATIONS

This data can be considered valid for its intended use, with no modifications required.

MEMORANDUM

DATE: April 23, 1993

TO: Ted Wall, Environmental Engineer JW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 13A-13E

On February 2, 1993, nine water samples were collected by Burlington field personnel. The identification numbers of these samples are listed below:

PLF-GW-015	PLF-GW-017MS	PLF-GW-019
PLF-GW-016	PLF-GW-017MSD	PLF-GW-020
PLF-GW-017	PLF-GW-018	PLF-GW-021

These samples were then submitted to Sound Analytical Services, of Tacoma, Washington (Work order 30098). I performed a data quality review of the analytical results receiving priority pollutant metals (PPM) analysis (USEPA SW-846, Method 6010) in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM02.0. I performed a data quality review of the analytical results from pesticide/PCB (USEPA SW-846, Method 8080), semivolatile compound (Method 8270), and volatile compound (Method 8240) analysis, in accordance with the USEPA CLP Document Number 0LM01.0. There are no CLP documents specific for evaluation of Minimal Functional Standards (MFS). However, CLP documents were also relied upon for advisory guidance for these analyses. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, and all samples received the requested analyses.

13A:

For volatile compound analysis, methylene chloride was detected in the method blanks; results received the appropriate "B" data qualifier flag to indicate this. Surrogate compound recoveries, as well as system monitoring compound recoveries, met CLP-required quality control (QC) limits for the sample, the accompanying method blank and matrix spikes. Matrix spike/matrix spike duplicate analyses met all required QC criteria. A search for tentatively-

identified compounds (TIC) was performed, and several were found. Per CLP protocol, they received the appropriate "J data qualifier flag. Requisite instrument tuning check with bromofluorobenzene (BFB) documented gas chromatograph/mass spectra (GC/MS) performance. All internal standards' retention times met required QC limits. Initial calibration data displays all analytes within required QC limits. Continuing calibration verification displays all compounds within advisory QC limits, with the exception of xylene. This compound was not detected in the samples. Per CLP protocol, no data qualifier flags are needed. Additional QC was supplied in the form of GC/MS printouts for the samples method blank, matrix spikes, and calibration standards. Data consistency was demonstrated throughout.

13B:

Semivolatile analysis displayed surrogate recoveries within required QC limits for all samples, method blank, and method spike. Matrix spike recoveries met required QC limits. Sample results report several species of phthalates were found. Chromatograph comparison with associated method blank does not reveal comparable peaks. However, these analytes have been demonstrated as significant laboratory contaminants by our subcontractor (SAS). Based upon this experience, it is my professional decision that these reported analytes be accompanied by a "B" data qualifier flag. Requisite instrument tuning check with DFTPP documented GC/MS performance. Initial calibration checks met minimum relative response factors. Continuing calibration checks met advisory QC limits for all compounds. Internal calibration standards met all QC criteria for retention times and area response. A search for tentatively-identified compounds (TIC) was performed and several were found. Per CLP protocol, they received the appropriate "J" data qualifier flag. Supporting chromatograms demonstrated data consistency for all samples, method blank, and matrix spikes.

13C:

All pesticide/PCB analyses were performed using dual column confirmation (columns DB-608 and DB-5) as required by CLP protocol. Surrogate compound recoveries for the analyses met required QC limits. Method blank analyses contained no contaminants and no corrections were required. Matrix spike/matrix spike duplicate analyses met expected QC guidelines with the exception of aldrin. Initial calibration data of column DB-608 displays 4,4'-DDT and methoxychlor are out of QC limits. Aldrin, 4,4'-DDT and methoxychlor were not detected in the samples using either column, and no data qualifier flags are used. Initial calibration of columns DB-5 displayed appropriate analytical performance. Analyte resolution and continuing calibration verification met expected QC limits for both columns. Dual column

chromatograms were included for all samples, the method blank, matrix spikes, and calibration standards. The chromatograms have been annotated with quantitation values calculated from the average response factors as needed by the laboratory. The reported summary information appears consistent with this data.

13D:

All metal analyses were performed by inductively coupled plasma (ICP) analysis, except mercury, which received cold vapor atomic absorption (CVAA) analysis. Duplicate analyses did not meet QC limits required for zinc; results received the appropriate CLP "*" data qualifier flag. All target analytes from the laboratory control samples (LCS) met expected QC limits. Arsenic, cadmium, copper, thallium, and zinc were found in the method blank; per CLP protocol, no further qualifications are made. Mercury and silver results do not meet required spike recovery QC criteria, nor did zinc and copper meet required QC limits for serial dilution. Post-digestion spike samples recoveries met required QC limits. Initial calibration data met required QC limits for all analytes. Due to the additive nature of QC issues regarding arsenic, thallium, and zinc analyses, all results from these analytes are unacceptable. Continuing calibration verification, check standards, ICP correction factors and line calibration data all met within required QC limits. Supporting documentation was supplied in the form of raw sample data consistent with reported summary information.

13E:

Duplicate analyses performed for MFS displayed acceptable precision between results as when matrix spike analyses were performed, the appropriate accuracy is evident. However, a transcription error was noted on the last column of data on page 10 of this work order report. Specifically, the title "RPD" for ammonia, nitrate, nitrite, chloride, and sulfate should instead read "%R" for percent recovery. Regardless, the analytical accuracy remains intact. Blank analysis met required QC limits with issues concerning iron, zinc, and manganese requirements being reported in previous metals (6010) analyses. Additional QC documentation consisting of laboratory worksheets, check standard analyses, sample run logs, raw data, and instrument calibration data was supplied. Data consistency was demonstrated throughout.

RECOMMENDATIONS

All reported detections of various phthalate species in these samples must be appended with a "B" data qualifier flag. All sample results from copper and zinc analyses must be appended with a CLP-metal "B" data qualifier flag to be considered as concentration estimates only.

NC/rlk/b46:2227b.mem

MEMORANDUM

DATE: May 7, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 15A-15F

On February 9, 1993, ten water samples were collected by Burlington field personnel. The identification numbers of these samples are listed below:

PLF-GW-022	PLF-GW-022MSD	PLF-GW-024	PLF-GW-026	PLF-GW-028
PLF-GW-022MS	PLF-GW-023	PLF-GW-025	PLF-GW-027	PLF-GW-029

These samples were then submitted to Sound Analytical Services, of Tacoma, Washington (Work order 30111). I performed a data quality review of the analytical results receiving priority pollutant metals (PPM) analysis (USEPA SW-846, Method 6010) in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM02.0. I performed a data quality review of the analytical results from pesticide/PCB (USEPA SW-846, Method 8080), semivolatile compound (Method 8270), and volatile compound (Method 8240) analysis, in accordance with the USEPA CLP Document Number 0LM01.0. There are no CLP documents specifically for evaluation of chlorinated herbicides (Method 8150) and Minimal Functional Standards (MFS). However, CLP documents were also relied upon for advisory guidance for these analyses. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, and all samples received the requested analyses.

15A:

For volatile compound analysis, methylene chloride, toluene, and acetone were detected in the method blanks; results did not always receive the appropriate "B" data qualifier flag to indicate this. Surrogate compound recoveries, did not meet CLP-required quality control (QC) limits for several samples. Analytical accuracy is affected to the extent that all detected analytes in samples PLF-GW-022MSD and PLF-GW-023 must be accompanied by a "J" flag, reflecting

an estimated value. Otherwise, the matrix spike/matrix spike duplicate analyses would have met the necessary QC criteria. A search for tentatively-identified compounds (TIC) was performed, and several were found. Per CLP protocol, they received the appropriate "J data qualifier flag. Requisite instrument tuning check with bromofluorobenzene (BFB) documented gas chromatograph/mass spectra (GC/MS) performance. All internal standards' retention times met required QC limits except for sample PLF-GW-028. Regardless, data precision remains unaffected. Initial calibration data displays all analytes within required QC limits. Continuing calibration verification displays several compounds outside advisory QC limits: carbon tetrachloride, 1,2-dichloroethene, 1,1,2-trichloroethane, ethylbenzene, and tetrachloroethene. These compounds were sometimes detected in the samples. As such, they should receive a "J" data qualifier flag as they can only be considered estimated quantities. Additional QC was supplied in the form of GC/MS printouts for the samples, method blank, matrix spikes, and calibration standards. Data consistency was demonstrated throughout.

15B:

Semivolatile analysis displayed surrogate recoveries within required QC limits for all samples, method blank, and matrix spikes. Matrix spike recoveries met required QC limits. Method blanks contained no contaminants and no corrections were required. Requisite instrument tuning check with DFTPP documented GC/MS performance. Initial calibration checks met minimum relative response factors. Continuing calibration checks met advisory QC limits for all compounds. Internal calibration standards met all QC criteria for retention times and area response. A search for tentatively-identified compounds (TIC) was performed and several were found. Per CLP protocol, they received the appropriate "J" data qualifier flag. Supporting chromatograms demonstrated data consistency for all samples, method blank, and matrix spikes.

15C:

All pesticide/PCB analyses were performed using dual column confirmation (columns DB-608 and DB-5) as required by CLP protocol. Acceptable laboratory extraction of sample PLF-GW-029 was not achieved. Subsequent analysis was not performed and results are unavailable for this sample only. Surrogate compound recoveries for the analyses met required QC limits with the exception of tetrachloro-m-xylene in sample PLF-GW-022. Regardless, the overall data accuracy remains unaffected. Method blank analyses contained no contaminants and no corrections were required. Matrix spike/matrix spike duplicate analysis met required QC guidelines. Initial calibration of columns DB-5 displayed appropriate analytical performance. Initial calibration data of column DB-608 displays 4,4'-DDT, 4,4'-DDD, endrin, and

methoxychlor are out of QC limits. Analyte resolution met expected QC limits for both columns. Dual column chromatograms were included for all samples, the method blank, matrix spikes, and calibration standards. The chromatograms have been annotated with quantitation values calculated from the average response factors as needed by the laboratory. The reported summary information appears consistent with this data.

15D

The chlorinated herbicide method blank contained no contaminants and no corrections were used. Surrogate compound recoveries met advisory QC limits for all analyses. Method spike/method spike duplicate results indicate all required QC limits were met with exception of the compound dalapon. However, this analyte was not detected in the samples and no data qualifier flags are used. Additional QC was supplied in the form of GC/MS data for the samples, method spikes, initial and continuing calibration data. Consistent dilution factors and proper data qualifier flags accompanied the analytical results as needed.

15E:

All metal analyses were performed by inductively coupled plasma (ICP) analysis, except mercury, which received cold vapor atomic absorption (CVAA) analysis. Initial analytical results for iron, manganese, and zinc, were not acceptable. The samples were re-analyzed within proper holding times, acceptable results re-submitted, and included prior to completion of this memorandum. Duplicate analyses met QC limits required for all analytes. All target analytes from the laboratory control samples (LCS) met expected QC limits. Arsenic, copper, cadmium, nickel, and zinc were found in the method blank; per CLP protocol, no further qualifications are made. Required spike recovery QC criteria was met by all analytes except silver; results received the appropriate "N" data qualifier flag. Post-digestion spike samples recoveries met required QC limits for all analytes. Calibration verification met required QC guidelines with the exception of arsenic, lead, selenium, and thallium. These analytes were reported with a "W" data qualifier flag. Due to the additive nature of QC issues regarding arsenic analyses, all results from this analyte should be considered as estimated quantities only and appended with a CLP "B" data qualifier flag. Continuing calibration verification, check standards, ICP correction factors and line calibration data all were within required QC limits. Supporting documentation was supplied in the form of raw sample data consistent with reported summary information.

15F:

Duplicate analyses performed for MFS met the advisory QC limits with the exception of iron. However, overall analytical precision remains unaffected. When matrix spike analyses were performed, the appropriate accuracy is evident. Blank analysis met required QC limits. Iron, zinc, and manganese requirements were reported in previous metals (6010) analyses. Additional QC documentation consisting of laboratory worksheets, check standard analyses, sample run logs, raw data, and instrument calibration data was supplied. Data consistency was demonstrated throughout.

RECOMMENDATIONS

All reported detections of acetone, methylene chloride, and toluene in these samples must be appended with a "B" data qualifier flag. All reported volatile compound detections in samples PLF-GW-022MSD and PLF-GW-023 must be appended with "J" data qualifier flags. All reported detections of carbon tetrachloride, 1,2-dichloroethene, 1,1,2-trichloroethane, tetrachloroethene, and ethylbenzene in any sample must also be appended with "J" data qualifier flags. All reported detections of arsenic are to be considered as a concentration estimate only and must be appended with a CLP "B" data qualifier flag.

NC/rlk/b46:2231b.mem

MEMORANDUM

DATE: May 7, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 11A-11F

On February 10, 1993, twelve water samples were collected by Burlington field personnel. The identification numbers of these samples are listed below:

PLF-GW-030	PLF-GW-030MSD	PLF-GW-032	PLF-GW-034	PLF-GW-036	PLF-GW-038
PLF-GW-030MS	PLF-GW-031	PLF-GW-033	PLF-GW-035	PLF-GW-037	PLF-GW-039

These samples were then submitted to Sound Analytical Services, of Tacoma, Washington (Work order 30158). I performed a data quality review of the analytical results receiving priority pollutant metals (PPM) analysis (USEPA SW-846, Method 6010) in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM02.0. I performed a data quality review of the analytical results from pesticide/PCB (USEPA SW-846, Method 8080), semivolatile compound (Method 8270), and volatile compound (Method 8240) analysis, in accordance with the USEPA CLP Document Number 0LM01.0. There are no CLP documents specifically for evaluation of chlorinated herbicides (Method 8150) and Minimal Functional Standards (MFS). However, CLP documents were also relied upon for advisory guidance for these analyses. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, and all samples received the requested analyses.

11A:

For volatile compound analysis, methylene chloride, acetone, and toluene were detected in the method blanks; results did not always receive the appropriate "B" data qualifier flag to indicate this. Surrogate compound recoveries, as well as system monitoring compound recoveries, met CLP-required quality control (QC) limits for the sample, the accompanying method blank and matrix spikes. As noted, matrix spike/matrix spike duplicates relative percent difference did not meet expected QC limits. However, spike compound recoveries were very consistent and

were within CLP accuracy requirements. Therefore, overall data accuracy is acceptable. A search for tentatively-identified compounds (TIC) was performed, and several were found. Per CLP protocol, they received the appropriate "J" data qualifier flag. Requisite instrument tuning check with bromofluorobenzene (BFB) documented gas chromatograph/mass spectra (GC/MS) performance. All internal standards' retention times met required QC limits. Initial calibration data displays all analytes within required QC limits. Continuing calibration verification displays all compounds within advisory QC limits, with the exception of xylene and ethylbenzene. These compounds were not detected in the samples. Per CLP protocol, no data qualifier flags were needed. Additional QC was supplied in the form of the laboratory worksheets, and GC/MS printouts for the samples method blank, matrix spikes, and calibration standards. Data consistency was demonstrated throughout.

11B:

Semivolatile analysis displayed surrogate recoveries within required QC limits for all samples, method blank, and method spike. Matrix spike recoveries met required QC limits. Method blanks contained no contaminants and no corrections are required. Requisite instrument tuning check with DFTPP documented GC/MS performance. Initial calibration checks met minimum relative response factors. Continuing calibration checks met advisory QC limits for all compounds, with the exception of isophorone and chrysene. These analytes were not detected in the samples and as per CLP protocol, no data qualifier flags are needed. Internal calibration standards met all QC criteria for retention times and area response. A search for tentatively-identified compounds (TIC) was performed and several were found. Per CLP protocol, they received the appropriate "J" data qualifier flag. Supporting chromatograms demonstrated data consistency for all samples, method blank, and matrix spikes.

11C:

All pesticide/PCB analyses were performed using dual column confirmation (columns DB-608 and DB-5) as required by CLP protocol. Surrogate compound recoveries for the analyses met required QC limits. Method blank analyses contained no contaminants and no corrections were required. Matrix spike/matrix spike duplicate met required QC limits. Initial calibration of columns DB-5 displayed appropriate analytical performance. Initial calibration data of column DB-608 shows that 4,4'-DDT, 4,4'-DDD and endrin are out of QC limits. These compounds were not detected in the samples using either column, and no data qualifier flags are used. Continuing calibration verification met expected QC limits for both columns. Both columns indicate individual analyte resolution within required QC parameters. Dual column chromatograms were included for all samples, the method blank, method spike, and calibration

standards. The chromatograms have been annotated with quantitation values calculated from the average response factors as needed by the laboratory. The reported summary information appears consistent with this data.

11D

The chlorinated herbicide method blank contained no contaminants and no corrections were used. Surrogate compound recoveries met advisory QC limits for all analyses. Matrix spike/matrix spike duplicate results indicate all required QC limits were met with exception of the compound dalapon. However, this analyte was not detected in the samples and no data qualifier flags were are used. Initial and continuing calibration data met required QC parameters. Additional QC was supplied in the form of GC/MS data for the samples, matrix spikes, calibration standards, and DFTPP tuning check. Proper data qualifier flags accompanied the analytical results as needed.

11E:

All metal analyses were performed by inductively coupled plasma (ICP) analysis, except mercury, which received cold vapor atomic absorption (CVAA) analysis. Duplicate analyses did not meet QC limits required for zinc; results received the appropriate CLP "*" data qualifier flag. All target analytes from the laboratory control samples (LCS) met expected QC limits. The method blank contained no contaminants and no corrections were required. Serial dilution QC criteria for zinc was not met and results received the appropriate CLP "E" data qualifier flag. Matrix spike recoveries met expected QC parameters. Post-digestion spike samples recoveries met required QC limits with the exception of thallium, selenium, lead, and arsenic; results received the appropriate CLP "W" data qualifier flag. Initial and continuing calibration verification, check standards, ICP correction factors and line calibration data all met within required QC limits. Supporting documentation was supplied in the form of raw sample data consistent with reported summary information.

11F:

Duplicate analyses performed for MFS displayed acceptable precision between results as when matrix spike analyses were performed, the appropriate accuracy is evident. Blank analysis met required QC limits. Iron, zinc, and manganese requirements were reported in previous metals (6010) analyses. Additional QC documentation consisting of laboratory worksheets, check standard analyses, sample run logs, raw data, and instrument calibration data was supplied. Data consistency was demonstrated throughout.

RECOMMENDATIONS

All reported detections of methyl chloride, acetone, and toluene in these samples must be appended with a "B" data qualifier flag.

NC/rlk/b46:2216b.mem

MEMORANDUM

DATE: May 7, 1993

TO: Ted Wall, Environmental Engineer TW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 14A-14E

On February 12, 1993, six water samples were collected by Burlington field personnel. The identification numbers of these samples are listed below:

PLF-GW-050	PLF-GW-050MSD	PLF-GW-052
PLF-GW-050MS	PLF-GW-051	PLF-GW-053

These samples were then submitted to Sound Analytical Services, of Tacoma, Washington (Work order 30200). I performed a data quality review of the analytical results receiving priority pollutant metals (PPM) analysis (USEPA SW-846, Method 6010) in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM02.0. I performed a data quality review of the analytical results from pesticide/PCB (USEPA SW-846, Method 8080), semivolatile compound (Method 8270), and volatile compound (Method 8240) analysis, in accordance with the USEPA CLP Document Number 0LM01.0. There are no CLP documents specifically for evaluation of chlorinated herbicides (Method 8150). However, CLP documents were also relied upon for advisory guidance for these analyses. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, and all samples received the requested analyses.

14A:

For volatile compound analysis, methylene chloride, toluene, and acetone were detected in the method blanks; results did not always receive the appropriate "B" data qualifier flag to indicate this. Surrogate compound recoveries, as well as system monitoring compound recoveries, met CLP-required quality control (QC) limits for all samples, except for one surrogate in PLF-GW-050. Overall, data accuracy remains unaffected. Matrix spike/matrix spike duplicate analyses met all required QC criteria. A search for tentatively-identified compounds (TIC)

was performed, and several were found. Per CLP protocol, they received the appropriate "J data qualifier flag. Requisite instrument tuning check with bromofluorobenzene (BFB) documented gas chromatograph/mass spectra (GC/MS) performance. All internal standards' retention times met required QC limits. Initial calibration data displays all analytes within required QC limits. Continuing calibration verification displays all compounds within advisory QC limits, with the exception of xylene, 1,1,1-trichloroethane, and carbon tetrachloride. These compounds were not detected in the samples. Per CLP protocol, no data qualifier flags are needed. Additional QC was supplied in the form of the laboratory worksheets, and GC/MS printouts for the samples method blank, matrix spikes, and calibration standards. Data consistency was demonstrated throughout.

14B:

Semivolatile analysis displayed surrogate recoveries within required QC limits for all samples, method blank, and matrix spike. Matrix spike recoveries met required QC limits. Method blanks contained several species of phthalates; results did not always receive the appropriate "B" data qualifier flag. Requisite instrument tuning check with DFTPP documented GC/MS performance. Initial calibration checks met minimum relative response factors. Continuing calibration checks met advisory QC limits for all compounds. Internal calibration standards met all QC criteria for retention times and area response. A search for tentatively-identified compounds (TIC) was performed and several were found. Per CLP protocol, they received the appropriate "J" data qualifier flag. Supporting chromatograms demonstrated data consistency for all samples, method blank, and matrix spikes.

14C:

All pesticide/PCB analyses were performed using dual column confirmation (columns DB-608 and DB-5) as required by CLP protocol. Surrogate compound recoveries for the analyses met required QC limits. Method blank analyses contained no contaminants and no corrections were required. Matrix spike/matrix spike duplicate analysis met required QC guidelines. Initial calibration of both columns displayed appropriate analytical performance. Analyte resolution met expected QC limits for both columns. Dual column chromatograms were included for all samples, the method blank, matrix spikes, and calibration standards. The chromatograms have been annotated with quantitation values calculated from the average response factors as needed by the laboratory. The reported summary information appears consistent with this data.

14D

The chlorinated herbicide method blank contained no contaminants and no corrections were used. Surrogate compound recoveries met advisory QC limits for all analyses. Matrix spike/matrix spike duplicate results indicate all required QC limits were met with exception of the compounds dalapon, dicamba, and 2,4,5-T. Since dicamba was detected in one of the samples, this result should only be considered an estimate. Additional QC was supplied in the form of GC/MS data for the samples, matrix spike, initial calibration data, and DFTPP tuning check. Proper data qualifier flags accompanied the analytical results as needed.

14E:

All metal analyses were performed by inductively coupled plasma (ICP) analysis, except mercury, which received cold vapor atomic absorption (CVAA) analysis. Duplicate analyses did not meet QC limits required for zinc; results received the appropriate CLP "*" data qualifier flag. All target analytes from the laboratory control samples (LCS) met expected QC limits. Lead, copper, thallium, and zinc were found in the method blank; per CLP protocol, no further qualifications are made. Post-digestion spike recoveries met required QC limits with selenium, lead, and arsenic reported as exceptions; results received the appropriate CLP "W" data qualifier flag. Initial and continuing calibration verification, check standards, ICP correction factors and line calibration data all met within required QC limits. Supporting documentation was supplied in the form of raw sample data consistent with reported summary information.

RECOMMENDATIONS

All reported detections of various phthalate species, acetone, methylene chloride, and toluene in these samples must be appended with a "B" data qualifier flag. The reported detection of dicamba must be appended with a "J" data qualifier flag.

MEMORANDUM

DATE: May 7, 1993

TO: Ted Wall, Senior Environmental Engineer TW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 17A

On March 22, 1993, eight soil-gas samples were collected by Burlington Environmental field personnel. The sample identifications numbers are as follows:

GPS-001	GPS-003	GPS-005	GPS-007
GPS-002	GPS-004	GPS-006	GPS-008

These samples were then submitted to Sound Analytical of Tacoma, Washington (work order 30894), for volatile organic compound analysis (USEPA SW-846, Method 8240). I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number 0LM01.0. These guidelines are normally used for water and soil monitoring. However, this document was relied upon for proper guidance in the soil-gas data validation. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. The samples received the requested analyses, and all holding, extraction, and analysis times met the required guidelines.

Methylene chloride was detected in the method blank; results received the appropriate "B" data qualifier flag to indicate this. Surrogate compound recoveries were within expected QC limits. Internal standards displayed area response and retention times within required limits, with the exception of sample GPS-001. As such, data from this sample should be considered estimated values only. Initial calibration check met the required minimum relative response factors for all detected compounds, with the exception of methylene chloride. This appears related to the previously mentioned blank contamination issue and results have received "B" data qualifier flags.

Requisite instrument tuning check with bromofluorobenzene documented performance of gas chromatograph/mass spectral analyses. Matrix spike/matrix spike duplicate analyses displayed analytical accuracy within required QC limits with the exception of chlorobenzene. This compound was not detected in any samples and per CLP protocol, no further action is taken. The

relative percent differences (RPD) between spike analyses did not meet required precision QC limits. However, data usability remains intact as the continuing calibration verifications met QC limits required for determination of precision. Additional QC was supplied in the form of gas chromatograms, mass spectral data for the samples, method blank, matrix spikes, and calibration standards. Data consistency was demonstrated throughout.

RECOMMENDATIONS

Overall, the data quality guidelines as advised in the CLP Statement of Work are met once the following changes are made: all reported detections in sample GPS-001 must be appended with "J" data qualifier flags. This data can then be considered valid for its intended use.

MEMORANDUM

DATE: May 19, 1993

TO: Ted Wall, Environmental Engineer JW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 16A-16E

From February 2 to 4, 1993, forty samples were collected by Burlington field personnel. The identification numbers of these samples are listed below:

PLF-GW-008	PLF-SBS-274	PLF-SBS-282	PLF-SBS-290	PLF-SBS-298
PLF-GW-009	PLF-SBS-275	PLF-SBS-283	PLF-SBS-291	PLF-SBS-299
PLF-GW-010	PLF-SBS-276	PLF-SBS-284	PLF-SBS-292	PLF-SBS-300
PLF-GW-011	PLF-SBS-277	PLF-SBS-285	PLF-SBS-293	PLF-SBS-301
PLF-GW-012	PLF-SBS-278	PLF-SBS-286	PLF-SBS-294	PLF-SBS-302
PLF-GW-013	PLF-SBS-279	PLF-SBS-287	PLF-SBS-295	PLF-SBS-303
PLF-GW-014	PLF-SBS-280	PLF-SBS-288	PLF-SBS-296	PLF-SBS-304
PLF-SBS-273	PLF-SBS-281	PLF-SBS-289	PLF-SBS-297	PLF-SBS-305

These samples were then submitted to Sound Analytical Services, of Tacoma, Washington (Work order 30100). I performed a data quality review of the analytical results receiving priority pollutant metals (PPM) analysis (USEPA SW-846, Method 6010) in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM02.0. I performed a data quality review of the analytical results from pesticide/PCB (USEPA SW-846, Method 8080), semivolatile compound (Method 8270), and volatile compound (Method 8240) analysis, in accordance with the USEPA CLP Document Number 0LM01.0. There are no CLP documents specific for evaluation of chlorinated herbicides (Method 8150). However, CLP documents were also relied upon for advisory guidance for these analyses. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, with the exception of semivolatile analysis for sample PLF-SBS-273 (this sample had no detections of semivolatile target compounds). All samples received the requested analyses.

16A:

For volatile compound analysis, methylene chloride, toluene, and acetone were detected in the method blanks; results did not always receive the appropriate "B" data qualifier flag to indicate this. Surrogate compound recoveries, as well as system monitoring compound recoveries, met CLP-required quality control (QC) limits for the samples, the accompanying method blank and matrix spikes. Matrix spike/matrix spike duplicate analyses met required QC criteria with the exception of toluene and trichloroethene recoveries for water matrix only. However, these two compounds were not found in the samples, and overall analytical accuracy remains intact. A search for tentatively-identified compounds (TIC) was performed, and several were found. Per CLP protocol, they received the appropriate "J data qualifier flag. Requisite instrument tuning check with bromofluorobenzene (BFB) documented gas chromatograph/mass spectra (GC/MS) performance. All internal standards' retention times met required QC limits. Initial calibration data displayed all analytes within required QC limits with the exception of xylenes. Continuing calibration verification displayed all compounds within advisory QC limits, with the exception of tetrachloroethene and 1,1,2-trichloroethane. These compounds were not detected in the samples. Per CLP protocol, no data qualifier flags are needed. Additional QC was supplied in the form of the laboratory worksheets, and GC/MS printouts for the samples method blank, matrix spikes, and calibration standards. Data consistency was demonstrated throughout.

16B:

Semivolatile analysis displayed surrogate recoveries within required QC limits for all samples, method blank, and matrix spikes. Matrix spike/matrix spike duplicate analyses displayed required analytical accuracy. Sample results report that di-n-butylphthalate and bis(2-ethylhexyl)phthalate were found. A chromatograph comparison with the associated method blank did not reveal comparable peaks. However, these analytes have been demonstrated as significant laboratory contaminants by our subcontractor (SAS). Based upon this experience, it is my professional decision that these reported analytes be accompanied by a "B" data qualifier flag. Requisite instrument tuning check with DFTPP documented GC/MS performance. Initial calibration checks met minimum relative response factors. Continuing calibration checks met advisory QC limits for all compounds. Internal calibration standards met all QC criteria for retention times and area response. A search for tentatively-identified compounds (TIC) was performed and several were found. Per CLP protocol, they received the appropriate "J" data qualifier flag. Supporting chromatograms demonstrated data consistency for all samples, method blank, and matrix spikes.

16C:

All pesticide/PCB analyses were performed using dual column confirmation (columns DB-608 and DB-5) as required by CLP protocol. Surrogate compound recoveries for the analyses met required QC limits for all analyses. Method blank analyses contained no contaminants and no corrections were required. Matrix spike/matrix spike duplicate analyses met required QC guidelines. Initial calibration of columns DB-5 displayed appropriate analytical performance. Initial calibration data of column DB-608 displays 4,4'-DDT, 4,4'-DDD, endrin, and methoxychlor out of QC limits. These compounds were not detected in the samples using either column, and no data qualifier flags are used. Analyte resolution and continuing calibration verification met expected QC limits for both columns. Dual column chromatograms were included for all samples, the method blank, method spike, and calibration standards. The chromatograms have been annotated with quantitation values calculated from the average response factors as needed by the laboratory. The reported summary information appears consistent with this data.

16D

The chlorinated herbicide method blank contained no contaminants and no corrections were used. Surrogate compound (2,4,6-Tribromophenol) recoveries met advisory QC limits for most analyses with the exception of samples PLF-SBS-278, PLF-SBS-281, PLF-SBS-282, PLF-SBS-286, and PLF-SBS-295. However, no target compounds were detected in the samples, and no data qualifier flags are used. Matrix spike/matrix spike duplicate results indicate all required QC limits were met with exception of the compound dalapon and dinoseb. However, these analytes were not detected in any of the samples and no data qualifier flags were are used. Additional QC was supplied in the form of GC/MS data for the samples, matrix spike, and continuing calibration data. Consistent dilution factors and proper data qualifier flags accompanied the analytical results as needed.

16E:

All metal analyses were performed by inductively coupled plasma (ICP) analysis, except mercury, which received cold vapor atomic absorption (CVAA) analysis. Duplicate analyses did not meet QC limits required for zinc, cadmium, chromium, copper, lead, and nickel; results received the appropriate CLP "*" data qualifier flag. All target analytes from the laboratory control samples (LCS) met expected QC limits except arsenic. Cadmium, chromium, copper, and zinc were found in the method blank; per CLP protocol, no further

qualifications are made. Thallium, mercury, silver, and antimony results do not meet required spike recovery QC criteria; results received the appropriate CLP "N" data qualifier flag. Zinc and copper did not meet required QC limits for serial dilution; results received the appropriate CLP "E" data qualifier flag. Post-digestion spike samples recoveries met required QC limits with the exception of silver; results did not receive the appropriate CLP "W" data qualifier flag. Due to the additive nature of QC issues regarding cadmium, chromium, silver, zinc and copper analyses, all results from these analytes can be considered as estimates only per CLP protocol. Initial and continuing calibration verification, check standards, ICP correction factors and line calibration data all met within required QC limits. Supporting documentation was supplied in the form of raw sample data consistent with reported summary information.

RECOMMENDATIONS

All reported detections of methylene chloride, toluene, acetone, di-n-butylphthalate, and bis(2-ethylhexyl)phthalate in these samples must be appended with a "B" data qualifier flag. All sample results from cadmium, chromium, silver, zinc and copper analysis must be appended with the CLP-metal "B" data qualifier flag to be considered estimated concentrations only. Semivolatile results from sample PLF-SBS-273 are unusable and must be rejected.

MEMORANDUM

DATE: June 7, 1993

TO: Ted Wall, Environmental Engineer JW

FROM: Nels Cone, Chemist NBC

SUBJECT: DATA VALIDATION OF CHEMICAL ANALYSIS FROM PASCO LANDFILL PHASE I REMEDIAL INVESTIGATION, PROJECT 624419, DATA SET 8A

During the period of January 22 - 24, 1993, nine soil samples were collected by Burlington field personnel. The sample identification numbers are listed below.

PLF-SBS-242	PLF-SBS-250	PLF-SBS-254
PLF-SBS-243	PLF-SBS-251	
PLF-SBS-244	PLF-SBS-252	
PLF-SBS-245	PLF-SBS-253	

These samples were then submitted to Sound Analytical Services of Tacoma, Washington (work order 29777). Data Set 8A represents results from volatile compound analysis (USEPA SW-846, Method 8240). I performed a data quality review of the analytical results in accordance with the USEPA Contract Laboratory Program (CLP) Document Number ILM01.0. My findings and recommendations are summarized below.

FINDINGS

Properly completed chain-of-custody forms were included with documented signatures from field to laboratory receipt. All samples were shown as having been properly iced and received in good condition. Holding, extraction, and analysis times for all samples met the required guidelines, and all samples received the requested analyses.

In this analysis, acetone and methylene chloride and toluene were detected in the method blanks. Even though not all results received the appropriate annotations, any reported values of these three analytes must be accompanied by the "B" data qualifier flag. Surrogate compound recoveries, as well as system monitoring compound recoveries, met CLP-required quality control (QC) limits for the samples, and accompanying method blanks. A search for tentatively-identified compounds (TIC) was performed and several were found. Per CLP protocol, they received the appropriate "J" data qualifier flags. Requisite instrument tuning check with bromofluorobenzene documented gas chromatograph/mass spectra (GC/MS) performance.

All internal standards' area and retention times met QC limits. Initial and continuing calibration data met required QC guidelines. All matrix spike/matrix spike duplicate recoveries met required QC limits with exception of 1,1-dichloroethene. However, this compound was not detected in

the samples and, per CLP protocol, no data qualifier flags are needed. Additional QC was supplied in the form of the laboratory worksheets, and GC/MS printouts for the sample method blank, matrix spikes, and calibration standards. The chromatograms have been annotated with quantitation values calculated as needed, by the laboratory. Data consistency was demonstrated throughout.

RECOMMENDATIONS

Overall, the data quality guidelines as described in the CLP Statement of Work are met when values reported as acetone, methylene chloride, and toluene receive "B" data qualifier flags. No further modifications to this data set would be required.

PHILIP ENVIRONMENTAL

Philip Environmental Services Corporation
210 West Sand Bank Road
Columbia, Illinois 62236

Phone: 618-281-7173 FAX: 618-281-5120

– MEMORANDUM –

TO: Mr. Dave Provance

FROM: Paul Anderson

DATE: July 17, 1995

PROJECT NUMBER: 624419

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO TIER II

The analytical data for the Pasco samples collected in April 1995, have been reviewed in accordance with the guidelines setforth in the USEPA "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses", 1994, and the method specific quality requirements. The seventeen (17) soil samples were analyzed for the project specific list of herbicides. The samples in the data set are as follows:

PLF-BKG-01	PLF-BKG-02
PLF-BKG-03	PLF-BKG-04
PLF-BKG-05	PLF-BKG-06
PLF-BKG-07	PLF-BKG-08
PLF-BKG-09	PLF-BKG-10
PLF-BKG-11	PLF-BKG-12
PLF-BKG-13	PLF-BKG-14
PLF-BKG-15	PLF-BKG-16
PLF-BKG-910	

The samples were received by Sound Analytical Services, Inc. on April 28, 1995.

8150 Herbicides

There were no problems concerning holding times.

No contamination was noted in the associated method blank analyzed. The surrogate recovery value had exceeded the method acceptable upper limit for the blank sample. No qualification was required since the exceeded value would bias only positive analyte detections. All analytes for the blank sample were non-detect.

There were no problems concerning the matrix spike / matrix spike duplicate associated with this data set.

Having completed a review of the data in this sampling event, the data appears acceptable based on the information supplied by the laboratory.

PHILIP ENVIRONMENTAL

Philip Environmental Services Corporation
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Columbia, Illinois 62236
Phone: 618-281-7173 FAX: 618-281-5120

– MEMORANDUM –

TO: Mr. Dave Provance

FROM: Paul Anderson

DATE: July 17, 1995

PROJECT NUMBER: 624419

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO TIER II

The analytical data for the Pasco samples collected in April 1995, have been reviewed in accordance with the guidelines setforth in the USEPA "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses", 1994, and the method specific quality requirements. The thirteen (13) soil samples were analyzed for the project specific list of herbicides. The samples in the data set are as follows:

PLF-SB13-10
PLF-SB15-10
PLF-SB14-10
PLF-MW26S-910
PLF-MW26S-15.5
PLF-MW25S-20
PLF-MW25S-40
PLF-SB13-20
PLF-SB15-20
PLF-SB14-20
PLF-MW26S-05
PLF-MW25S-10
PLF-MW25S-30

The samples were received by Sound Analytical Services, Inc. on May 04, 1995.

8150 Herbicides

There were no problems concerning holding times.

No contamination was noted in the associated method blank analyzed.

There were no problems concerning surrogate recovery values.

There were no problems concerning the matrix spike / matrix spike duplicate associated with this data set.

Having completed a review of the data in this sampling event, the data appears acceptable based on the information supplied by the laboratory.

PHILIP ENVIRONMENTAL

Philip Environmental Services Corporation
210 West Sand Bank Road
Columbia, Illinois 62236
Phone: 618-281-7173 FAX: 618-281-5120

– MEMORANDUM –

TO: Mr. Dave Provance

FROM: Paul Anderson

DATE: July 17, 1995

PROJECT NUMBER: 624419

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO TIER II

The analytical data for the Pasco samples collected in April 1995, have been reviewed in accordance with the guidelines setforth in the USEPA "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses", 1994, and the method specific quality requirements. The thirteen (13) soil samples were analyzed for the project specific list of herbicides. The samples in the data set are as follows:

PLF-SB13-10
PLF-SB15-10
PLF-SB14-10
PLF-MW26S-910
PLF-MW26S-15.5
PLF-MW25S-20
PLF-MW25S-40
PLF-SB13-20
PLF-SB15-20
PLF-SB14-20
PLF-MW26S-05
PLF-MW25S-10
PLF-MW25S-30

The samples were received by Sound Analytical Services, Inc. on May 04, 1995.

8150 Herbicides

There were no problems concerning holding times.

No contamination was noted in the associated method blank analyzed.

There were no problems concerning surrogate recovery values.

There were no problems concerning the matrix spike / matrix spike duplicate associated with this data set.

Having completed a review of the data in this sampling event, the data appears acceptable based on the information supplied by the laboratory.

PHILIP ENVIRONMENTAL

Philip Environmental Services Corporation
210 West Sand Bank Road
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– MEMORANDUM –

TO: Mr. Dave Provance

FROM: Paul Anderson

DATE: July 17, 1995

PROJECT NUMBER: 624419

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO TIER II

The analytical data for the Pasco samples collected in April 1995, have been reviewed in accordance with the guidelines setforth in the USEPA "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses", 1994, and the method specific quality requirements. The seventeen (17) soil samples were analyzed for the project specific list of herbicides. The samples in the data set are as follows:

PLF-BKG-01	PLF-BKG-02
PLF-BKG-03	PLF-BKG-04
PLF-BKG-05	PLF-BKG-06
PLF-BKG-07	PLF-BKG-08
PLF-BKG-09	PLF-BKG-10
PLF-BKG-11	PLF-BKG-12
PLF-BKG-13	PLF-BKG-14
PLF-BKG-15	PLF-BKG-16
PLF-BKG-910	

The samples were received by Sound Analytical Services, Inc. on April 28, 1995.

8150 Herbicides

There were no problems concerning holding times.

No contamination was noted in the associated method blank analyzed. The surrogate recovery value had exceeded the method acceptable upper limit for the blank sample. No qualification was required since the exceeded value would bias only positive analyte detections. All analytes for the blank sample were non-detect.

There were no problems concerning the matrix spike / matrix spike duplicate associated with this data set.

Having completed a review of the data in this sampling event, the data appears acceptable based on the information supplied by the laboratory.

PHILIP ENVIRONMENTAL

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- MEMORANDUM -

TO: Mr. Dave Provance

FROM: Paul Anderson

DATE: July 17, 1995

PROJECT NUMBER: 624419

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO PHASE II

The analytical data for the Pasco Phase II samples collected on May 1, 1995, have been reviewed in accordance with the guidelines setforth in the USEPA "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses", 1994, and the method specific quality requirements. The eight soil samples were analyzed for the project specific list of herbicides. The samples in the data set are as follows:

PLF-SB13-15	PLF-SB13-2S
PLF-SB15-15	PLF-SB-15-25
PLF-SB14-15	PLF-SB14-25
PLF-MW26S-10	PLF-MW26S-20

The samples were received by Sound Analytical Services, Inc. on May 04, 1995. The samples were to be on hold until approved, per the Chain of Custody. Sound Analytical Services received approval to proceed with the analyses on May 23, 1995. The samples had already exceeded the holding period at time of approval.

8150 Herbicides

Holding times had exceeded prior to the samples being extracted by the laboratory. Soil samples should be extracted within 14 days of sample collection. Per the "Functional Guidelines", both detects and non-detects should be 'J' qualified as estimated There were no positive results noted in the eight samples. The non-detects have been 'J' qualified as part of the validation process.

No contamination was noted in the associated method blanks analyzed.

Relative Percent Differences (RPD) were very high between the Matrix Spike and the Matrix Spike Duplicate sample (MS/MSD) that were analyzed as part of this data package. For the MS/MSD sample analyzed, the percent recovery values were within the method acceptable limits, but the recovery values were at opposite ends of the acceptable limits. This creates the high RPD values. No qualification of the data was required based on this criteria only.

The surrogate percent recovery value had exceeded the method acceptable upper limit. Per the "Functional Guidelines", the positive results should be 'J' qualified and the non-detects are not qualified. No qualification was required since there were no positive values among the eight samples.

A continuing calibration was analyzed on 06/01/95 as part of this analytical data set. Per the "Functional Guidelines", the Percent Difference (%D) value for analytes and surrogates should not exceed 25%. The %D is the amount by which the continuing calibrations response factor varies from the initial response. No qualification was required as the "Functional Guidelines" require that only compounds to be quantified need to be 'J' qualified.

Having completed a review of the data in this sampling event, the data appears acceptable with the exceptions noted above and the addition of the appropriate qualifiers.

PHILIP ENVIRONMENTAL

Philip Environmental Services Corporation
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– MEMORANDUM –

TO: Mr. Dave Provance

FROM: Paul Anderson

DATE: July 17, 1995

PROJECT NUMBER: 624419

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO PHASE II

The analytical data for the Pasco Phase II samples collected on May 1, 1995, have been reviewed in accordance with the guidelines setforth in the USEPA "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses", 1994, and the method specific quality requirements. The eight soil samples were analyzed for the project specific list of herbicides. The samples in the data set are as follows:

PLF-SB13-15	PLF-SB13-2S
PLF-SB15-15	PLF-SB-15-25
PLF-SB14-15	PLF-SB14-25
PLF-MW26S-10	PLF-MW26S-20

The samples were received by Sound Analytical Services, Inc. on May 04, 1995. The samples were to be on hold until approved, per the Chain of Custody. Sound Analytical Services received approval to proceed with the analyses on May 23, 1995. The samples had already exceeded the holding period at time of approval.

8150 Herbicides

Holding times had exceeded prior to the samples being extracted by the laboratory. Soil samples should be extracted within 14 days of sample collection. Per the "Functional Guidelines", both detects and non-detects should be 'J' qualified as estimated There were no positive results noted in the eight samples. The non-detects have been 'J' qualified as part of the validation process.

No contamination was noted in the associated method blanks analyzed.

Relative Percent Differences (RPD) were very high between the Matrix Spike and the Matrix Spike Duplicate sample (MS/MSD) that were analyzed as part of this data package. For the MS/MSD sample analyzed, the percent recovery values were within the method acceptable limits, but the recovery values were at opposite ends of the acceptable limits. This creates the high RPD values. No qualification of the data was required based on this criteria only.

The surrogate percent recovery value had exceeded the method acceptable upper limit. Per the "Functional Guidelines", the positive results should be 'J' qualified and the non-detects are not qualified. No qualification was required since there were no positive values among the eight samples.

A continuing calibration was analyzed on 06/01/95 as part of this analytical data set. Per the "Functional Guidelines", the Percent Difference (%D) value for analytes and surrogates should not exceed 25%. The %D is the amount by which the continuing calibrations response factor varies from the initial response. No qualification was required as the "Functional Guidelines" require that only compounds to be quantified need to be 'J' qualified.

Having completed a review of the data in this sampling event, the data appears acceptable with the exceptions noted above and the addition of the appropriate qualifiers.

PHILIP ENVIRONMENTAL

Philip Environmental Services Corporation
210 West Sand Bank Road
Columbia, Illinois 62236

Phone: 618-281-7173 FAX: 618-281-5120

– MEMORANDUM –

TO: Mr. Dave Provance

FROM: Paul Anderson

DATE: July 17, 1995

PROJECT NUMBER: 624419

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO LANDFILL

The analytical data for the Pasco Landfill samples collected on May 2,5, and 6, 1995, have been reviewed in accordance with the guidelines setforth in the USEPA "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses", 1994, and the method specific quality requirements. The two soil and two groundwater samples were analyzed for the project specific list of herbicides. The samples in the data set are as follows:

PLF-MW27S-60	soil sample collected on 05/05/95
PLF-MW28S-60	soil sample collected on 05/05/95
PLF-EQS-01	water sample collected on 05/02/95
PLF-EQS-02	water sample collected on 05/06/95

The samples were received by Sound Analytical Services, Inc. on May 12, 1995.

8150 Herbicides

Holding times had exceeded prior to the samples being extracted by the laboratory. Water samples should be extracted within 7 days and soils within 14 days of sample collection. Per the "Functional Guidelines", both detects and non-detects should be 'J' qualified as estimated There were no positive results noted in the four samples. The non-detects have been 'J' qualified as part of the validation process.

No contamination was noted in the associated method blanks analyzed.

Relative Percent Differences (RPD) were very high between the Matrix Spike and the Matrix Spike Duplicate samples (MS/MSD) that were analyzed as part of this data package. For both MS/MSD samples analyzed, the percent recovery values were within the method acceptable limits, but the recovery values were at opposite ends of the acceptable limits. This creates the high RPD values. No qualification of the data was required based on this criteria only.

Having completed a review of the data in this sampling event, the data appears acceptable with the exceptions noted above and the addition of the appropriate qualifiers.

PHILIP ENVIRONMENTAL

Philip Environmental Services Corporation
210 West Sand Bank Road
Columbia, Illinois 62236
Phone: 618-281-7173 FAX: 618-281-5120

– MEMORANDUM –

TO: Mr. Dave Provance

FROM: Paul Anderson

DATE: July 17, 1995

PROJECT NUMBER: 624419

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO

The analytical data for the Pasco samples collected on May 4, 1995, have been reviewed in accordance with the guidelines setforth in the USEPA "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses", 1994, and the method specific quality requirements. The two air samples were analyzed for the project specific list of volatile organic compounds (VOCs) by USEPA method 8260. The samples in the data set are as follows:

PLF-PH938-30 PLF-PH936-10

The samples were received by Burlington Environmental, Inc. - Corporate Laboratory on May 05, 1995.

8260 VOCs

There were no problems associated with holding times.

There were no problems associated with the surrogate recovery values.

Having completed a review of the data in this sampling event, the data appears acceptable based on the information supplied by the laboratory.

PHILIP ENVIRONMENTAL

Philip Environmental Services Corporation
210 West Sand Bank Road
Columbia, Illinois 62236

Phone: 618-281-7173 FAX: 618-281-5120

– MEMORANDUM –

TO: Mr. Dave Provance

FROM: Paul Anderson

DATE: July 17, 1995

PROJECT NUMBER: 624419

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO PHASE II RI/FS

The analytical data for the Pasco samples collected on May 09, 1995, have been reviewed in accordance with the guidelines setforth in the USEPA "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses", 1994, and the method specific quality requirements. The one water sample was analyzed for the project specific list of volatile organic compounds (VOCs), by USEPA method 8260. The samples in the data set are as follows:

PLF-EE3-66 PLF-EE2-67

The samples were received by Burlington Environmental, Inc. - Corporate Laboratory on May 09, 1995.

8260 VOCs

There were no problems associated with holding times.

There were no problems associated with the surrogate recovery values.

There were several dates that were not properly updated. The dates refer to the analysis and reporting dates.

Having completed a review of the data in this sampling event, the data appears acceptable based on the information supplied by the laboratory.

PHILIP ENVIRONMENTAL

Philip Environmental Services Corporation
210 West Sand Bank Road
Columbia, Illinois 62236
Phone: 618-281-7173 FAX: 618-281-5120

– MEMORANDUM –

TO: Mr. Dave Provance

FROM: Paul Anderson

DATE: July 17, 1995

PROJECT NUMBER: 624419

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO PHASE II RI/FS

The analytical data for the Pasco samples collected on May 10, 1995, have been reviewed in accordance with the guidelines setforth in the USEPA "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses", 1994, and the method specific quality requirements. The one water sample was analyzed for the project specific list of volatile organic compounds (VOCs), primarily Hexane, by USEPA method 8260. The samples in the data set are as follows:

PLF-RB-01

The samples were received by Burlington Environmental, Inc. - Corporate Laboratory on May 11, 1995.

8260 VOCs

There were no problems associated with holding times.

There were no problems associated with the surrogate recovery values.

Having completed a review of the data in this sampling event, the data appears acceptable based on the information supplied by the laboratory.

PHILIP ENVIRONMENTAL

Philip Environmental Services Corporation
210 West Sand Bank Road
Columbia, Illinois 62236

Phone: 618-281-7173 FAX: 618-281-5120

– MEMORANDUM –

TO: Mr. David Provance

FROM: Fred Grabau

DATE: August 31, 1995

PROJECT NUMBER: 624419

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO TIER II

The quality assurance review for the Pasco Landfill samples collected in May 30, 1995 is attached. The analysis was performed and reported by Sound Analytical Services for the following samples:

Sample ID

PLF-MW28S-60

A rigorous examination of the data was performed in accordance with the guidelines setforth in the USEPA "Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses", 1994, and the method specific quality requirements. The purpose of the review was to determine the usability of the analytical results and also to determine compliance to the requirements of the analytical methods. The criteria employed for technical data review are different from the from those specified in the methods. Data may be in full compliance with the method requirements but may not be usable for all purposes, such as risk assessment. The data qualifiers as defined in the USEPA Data Validation Functional Guidelines have been added to the results. The definitions of the qualifiers are included at the end of the quality assurance review.

The data packages consisted of a summary of analytical results along with raw data and calibration summaries.

Overall Assessment

The overall quality of the data is acceptable. However, portions of the data have been qualified due to poor matrix spike recovery.

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO TIER II
MEMO FROM: Fred Grabau
DATE: August 31, 1995

Project 624419 Site Pasco Landfill SDG 49011

Laboratory Sound Analytical Services No. of Samples/Matrix 1 water

SOW # SW-846, 200.8, 7471 Reviewer Org. Philip Environmental

Inorganic Data Assessment Summary

	ICP	AA	Hg	CYANIDE
1. Holding Times	V		V	
2. Calibrations	V		V	
3. Blanks	V		V	
4. ICS	V			
5. LCS	V comment 1			
6. Duplicate Analysis	V comment 2		V	
7. Matrix Spike	V action 1		V	
8. MSA				
9. Serial Dilution	V			
10. Sample Verification	V		V	
11. Other QC	V comment 3		V	
12. Overall Assessment	V		V	

V = Data had no problems/or qualified due to minor problems.
A = Data qualified due to major problems.
R = Data Unacceptable.
X = Problems, but do not affect data.

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO TIER II
MEMO FROM: Fred Grabau
DATE: August 31, 1995

Actions Items:

1. The Zinc matrix spike recovery was above the acceptable range. All positive results in the batch have been 'J' qualified as estimated values.

Comments:

1. The LCS results were not included in the original data package. The results were obtained from the laboratory and were inserted into the data package.

2. The Silver precision between duplicates had a high %RPD, but qualification was not indicated since the difference in results was less than one times the detection limit.

3. The digestion records were not included in the original data package. The details of the digestion were confirmed with the laboratory. The quarterly verification parameters were not included in the data package. A copy of the current data was obtained from the lab to confirm that the instruments were operating within acceptable ranges.

Reviewed by: Fred Grabau

Date of Review: 8/31/95

Inorganic Data Qualifier Definitions

U The analyte was not detected.

J The value is an estimated quantity.

R The result is not usable for any purpose. The analyte may or may not be present.

UJ The analyte was not detected, however the reported detection limits is inaccurate or imprecise.

PHILIP ENVIRONMENTAL

Philip Environmental Services Corporation
210 West Sand Bank Road
Columbia, Illinois 62236
Phone: 618-281-7173 FAX: 618-281-5120

– MEMORANDUM –

TO: Mr. David Provance

FROM: Fred Grabau

DATE: September 5, 1995

PROJECT NUMBER: 624419

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO TIER II

The quality assurance review for the Pasco Landfill samples collected in May 30, 1995 is attached. The analysis was performed and reported by Sound Analytical Services for the following samples:

Sample ID	
PLF-MW23S-40	49010-01
PLF-MW23-940	49010-02
PLF-MW24S-50	49010-03
PLF-MW27S-60	49010-04
PLF-EQS-3	49010-05

A rigorous examination of the data was performed in accordance with the guidelines setforth in the USEPA "Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses", 1994, and the method specific quality requirements. The purpose of the review was to determine the usability of the analytical results and also to determine compliance to the requirements of the analytical methods. The criteria employed for technical data review are different from the from those specified in the methods. Data may be in full compliance with the method requirements but may not be usable for all purposes, such as risk assessment. The data qualifiers as defined in the USEPA Data Validation Functional Guidelines have been added to the results. The definitions of the qualifiers are included at the end of the quality assurance review.

The data packages consisted of a summary of analytical results along with raw data and calibration summaries.

Overall Assessment

The overall quality of the data is acceptable. However, portions of the data have been qualified due to poor matrix spike recovery.

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO TIER II
MEMO FROM: Fred Grabau
DATE: September 5, 1995

Project 624419 Site Pasco Landfill SDG 49010

Laboratory Sound Analytical Services No. of Samples/Matrix 4 soil, 1 water

SOW # SW-846, 200.8, 7471 Reviewer Org. Philip Environmental

Inorganic Data Assessment Summary

	ICP	AA	Hg	CYANIDE
1. Holding Times	V		V	
2. Calibrations	V		V	
3. Blanks	V		V	
4. ICS	V			
5. LCS	V comment 1			
6. Duplicate Analysis	V comment 2		V comment 2	
7. Matrix Spike	V action 1		V comment 3	
8. MSA				
9. Serial Dilution	V			
10. Sample Verification	V		V	
11. Other QC	V comment 3		V	
12. Overall Assessment	V		V	

V = Data had no problems/or qualified due to minor problems.
A = Data qualified due to major problems.
R = Data Unacceptable.
X = Problems, but do not affect data.

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO TIER II
MEMO FROM: Fred Grabau
DATE: September 5, 1995

Actions Items:

1. The Zinc matrix spike recovery was above the acceptable range for the soil batch. All positive results in the batch have been 'J' qualified as estimated values. The water matrix spikes were acceptable.

Comments:
1. The LCS results were not included in the original data package. The results were obtained from the laboratory and were inserted into the data package.

2. The Silver precision between soil duplicates had a high %RPD, but qualification was not indicated since the difference in results was less than one times the detection limit.

3. The digestion records were not included in the original data package. The details of the digestion were confirmed with the laboratory. The quarterly verification parameters were not included in the data package. A copy of the current data was obtained from the lab to confirm that the instruments were operating within acceptable ranges.

4. The matrix spike recoveries for mercury were not included in the initial data package The results were requested and received from the laboratory and included in the data package.

Reviewed by: Fred Grabau

Date of Review: 8/31/95

Inorganic Data Qualifier Definitions

U The analyte was not detected.

J The value is an estimated quantity.

R The result is not usable for any purpose. The analyte may or may not be present.

UJ The analyte was not detected, however the reported detection limits is inaccurate or imprecise.

ENVIRONMENTAL STANDARDS

Setting the Standards for Innovative Environmental Solutions

September 13, 1995

Mr. Dave Provance
Philip Environmental, Inc.
955 Powell Avenue, Southwest
Renton, Washington 98055

Dear Mr. Provance:

Enclosed is the quality assurance review for the samples collected between April 27 and May 10, 1995, as part of the Weyerhaeuser Pasco Landfill Phase II investigation. Overall, the data quality is acceptable. However, portions of the data have been qualified due to laboratory method blank contamination.

If you have any questions/comments, or if I can be of further assistance, please feel free to call.

Sincerely,

Meg A. Clark for KAB

Kathleen A. Blaine
Senior Quality Assurance Chemist II

KAB:kb

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ENVIRONMENTAL STANDARDS

Setting the Standards for Innovative Environmental Solutions

QUALITY ASSURANCE REVIEW

OF SAMPLES COLLECTED FOR

WEYERHAEUSER PASCO LANDFILL PHASE II INVESTIGATION

PASCO, WASHINGTON

September 13, 1995

Prepared for:

PHILIP ENVIRONMENTAL, INC.
955 Powell Avenue, Southwest
Renton, Washington 98124

Prepared by:

ENVIRONMENTAL STANDARDS, INC.
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Introduction

Quality Assurance Review

A. Organic Data

B. Conclusions

TABLE 1

SAMPLES INCLUDED IN THIS QUALITY ASSURANCE REVIEW

Philip Environmental, Inc. Sample Number	Laboratory Sample Number	SDG Number	Date of Sample Collection	Matrix	Parameter(s) Analyzed
PLF-BKG-01	45735	17862	04/27/95	soil	D
PLF-BKG-02	45736	17862	04/27/95	soil	D
PLF-BKG-03	45737	17862	04/27/95	soil	D
PLF-BKG-04	45738	17862	04/27/95	soil	D
PLF-BKG-05	45739	17862	04/27/95	soil	D
PLF-BKG-06	45740	17862	04/27/95	soil	D
PLF-BKG-07	45741	17862	04/27/95	soil	D
PLF-BKG-08	45742	17862	04/27/95	soil	D
PLF-BKG-09	45743	17862	04/27/95	soil	D
PLF-BKG-10	45744	17862	04/27/95	soil	D
PLF-BKG-11	45745	17862	04/27/95	soil	D
PLF-BKG-12	45746	17862	04/27/95	soil	D
PLF-BKG-13	45747	17862	04/27/95	soil	D
PLF-BKG-14	45748	17862	04/27/95	soil	D
PLF-BKG-15	45749	17862	04/27/95	soil	D
PLF-BKG-16	45750	17862	04/27/95	soil	D
PLF-BKG-910 (duplicate of PLF-BKG-10)	45751	17862	04/27/95	soil	D
PLF-MW25S-10	46156	17920	05/02/95	soil	D

TABLE 1(Cont.)

Philip Environmental, Inc. Sample Number	Laboratory Sample Number	SDG Number	Date of Sample Collection	Matrix	Parameter(s) Analyzed
PLF-MW25S-20	46157	17920	05/02/95	soil	D
PLF-MW25S-30	46158	17920	05/02/95	soil	D
PLF-MW25S-40	46159	17920	05/02/95	soil	D
PLF-MW26S-05	46160	17920	05/01/95	soil	D
PLF-MW26S-15.5	46161	17920	05/01/95	soil	D
PLF-MW26S-910	46162	17920	05/01/95	soil	D
PLF-SB13-10	46163	17920	05/01/95	soil	D
PLF-SB13-20	46164	17920	05/01/95	soil	D
PLF-SB14-10	46165	17920	05/01/95	soil	D
PLF-SB14-20	46166	17920	05/01/95	soil	D
PLF-SB15-10	46167	17920	05/01/95	soil	D
PLF-SB15-20	46168	17920	05/01/95	soil	D
PLF-EQS-01	46666	17981	05/10/95	water	D
PLF-EQS-02	46667	17981	05/10/95	water	D

NOTES:

D - Total and 2,3,7,8-isomer specific polychlorinated dibenzo-p-dioxin and dibenzofuran compounds by U.S. EPA Method 1613.

Introduction

This quality assurance review is based upon a rigorous examination of the data generated from the samples collected between April 27 and May 10, 1995, as part of the Weyerhaeuser Pasco Landfill Phase II investigation. The samples that have undergone the quality assurance review are presented on Table 1.

This review has been performed in accordance with the "National Functional Guidelines for Organic Data Review" (U.S. EPA, 1990) and the method-specific requirements.

Data were examined to determine the usability of the analytical results and to determine compliance relative to requirements specified in U.S. EPA Method 1613. Qualifier codes have been placed next to the results so that the data user can quickly assess the qualitative and/or quantitative reliability of any result. The narrative section of this report contains details of this quality assurance review. This report was prepared to provide a critical review of the laboratory analyses and reported analytical results. Rigorous quality assurance reviews of laboratory-generated data routinely identify various problems associated with analytical measurements, even from the most experienced and capable laboratories. This critical quality assurance review identified data quality issues for specific samples and specific evaluation criteria. The data qualifications allow the data end-user to best understand the usability of the analytical results. The nature and extent of problems identified in this critical review should not be interpreted to mean that those results that have qualifier codes are less than valid. In addition, it should be understood that data that have not been qualified in this report are considered valid based on the quality control criteria that have been reviewed.

Quality Assurance Review

A. Organic Data

The organic analysis of 30 soil samples (including one field duplicate) and two water samples was performed by Weyerhaeuser Analytical and Testing Services of Tacoma, Washington. All 32 samples were analyzed for total and 2,3,7,8-isomer specific polychlorinated dibenzo-p-dioxin and dibenzofuran compounds by U.S. EPA Method 1613 as indicated on Table 1.

Data Package Deliverables

The data package provided by the laboratory included initial calibration data, selected ion chromatograms, extraction logs, performance check data, ion ratio data, method blank results, and window defining mix data.

Noncorrectable Deficiencies

1. The samples were extracted and analyzed in three sets. Each set had an associated method blank. Each of these laboratory method blanks contains low-level concentrations of the hexa-, hepta-, and octa-chlorinated isomers of dioxins and furans. All of the project samples are impacted by this contamination (see subsequent qualifiers).

2. A matrix spike/matrix spike duplicate was not analyzed as part of the data set. This was required based on the project Quality Assurance Project Plan.

Comments

1. The M+2/M+4 ion ratio was used for the quantification of the labeled HxCDF and HpCDF compounds. The acceptance criteria listed in Table 3A of U.S. EPA Method 1613 was used for evaluation.

2. The initial calibration concentrations listed in U.S. EPA Method 1613 were used with the exception of the OCDD levels. The laboratory employed a five point calibration for OCDD spanning 2.5 to 1000 ng/mL instead of the required 5 ng/mL to 1000 ng/mL. In addition, in order to meet the mid-level concentration for the calibration verification, the OCDD concentration was adjusted to 500 ng/mL.

3. The C^{13}-1,2,3,7,8,9-HxCDF surrogate recovery exceeded the 150% acceptance criteria in samples PLF-EQS-01, PLF-EQS-02, PLF-SB14-20, and PLF-BKG-15. This compound was not detected in any of the four samples; therefore, there is no impact on

the sample quantitation and no qualification of the data is required. It should be noted that no corrective action is noted in U.S. EPA Method 1613 for failing surrogate recoveries.

Data Evaluation

The findings offered in this report are based upon a rigorous review of all data provided in the laboratory submission. The information examined includes holding times, blank analysis results, surrogate spike recoveries, field duplicate results, instrument calibration, instrument performance checks, internal standard areas, compound identification and quantification, and compound retention time.

With respect to data usability, the principal area of concern was sample contamination based on the laboratory method blank results. The addition of the above stated data qualifiers addresses this issue.

Organic Data Qualifiers

- Due to the trace-level presence of the following compounds in the laboratory method blanks, the reported positive results for these compounds in the samples listed below are qualitatively questionable and have been flagged "U" on the laboratory reports. It should be noted that dilution factors, sample weights, and percent solids were taken into consideration when evaluating blank contamination. The samples have been qualified based on the method blank extracted with that sample set.

Compound	Sample(s) With Qualitatively Questionable Results ("U")
1234789-HpCDD	PLF-BKG-02, PLF-BKG-03, PLF-BKG-04, PLF-BKG-05, PLF-BKG-07, PLF-BKG-08, PLF-BKG-09, PLF-BKG-11, PLF-BKG-12, PLF-BKG-13, PLF-BKG-15, and PLF-BKG-16
OCDD	PLF-BKG-02, PLF-BKG-03, PLF-BKG-07, PLF-BKG-11, PLF-BKG-13, PLF-BKG-15, PLF-BKG-16, PLF-MW25S-40, PLF-EQS-01, and PLF-EQS-02

Compound	Sample(s) With Qualitatively Questionable Results ("U")
234678-HxCDF	PLF-BKG-01, PLF-BKG-02, PLF-BKG-03, PLF-BKG-04, PLF-BKG-05, PLF-BKG-06, PLF-BKG-07, PLF-BKG-08, PLF-BKG-09, PLF-BKG-10, PLF-BKG-11, PLF-BKG-12, PLF-BKG-13, PLF-BKG-14,

	PLF-BKG-15, PLF-BKG-16, PLF-MW25-S-10, PLF-MW25S-20, PLF-MW25S-30, PLF-MW25S-40, PLF-MW26S-05, PLF-MW26S-15.5, PLF-MW-26S-910, PLF-SB13-10, PLF-SB13-20, PLF-SB14-10, PLF-SB14-20, PLF-SB15-10, PLF-SB15-20, RLF-EQS-01, and RFL-EQS-02
1234678-HpCDF	PLF-BKG-01, PLF-BKG-02, PLF-BKG-04, PLF-BKG-05, PLF-BKG-08, PLF-BKG-09, PLF-BKG-13, PLF-BKG-15, and PLF-BKG-16
1234789-HpCDF	PLF-BKG-06, PLF-BKG-10, and PLF-BKG-14
OCDF	PLF-BKG-01, PLF-BKG-02, PLF-BKG-03, PLF-BKG-04, PLF-BKG-05, PLF-BKG-06, PLF-BKG-07, PLF-BKG-08, PLF-BKG-09, PLF-BKG-10, PLF-BKG-12, PLF-BKG-13, PLF-BKG-14, PLF-BKG-15, PLF-BKG-16, and PLF-EQS-02
Total HpCDD	PLF-BKG-02, PLF-BKG-03, PLF-BKG-07, PLF-BKG-11, PLF-BKG-12, PLF-BKG-15, and PLF-BKG-16
Total HxCDF	PLF-BKG-01, PLF-BKG-02, PLF-BKG-03, PLF-BKG-04, PLF-BKG-05, PLF-BKG-07, PLF-BKG-08, PLF-BKG-09, PLF-BKG-11, PLF-BKG-12, PLF-BKG-13, PLF-BKG-15, PLF-BKG-16, PLF-MW25-S-10, PLF-MW25S-30, PLF-MW25S-40, PLF-MW26S-15.5, PLF-SB13-10, PLF-SB13-20, PLF-SB14-10, PLF-SB14-20, PLF-SB15-10, PLF-SB15-20, and RLF-EQS-01
Total HpCDF	PLF-BKG-01, PLF-BKG-02, PLF-BKG-04, PLF-BKG-05, PLF-BKG-08, PLF-BKG-09, PLF-BKG-12, PLF-BKG-13, PLF-BKG-15, and PLF-BKG-16

One field duplicate pair was submitted with the project samples for analysis. Sample PLF-BKG-910 was identified as the field duplicate of sample PLF-BKG-10. In general, the field duplicate sample analysis displayed acceptable precision in that the field duplicate pair displayed acceptable relative percent differences (<40%) between the positive results for the two samples.

B. Conclusions

This quality assurance review has identified one aspect of the analytical data that required qualification or rejection. The majority of the data are acceptable. However, a portion of the organic data has been qualified due to method blank contamination. To confidently use any of the analytical data within these sample sets, the data user should understand the qualifications and limitations of the results.

Report prepared by:

Meg A Clark for KAB

Kathleen A. Blaine
Senior Quality Assurance Chemist II/
Project Manager

Report reviewed by:

Don Lancaster
Senior Quality Assurance Chemist II

Report reviewed and approved by:

Rock J. Vitale
Director of Chemistry

ENVIRONMENTAL STANDARDS, INC. Date:
1140 Valley Forge Road
P.O. Box 911
Valley Forge, PA 19482-0911

Organic Qualifiers

U This compound should be considered "not-detected" since it was detected in a laboratory method blank at a similar level.

J Quantitation is approximate due to limitations identified during the quality assurance review (data validation).

UJ This compound was not detected, but the quantitation limit may or may not be higher due to a bias identified during the quality assurance review.

R Unreliable result - Compound may or may not be present in this sample.

It should be noted that the results for all organic solid samples are reported on a "dry-weight" basis.

PHILIP ENVIRONMENTAL

– MEMORANDUM –

TO: Dave Provance

FROM: Paul Anderson

cc: Mike Caputo

DATE: October 22, 1996

PROJECT NUMBER: 624419

SUBJECT: **Analytical Data QA Review - Pasco Phase II (July, 1996)**

SUMMARY AND DATA USABILITY

Data Quality Review Project Summary

This report addresses data quality for samples collected July 24-30, 1996, during quarterly groundwater sampling conducted at the Pasco Landfill. Sample collection activities were conducted by Philip Environmental Services Corporation (Philip).

Samples collected at the facility were analyzed for a selected list of analytical parameters, which included the following: volatiles, semi-volatiles , herbicides, and total metals. The analyte list and detection limits were as specified by the Washington Administrative Code (WAC) Appendix I & II list, as described in the Quality Assurance Project Plan (QAPP). The chemical analyses were performed and reported by Philip Analytical Services (PAS) in Burnaby, British Columbia. The samples were received by the laboratory on July 25 through 31, 1996. Table 1 presents a summary of the validated samples, including their identification information, matrix, collection dates, and methods of analysis performed. Table 1 also provides the deviated quality control criteria noted for each sample.

Sample data resulting from the analysis of samples shown on Table 1 underwent data validation review. The purpose of the data validation is to provide an independent opinion of the quality of data generated from the measurement process. The validation focuses on all aspects of the data generation process and involved a rigorous examination of the data packages. The purpose of the review was to determine the usability of the analytical results and also to determine compliance with the requirements of the analytical methods. Accordingly, this report outlines excursions from the applicable quality control criteria outlined in the analytical methods referenced in Table 1.

Data Usability

The analytical data were reviewed and qualified in accordance with U.S. Environmental Protection Agency (USEPA) Data Validation Functional Guidelines (USEPA, 1994a,b). Rejected data, which are considered unusable for either qualitative or quantitative purposes, are a result of a major deficiency noted in the data generation process. Minor deficiencies in

the data generation process result in approximation of sample data. Approximation of a data point indicates uncertainty in the reported concentration of the chemical, but not its assigned identity. Conservative assumptions made when basing conclusions on analytical data allow the use of approximated analytical data. This approach to the use of analytical data is consistent with USEPA (USEPA, 1992) risk assessment and data usability guidance. A summary of specific quality assurance/quality control (QA/QC) excursions that resulted in qualification of sample data is presented in the following sections.

This section summarizes the analytical data in terms of its completeness and usability for characterization of the current water quality for engineering decisions and risk management. Data completeness is defined as the percentage of sample results that have been determined to meet quality control criteria during the data review process. The completeness of the data set was determined to be 98%. However, some sample results have been qualified due to blank, matrix spike/matrix spike duplicate (MS/MSD), laboratory control sample (LCS), holding time and preservation, calibration, surrogate, and quantitation quality control and reporting limit excursions described below.

Data usability is a qualitative evaluation that utilizes the findings of the data validation review, historical information, regulatory guidance and other applicable information to provide an assessment of how the data set may be used. The assessment is made with reference to the specific data uses specified in the previous paragraph. Data which do not meet completeness requirements are not considered usable, however, data which are complete are not necessarily usable.

The data usability analysis found that with the exception of analytical results for 2-butanone that were rejected for low response factors, the remaining data set is usable. No other issues which affect data usability were noted.

DATA VALIDATION METHODS AND RESULTS

Data Validation Protocols

The criteria employed for data validation review (USEPA, 1994) provide differing quality control criteria from those specified in the methods. In cases where method requirements and validation requirements overlap, method quality control criteria are used and the validation guidelines are followed for applying data qualifiers, if required. The data validation guidelines quality control criteria are used when the method does not provide criteria. Data may be in full compliance with the method requirements, but may not meet data validation guidance.

Quality Control Parameters

The following QA/QC parameters were evaluated for inorganic analyses:

1. Holding Times and Preservation
2. Initial and Continuing Calibration
3. Contract Required Detection Limit (CRDL) Standard Criteria
4. Blank Analyses
5. Inductively Coupled Plasma (ICP) Interference Check Sample (if applicable)
6. MS Sample Recovery Criteria
7. Laboratory Duplicate Analysis
8. Field Duplicate Analysis
9. LCS Analysis
10. ICP Serial Dilution (if applicable)
11. Furnace Atomic Absorption Analysis (if applicable)
12. Method of Standard Additions (MSA) (if applicable)
13. Analyte Quantitation and Reporting Limits
14. Documentation Completeness

The following QA/QC parameters were evaluated for volatile and semivolatile analyses:

1. Holding Times
2. Gas Chromatography/Mass Spectrometry (GC/MS) Instrument Performance Check
3. Initial Calibration
4. Continuing Calibration
5. Blank Analyses
6. Surrogate Spikes
7. MS/MSD Analysis
8. LCS Analysis
9. Internal Standards
10. Target Compound Identification
11. Compound Quantitation and Reporting Limits

The following QA/QC parameters were evaluated for herbicide analyses:

1. Holding Times
2. GC Instrument Performance Check
3. Initial Calibration
4. Continuing Calibration
5. Blank Analyses
6. Surrogate Spikes
7. MS/MSD Analysis
8. LCS Analysis
9. Target Compound Identification
10. Compound Quantitation and Reporting Limits

Data Qualifiers Used in Validation

The following data qualifiers are defined by the USEPA in the Data Validation Functional Guidelines for use in validating analytical data. The appropriate data qualifiers were added to the data packages in red ink during data validation. Any necessary corrections to the data due to transcription errors or calculation errors were also added with red ink. Each page with changes was also initialed and dated by the validator.

The following data validation qualifiers may be used during the validation of data:

R	Indicates that the reporting limit or sample result has been determined to be unusable due to a major deficiency in the data generation process. The data should not be used for any qualitative or quantitative purposes.
U	Indicates that the analyte was analyzed for, but was not detected. The sample-specific reporting limit is presented and adjusted for dilution and percent solids, as appropriate. The qualifier is also used to signify that the reporting limit of an analyte was raised due to blank contamination.
J	The analyte was positively identified but the concentration should be considered approximate. This qualifier indicates that the data validation process identified a deficiency in the data generation process.
UJ	Indicates that the sample-specific reporting limit for the analyte in this sample should be considered approximate. This qualifier is used when the data validation process identified a deficiency in the data generation process.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate

Data Evaluation Results

This section describes the qualifiers that were added to sample data where QA/QC criteria were not met. QA/QC parameters that were met are not discussed. Samples that required qualification are identified in the following sections by the sample location documented on the field chain-of-custody record.

Volatiles

General Comments

Volatiles analyses were performed in full scan and selected ion monitoring (SIM) mode. In order to meet the WAC limit requirements, vinyl chloride, 1,1-dichloroethene and carbon tetrachloride were analyzed in the SIM mode.

Detected volatile results were flagged with an 'NJ' when the ion ratios for a target analyte was outside the ion ratio tolerance limits.

Bromoflurobenzene (BFB) tunes were analyzed after, rather than prior to, the continuing calibration standards. This sequence was used since BFB tuning is monitored from the method blank which is analyzed after the continuing calibration standard. The laboratory employs this sequence in order to reduce the sequence by one analysis (BFB standard alone) since BFB is in all samples and the laboratory monitors the BFB on an ongoing basis, as well. If the BFB tuning monitored from the method blank failed criteria the laboratory would be required to recalibrate the system prior to proceeding with sample analysis. No action was required for the alteration of the standard analysis sequence.

The internal standard reference controls were monitored from the low concentration standard of the initial calibrations as opposed to the intermediate concentration standard. No action was required for this procedural modification.

The sample log-in sheet indicated that one of the coolers containing samples for volatile analyses arrived at the laboratory at 11.8° C, which is above the 6° C maximum acceptable temperature. However, no action was taken since the samples were stored in sample vial holders which are constructed from foam blocks. The foam acted to insulate the vials from the ice that was packed in the cooler. The laboratory also noted that sufficient ice remained in the cooler upon arrival.

Blank Analyses

Contamination was detected in the method blanks and the trip blanks. The sample results have been qualified based on the observed contamination. Sample results reported at concentrations less than five times the blank contamination (ten times for the common laboratory contaminants and tentatively identified compounds (TICs)) have been 'U' qualified as not detected and the reporting limit raised to the reported value for the analyte. The observed compounds, their reported concentrations and the affected samples are summarized in the following table. Blank contaminants that did not affect sample results have not been listed in the table.

Blank I.D.	Analysis Date	Analyte	Conc. (µg/L)	Reporting Limit (ug/L)	Action Level[1] (ug/L)	Affected Samples	Qualified Results[2]
jul290901010	7/29/96	unknown	28.4 J	NA	142	MW35S	235 U
						MW37S	234 U
						MW36S	258 U
						MW38S	244 U
						MW39S	274 U
		pentafluoro -benzene	29.3 NJ	NA	146.5	MW37S	28.5 U
						MW39S	24.6 U
		decane	28.8 NJ	NA	144	MW35S	23.4 U
						MW37S	31.5 U
						MW36S	30.5 U
						MW38S	34.9 U
						MW39S	29.8 U
						MW33S	35.6 U
jul290901019	7/29/96	pentafluoro -benzene	24.6 NJ	NA	123	MW19S	22.0 U
						MW25S	21.4 U
						#8	22.8 U
jul290901021	7/29/96	unknown	34.3 J	NA	171.5	MW32S	U
						MW27S	U
						MW20S	U
						MW28S	U
						MW19S	U
						EE7	U
						EE8	U
						#96	U
		decane	25.6 NJ	NA	128	MW32S	27.6 U
						MW27S	24.4 U
						MW20S	29.1 U
						MW28S	31.1 U
						MW19S	36.6 U
						EE7	37.9 U
						EE8	26.8 U
						#96	38.1 U
jul290901038	7/29/96	acetone	7.17	6.0	71.7	MW26S	7.0 U
		2-butanone	4.77	3.0	47.7	MW26S	5.0 U
		2-hexanone	3.22	3.0	16.1	MW26S	3.0 U
		decane	28.6 NJ	NA	143	#4	29.4 U
						#6	25.7 U
						MW26S	32.0 U
aug011001010	8/01/96	pentafluoro benzene	30.7 NJ	NA	153.5	MW17SR	31.7 U
						MW23S	36.9 U
						MW42S	28.2 U
						MW40S	36.9 U

Blank I.D.	Analysis Date	Analyte	Conc. (µg/L)	Reporting Limit (ug/L)	Action Level[1] (ug/L)	Affected Samples	Qualified Results[2]
		decane	25.0 NJ	NA	125	MW17SR MW13S MW29S MW42S MW40S- MW41S	14.9 U 25.3 U 18.9 U 16.0 U 18.9 U 18.7 U
aug012701027	8/01/96	acetone	8.06	6.0	80.6	MW10S MW12ID EE2 MW24S	7.0 U 7.0 U 7.0 U 9.0 U
aug013801038	8/01/96	decane	24.6 NJ	NA	123	EE2	21.1 U

Action References: 1 - Action Level = highest blank contaminant value above the reporting limit x 5 or x 10.
2 - Qualified Results = reported value, which becomes the qualified reporting limit.

Notes: NA - Reporting limits not applicable to tentatively identified compounds.

Initial and Continuing Calibration

Initial and continuing calibrations for several compounds exceeded QC criteria. The following table summarizes those compounds that failed to meet the minimum average relative response factor (RRF) criteria of ≥0.05. The low RRFs may indicate poor sensitivity for the compound. Non-detected results for the compounds in the associated samples were 'R' qualified as unusable. Detected results for the compounds in the associated samples were 'J' qualified as estimates. Continuing calibrations percent differences (%Ds) which were greater than 30% for low level calibrations and 25% for medium level calibrations are summarized in the following table. The high %Ds may indicate variability in the results. Detected results for the compounds in the associated samples were 'J' qualified as estimates and non-detected results were 'UJ' qualified as estimated reporting limits. Analytes with correlation coefficients which failed to meet the ≥ 0.990 criteria have been 'J' qualified as estimates.

Calibration Date	QC Criteria	Compound	Obtained Value	Control Limits	Action	Affected Samples
Initial Calibration						
7/30/96	CC	vinyl chloride 1,1-DCE 1,1,2,2-PCA	0.983 0.980 0.984	≥0.990	1	MW38S TB-F2903 TB-F2905
7/29/96	RRF	2-butanone	0.04371	.0.05	2	all July 29 data
8/01/96	RRF	2-butanone	0.04377	.0.05	2	all Aug 01 data

Calibration Date	QC Criteria	Compound	Obtained Value	Control Limits	Action	Affected Samples
Continuing Calibration						
7/29/96	%D	iodomethane cis-1,2-DCE 1,4-DCB 1,2-DCB	25.9 25.1 27.7 36.9	≤25%	1	Trip Blank-F2903 Trip Blank-F2905 Trip Blank-F2907 MW32S MW27S MW20S MW28S MW19S MW22S EE7 EE8 MW25S #8 #96
8/02/96	%D	acrylonitrile 4-methyl-2-pentanone 2-hexanone 1,2,3-trichloropropane	35.5 39.2 37.3 30.9	≤25%	1	MW10S MW11S MW912S MW12ID EE3 EE2 MW24S MW16S #5

Action References: 1 - The detected results for this analyte associated with this calibration have been 'J' qualified as estimates. The non-detected results for this analyte associated with this calibration have been 'UJ' qualified as estimated reporting limits.

2 - The detected results for this analyte associated with this calibration have been 'J' qualified as estimates. The non-detected results for this analyte associated with this calibration have been 'R' qualified as unusable.

Notes: CC - correlation coefficient
RRF - relative response factor
%D - percent difference
DCE - dichloroethene
PCA - tetrachloroethane

Surrogate Spikes

Several surrogate percent recovery values exceeded control limits for several of the samples. For recoveries that were above control limits, the detected samples results were 'J' qualified as

estimates. For recoveries that were below control limits, the detected samples results were 'J' qualified and the non-detected sample results were 'UJ' qualified as estimated reporting limits. Surrogate excursions that resulted in data qualification are presented in the following table.

Sample I.D.	Lab I.D.	Surrogate Compound	Percent Recovery	Control Limits (%)	Action	Affected Analytes
EE3	aug013201032	toluene-d8	167.36	88-110	1	all, except diluted results and SIM results
MW24S	aug013401034	1,2-DCA toluene-d8 4-BFB	122.42 111.84 83.32	80-120 88-110 86-115	1, 2	all, except SIM results
MW29S	aug014201042	4-BFB	83.47	86-115	1	diluted result (cis-1,2-DCE)
MW17SR	aug034901049	1,2-DCA	121.57	80-120	1	SIM result only (1,1-DCE)

Action References: 1 - The detected results for analytes associated with this surrogate were 'J' qualified as estimates.

2 - The non-detected results for analytes associated with this surrogate were 'UJ' qualified as estimated reporting limits.

Notes: BFB - bromofluorobenzene
DCA - dichloroethane
DCE - dichloroethene
SIM - selected ion monitoring

Laboratory Control Samples

Percent recoveries exceeded control limits for several analytes in several LCS samples. For recoveries that exceeded control limits, detected sample results were 'J' qualified as estimates. For recoveries that were less than control limits, detected sample results were 'J' qualified and non-detected samples results were 'UJ' qualified as estimated reporting limits. LCS excursions are presented in the following table.

Analysis Date	QC Batch File	Matrix	Analyte	Percent Recovery	Control Limits (%)	Action	Affected Samples
8/01/96	aug010901009	water	acetone vinyl acetate	46.55 62.97	70-130 70-130	1, 2	TB-F2909 MW17SR MW23S MW13S MW29S MW42S MW40S MW41S TB-F2913 MW12S
8/02/96	aug012601026	water	vinyl acetate	25.94	70-130	1, 2	MW10S MW11S MW912S MW12ID EE3 EE2 MW24S MW16S #5
8/03/96	aug030601006	water	CTT	67.91	78-138	1, 2	all samples*
7/30/96	jul300601006	water	1,1-DCE	135.49	65-125	1	MW38S

Action References:
1 - Detected results for the analyte have been 'J' qualified as estimates.
2 - Non-detected results for the analyte have been 'UJ' qualified as estimated reporting limits.
3 - Non-detected results for the analyte, has been 'R' qualified as not useable since the percent recovery was <30.
4 - No action was necessary since there were no positive results.

Notes:
CTT - carbon tetrachloride
DCE - dichloroethene
* - Only one LCS sample was analyzed for all four batches.

Matrix Spike/Matrix Spike Duplicates

MS/MSD percent recoveries exceeded control limits for several analytes for several of the matrix spike samples. For percent recoveries that exceeded control limits, the detected results in the unspiked sample only were 'J' qualified as estimates. For recoveries that were less than control limits, detected results were 'J' qualified as estimates and non-detected results were 'UJ' qualified as estimated reporting limits. MS/MSD excursions are presented in the following table.

Sample	QC Batch File	Matrix	Analyte	MS % Recovery	MSD % Recovery	Control Limits (%)	Action
#6	jul294301043	water	trans-1,4-D-2-B	66	67	70-130	1, 2
MW12S	aug012101021	water	methylene chloride	43	39		1, 2
			1,1,1-TCA	64	48	70-130	1, 2
			1,2,3-TCP	162	129	66-126	3
#5	aug014001040	water	1,2,3-TCP	146	135	66-126	3
MW22S	aug031901019	water	CTT	58	76	78-138	1, 2
MW12S	aug035001050	water	CTT	62	54	78-138	1, 2

Action References: 1 - Detected results for the analyte have been 'J' qualified as estimates.
2 - Non-detected results for the analyte have been 'UJ' qualified as estimated reporting limits.
3 - No action was necessary since there were no detected results.

Notes: TCA - trichloroethane
TCP - trichloropropane
CTT - carbon tetrachloride
1,4-D-2-B - 1,4-dichloro-2-butene

Compound Quantitation and Reporting Limits

The laboratory analyzed and reported analytes designated for SIM analysis from full scan analyses in several samples since their concentrations exceeded the SIM calibration linear range. Several samples had analytes that exceeded the response of the high standard on the SIM calibration and were not reanalyzed by full scan mode. These analytes that exceeded the SIM calibration linear range were 'J' qualified as estimates. The excursions are presented in the following table.

Sample I.D.	Lab I.D.	Analyte	Result (µg/L)	Area Counts		Action
				Sample	High Standard	
MW12ID	20474	1,1-DCE	3.1	533376	389495	1
EE2	20476	1,1-DCE	2.3	397687	389495	1
MW13S	20482	1,1-DCE	2.6	479177	389495	1
MW29S	20483	1,1-DCE	2.8	498922	389495	1

Action References: 1 -The positive result for this analyte has been 'J' qualified as an estimate.

Notes: DCE - dichloroethene

Semi-Volatiles

General Comments

A duplicate extraction was performed on sample MW25S by splitting the sample into two 400 mL aliquots instead of the standard 800 mL volume. As a result, the reporting limits for this sample were raised by a factor of two. The reporting limits were corrected on the Certificates of Analysis during the validation process. As a corrective action, discussions were held with the laboratory regarding the use of an 800 mL initial volume and the aliquoting of samples for the purposes of duplicate analyses. In the future, water volumes of 1 liter will be used for extraction of samples including duplicate samples.

The SIM analyses were performed on the full scan extract, therefore; the surrogate spike concentrations were not appropriate for the SIM analysis and surrogate recoveries were not measured. In addition, MS/MSD and LCS samples were not analyzed for the SIM analysis. As a corrective action , discussions were held with the laboratory regarding the use of surrogates, MS/MSDs and LCSs. In the future, the laboratory will prepare a separate SIM extract that will be analyzed with the SIM analyses. No action was required regarding the omission of these QC samples for SIM analyses, since the concentration range affected was very small (less than full scan reporting limit to the SIM reporting limit) and any detects above the full scan reporting limit were confirmed.

Satisfactory method detection limits (MDLs) have not yet been determined for the following analytes: benzyl alcohol, benzoic acid, 3,3'-dichlorobenzidine, and N-nitroso-di-n-propylamine. Instrument detection limits studies for 3,3'-dichlorobenzidine and N-nitroso-di-n-propylamine indicate that satisfactory MDLs are achievable. The MDL for bis(2-chloroethyl)ether is 0.6 µg/L, whereas the WAC level is 0.04 µg/L. The laboratory is in the process of performing the required MDL studies to be in compliance with the WAC requirements. Based on the previous analytical data, the lack of MDL studies for these compounds will not have an adverse effect on the usability of the data.

The internal standard reference controls were monitored from the high concentration standard of the initial calibrations as opposed to the intermediate concentration standard. No action was required for this procedural modification.

Blank Analyses

Contamination was detected in method blanks extracted and analyzed in conjunction the samples. Sample results have been qualified based on the observed contamination. Detected results reported at concentrations less than five times the blank contamination (ten times for the phthalates and TICs) have been 'U' qualified as non-detected, and the reporting limit raised to the reported value of the analyte. The observed compounds, their reported concentrations and

the affected samples are summarized in the following table. Blank contaminants that did not effect sample results have not been listed in the table.

Blank I.D.	Extraction Date	Analyte	Conc. (µg/L)	Reporting Limit (ug/L)	Action Level[1] (ug/L)	Affected Samples	Qualified Results[2]
au1506 01021	8/02/96	benzo(a)-anthracene	0.20	0.01	0.1	MW25S MW26S MW926S	0.39 U 0.19 U 0.21 U
		benzo(a)-pyrene	0.01	0.01	0.05	MW26S MW926S	0.01 U 0.01 U
		indeno(1,2,3-cd)pyrene	0.03	0.01	0.15	MW25S MW26S MW926S	0.04 U 0.02 U 0.02 U
		dibenzo(a,h)-anthracene	0.03	0.01	0.15	MW25S MW26S MW926S	0.04 U 0.02 U 0.02 U

References: 1 - Action Level = highest blank contaminant value above the reporting limit x 5 or x 10.
2 - Qualified Results = non-detected reported value, which becomes the qualified reporting limit.

Initial and Continuing Calibration

The initial calibrations for several compounds exceeded QC criteria. The following table summarizes the compounds that had correlation coefficients less than 0.990. Non-detects for these compounds in the associated samples were 'UJ' qualified as estimated reporting limits. Detected values for these compounds in the associated samples were 'J' qualified as estimated.

Calibration Date	QC Criteria	Compound	Obtained Value	Control Limits	Action	Affected Samples
Initial Calibration						
8/15/96	CC	benzyl alcohol benzoic acid 4-chloroaniline 2,4-dinitrophenol 4-nitroaniline	0.985 0.984 0.985 0.986 0.986	≥0.990	1	MW25S MW26S MW926S
8/16/96	CC	indeno(1,2,3-cd)pyrene dibenzo(a,h)anthracene	0.984 0.972	≥0.990	1	MW25S MW26S MW926S

Excursion References: 1 - The detected results for this analyte have been 'J' qualified as estimates. The non-detected results for this analyte been 'UJ' qualified as estimated reporting limits.

Notes: CC - correlation coefficient

Laboratory Control Samples

Percent recovery values for the LCSs were not provided in the data package. Several analytes had recoveries that exceeded the upper acceptance limits, however, no action was necessary since there were no detected results.

Matrix Spikes/Matrix Spike Duplicates

The majority of the MS/MSD results from the full scan analysis of sample MW26S, were approximately double the spiked amount. However, some analytes had low recoveries and 3,3'-dichlorobenzidine had 0% recovery. The laboratory was unable to determine the cause of the poor recoveries and is still investigating. The elevated recoveries did not affect sample results, since the associated samples were non-detects for those analytes. The low percent recoveries resulted in 'UJ' qualifying the non-detected as estimated reporting limits. The excursions are listed in the table below.

Sample	QC Batch	Matrix	Analyte	MS % Recovery	MSD % Recovery	Control Limits	Action
MW26S	au151201011	water	3,3'-dichlorobenzidine	0	0	0-262	1
			2,4-dimethylphenol	16	21	32-119	1

Excursion References: 1 - The non-detected results for the analyte have been 'UJ' qualified as estimated reporting limits.

Herbicides

General Comments

The following quality control results were not provided in the data package and were calculated during the validation: relative response factors; retention times windows; internal standard areas; surrogate recoveries; and LCS recoveries.

The MS/MSD samples were spiked at a level of 0.04 ppb instead of 4.0 ppb as required by the method. The laboratory accepted the results since the instrument was sensitive enough to quantify acceptable spike recoveries for dicamba; 2,4,5-T; and 2,4,5-TP. However, the recovery for 2,4-D was not within the acceptance limits of 50-130. No action was required since the recovery was high and the sample result was a non-detect.

The LCS percent recovery for the analyte 2,4-D exceeded the 50-130 acceptance limits. No action was necessary, since the recovery was high and the sample result was a non-detect

Metals

General Comments

Serial dilution analyses were performed at a 2 x and 5 x dilution on two arsenic samples. Agreement between the two dilution concentrations fell outside the ±10% acceptance criteria. Therefore, all arsenic samples were re-analyzed, including the serial dilution study, at a 2 x dilution factor. The re-analysis of the serial dilution study yielded acceptable results.

Holding Times and Preservation

The sample log-in sheet indicated that one of the coolers containing samples for metals analyses arrived at the laboratory at 8.9° C, which is above the 6° C acceptable temperature. However, no action was taken since the samples were preserved with nitric acid to a pH of <2. One sample (MW28S) was not at pH<2 upon arrival; however, the laboratory preserved the sample with nitric acid to a pH <2 subsequent to arrival. No action was taken for the sample, since the sample was in a cooler that arrived at an acceptable temperature and the sample was digested and analyzed in a short period of time.

Blank Analyses

The Test Blank (equipment blank) submitted with the samples had a zinc concentration which affected other samples submitted within the same time period, since the other samples had zinc concentrations less than the action limit. Several of the method blanks and continuing calibration blanks had analyte concentrations that were above reporting limits. Results in associated samples less than 5x the highest reported blank values were 'U' qualified as not detected and the reporting limit was raised to the reported value for the analytes. Blank contamination had no affect on most of the samples, since the samples were either non-detects or were greater than 5x the highest blank value. The table below list the affected samples and their qualified results.

Blank I.D.	Analysis Date/Time	Analyte	Conc. (mg/L)	Reporting Limit (mg/L)	Action Level[1] (mg/L)	Affected Samples	Qualified Results[a] (mg/L)
1768TMB	8/09/96	Cr	0.0025	0.002	0.0125	MW20S	0.007 U
						MW22S	0.009 U
						MW10S	0.010 U
						MW11S	0.009 U
						MW24S	0.008 U
						MW23S	0.007 U
						MW13S	0.010 U

Blank I.D.	Analysis Date/Time	Analyte	Conc. (mg/L)	Reporting Limit (mg/L)	Action Level[1] (mg/L)	Affected Samples	Qualified Results[2] (mg/L)
1769TMB	8/09/96	Cr	0.0035	0.002	0.0175	MW28S	0.007 U
						#8	0.015 U
						#6	0.007 U
						#96	0.013 U
						#4	0.016 U
						MW12S	0.011 U
						MW912S	0.015 U
						MW12ID	0.007 U
						EE3	0.005 U
						EE2	0.012 U
						MW16S	0.009 U
						#5	0.012 U
						MW17SR	0.009 U
1790MB1	8/13/96	Be	0.00001	0.00001	0.00005	#6	0.00002 U
CCB	8/13/96 14:16	Be	0.00002	0.00001	0.00010	MW12S	0.00001 U
Test Blank	7/29/96 (collection)	Zn	0.01	0.01	0.05	MW11S	0.01 U
						MW12S	0.01 U
						EE3	0.02 U
						EE2	0.02 U
						MW16S	0.01 U
						MW17SR	0.02 U
						MW23S	0.02 U
						MW13S	0.01 U

References: 1 - Action Level = highest blank contaminant value above the reporting limit x 5
2 - Qualified Results = reported value which becomes the reporting limit.

Notes: Calculations were performed against the raw data. The values listed are according to the raw data.

Matrix Spike/Matrix Spike Duplicate Analysis

The MS/MSD analysis performed on sample #6 yielded potassium percent recoveries that exceeded acceptance limits. Samples with concentrations less than 4x the spike concentration were 'J' qualified as estimates. The following table presents matrix spike recovery excursions, affected samples, and actions.

Sample I.D.	Preparation Date	Matrix	Analyte	MS Percent Recovery	MSD Percent Recovery	Control Limits	Action	Affected Samples
#6	8/08/96	water	potassium	183	402	75-125	1	all, except MW12S

Excursion References 1 The positive results for the analyte >instrument detection limit, have been 'J' qualified as estimates.

Analyte Quantitation and Reporting Limits

The thallium MDL was higher than the WAC detection limit requirements. The following table shows the reporting limit comparisons. No action was required regarding the elevated MDL since thallium is not an analyte of concern at the facility.

Analyte	MDL (mg/L)	WAC (mg/L)
thallium	0.003	0.0011

References

U.S. Environmental Protection Agency(USEPA). 1995. *Test Methods for Evaluating Solid Waste.* SW-846. Office of Solid Waste and Emergency Response.

_____. 1994a. *CLP National Functional Guidelines for Organic Data Review.* EPA-540/R-94/012. Office of Solid Waste and Emergency Response.

_____. 1994b. *CLP National Functional Guidelines for Inorganic Data Review.* EPA-540/R--94/013. Office of Solid Waste and Emergency Response.

_____. 1992. *Guidance for Data Usability in Risk Assessment (Part A)*, Final 9285.7A, April.

Table 1

PASCO QUARTERLY MONITORING DATA VALIDATION
SAMPLE CROSS REFERENCE

C.O.C.	Client I.D.	Lab I.D.	Package I.D.	Matrix	Collection Date	Method	Deviated Criteria
F2903	PLF-MW35S-0796	96020032	64502105	water	7/24/96	8260 8260 SIM	IR IC, LCS
F2903	PLF-MW37S-0796	96020033	64502105	water	7/24/96	8260 8260 SIM	IC, LCS
F2903	PLF-MW36S-0796	96020034	64502105	water	7/24/96	8260 8260 SIM	IC, LCS
F2903	PLF-MW38S-0796	96020035	64502105	water	7/24/96	8260 8260 SIM	IR IC, LCS
F2903	PLF-MW39S-0796	96020036	64502105	water	7/24/96	8260 8260 SIM	IC, LCS
F2903	PLF-MW33S-0796	96020037	64502105	water	7/24/96	8260 8260 SIM	IC, LCS
F2903	PLF-MW32S-0796	96020038	64502106	water	7/24/96	8260 8260 SIM	CC IC, LCS
F2903	Trip Blank-2903	96020039	64502106	water	7/24/96	8260 8260 SIM	CC, IC, LCS
F2905	PLF-MW27S-0796	96020312	64502106	water	7/25/96	8260 8260 SIM APP I Metals	CC IC, LCS MDL
F2905	PLF-MW20S-0796	96020313	64502106	water	7/25/96	8260 8260 SIM APP I Metals	CC IC, LCS MB, MDL
F2905	PLF-MW28S-0796	96020314	64502106	water	7/25/96	8260 8260 SIM APP I Metals APP II Metals	CC IC, LCS MB, MDL MS
F2905	PLF-MW19S-0796	96020315	64502106	water	7/25/96	8260 8260 SIM APP I Metals	CC IC, LCS MDL
F2905	PLF-MW22S-0796	96020316	64502106	water	7/25/96	8260 8260 SIM APP I Metals	CC IC, LCS, MS MB, MDL
F2905	Trip Blank-2905	96020317	64502106	water	7/25/96	8260 8260 SIM	CC, IC, LCS
F2907	PLF-EE7-0796	96020332	64502106	water	7/26/96	8260 8260 SIM APP I Metals APP II Metals	CC IC, LCS MDL MS

Table 1

PASCO QUARTERLY MONITORING DATA VALIDATION
SAMPLE CROSS REFERENCE

C.O.C.	Client I.D.	Lab I.D.	Package I.D.	Matrix	Collection Date	Method	Deviated Criteria
F2907	PLF-EE8-0796	96020333	64502106	water	7/26/96	8260 8260 SIM APP I Metals	CC IC, LCS MDL
F2907	PLF-MW25S-0796	96020334	64502106	water	7/26/96	8260 8260 SIM 8270 8150	CC IC, LCS MB, IC
F2907	PLF-MW26S-0796	96020335	64502107	water	7/26/96	8260 8260 SIM 8270 8150	MB IC, LCS MB, IC, MS
F2907	PLF-MW926S-0796	96020336	64502106	water	7/26/96	8270 8150	MB, IC
F2907	PLF-#8-0796	96020337	64502106	water	7/26/96	8260 8260 SIM APP I Metals APP II Metals	CC IC, LCS MB, MDL MS
F2907	PLF-#6-0796	96020338	64502107	water	7/26/96	8260 8260 SIM APP I Metals APP II Metals	MS IC, LCS MB, MDL MS
F2907	PLF-#96-0796	96020339	64502106	water	7/26/96	8260 8260 SIM APP I Metals APP II Metals	CC IC, LCS MB, MDL MS
F2907	PLF-#4-0796	96020340	64502107	water	7/26/96	8260 8260 SIM APP I Metals APP II Metals	IR IC, LCS MB, MDL MS
F2907	Trip Blank-2907	96020341	64502106	water	7/26/96	8260 8260 SIM	CC, IC, LCS
F2911	PLF-MW10S-0796	96020470	64502109	water	7/29/96	8260 8260 SIM APP I Metals	CC, MB, LCS IC, LCS MB, MDL

Table 1

PASCO QUARTERLY MONITORING DATA VALIDATION
SAMPLE CROSS REFERENCE

C.O.C.	Client I.D.	Lab I.D.	Package I.D.	Matrix	Collection Date	Method	Deviated Criteria
F2911	PLF-MW11S-0796	96020471	64502109	water	7/29/96	8260 8260 SIM APP I Metals	CC, LCS, IR IC, LCS MB, TB, MDL
F2911	PLF-MW12S-0796	96020472	64502108	water	7/29/96	8260 8260 SIM APP I Metals APP II Metals	MS, IR IC, LCS, MS MB, CCB, TB, MDL
F2911	PLF-MW912S-0796	96020473	64502109	water	7/29/96	8260 8260 SIM APP I Metals APP II Metals	CC, LCS, IR IC, LCS MB, MDL MS
F2911	PLF-MW12ID-0796	96020474	64502109	water	7/29/96	8260 8260 SIM APP I Metals APP II Metals	CC, MB, LCS IC, LCS, LR MB, MDL MS
F2911	PLF-EE3-0796	96020475	64502109	water	7/29/96	8260 8260 SIM APP I Metals APP II Metals	CC, SR, LCS, IR IC, LCS MB, TB, MDL MS
F2911	PLF-EE2-0796	96020476	64502109	water	7/29/96	8260 8260 SIM APP I Metals APP II Metals	CC, MB, LCS, IR IC, LCS, LR MB, TB, MDL MS
F2909	PLF-MW24S-0796	96020477	64502109	water	7/27/96	8260 8260 SIM APP I Metals	CC, MB, SR, LCS, IR IC, LCS MB, MDL

Table 1

PASCO QUARTERLY MONITORING DATA VALIDATION SAMPLE CROSS REFERENCE

C.O.C.	Client I.D.	Lab I.D.	Package I.D.	Matrix	Collection Date	Method	Deviated Criteria
F2909	PLF-MW16S-0796	96020478	64502109	water	7/27/96	8260 8260 SIM APP I Metals APP II Metals	CC, LCS, IR IC, LCS MB, TB, MDL MS
F2909	PLF-#5-0796	96020479	64502109	water	7/27/96	8260 8260 SIM APP I Metals APP II Metals	CC, LCS, MS, IR IC, LCS MB, MDL MS
F2909	PLF-MW17SR-0796	96020480	64502108	water	7/27/96	8260 8260 SIM APP I Metals APP II Metals	LCS, IR IC, SR, LCS MB, TB, MDL MS
F2909	PLF-MW23S-0796	96020481	64502108	water	7/27/96	8260 8260 SIM APP I Metals	LCS, IR IC, LCS, MB, TB, MDL
F2909	PLF-MW13S-0796	96020482	64502108	water	7/27/96	8260 8260 SIM APP I Metals	LCS, IR IC, LCS, LR MB, TB, MDL
F2909	PLF-MW29S-0796	96020483	64502108	water	7/27/96	8260 8260 SIM	SR, LCS, IR IC, LCS, LR
F2909	Test Blank-2909	96020484	64502109	water	7/27/96	APP I Metals APP II Metals	PD, MDL MS
F2909	Trip Blank-2909	96020485	64502108	water	7/27/96	8260 8260 SIM	LCS IC, LCS
F2913	PLF-MW42S-0796	96020664	64502108	water	7/30/96	8260 8260 SIM	LCS, IR IC, LCS
F2913	PLF-MW40S-0796	96020665	64502108	water	7/30/96	8260 8260 SIM	LCS, IR IC, LCS
F2913	PLF-MW41S-0796	96020666	64502108	water	7/30/96	8260 8260 SIM	LCS, IR IC, LCS
F2913	Trip Blank-2913	96020667	64502108	water	7/30/96	8260 8260 SIM	LCS, IR, CC, IC, LCS

Table 1

PASCO QUARTERLY MONITORING DATA VALIDATION SAMPLE CROSS REFERENCE

Method References:

"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986, and it's updates, (SW-846 / 8260, 8270, 8150, 6010, 7000) (USEPA, 1995).
SIM - Selected Ion Monitoring.
APP I - Washington Administrative code (WAC) Appendix I Metals List.
APP II - WAC Appendix II Metals List.

Excursion References:

IC- Initial Calibration
CC- Continuing Calibration
MB- Method Blank
SR- Surrogate Recovery
LCS- Laboratory Control Sample
MS- Matrix Spike
LR- Linear Range
CCB- Continuing Calibration Blank
TB- Test Blank
MDL- Reporting Limit >MTCA
IR- Mass Ion Ratios

PHILIP ENVIRONMENTAL

– MEMORANDUM –

TO: Dave Provance

FROM: Paul Anderson

cc: Mike Caputo

DATE: February 26, 1997

PROJECT NUMBER: 624419

SUBJECT: **Analytical Data QA Review - Pasco Phase II (September, 1996)**

SUMMARY AND DATA USABILITY

Data Quality Review Project Summary

This report addresses data quality for samples collected September 17-21, 1996, during quarterly groundwater sampling conducted at the Pasco Landfill. Sample collection activities were conducted by Philip Environmental Services Corporation (Philip).

Samples collected at the facility were analyzed for a selected list of analytical parameters, which included the following: volatiles, semi-volatiles , herbicides, and total metals. The analyte list and detection limits were as specified by the Washington Administrative Code (WAC) Appendix I & II list, as described in the Quality Assurance Project Plan (QAPP). The chemical analyses were performed and reported by Philip Analytical Services (PAS) in Burnaby, British Columbia. The samples were received by the laboratory on September 18 through 24, 1996. Table 1 presents a summary of the validated samples, including their identification information, matrix, collection dates, and methods of analysis performed. Table 1 also provides the deviated quality control criteria noted for each sample.

Sample data resulting from the analysis of samples shown on Table 1 underwent data validation review. The purpose of the data validation is to provide an independent opinion of the quality of data generated from the measurement process. The validation focuses on all aspects of the data generation process and involved a rigorous examination of the data packages. The purpose of the review was to determine the usability of the analytical results and also to determine compliance with the requirements of the analytical methods. Accordingly, this report outlines excursions from the applicable quality control criteria outlined in the analytical methods referenced in Table 1.

Data Usability

The analytical data were reviewed and qualified in accordance with U.S. Environmental Protection Agency (USEPA) Data Validation Functional Guidelines (USEPA, 1994a,b). Rejected data, which are considered unusable for either qualitative or quantitative purposes, are a result of a major deficiency noted in the data generation process. Minor deficiencies in

the data generation process result in approximation of sample data. Approximation of a data point indicates uncertainty in the reported concentration of the chemical, but not its assigned identity. Conservative assumptions made when basing conclusions on analytical data allow the use of approximated analytical data. This approach to the use of analytical data is consistent with USEPA (USEPA, 1992) risk assessment and data usability guidance. A summary of specific quality assurance/quality control (QA/QC) excursions that resulted in qualification of sample data are presented in the following sections.

This section summarizes the analytical data in terms of its completeness and usability for characterization of the current water quality for engineering decisions and risk management. Data completeness is defined as the percentage of sample results that have been determined to meet quality control criteria during the data review process. The completeness of the data set was determined to be 99.96%. However, some sample results have been qualified due to blank, matrix spike/matrix spike duplicate (MS/MSD), laboratory control sample (LCS), calibration, surrogate, and quantitation quality control and reporting limit excursions described below.

Data usability is a qualitative evaluation that utilizes the findings of the data validation review, historical information, regulatory guidance and other applicable information to provide an assessment of how the data set may be used. The assessment is made with reference to the specific data uses specified in the previous paragraph. Data which do not meet completeness requirements are not considered usable, however, data which are complete are not necessarily usable.

The data usability analysis found that with the exception of the analytical result of one sample for benzoic acid, that was rejected for having a zero percent recovery in the MS/MSD samples, the remaining data set is usable. No other issues which affect data usability were noted.

DATA VALIDATION METHODS AND RESULTS

Data Validation Protocols

The criteria employed for data validation review (USEPA, 1994) provide differing quality control criteria from those specified in the methods. In cases where method requirements and validation requirements overlap, method quality control criteria are used and the validation guidelines are followed for applying data qualifiers, if required. The data validation guidelines quality control criteria are used when the method does not provide criteria. Data may be in full compliance with the method requirements, but may not meet data validation guidance.

Quality Control Parameters

The following QA/QC parameters were evaluated for inorganic analyses:

1. Holding Times and Preservation
2. Initial and Continuing Calibration
3. Contract Required Detection Limit (CRDL) Standard Criteria
4. Blank Analyses
5. Inductively Coupled Plasma (ICP) Interference Check Sample (if applicable)
6. MS Sample Recovery Criteria
7. Laboratory Duplicate Analysis
8. Field Duplicate Analysis
9. LCS Analysis
10. ICP Serial Dilution (if applicable)
11. Furnace Atomic Absorption Analysis (if applicable)
12. Method of Standard Additions (MSA) (if applicable)
13. Analyte Quantitation and Reporting Limits
14. Documentation Completeness

The following QA/QC parameters were evaluated for volatile and semivolatile analyses:

1. Holding Times
2. Gas Chromatography/Mass Spectrometry (GC/MS) Instrument Performance Check
3. Initial Calibration
4. Continuing Calibration
5. Blank Analyses
6. Surrogate Spikes
7. MS/MSD Analysis
8. LCS Analysis
9. Internal Standards
10. Target Compound Identification
11. Compound Quantitation and Reporting Limits

The following QA/QC parameters were evaluated for herbicide analyses:

1. Holding Times
2. GC Instrument Performance Check
3. Initial Calibration
4. Continuing Calibration
5. Blank Analyses
6. Surrogate Spikes
7. MS/MSD Analysis

8. LCS Analysis
9. Target Compound Identification
10. Compound Quantitation and Reporting Limits

Data Qualifiers Used in Validation

The following data qualifiers are defined by the USEPA in the Data Validation Functional Guidelines for use in validating analytical data. The appropriate data qualifiers were added to the data packages in red ink during data validation. Any necessary corrections to the data due to transcription errors or calculation errors were also added with red ink. Each page with changes was also initialed and dated by the validator.

The following data validation qualifiers may be used during the validation of data:

R	Indicates that the reporting limit or sample result has been determined to be unusable due to a major deficiency in the data generation process. The data should not be used for any qualitative or quantitative purposes.
U	Indicates that the analyte was analyzed for, but was not detected. The sample-specific reporting limit is presented and adjusted for dilution and percent solids, as appropriate. The qualifier is also used to signify that the reporting limit of an analyte was raised due to blank contamination.
J	The analyte was positively identified but the concentration should be considered approximate. This qualifier indicates that the data validation process identified a deficiency in the data generation process.
UJ	Indicates that the sample-specific reporting limit for the analyte in this sample should be considered approximate. This qualifier is used when the data validation process identified a deficiency in the data generation process.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

Data Evaluation Results

This section describes the qualifiers that were added to sample data where QA/QC criteria were not met. QA/QC parameters that were met are not discussed. Samples that required qualification are identified in the following sections by the sample location documented on the field chain-of-custody record.

Volatiles

General Comments

Volatile analyses were performed in full scan and selected ion monitoring (SIM) mode. In order to meet the WAC limit requirements, vinyl chloride, 1,1-dichloroethene, carbon tetrachloride, and 1,1,2,2-tetrachloroethane were analyzed in the SIM mode.

In some instances, bromofluorobenzene (BFB) tunes were analyzed after, rather than prior to, the continuing calibration standards. This sequence was used since BFB tuning is monitored from the method blank which is analyzed after the continuing calibration standard. The laboratory employs this sequence in order to reduce the sequence by one analysis (BFB standard alone) since BFB is in all samples and the laboratory monitors the BFB on an ongoing basis, as well. If the BFB tuning monitored from the method blank failed criteria the laboratory would be required to recalibrate the system prior to proceeding with sample analysis. No action was required for the alteration of the standard analysis sequence.

The internal standard reference controls were reported from the latter continuing calibrations as opposed to the initial calibration. This was due to the reprocessing of the data after the initial generation. No action was required for the alteration of the reference controls, as they were well within the acceptance limits.

The SIM analysis was not re-performed or reported for sample 26157, which is the trip blank from COC F2915. This was due to insufficient sample volume. There were only two vials shipped and the first vial which was used for the SIM analysis, had to be re-analyzed due to an invalidated run. The second vial was already used for the full scan run.

Blank Analyses

Contamination was detected in the method blanks and the trip blanks. The sample results have been qualified based on the observed contamination. Sample results reported at concentrations less than five times the blank contamination (ten times for the common laboratory contaminants and tentatively identified compounds (TICs)) have been 'U' qualified as not detected and the reporting limit raised to the reported value for the analyte. The observed compounds, their

reported concentrations and the affected samples are summarized in the following table. Blank contaminants that did not affect sample results have not been listed in the table. Blank contaminants reported from the library search as TICs have not been qualified. Excursions that did not affect the data were not listed in the table.

Blank I.D.	Analysis Date / COC	Analyte	Conc. (µg/L)	Reporting Limit (ug/L)	Action Level[1] (ug/L)	Affected Samples	Qualified Results[2]
sep251001010	9/25/96	DCM	2.2	0.9	22.0	MW32S MW33S MW27S MW22S MW37S	1.2 U 1.3 U 1.2 U 1.6 U 1.4 U
sep252001020	9/25/96	DCM	3.2	0.9	32.0	MW28S MW20S MW25S MW26S PLF-#8 MW23S MW24S EE8	1.8 U 1.6 U 2.8 U 1.2 U 1.9 U 1.2 U 1.5 U 1.4 U
sep254101041	9/26/96	DCM	17.4	0.9	174	MW40S MW36S MW38S MW42S PLF-#4 MW17SR	1.1 U 1.1 U 1.2 U 1.0 U 0.9 U 1.0 U
oct021201012	10/02/96	DCM	1.24	0.9	12.4	EE2 EE3	0.9 U 14.0 U
Trip Blank-26332	COC: F2917	chloroform	1.4	0.6	7.0	MW19S	1.4 U
Trip Blank-26437	COC: F2919	chloroform	1.7	0.6	8.5	MW41S MW36S MW38S	2.3 U 2.5 U 2.0 U
Trip Blank-27044	COC: F2923	DCM	1.5	0.9	15.0	EE3	14.0 U
		chloroform	1.5	0.6	7.5	EE2 MW10S MW11S	1.9 U 2.1 U 1.1 U

Action References: 1 - Action Level = highest blank contaminant value above the reporting limit x 5 or x 10.
2 - Qualified Results = reported value, which becomes the qualified reporting limit.

Notes: DCM - methylene chloride, dichloromethane

Initial and Continuing Calibration

Initial and continuing calibrations for several compounds exceeded QC criteria. The following table summarizes those compounds that failed to meet the minimum average relative response factor (RRF) criteria of ≥0.05. The Level 1 (1.0ppb) initial calibration on 9/25/96, was not included in the RRF calculation for methylene chloride, due to having a response less than 0.05. The Level 6 (50ppb) initial calibration on 9/25/96, was not included in the RRF calculation for acetone, due to having a response less than 0.05. The low RRFs may indicate poor sensitivity for the compound. However, the lab did not include these in the RRF calculations. Therefore, the non-detected results for methylene chloride in the associated samples were 'UJ' qualified as estimates. Detected results for methylene chloride less than level 2 (2.0ppb) in the associated samples were 'J' qualified as estimates. Detected results for acetone greater than level 5 (25ppb) in the associated samples were 'J' qualified as estimates. Initial calibration relative standard deviations (RSD) which were greater than 30% are summarized in the following table. Continuing calibrations percent differences (%Ds) which were greater than 30% for low level calibrations and 25% for medium level calibrations are summarized in the following table. The high RSDs and %Ds may indicate variability in the results. Detected results for the compounds in the associated samples were 'J' qualified as estimates and non-detected results were 'UJ' qualified as estimated reporting limits. Excursions that did not affect the data were not listed in the table.

Calibration Date (File)	QC Criteria (RRF/RSD/%D)	Compound	Obtained Value	Control Limits	Action	Affected Samples
Initial Calibration						
9/25/96 (1008 and 1003)	RRF	methylene chloride acetone	not obtained	≤0.05	2 3	all except EE2 and EE3
10/02/96 (1003-1009)	RSD	methylene chloride acetone vinyl acetate	34.8% 39.7% 32.9%	≤30%	1	EE2, EE3
Continuing Calibration						
9/25/96 (1019)	%D	acrylonitrile 4-methyl-2-pentanone 2-hexanone	37.5% 34.9% 36.6%	≤25%	1	MW28S MW20S MW25S MW26S MW19S #8 MW23S MW24S EE7 EE8 #96 #6 #6 (replicate) MW41S

Calibration Date (File)	QC Criteria (RRF/RSD/%D)	Compound	Obtained Value	Control Limits	Action	Affected Samples
9/26/96 (1040)	%D	acetone trans-1,4-dichloro-2-butene	33.4% 37.3%	≤25%	1	Trip Blank-26157 MW40S MW36S MW38S MW42S #4 MW16S MW17SR #5 MW29S MW12S
9/26/96 (1056)	%D	chloromethane acrylonitrile 4-methyl-2-pentanone 2-hexanone	25.8% 44.3% 36.8% 40.3%	≤25%	1	Trip Blank-26545 Trip Blank-27044 MW912S MW12ID MW10S MW11S MW13S

Action References: 1 - The detected results for this analyte associated with this calibration have been 'J' qualified as estimates. The non-detected results for this analyte associated with this calibration have been 'UJ' qualified as estimated reporting limits.

2 - The detected results for this analyte associated with this calibration have been 'J' qualified as estimates and the non-detected results for this analyte associated with this calibration have been 'UJ' qualified as unusable, for concentrations less than the level 2 (2ppb) calibration.

3 - The detected results for this analyte associated with this calibration have been 'J' qualified as estimates, for concentrations greater than the level 5 (25ppb) calibration.

Notes: RRF - relative response factor
RSD - relative standard deviation
%D - percent difference

Surrogate Spikes

Several surrogate percent recovery values exceeded control limits for several of the samples. For recoveries that were above control limits, the detected samples results were 'J' qualified as estimates. For recoveries that were below control limits, the detected samples results were 'J' qualified and the non-detected sample results were 'UJ' qualified as estimated reporting limits. Surrogate excursions that resulted in data qualification are presented in the following table. . Excursions that did not affect the data were not listed in the table.

Sample I.D.	Lab I.D.	Surrogate Compound	Percent Recovery	Control Limits (%)	Action	Affected Analytes
MW12S	26540	toluene-d8	111	88-110	1	file 1055 detects
MW10S	27041	toluene-d8	113	88-110	1	file 1064 detects
EE3	27040	toluene-d8	154	88-110	1	file 1014 detects
MW16S	26536	1,2-dichloroethane-d4	122	80-120	1	sim file 1031 detects
Trip Blank	27044	1,2-dichloroethane-d4	74.6	80-120	1, 2	sim file 1050 analytes

Action References: 1 - The detected results for analytes associated with this surrogate were 'J' qualified as estimates.

2 - The non-detected results for analytes associated with this surrogate were 'UJ' qualified as estimated reporting limits.

Notes: SIM - selected ion monitoring

Laboratory Control Samples

Percent recoveries exceeded control limits for several analytes in several LCS samples. For recoveries that exceeded control limits, detected sample results were 'J' qualified as estimates. For recoveries that were less than control limits, detected sample results were 'J' qualified and non-detected samples results were 'UJ' qualified as estimated reporting limits. LCS excursions are presented in the following table. Excursions that did not affect sample results have not been listed in the table. Excursions that did not affect the data results were not listed in the table.

Analysis Date	QC Batch File	Matrix	Analyte	Percent Recovery	Control Limits (%)	Action	Affected Samples
9/25/96	sep250901009	water	acetone	56.1	70-130	1, 2	all 9/25/96 data samples
10/02/96	oct021001010	water	acetone	69.1	70-130	1, 2	EE2, EE3
9/30/96	sep300901009	water	CTT	55.9	78-138	1, 2	sim 9/30/96 data samples

Action References: 1 - Detected results for the analyte have been 'J' qualified as estimates.
2 - Non-detected results for the analyte have been 'UJ' qualified as estimated reporting limits.

Notes: CTT - carbon tetrachloride
SIM - selective ion monitoring

Matrix Spike/Matrix Spike Duplicates

MS/MSD percent recoveries exceeded control limits for several analytes for several of the matrix spike samples. No qualification was required for percent recoveries that exceeded control limits, since there were either no positive detects for those analytes or the positive results had a concentration that was greater than 4x the spike added.

Compound Quantitation/Identification and Reporting Limits

The laboratory analyzed and reported analytes designated for SIM analysis from full scan analyses in several samples, since their concentrations exceeded the SIM calibration linear range.

The analyte 1,2-dichloroethane was reported with a method detection limit (MDL) of 0.5 µg/L. The Actual is 0.4 µg/L. The MTCA cleanup level for this analyte is 0.48 µg/L. The laboratory stated that the difference is in the rounding when the report is generated.

Sample MW12S was reported with a concentration 60 µg/L for 1,1-dichloroethane, which was from a dilution. The value was transcribed incorrectly from the raw data. The correct value of 121 µg/L was penned in on the sample result summary tables.

The units for the compound 1,2-dibromoethane were mis-labeled as mg/L instead of µg/L for several samples on the sample result summary tables. The compounds 1,4-dichlorobenzene and 1,2-dichlorobenzene were analyzed by both volatile and semi-volatile analyses. Since there were no positive results for these compounds, either result is acceptable.

Analytes that occasionally failed the ion ratio tolerance limits on the mass spectra have been 'N' qualified as tentatively identified. This was usually due to the presence of other miscellaneous ions in the spectrum. This occurred with the analytes: 1,1,1-trichloroethane; cis-1,2-dichloroethene; acetone; styrene; and 1,4-dichlorobenzene. The following table lists those samples with tentatively identified analytes. Excursions that did not affect the data results were not listed in the table.

Sample I.D.	Lab I.D.	1,1,1-TCA	cis-1,2-DCE	acetone styrene 1,4-DCB
MW19S	26328	N		
#8	26329		N	
MW40S	26432		N	
MW41S	26433	N		
MW36S	26434		N	
MW38S	26435	N		

Sample I.D.	Lab I.D.	1,1,1-TCA	cis-1,2-DCE	acetone styrene 1,4-DCB
MW42S	26436		N	
#5	26538		N	
MW29S	26539	N		
MW12S	26540	N		
EE2	27039	N		
EE3	27040			N
MW11S	27042	N		

Notes: TCA - trichloroethane
DCE - dichloroethene
DCB - dichlorobenzene

Semi-Volatiles

General Comments

Semi-volatile analyses were performed in full scan and selected ion monitoring (SIM) mode. In order to meet the WAC limit requirements, n-nitroso-di-n-propylamine; hexachlorobenzene; 3,3'-dichlorobenzidine; benzo(a)anthracene; chrysene; benzo(b)fluoranthene; benzo(k)fluoranthene; benzo(a)pyrene; indeno(1,2,3-cd)pyrene; and dibenzo(a,h)anthracene were analyzed in the SIM mode.

The internal standard reference controls were reported from the latter continuing calibration as opposed to the initial calibration. This was due to the reprocessing of the data after the initial generation. No action was required for the alteration of the reference controls, as they were well within the acceptance limits.

Surrogate Spikes

Several surrogate percent recovery values exceeded control limits for several of the samples. For recoveries that were above control limits, the detected samples results were 'J' qualified as estimates. For recoveries that were below control limits, the detected samples results were 'J' qualified and the non-detected sample results were 'UJ' qualified as estimated reporting limits. Surrogate excursions that resulted in data qualification are presented in the following table. Excursions that did not affect the data results were not listed in the table.

Sample I.D.	Lab I.D.	Surrogate Compound	Percent Recovery	Control Limits (%)	Action	Affected Analytes
MW26S	26324	2-fluorophenol nitrobenzene-d5 2-fluorobiphenyl	19.3 6.6 29.2	21-100 35-114 43-116	1, 2	file 1023, base/neutrals only

Action References: 1 - The detected results for analytes associated with this surrogate were 'J' qualified as estimates.

2 - The non-detected results for analytes associated with this surrogate were 'UJ' qualified as estimated reporting limits.

Laboratory Control Samples

Percent recovery values for the LCSs were acceptable, however, 3 of the 6 surrogates exceeded the control limits in the full scan analysis and 2 of the 6 surrogates exceeded the control limits in the SIM analysis. No action was required, since there were no positive detects among the samples.

Matrix Spikes/Matrix Spike Duplicates

The percent recovery for benzoic acid was 0%. This may be due to its nature of high variability during the extraction process. The lab is currently studing this situation and will evaluate increasing the spiking level above the current 40 µg/L. Only the result of the original sample has been 'R' qualified as unusable. The excursion is listed in the table below. Excursions in the full scan and SIM analyses that did not affect sample results have not been listed in the table.

Sample	QC Batch	Matrix	Analyte	MS % Recovery	MSD % Recovery	Control Limits	Action
MW26S	9/24/96	water	benzoic acid	0	0	10-130	1

Excursion References: 1 - The non-detected result for the analyte has been 'R' qualified as unusable.

Compound Quantitation/Identification and Reporting Limits

Satisfactory method detection limits (MDLs) have not yet been determined for the following analytes: 3,3'-dichlorobenzidine, and N-nitroso-di-n-propylamine. Instrument detection limit studies for 3,3'-dichlorobenzidine and N-nitroso-di-n-propylamine indicate that satisfactory MDLs are achievable.

The MDL for bis(2-chloroethyl)ether is 0.0006 mg/L, whereas the WAC detection limit is 0.0000398 mg/L. Currently, this compound is being analyzed in the full scan mode, but will be

changed to the SIM mode. The laboratory is in the process of performing the required MDL studies to be in compliance with the WAC requirements. Based on the previous analytical data, the lack of MDL studies for these compounds will not have an adverse effect on the usability of the data.

The compounds 1,4-dichlorobenzene and 1,2-dichlorobenzene were analyzed by volatile and semi-volatile analyses. Since there were no positive results for these compounds, either result is acceptable.

Herbicides

General Comments

Herbicide analyses were reported as phenoxy acid pesticides on the sample result summary tables due to a computer error. The correct analyses was performed.

No compounds were detected in the samples or the method blank, however, there were false positives for dalapon, MCPA, and dichlorprop. Subsequent GC/MS/SIM confirmation of the detected analytes showed that they were due to interferences and that there were no positive confirmations for target analytes.

Surrogate Spikes

The percent recovery for the method blank had exceeded the control limits of 50-130%. No action was necessary, since there were no positive results among the samples.

Matrix Spikes/Matrix Spike Duplicates

The percent difference between the matrix spike and the duplicate for dalapon exceeded the control limits of less than 30% difference. No action was necessary since there were no positive results in the original sample.

Metals

General Comments

Metals analyses were performed as two separate ICP runs and one hydride AA run. A regular level ICP analysis was employed for the analysis of silver, barium, calcium, cadmium, cobalt,

chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel, selenium, vanadium, and zinc. A 10x preconcentrated level ICP analysis was employed for the analysis of beryllium, lead, antimony, and thallium. The hydride AA was performed for arsenic. The preconcentrated ICP and the hydride AA analyses were performed in order to meet the WAC detection limits.

Blank Analyses

Several of the method blanks and continuing calibration blanks yielded analyte concentrations that were above the reporting limits. Results in associated samples less than 5x the highest reported blank values were 'U' qualified as not detected and the reporting limit was raised to the reported value for the analytes. Blank contamination had no affect on most of the samples, since the samples were either non-detects or were greater than 5x the highest blank value. The table below lists the affected samples and their qualified results. Excursions that did not affect the data results were not listed in the table. Initial sample result summary tables reported a detect for arsenic in the method blank. However, the value was incorrect, since the method blanks were all non-detect.

Blank I.D.	Digest/ Analysis Date/Time	Analyte	Conc. (mg/L)	Reporting Limit (mg/L)	Action Level[1] (mg/L)	Affected Samples	Qualified Results[2] (mg/L)
2198MB1	10/02/96 (1-10)	chromium	0.0024	0.002	0.012	MW28S #6 MW20S MW22S	0.003 U 0.004 U 0.007 U 0.002 U
2198MB1	10/02/96 (11-20)	chromium	0.0028	0.002	0.014	#8 #4 MW16S MW17SR #5 MW912S MW12ID	0.008 U 0.003 U 0.003 U 0.007 U 0.006 U 0.010 U 0.004 U
2198MB3	10/02/96 (21-24)	chromium	0.0038	0.002	0.019	MW12S MW10S	0.019 U 0.004 U

References: 1 - Action Level = highest blank contaminant value above the reporting limit x 5
2 - Qualified Results = reported value which becomes the reporting limit.

Notes: Calculations were performed against the raw data. The values listed are according to the raw data.

Initial and Continuing Calibrations

Initial calibration verification (ICV) and continuing calibration verifications (CCV) for several analytes exceeded the QC criteria of 90-110% recovery. The high recoveries may indicate a high bias. Detected results for the analytes in the associated samples were 'J' qualified as estimates. The following table summarizes those compounds that failed to meet the percent recovery criteria and the affected samples.

Calibration File	Analyte	Obtained Value	Control Limits	Action	Affected Samples
Initial Calibration					
ICV-961003	silver	117%	90-110	2	none
Continuing Calibration					
CCV-2(12:18)	sodium	114%	90-110	1	#96 #4 MW16S MW17SR #5 EE2 EE3

Action References: 1 - The detected results for this analyte associated with this calibration have been 'J' qualified as estimates.

2 - The excursion did not affect the samples, since there were no positive results.

Laboratory Control Sample

Percent recovery values for several analytes exceeded the acceptance limits in the laboratory control samples. However, the excursions did not affect the samples, since there were no positive results among the data set for the affected analytes.

Matrix Spike/Matrix Spike Duplicate Analysis

Several MS/MSD percent recoveries were below acceptance limits. Affected samples with positive results were 'J' qualified as estimates. Non-detected results were 'UJ' qualified as not detected but at an estimated detection limit. The following table presents matrix spike recovery excursions, affected samples, and actions. Excursions that did not affect the data were not listed in the table.

Sample I.D.	Preparation Date	Matrix	Analyte	MS Percent Recovery	MSD Percent Recovery	Control Limits	Action	Affected Samples
MW12S	10/02/96	water	sodium	66	63	75-125	1	all except #6, #96

Excursion References
1 - The positive results for the analyte, has been 'J' qualified as estimated.
2 - The non-detected results have been 'UJ' qualified as not detected but at an estimated detection limit.

Laboratory Duplicates

The laboratory duplicate RPD for sample MW12S was 187% for manganese. Since the sample concentration was less than 5x the CRDL, a control limit of +/- the CRDL was used. Therefore, the positive results for manganese have been 'J' qualified as estimates in all of the associated data, except for sample #6, since its replicate did meet the control criteria. Excursions that did not affect the data were not listed in the table.

Sample I.D.	Matrix	Analyte	Sample Result mg/L	Replicate Result mg/L	RPD	Control Limits (RPD≤20%) / (+/-CRDL)	Action	Affected Samples
MW12S	water	manganese	0.0562	0.0019	187	+/-CRDL	1	#4 MW16S MW912S EE3

Excursion References
1 - The positive results for the analyte, has been 'J' qualified as estimated.

ICP Serial Dilution

Several analytes had serial dilution percent difference values that were greater than 10%, but the initial sample concentrations were less than 50x the IDL for the ICP Serial Dilution samples analyzed. Therefore, no action was required for those analytes. However, several analytes had percent difference values that were greater than 10% and the initial sample concentrations were greater than 50x the IDL. The positive results greater than 50x the IDL for these analytes have been 'J' qualified as estimates. The excursions are listed in the table below. Excursions that did not affect the data were not listed in the table.

Sample I.D.	Analyte	MDL (mg/L)	Percent Difference	Control Limits	Action Limit (mg/L)	Action	Samples Affected

Sample I.D.	Analyte	MDL (mg/L)	Percent Difference	Control Limits	Action Limit (mg/L)	Action	Samples Affected
EE7	barium	0.001	20.7	≤10%	0.050	1	MW28S MW27S MW22S #8 MW23S MW24S EE7 EE8 #96 #6 #4 MW16S MW17SR #5 MW12S MW912S MW12ID EE2 EE3 MW10S MW11S
	magnesium	0.02	13.8	≤10%	1.0	1	MW28S #8 EE7 #96 #6 #4 MW16S MW17SR #5 MW12S MW912S EE2 EE3
	sodium	0.4	21.9	≤10%	20.0	1	MW28S #8 EE7 #96 #6 #4 MW16S MW17SR #5 MW12S MW912S EE2 EE3

Action References: 1 - The positive sample results greater than 50x the IDL have been 'J' qualified as estimates for this analyte.

Field Duplicates

The duplicate for sample MW12S was MW912S. The reported values for manganese were 0.056 mg/L and 0.002 mg/L respectively. Since the values are less than 5x the CRDL, a control limit of +/- the CRDL was used. The duplicate sample failed to meet the control limits for manganese. Therefore, the reported results for the two samples have been 'J' qualified as estimates.

Analyte Quantitation and Reporting Limits

The thallium MDL was higher than the WAC detection limit requirements. The following table shows the reporting limit comparisons. No action was required regarding the elevated MDL, since thallium is not an analyte of concern at the facility. The laboratory stated that next quarter, they will analyze thallium on the AA in order to meet the WAC detection limit.

Analyte	MDL (mg/L)	WAC (mg/L)
thallium	0.003	0.001

References

U.S. Environmental Protection Agency(USEPA). 1995. *Test Methods for Evaluating Solid Waste.* SW-846. Office of Solid Waste and Emergency Response.

_____. 1994a. *CLP National Functional Guidelines for Organic Data Review.* EPA-540/R-94/012. Office of Solid Waste and Emergency Response.

_____. 1994b. *CLP National Functional Guidelines for Inorganic Data Review.* EPA-540/R--94/013. Office of Solid Waste and Emergency Response.

_____. 1992. *Guidance for Data Usability in Risk Assessment (Part A)*, Final 9285.7A, April.

Table 1

PASCO QUARTERLY MONITORING DATA VALIDATION
SAMPLE CROSS REFERENCE

C.O.C.	Client I.D.	Lab I.D.	Package I.D.	Matrix	Collection Date	Method	Deviated Criteria
F2915	PLF-MW32S-0996	26150	6112395	water	9/17/96	VOCs	MB, RRF, LCS
F2915	PLF-MW33S-0996	26151	6112395	water	9/17/96	VOCs	MB, RRF, LCS
F2915	PLF-MW28S-0996	26152	6112395	water	9/17/96	VOCs App I-II Metals	MB, RRF, %D, LCS MB, MS, SD
F2915	PLF-MW20S-0996	26153	6112395	water	9/17/96	VOCs App I Metals	MB, RRF, %D, LCS MB, MS
F2915	PLF-MW27S-0996	26154	6112395	water	9/17/96	VOCs App I Metals	MB, RRF, LCS MS, SD
F2915	PLF-MW22S-0996	26155	6112395	water	9/17/96	VOCs App I Metals	MB, RRF, LCS MB, MS, SD
F2915	PLF-MW37S-0996	26156	6112395	water	9/17/96	VOCs	MB, RRF, LCS
F2915	Trip Blank	26157	6112395	water	9/17/96	VOCs	RRF, %D, LCS
F2917	PLF-MW25S-0996	26323	6112397	water	9/18/96	VOCs SVOCs Herbicides	MB, RRF, %D, LCS none none
F2917	PLF-MW26S-0996 MS MSD	26324 26325 25326	6112397	water	9/18/96	VOCs SVOCs Herbicides	MB, RRF, %D, LCS SR, MS none
F2917	PLF-MW926S-0996	26327	6112397	water	9/18/96	SVOCs Herbicides	none none
F2917	PLF-MW19S-0996	26328	6112397	water	9/18/96	VOCs App I Metals	MB, RRF, %D, LCS, CI MS
F2917	PLF-#8-0996	26329	6112397	water	9/18/96	VOCs App I-II Metals	MB, RRF, %D, LCS, CI MB, MS, SD
F2917	PLF-MW23S-0996	26330	6112397	water	9/18/96	VOCs App I Metals	MB, RRF, %D, LCS MS, SD
F2917	PLF-MW24S-0996	26331	6112397	water	9/18/96	VOCs App I Metals	MB, RRF, %D, LCS MS, SD
F2917	Trip Blanks	26332	6112397	water	9/18/96	VOCs	RRF, LCS
F2919	PLF-EE7-0996	26426	6112398	water	9/19/96	VOCs App I-II Metals	RRF, %D, LCS MS, SD
F2919	PLF-EE8-0996	26427	6112398	water	9/19/96	VOCs App I Metals	MB, RRF, %D, LCS MS, SD
F2919	PLF-#96-0996	26428	6112398	water	9/19/96	VOCs App I-II Metals	RRF, %D, LCS SD
F2919	PLF-#6-0996 MS MSD	26429 26430 26431	6112398	water	9/19/96	VOCs App I-II Metals	RRF, %D, LCS MB, SD

Table 1

PASCO QUARTERLY MONITORING DATA VALIDATION
SAMPLE CROSS REFERENCE

C.O.C.	Client I.D.	Lab I.D.	Package I.D.	Matrix	Collection Date	Method	Deviated Criteria
F2919	PLF-MW40S-0996	26432	6112398	water	9/19/96	VOCs	MB, RRF, %D, LCS, CI
F2919	PLF-MW41S-0996	26433	6112398	water	9/19/96	VOCs	MB, RRF, %D, LCS, CI
F2919	PLF-MW36S-0996	26434	6112398	water	9/19/96	VOCs	MB, RRF, %D, LCS, CI
F2919	PLF-MW38S-0996	26435	6112398	water	9/19/96	VOCs	MB, RRF, %D, LCS, CI
F2919	PLF-MW42S-0996	26436	6112398	water	9/19/96	VOCs	MB, RRF, %D, LCS, CI
F2921	PLF-#4-0996	26535	6112402	water	9/20/96	VOCs App I-II Metals	MB, RRF, %D, LCS MB, CCV, MS, LD, SD
F2921	PLF-MW16S-0996	26536	6112402	water	9/20/96	VOCs App I-II Metals	RRF, %D, SR, LCS MB, CCV, MS, LD, SD
F2921	PLF-MW17SR-0996	26537	6112402	water	9/20/96	VOCs App I-II Metals	MB, RRF, %D, LCS MB, CCV, MS, SD
F2921	PLF-#5-0996	26538	6112402	water	9/20/96	VOCs App I-II Metals	RRF, %D, LCS, CI MB, CCV, MS, SD
F2921	PLF-MW29S-0996	26539	6112402	water	9/20/96	VOCs	RRF, %D, LCS, CI
F2921	PLF-MW12S-0996	26540 26543 26544	6112402	water	9/20/96	VOCs App I-II Metals	RRF, %D, SR, LCS, CQ, CI MB, MS, SD, FD
F2921	PLF-MW912S-0996	26541	6112402	water	9/20/96	VOCs App I-II Metals	RRF, %D, LCS MB, MS, LD, SD, FD
F2921	PLF-MW12ID-0996	26542	6112402	water	9/20/96	VOCs App I Metals	RRF, %D, LCS MB, MS, SD
F2921	Trip Blanks	26545	6112402	water	9/20/96	VOCs	RRF, %D, LCS
F2923	PLF-EE2-0996	27039	6111284	water	9/21/96	VOCs App I-II Metals	TB, RSD, LCS CCV, MS, SD
F2923	PLF-EE3-0996	27040	6111284	water	9/21/96	VOCs App I-II Metals	TB, RSD, SR, LCS CCV, MS, LD, SD
F2923	PLF-MW10S-0996	27041	6111284	water	9/21/96	VOCs App I Metals	TB, RRF, %D, SR, LCS MB, MS, SD
F2923	PLF-MW11S-0996	27042	6111284	water	9/21/96	VOCs App I Metals	TB, RRF, %D, LCS MS, SD
F2923	PLF-MW13S-0996	27043	6111284	water	9/21/96	VOCs App I Metals	RRF, %D, LCS MS
F2923	Travel Blanks	27044	6111284	water	9/21/96	VOCs	RRF, %D, SR, LCS

Table 1

PASCO QUARTERLY MONITORING DATA VALIDATION SAMPLE CROSS REFERENCE

Method References:

"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986, and it's updates, (SW-846 / 8260, 8270, 8150, 6010, 7000) (USEPA, 1995).
SIM - Selected Ion Monitoring.
VOCs - Volatile Organic Compounds
SVOCs - Semi-volatile Organic Compounds
App I - Washington Administrative code (WAC) Appendix I Metals List.
App II - WAC Appendix II Metals List.

Excursion References:

MB - Method Blank
TB - Trip Blank
RRF - Relative Response Factor
RSD - Relative Standard Deviation
%D - Percent Difference
SR - Surrogate Recovery
LCS - Laboratory Control Sample
CQ - Compound Quantitation
CI - Compound Identification
RL - Reporting Limit
MS - Matrix Spike
LD - Laboratory Duplicate
FD - Field Duplicate
SD - Serial Dilution
CCV - Continuing Calibration Verification
none - There were no excursions.

PHILIP ENVIRONMENTAL

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– MEMORANDUM –

TO: Dave Provance

FROM: Paul Anderson

cc: Mike Caputo

DATE: February 26, 1997

PROJECT NUMBER: 624419

SUBJECT: ANALYTICAL DATA QA REVIEW - PASCO PHASE II (DECEMBER 96)

SUMMARY AND DATA USABILITY

Data Quality Review Project Summary

This report addresses data quality for samples collected December 05-11, 1996, during quarterly groundwater sampling conducted at the Pasco Landfill. Sample collection activities were conducted by Philip Environmental Services Corporation (Philip).

Samples collected at the facility were analyzed for a selected list of analytical parameters, which included the following: volatiles (8260), semi-volatiles (8270) , herbicides (8150), and total metals (Be, Pb, Sb, Tl / 10x Preconcentrated EPA 200.7/6010B ICP), (Ag, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Se, V, Zn / EPA 200.7/6010B ICP), and (As / SM 3114C hydride AA). The analyte list and detection limits were as specified by the Washington Administrative Code (WAC) Appendix I & II list, as described in the Quality Assurance Project Plan (QAPP). The Appendix I list includes; Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Ni, Se, Ag, Tl, V, and Zn. The Appendix II list includes; Ca, Mg, Na, K, Fe, and Mn. The chemical analyses were performed and reported by Philip Analytical Services (PAS) in Burnaby, British Columbia, Canada. The samples were received by the laboratory on December 06 through 12, 1996.

Table 1 presents a summary of the validated samples, including their identification information, matrix, collection dates, methods of analysis performed, and deviated quality control criteria noted for each sample. The data package included a summary of sample results, QC summary tables and the supporting raw data. Overall, the data packages were sufficiently complete to properly assess the quality of the analytical results according to the QAPP.

Sample data resulting from the analysis of samples shown on Table 1 underwent data validation review. The purpose of the data validation is to provide an independent opinion of the quality of data generated from the measurement process. The validation focuses on all aspects of the data generation process and involved a rigorous examination of the data packages.

The purpose of the review was to determine the usability of the analytical results and also to determine compliance with the requirements of the analytical methods. Accordingly, this report outlines excursions from the applicable quality control criteria outlined in the analytical methods referenced in Table 1.

Data Usability

The analytical data were reviewed and qualified in accordance with U.S. Environmental Protection Agency (USEPA) Data Validation Functional Guidelines (USEPA, 1994a,b). Rejected data, which are considered unusable for either qualitative or quantitative purposes, are a result of a major deficiency noted in the data generation process. Minor deficiencies in the data generation process result in approximation of sample data. Approximation of a data point indicates uncertainty in the reported concentration of the chemical, but not its assigned identity. Conservative assumptions made when basing conclusions on analytical data allow the use of approximated analytical data. This approach to the use of analytical data is consistent with USEPA (USEPA, 1992) risk assessment and data usability guidance. A summary of specific quality assurance/quality control (QA/QC) excursions that resulted in qualification of sample data are presented in the following sections.

This section summarizes the analytical data in terms of its completeness and usability for characterization of the current water quality for engineering decisions and risk management. Data completeness is defined as the percentage of sample results that have been determined to meet quality control criteria during the data review process. The completeness of the data set was determined to be 100%. However, some sample results have been qualified due to method blank, calibration, performance evaluation mixture (PEM), laboratory control sample (LCS), matrix spike (MS), compound identification, and quantitation quality control and reporting limit excursions described below.

Data usability is a qualitative evaluation that utilizes the findings of the data validation review, historical information, regulatory guidance and other applicable information to provide an assessment of how the data set may be used. The assessment is made with reference to the specific data uses specified in the previous paragraph. Data which do not meet completeness requirements are not considered usable, however, data which are complete are not necessarily usable.

No issues which affect data usability were noted. Therefore, the data are usable with the qualifications described below.

DATA VALIDATION METHODS AND RESULTS

Data Validation Protocols

The criteria employed for data validation review (USEPA, 1994) provide differing quality control criteria from those specified in the methods. In cases where method requirements and validation requirements overlap, method quality control criteria are used and the validation guidelines are followed for applying data qualifiers, if required. The data validation guidelines' quality control criteria are used when the method does not provide criteria. Data may be in full compliance with the method requirements, but may not meet data validation guidance.

Quality Control Parameters

The following QA/QC parameters were evaluated for volatile and semivolatile analyses:

1. Holding Times and Preservation
2. Blank Analyses (Method, Trip, Rinsate)
3. Gas Chromatography/Mass Spectrometry (GC/MS) Instrument Performance Check
4. Initial Calibration and Continuing Calibration
5. Surrogate Recovery
6. Laboratory Control Sample (LCS) Analysis
7. Matrix Spike/Matrix Spike Duplicate (MS/MSD) Analysis
8. Internal Standard Criteria
9. Target Compound Identification
10. Compound Quantitation and Reported Contract Required Detection Limits
11. Field Duplicate Analysis
12. Documentation Completeness

The following QA/QC parameters were evaluated for herbicide analyses:

1. Holding Times and Preservation
2. Blank Analyses (Method)
3. GC Instrument Performance Check
4. Initial Calibration and Continuing Calibration
5. Surrogate Recovery
6. LCS Analysis
7. MS/MSD Analysis
8. Target Compound Identification
9. Compound Quantitation and Reported Contract Required Detection Limits
10. Documentation Completeness

The following QA/QC parameters were evaluated for inorganic analyses:

1. Holding Times and Preservation
2. Blank Analyses (ICB, CCB, Preparation, Trip)
3. Calibration Criteria
4. Contract Required Detection Limit (CRDL) Standard Criteria (CRI/CRA) (if applicable)
5. Inductively Coupled Plasma (ICP) Interference Check Sample (if applicable)
6. ICP Serial Dilution (if applicable)
7. MS Sample Recovery Criteria
8. LCS Analysis
9. Laboratory Replicate Analysis
10. Furnace Atomic Absorption Post Spike Analysis (if applicable)
11. Method of Standard Additions (MSA) (if applicable)
12. Field Duplicate Analysis
13. Compound Quantitation and Reported Contract Required Detection Limits
14. Documentation Completeness

Data Qualifiers Used in Validation

The following data qualifiers are defined by the USEPA in the Data Validation Functional Guidelines for use in validating analytical data. The appropriate data qualifiers were added to the data packages in red ink during data validation. Any necessary corrections to the data due to transcription errors or calculation errors were also added with red ink. Each page with changes was also initialed and dated by the validator.

The following data validation qualifiers may be used during the validation of data:

R	Indicates that the reporting limit or sample result has been determined to be unusable due to a major deficiency in the data generation process. The data should not be used for any qualitative or quantitative purposes.
U	Indicates that the analyte was analyzed for, but was not detected. The sample-specific reporting limit is presented and adjusted for dilution and percent solids, as appropriate. The qualifier is also used to signify that the reporting limit of an analyte was raised due to blank contamination.
J	The analyte was positively identified but the concentration should be considered approximate. This qualifier indicates that the data validation process identified a deficiency in the data generation process.
UJ	Indicates that the sample-specific reporting limit for the analyte in this sample should be considered approximate. This qualifier is used when the data validation process identified a deficiency in the data generation process.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

Data Evaluation Results

This section describes the qualifiers that were added to sample data where QA/QC criteria were not met. QA/QC parameters that were met are not discussed. Samples that required qualification are identified in the following sections by the sample location documented on the field chain-of-custody record.

General Comments

The laboratory routinely analyzes a Performance Evaluation Mixture (PEM) sample, which is a second source control standard. The laboratory periodically performed a Laboratory Control Sample (LCS), which is a blank spike sample. The laboratory also performed the required matrix spike/matrix spike duplicate (MS/MSD) samples.

Volatiles

Volatile analyses were performed in full scan with a 5mL purge and selected ion monitoring (SIM) mode with a 25mL purge. In order to meet the WAC limit requirements, vinyl chloride, 1,1-dichloroethene, carbon tetrachloride, and 1,1,2,2-tetrachloroethane were analyzed in the SIM mode.

BFB GC/MS Tune Criteria

In some instances, bromofluorobenzene (BFB) tunes were analyzed after, rather than prior to, the continuing calibration standards. This sequence was used since BFB tuning is monitored from the method blank which is analyzed after the continuing calibration standard. The laboratory employs this sequence in order to reduce the sequence by one analysis (BFB standard alone), since BFB is in all samples and the laboratory monitors the BFB on an ongoing basis, as well. If the BFB tuning monitored from the method blank failed criteria the laboratory would be required to recalibrate the system prior to proceeding with sample analysis. No action was required for the alteration of the standard analysis sequence.

The BFB tune criteria associated with runs' dec103301033, 1034, and 1035 (samples MW38S, MW27S-MS, MW27S-MSD respectively), were evaluated from the BFB in run 1033 and not from a method blank. This is not a concern as the tune was acceptable and since the initial 12 hour tune was still within the acceptable 12 hour period.

Initial and Continuing Calibration

All analytes were calibrated using Average Relative Response Factors (RRF)'s, except methylene chloride on the full scan analyses and carbon tetrachloride (CTT) on the SIM analyses. The laboratory calibrated these compounds by quadratic equation with a resulting correlation coefficient of 0.990 or better for methylene chloride and 0.989 for CTT. The minimum requirement for correlation coefficient of 0.990 was not met for CTT. Therefore, all samples have been qualified for CTT.

Initial and continuing calibrations for several compounds exceeded QC criteria. The following table summarizes those compounds that failed to meet the minimum correlation coefficient (R^2) or the minimum average relative response factor (RRF) criteria of $\geq$0.05. Initial calibration relative standard deviations (RSD) which were greater than 30% are summarized in the following table. Continuing calibration percent differences (%Ds) which were greater than 30% for low level calibrations and 25% for medium level calibrations are summarized in the following table. Detected results for the compounds in the associated samples were 'J' qualified as estimates and non-detected results were 'UJ' qualified as estimated reporting limits. Excursions that did not affect the data were not listed in the table.

Calibration Date (File)	QC Criteria (R^2/RRF/RSD/%D)	Compound	Obtained Value	Control Limits	Action	Affected Samples
Initial Calibration						
dec160401004	R^2	methylene chloride	0.989	0.990	1	MW27S / 36440 MW22S / 36441 MW32S / 36442 MW24S / 36443 MW-40S / 36444 MW-42S / 36445 MW-28S / 36446 MW-20S / 36447 MW-23S / 36448 MW-33S / 36449 Trip Blank / 36450 MW-25S / 36538 MW-26S / 36539 MW-19S / 36543 MW-10S / 36544 MW-11S / 36545 MW-36S / 36546 MW-37S / 36547 MW-38S / 36548 Trip Blank / 36549 #8 / 36564 #5 / 36565 MW29S / 36566 MW41S / 36567 MW12ID / 36568

Calibration Date (File)	QC Criteria (R^2/RRF/RSD/%D)	Compound	Obtained Value	Control Limits	Action	Affected Samples
						MW12S / 36569 MW912S / 36572 EE7 / 36573 EE8 / 36574 Trip Blank / 36575 #4 / 37053 #6 / 37054 #96 / 37057 MW16S / 37058 MW17SR / 37059 EE3 / 37060 EE2 / 37061 MW13S / 37062 Trip Blank / 37063
Continuing Calibration						
dec101701017	%D %D	acetone styrene	31.5% 90.3%	≤25% ≤25%	1 1	MW-40S / 36444 MW-42S / 36445 MW-28S / 36446 MW-20S / 36447 MW-23S / 36448 MW-33S / 36449 MW-25S / 36538 MW-26S / 36539 MW-19S / 36543 MW-10S / 36544 MW-11S / 36545 MW-36S / 36546 MW-37S / 36547 MW-38S / 36548
dec120201002	%D %D	2-butanone 2-hexanone	29.4% 33.1%	≤25% ≤25%	1 1	Trip Blank / 36575 #8 / 36564 #5 / 36565 MW29S / 36566 MW41S / 36567 MW12ID / 36568 MW12S / 36569 MW912S / 36572 EE7 / 36573 EE8 / 36574

Calibration Date (File)	QC Criteria (R^2/RRF/RSD/%D)	Compound	Obtained Value	Control Limits	Action	Affected Samples
dec122001020	%D	acetone	32.7%	≤25%	1	Trip Blank / 37063
	%D	acrylonitrile	48.0%	≤25%	1	
	%D	vinyl acetate	65.3%	≤25%	1	
	%D	2-butanone	43.6%	≤25%	1	
	%D	4-mehtyl-2-pentanone	46.2%	≤25%	1	
	%D	2-hexanone	41.9%	≤25%	1	
	%D	1,1,1,2-tetrachloroethane	30.2%	≤25%	1	
	%D	trans-1,4-dichloro-2-butene	45.9%	≤25%	1	
	%D	1,2-dibromo-3-chloropropane	50.4%	≤25%	1	

Action References: 1 - The detected results for this analyte associated with this calibration have been 'J' qualified as estimates. The non-detected results for this analyte associated with this calibration have been 'UJ' qualified as estimated reporting limits.

Notes: R^2 - correlation coefficient
RRF - relative response factor
RSD - relative standard deviation
%D - percent difference

Performance Evaluation Mixture Sample

Percent recoveries did not meet the control limits for several analytes in several PEM samples. For recoveries that exceeded control limits, detected sample results were 'J' qualified as estimates. For recoveries that were less than control limits, detected sample results were 'J' qualified and non-detected sample results were 'UJ' qualified as estimated reporting limits. PEM excursions are presented in the following table. Excursions that did not affect sample results have not been listed in the table.

Analysis Date	QC Lab File	Matrix	Analyte	Percent Recovery	Control Limits (%)	Action	Affected Samples
12/12/97	dec120301003	water	chloromethane	62.77%	70-130	1	Trip Blank / 36575 #8 / 36564 #5 / 36565 MW29S / 36566 MW41S / 36567 MW12ID / 36568 MW12S / 36569 MW912S / 36572 EE7 / 36573 EE8 / 36574 Trip Blank / 37063

Action References: 1 - Detected results for the analyte have been 'J' qualified as estimates and the non-detected results for the analyte have been 'UJ' qualified as estimated reporting limits.

Notes: Percent recoveries were above the control limits for the compound 'trans-1,4-dichloro-2-butene in the PEM samples performed: on 12/10/96, file dec100801008; on 12/12/97. file dec120301003; and on 12/18/97, file dmr180801008. No action was necessary, since there were no positive results for this compound.

Matrix Spike/Matrix Spike Duplicates

MS/MSD percent recoveries were outside the control limits for several analytes for several of the matrix spike samples. No qualification was required for percent recoveries that exceeded control limits, if there were either no positive detects for those analytes or if the positive results had a concentration that was greater than 4x the spike added. Samples were only qualified if both the matrix spike and the duplicate were outside the limits. Matrix spike excursions are presented in the following table. Excursions that did not affect sample results have not been listed in the table.

Sample I.D.	Lab I.D.	Matrix	Analyte	% Recovery (MS/MSD)	Control Limits (%)	Action
MW-27S	36440	water	acetone	65 / 62	70-130	1
			vinyl acetate	49 / 43	70-130	1
			trans-1,4-dichloro-2-butene	68 / 69	70-130	1

Action References: 1 - Detected results for the analyte have been 'J' qualified as estimates and the non-detected results for the analyte have been 'UJ' qualified as estimated reporting limits for this sample.

Notes: Several analytes did not meet the control limits for the MS performed on sample 'MW12S', due to elevated concentration levels and a poor injection on the dilution. All analytes were within control limits for the MSD sample. The RPD between the MS and MSD samples exceeded limits for several analytes. No action was required.

One SIM analyte exceeded the control limits for the MS/MSD performed on samples 'MW26S' and '#6'. No action was necessary, since there were no positive results in the original samples.

Two SIM analytes exceeded the control limits for the MS/MSD performed on sample 'MW12S'. No action was necessary, since the concentration in the original sample was >4x the spike added for one analyte, and there were no positive results in the original samples for the other analyte.

Internal Standard Criteria

The internal standard reference controls were reported from the latter continuing calibrations as opposed to the initial calibration. This was due to the reprocessing of the data after the initial generation. No action was required for the alteration of the reference controls, as they were well within the acceptance limits and would have been if the initial calibration reference controls were used.

Compound Quantitation/Identification and Reporting Limits

The analyte 1,2-dichloroethane was reported with a method detection limit (MDL) of 0.50 µg/L. The actual MDL is 0.48 µg/L. The MTCA cleanup level for this analyte is 0.48 µg/L. The laboratory stated that the difference was due to rounding when the report was generated.

The compounds 1,4-dichlorobenzene and 1,2-dichlorobenzene were analyzed by volatile and semi-volatile analyses. Since there were no positive results for these compounds, either result is acceptable.

The laboratory analyzed and reported analytes designated for SIM analysis from full scan analyses in several samples, since their concentrations exceeded the SIM calibration linear range. Also, several full scan analytes needed dilutions performed due to concentrations exceeding the calibration linear range. The 'out of range' reported values have been 'E' flagged and the values crossed out on the SIM and full scan Form 1's. The correct values to be used have been penned in on the Form 1's during the validation process.

Several analytes exceeded the calibration's linear range in several samples. In one sample, the analyte 'cis-1,2-dichloroethene' had exceeded the linear range, but was still within 20% of the high standard's nanograms on-column amount. Therefore, the laboratory did not perform a dilution for this compound and considered the value acceptable. The value has been 'J' qualified as estimated for exceeding the linear range. The other samples were diluted when they contained compounds that exceeded the linear range. However, the laboratory did not 'E' flag the results or indicate that the diluted values should be used. Therefore, the diluted values have been penned in on the undiluted sample Form 1's during the validation process. The following table lists the results that should be used from dilutions and the results for 1,1-dichloroethene that are from the full scan analyses that should be used, due to exceeding the linear range on the SIM analyses.

Analyte Concentration (µg/L)										
Sample I.D.	vinyl chloride	1,1-DCE	1,1-DCA	cis-1,2-DCE	1,1,1-TCA	1,2-DCA	TCE	Toluene	Ethylbenzene	Xylenes (m&p / o)
MW10S / 36544		3.04	30.0	59.3	29.8 NJ					
MW29S / 36566				33.8 J						

Analyte Concentration (µg/L)										
Sample I.D.	vinyl chloride	1,1-DCE	1,1-DCA	cis-1,2-DCE	1,1,1-TCA	1,2-DCA	TCE	Toluene	Ethylbenzene	Xylenes (m&p / o)
MW41S / 36567				37.1						
MW12ID / 36568		2.50	31.8	72.1	27.7 NJ					
MW12S / 36569		6.29	86.8	206	67.5 NJ		45.2			
MW912S / 36572		6.27	94.5	232	73.2 NJ		46.2			
EE2 / 37061		4.13	54.1	62.3	64.8 NJ		73.6			
EE3 / 37060	6.27	39.4	496	1470	610 NJ	60.4	136	881	147	390 / 152

Notes:
DCE - dichloroethene
DCA - dichloroethane
TCA - trichloroethane
TCE - trichloroethene

Analytes that occasionally failed the ion ratio tolerance limits on the mass spectra have been 'NJ' qualified as tentatively identified. This was usually due to the presence of other miscellaneous ions in the spectrum. This occurred with the analytes: 1,1,1-trichloroethane; acetone; and styrene. The following table lists those samples with tentatively identified analytes. Excursions that did not affect the data results were not listed in the table.

Sample I.D.	Lab I.D.	1,1,1-TCA (µg/L)	acetone (µg/L)	styrene (µg/L)
MW19S	36543	2.33 NJ		
MW10S	36544	29.8 NJ		
MW11S	36545	2.17 NJ		
MW12ID	36568	27.7 NJ		
MW12S	36569	67.5 NJ		
MW912S	36572	73.2 NJ		
MW13S	37062	13.0 NJ		
EE2	37061	64.8 NJ		
EE3	37060	610 NJ	31.4 NJ	19.0 NJ

Notes: TCA - trichloroethane

Semi-Volatiles

Semi-volatile analyses were performed in full scan and selected ion monitoring (SIM) mode. In order to meet the WAC limit requirements the compounds; bis(2-chloroethyl)ether; n-nitroso-di-n-propylamine; hexachlorobenzene; 3,3'-dichlorobenzidine; benzo(a)anthracene; chrysene; benzo(b)fluoranthene; benzo(k)fluoranthene; benzo(a)pyrene; indeno(1,2,3-cd)pyrene; and dibenzo(a,h)anthracene were analyzed in the SIM mode.

Blank Analyses

Contamination was detected in the method blank and the Trip Blank. The sample results have been qualified based on the observed contamination. Sample results reported at concentrations less than 5x the blank contamination (ten times for the common laboratory contaminants and tentatively identified compounds (TICs)) have been 'U' qualified as not detected and the reporting limit raised to the reported value for the analyte. The observed compounds, their reported concentrations and the affected samples are summarized in the following table. Blank contaminants that did not affect sample results have not been listed in the table. Blank contaminants reported from the library search as TICs have not been qualified.

Blank I.D.	Lab File I.D. / COC	Analyte	Conc. (µg/L)	Reporting Limit (µg/L)	Action Level[1] (µg/L)	Affected Samples	Qualified Results[2]
method blank	dec180901009	BEHP	0.587	3.30	5.870	MW25S MW926S	1.09 U 0.296 U

Action References: 1 - Action Level = highest blank contaminant value above the reporting limit x 5 or x 10.
2 - Qualified Results = reported value, which becomes the qualified reporting limit.

Notes: BEHP - bis(2-ethylhexyl)phthalate

The trip blank had reported BEHP contamination as well, however, the method blank had already qualified the blank contamination in the samples.

Surrogate Spikes

One of the surrogates exceeded the control limits for the full scan PEM and method spike samples. No action was necessary, since two surrogates within one fraction are to be out before qualification is required.

Performance Evaluation Mixture Sample

Percent recovery values exceeded the control limits for one of the analytes in the full scan and SIM PEM samples analyzed. No qualification was necessary, since there were no positive results for this analytes in the associated samples.

Laboratory Control Samples

Percent recoveries did not meet the control limits for one of the SIM analytes in the SIM LCS sample. For recoveries that were less than control limits, the non-detected sample results were 'UJ' qualified as estimated reporting limits. LCS excursions are presented in the following table. Excursions that did not affect sample results have not been listed in the table.

Analysis Date	QC Lab File	Matrix	Analyte	Percent Recovery	Control Limits (%)	Action	Affected Samples
12/12/96	dec142201022	water	n-nitroso-di-n-propylamine	not detected	0-230	1	MW25S / 36538 MW926S / 36542 Trip Blank / 36549

Action References: 1 - Detected results for the analyte have been 'J' qualified as estimates and the non-detected results for the analyte have been 'UJ' qualified as estimated reporting limits.

Notes: The sample 'MW26S' was not qualified, since the MS/MSD performed on this sample had acceptable recoveries for this compound. Sample 'MW926S' was not qualified, since it is a field duplicate of sample 'MW26S', and therefore, should have the same affect.

Matrix Spikes/Matrix Spike Duplicates

The SIM MS/MSD spiking levels were at 0.1 µg/L, and although they have passed QC requirements, in the future they should be spiked at a level of 0.5 µg/L.

Percent recovery values were within the acceptable control limits for the MS/MSD samples. However, the recoveries were variable for two analytes in the full scan analyses and one analyte in the SIM analyses, which caused their RPD values to exceed the RPD control limits. No action was necessary, since there were no positive results for these analytes.

Internal Standard

The internal standard reference controls were reported from the latter continuing calibration as opposed to the initial calibration. This was due to the reprocessing of the data after the initial generation. No action was required for the alteration of the reference controls, as they were well within the acceptance limits, as they were well within the acceptance limits and would have been if the initial calibration reference controls were used.

Compound Quantitation/Identification and Reporting Limits

Satisfactory method detection limits (MDLs) have been determined as of December 16, 1996, for the following analytes: bis(2-chloroethyl)ether; 3,3'-dichlorobenzidine, and N-nitroso-di-n-propylamine.

The compounds '1,4-dichlorobenzene' and '1,2-dichlorobenzene' were analyzed by volatile and semi-volatile analyses. Since there were no positive results for these compounds, either result is acceptable.

Herbicides

The acid extractable herbicides were analyzed on a Hewlett Packard 5973 MSD. Therefore, secondary confirmational analysis would not be necessary, as mass spectral identification was used.

Holding Period/Sample Preservation

The laboratory sample log-in sheet indicated that one cooler which contained herbicide samples had arrived at a temperature of 7.3°C. This is above the recommended temperature of 2-6°C. No action was taken, since samples to be analyzed for the herbicide fraction are not known to be affected by a temperature elevated 1°C over the recommended cooler temperature. Also, the samples were analyzed within the recommended holding period.

Performance Evaluation Mixture Sample

The percent recovery for dinoseb had exceeded the control limits of 10-90% in the PEM sample. No action was necessary, since there were no positive results among the samples.

Matrix Spikes/Matrix Spike Duplicates

The relative percent difference between the matrix spike and the duplicate for MCPP and MCPA exceeded the control limits of less than 30% difference. No action was necessary, since there were no positive results in the original sample.

Metals

Metals analyses were performed as two separate ICP runs and one hydride AA run. A regular level ICP analysis was employed for the analysis of silver, barium, calcium, cadmium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel, selenium, vanadium, and zinc. A 10x preconcentrated level ICP analysis was employed for the analysis of beryllium, lead, antimony, and thallium. The hydride AA was performed for arsenic. The preconcentrated ICP and the hydride AA analyses were performed in order to meet the WAC detection limits. However, thallium did not meet WAC detection limits. In the future, thallium will be analyzed by graphite furnace atomic absorption (GFAA).

The laboratory analyzes several QC standards. The second source standards are QCA, QCB, APG. The in-house QC standard is ZEL/2000, which is the ZEL standard with a 2000 fold dilution. The spike levels for the ZEL/2000 were very close to the method detection concentrations (MDC) for some analytes, and lower than the MDC for other analytes. No action was taken for deviations regarding the diluted ZEL/2000 standard, since the spike levels were too low to provide a meaningful evaluation. The spiking levels were not consistent with CLP or SW-846 protocols. The percent recoveries for the other QC samples were evaluated in the same manner as the laboratory method spike, which is a laboratory control sample (LCS).

Blank Analyses

Several of the method blanks yielded analyte concentrations that were above the reporting limits. Results in associated samples less than 5x the highest reported blank values (10x for method blanks) were 'U' qualified as not detected and the reporting limit was raised to the reported value for the analytes. Blank contamination had no affect on samples, if the samples were either non-detects or were greater than 5x the highest blank value. The table below lists the affected samples and their qualified results. Excursions that did not affect the data were not listed in the table.

Blank I.D.	Digest/Analysis Date/Time	Analyte	Conc. (mg/L)	Reporting Limit (mg/L)	Action Level[1] (mg/L)	Affected Samples	Qualified Results[2] (mg/L)
2806MB3	12/23/96	lead	0.00379	0.003	0.0379	MW23S	0.005 U
						MW10S	0.006 U
						MW11S	0.007 U
						#8	0.003 U
						#5	0.005 U
						MW12ID	0.003 U
						MW912S	0.003 U
						MW13S	0.006 U

References: 1 - Action Level = highest blank contaminant value above the reporting limit x 5
2 - Qualified Results = reported value which becomes the reporting limit.

Notes: Calcium was detected in the method blank '2813MB3'. However, the contamination did not affect the data, since the data results were greater than 10x the blank contaminant concentration.

Calcium and zinc was detected in three trip blanks analyzed. No action was taken, since the trip blank contamination would not have an affect on the metals analyses. The origin of the contaminants is unknown.

Continuing Calibrations

Continuing calibration verifications (CCV) for one of the analytes exceeded the QC criteria of 90-110% recovery. Detected results for the analytes in the associated samples were 'J' qualified as estimates. The following table summarizes those compounds that failed to meet the percent recovery criteria and the affected samples.

Calibration File	Analyte	Obtained Value	Control Limits	Action	Affected Samples
Continuing Calibration					
CVS/10 (13:46)	lead	115.1%	90-110%	1	MW11S / 36545 #8 / 36564 #5 / 36565 MW12ID / 36568 MW912S / 36572 EE7 / 36573 EE8 / 36574 Trip Blank / 36575 #4 / 37053 #6 / 37054 #96 / 37057 MW16S / 37058 MW17SR / 37059 EE3 / 37060 EE2 / 37061 MW13S / 37062 Trip Blank / 37063

Action References: 1 - The detected results for this analyte associated with this calibration have been 'J' qualified as estimates.

Laboratory Control Sample

Percent recovery values for several analytes exceeded the acceptance limits in the laboratory control samples. However, the excursions did not affect most of the samples, since they had no positive results among the data set for the affected analytes. One sample was affected and is reported in the following table. Excursions that did not affect the data are not reported on the table.

Analysis Date	QC Lab File	Matrix	Analyte	Percent Recovery	Control Limits (%)	Action	Affected Samples
12/23/96	2806MS1	water	lead	122.4	80-120	1	EE2 / 37061

Action References: 1 - Detected results for the analyte have been 'J' qualified as estimates and the non-detected results for the analyte have been 'UJ' qualified as estimated reporting limits.

Matrix Spike/Matrix Spike Duplicate Analysis

Several MS/MSD percent recoveries did not meet the acceptance limits. No action was necessary for samples where the original sample concentrations were greater than 4x the spike added for the deviated analytes. The following table presents matrix spike recovery excursions, affected samples, and actions. Excursions that did not affect the data were not listed in the table.

Sample I.D.	Preparation Date	Matrix	Analyte	% Recovery (MS/MSD)	Control Limits (%)	Action	Affected Samples
#6	12/20/96	water	iron	102.0 / 154.2	75-125	1	#8 #5 EE7 EE8 #4 #6 #96 MW16S MW17SR EE3 EE2

Excursion References 1 - The positive results for the analyte, has been 'J' qualified as estimated.
2 - The non-detected results have been 'UJ' qualified as not detected but at an estimated detection limit.

Notes: Samples 'MW12S' and 'MW912S' were not qualified for iron, since the MS/MSD performed on 'MW12S' was acceptable. MW912S is the field duplicate of MW12S, and therefore, should have the same affect.

ICP Interference Check Sample

The Interference Check Sample (ICS) for the preconcentrated samples did not contain lead. Therefore, lead recoveries could not be evaluated. However, no action was necessary, since there were no elevated levels of interference compounds present in the samples. The laboratory will include lead in the ICS standard in future analyses.

Laboratory Replicates

The laboratory replicate criteria for samples with analyte concentrations greater than 5x the CRDL is a RPD of <20%. For samples with analyte concentrations less than 5x the CRDL, a control limit of +/- the CRDL was used. Several analytes did not meet the RPD criteria, but were less than 5x the CRDL, and were within +/- the CRDL criteria.

Analyte Quantitation and Reporting Limits

The thallium MDC was higher than the WAC detection limit requirements. The following table shows the reporting limit comparisons. No action was required regarding the elevated MDC, since thallium is not an analyte of concern at the facility. The laboratory stated that next quarter, they will analyze thallium by GFAA in order to meet the WAC detection limit.

Analyte	MDL (mg/L)	WAC (mg/L)
thallium	0.003	0.001

References

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American Public Health Association (APHA). American Water Works Association (AWWA). Water Pollution Control Federation (WPCF). *Standard Methods for the Examination of Water and Wastewater.* 19th Edition 1995. Office of American Public Health Association.

Table 1

PASCO QUARTERLY MONITORING DATA VALIDATION
SAMPLE CROSS REFERENCE

C.O.C.	Client I.D.	Lab I.D.	Package I.D.	Matrix	Collection Date	Analysis Method	Deviated Criteria
F2927	PLF-MW27S-1296	36440	06113521	water	12/03/96	VOCs App I Metals	CC, MS RL
	PLF-MW22S-1296	36441	06113521	water	12/04/96	VOCs App I Metals	CC RL
	PLF-MW32S-1296	36442	06113521	water	12/04/96	VOCs	CC
	PLF-MW24S-1296	36443	06113521	water	12/04/96	VOCs App I Metals	CC, %D, CI RL
	PLF-MW40S-1296	36444	06113521	water	12/04/96	VOCs	CC, %D, CI
	PLF-MW42S-1296	36445	06113521	water	12/04/96	VOCs	CC, %D, CI
	PLF-MW28S-1296	36446	06113521	water	12/04/96	VOCs App I-II Metals	CC, %D RL
	PLF-MW20S-1296	36447	06113521	water	12/04/96	VOCs App I Metals	CC, %D RL
	PLF-MW23S-1296	36448	06113521	water	12/04/96	VOCs App I Metals	CC, %D RL, MB
	PLF-MW33S-1296	36449	06113521	water	12/04/96	VOCs	CC, %D
	Trip Blank	36450	06113521	water	12/04/96	VOCs App I Metals	CC RL
F2929	PLF-MW25S-1296	36538	06113522	water	12/05/96	VOCs SVOCs Herbicides	CC, %D MB, LCS none
	PLF-MW26S-1296 MS (svoc, herbicides) MSD (svoc, herbicides)	36539 36540 36541	06113522	water	12/05/96	VOCs SVOCs Herbicides	CC, %D none none
	PLF-MW926S-1296	36542	06113522	water	12/05/96	SVOCs Herbicides	MB, LCS none
	PLF-MW19S-1296	36543	06113522	water	12/05/96	VOCs App I Metals	CC, %D RL
	PLF-MW10S-1296	36544	06113522	water	12/05/96	VOCs App I Metals	CC, %D RL, MB

Table 1

PASCO QUARTERLY MONITORING DATA VALIDATION
SAMPLE CROSS REFERENCE

C.O.C.	Client I.D.	Lab I.D.	Package I.D.	Matrix	Collection Date	Analysis Method	Deviated Criteria
F2929	PLF-MW11S-1296	36545	06113522	water	12/05/96	VOCs App I Metals	CC, %D RL, MB, CCV
	PLF-MW36S-1296	36546	06113522	water	12/05/96	VOCs	CC, %D
	PLF-MW37S-1296	36547	06113522	water	12/05/96	VOCs	CC, %D
	PLF-MW38S-1296	36548	06113522	water	12/05/96	VOCs	CC, %D
	Travel Blank	36549	06113522	water	12/05/96	VOCs SVOCs Herbicides	CC LCS none
F2889	PLF-#8-1296	36564	061135221	water	12/06/96	VOCs App I-II Metals	CC, %D, PEM RL, MB, CCV, MS
	PLF-#5-1296	36565	061135221	water	12/06/96	VOCs App I-II Metals	CC, %D, PEM RL, MB, CCV, MS
	PLF-MW29S-1296	36566	061135221	water	12/06/96	VOCs	CC, %D, PEM, CQ
	PLF-MW41S-1296	36567	061135221	water	12/06/96	VOCs	CC, %D, PEM
	PLF-MW12ID-1296	36568	061135221	water	12/06/96	VOCs App I Metals	CC, %D, PEM, CI RL, MB, CCV
	PLF-MW12S-1296 MS (voc, app I-II) MSD (voc, app I-II)	36569 36570 36571	061135221	water	12/06/96	VOCs App I-II Metals	CC, %D, PEM, CI RL
	PLF-MW912S-1296	36572	061135221	water	12/06/96	VOCs App I-II Metals	CC, %D, PEM, CI RL, MB, CCV
	PLF-EE7-1296	36573	061135221	water	12/06/96	VOCs App I-II Metals	CC, %D, PEM RL, CCV, MS
	PLF-EE8-1296	36574	061135221	water	12/06/96	VOCs App I-II Metals	CC, %D, PEM RL, CCV, MS
	Trip Blanks	36575	061135221	water	12/06/96	VOCs App I-II Metals	CC, %D, PEM RL, CCV

Table 1

PASCO QUARTERLY MONITORING DATA VALIDATION
SAMPLE CROSS REFERENCE

C.O.C.	Client I.D.	Lab I.D.	Package I.D.	Matrix	Collection Date	Analysis Method	Deviated Criteria
F2891	PLF-#4-1296	37053	06113524	water	12/07/96	VOCs App I-II Metals	CC RL, CCV, MS
	PLF-#6-1296 MS (voc, app I-II) MSD (voc, app I-II)	37054 37055 37056	06113524	water	12/07/96	VOCs App I-II Metals	CC RL, CCV, MS
	PLF-#96-1296	37057	06113524	water	12/07/96	VOCs App I-II Metals	CC RL, CCV, MS
	PLF-MW16S-1296	37058	06113524	water	12/07/96	VOCs App I-II Metals	CC RL, CCV, MS
	PLF-MW17SR1296	37059	06113524	water	12/07/96	VOCs App I-II Metals	CC RL, CCV, MS
	PLF-EE3-1296	37060	06113524	water	12/07/96	VOCs App I-II Metals	CC, CI RL, CCV, MS
	PLF-EE2-1296	37061	06113524	water	12/07/96	VOCs App I-II Metals	CC, CI RL, CCV, MS, LCS
	PLF-MW13S-1296	37062	06113524	water	12/07/96	VOCs App I Metals	CC, CI RL, MB, CCV
	Trip Blanks	37063	06113524	water	12/07/96	VOCs App I-II Metals	CC, %D, PEM RL, CCV

Table 1

PASCO QUARTERLY MONITORING DATA VALIDATION
SAMPLE CROSS REFERENCE

Method References:

"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," Third Edition, November 1986, and it's updates, (SW-846 / 8260, 8270, 8150, 6010) (USEPA, 1995).

"Methods for the Determination of Metals in Environmental Samples. Supplement I, EPA/600/R-94/111, May 1994, (EPA / 200.7).

"Standard Methods for the Examination of Water and Wastewater," 19th Edition 1995, (APHA, AWWA, WPCF), (SM / 3114C).

Notes:

SIM - Selected Ion Monitoring.
VOCs - Volatile Organic Compounds
SVOCs - Semi-volatile Organic Compounds
App I - Washington Administrative code (WAC) Appendix I Metals List.
App II - WAC Appendix II Metals List.

Excursion References:

MB - Method Blank
TB - Trip Blank
CC - correlation coefficient
%D - Percent Difference
PEM - Performance Evaluation Mixture
LCS - Laboratory Control Sample
MS - Matrix Spike
CI - Compound Identification
CQ - Compound Quantitation
CCV - Continuing Calibration Verification
RL - Reporting Limit
none - There were no excursions.

To: Dave Provance, Philip Environmental Services Corporation
From: Melissa Listman, O'Brien & Gere Engineers, Inc. MSL
Re: Data Validation for Samples Collected February 26 to March 1, 1997
File: 6127.003
Date: May 9, 1997

cc: Philip Environmental Services Corporation: Mike Caputo

O'Brien & Gere Engineers Inc.: Paul Steinberg

SUMMARY AND DATE USABILITY

Data Quality Project Summary

This report addresses data quality for ground water samples collected between February 26 and March 1, 1997 during the quarterly ground water sampling conducted at Pasco Landfill. Sample collection activities were conducted by Philip Environmental Services Corporation (Philip).

Samples were analyzed for a selected list of parameters, which included the following: volatile organics, semivolatile organics, herbicides, and total metals. The analyte list and detection limits were specified by the Washington Administrative Code (WAC) Appendix I and II list, as described in the Quality Assurance Project Plan (QAPP). The chemical analyses were performed and reported by Philip Analytical Services (PAS) located in Burnaby, British Columbia, Canada. The samples were received by the laboratory between February 27 and March 5, 1997 intact and at the required preservation. Sample chain of custody records were accurate and complete. Table 1 presents a summary of the validated samples, including their identification information, collection dates and methods of analysis performed.

The purpose of the data validation was to provide an opinion of the quality of the data generated from the measurement processes conducted during chemical analysis of the samples. The data validation focused on the data generation process and involved a detailed examination of the data packages. The purpose of the data validation was to assess the usability of the analytical results and to evaluate on the laboratory's compliance with the quality assurance/quality control (QA/QC) criteria outlined in the analytical methods referenced in Table 1. Table 1 also provides a summary of quality control deficiencies that were observed during the data validation.

Data Usability

The analytical data were reviewed and qualified in accordance with U.S. Environmental Protection Agency (USEPA) Data Validation Functional Guidelines (USEPA, 1994a,b). Rejected data are a result of a major excursion from QA/QC criteria and should not be used for either qualitative or quantitative purposes. Minor excursions from QA/QC criteria result in approximation of sample data. Approximation of a data point indicates uncertainty in the reported concentration of the chemical, but not its assigned identity. Approximated data can generally be used for either quantitative or qualitative purposes. This approach to the use of analytical data is consistent with USEPA (USEPA, 1992) risk assessment and data usability guidance. A summary of specific QA/QC excursions that resulted in qualification of sample data are presented in the following sections.

This section summarizes the analytical data in terms of its completeness and usability for characterization of the current water quality for engineering decisions and risk management. Data completeness is defined as the percentage of sample results that have been determined to meet quality control criteria during the data review process. The completeness of the data set was determined to be 100%. However, some volatile and semivolatile organic results were qualified due to minor deficiencies that were associated with calibration, matrix spike/matrix

spike duplicate (MS/MSD), laboratory control sample (LCS), internal standard criteria, method blank, and compound identification criteria. Metals and herbicide data were not qualified.

Data usability is an evaluation that utilizes the findings of the data validation review, historical information, regulatory guidance and other applicable information to provide an assessment of how the data set may be used. The assessment was made with reference to using the data to characterize ground water for assessing engineering and risk management options. Data which do not meet completeness requirements are not considered usable, however, data which are complete are not necessarily usable. Issues which affect data usability were not observed.

DATA VALIDATION METHODS AND RESULTS

Data Validation Protocols

The criteria employed for data validation review (USEPA, 1994) provide differing quality control criteria from those specified in the methods. In cases where method requirements and validation requirements overlap, method quality control criteria were used and the validation guidelines were followed for applying data qualifiers, if required. QA/QC criteria outlined in the data validation guidelines were used when the method did not provide criteria. Data may be in full compliance with the method requirements, but may not meet data validation guidance.

Quality Control Parameters

The following QA/QC parameters were evaluated for metals analyses:

- Holding Times and Preservation
- Initial and Continuing Calibration
- Calibration Verification Standard
- Blank Analyses
- Inductively Coupled Plasma (ICP) Interference Check Sample (if applicable)
- MS/MSD Sample Recovery Criteria
- Laboratory Duplicate and MSD Analysis
- Field Duplicate Analysis
- Laboratory Control Sample (LCS) Analysis (the laboratory used the reference "Method Spike" for LCS)
- ICP Serial Dilution (if applicable)
- Furnace Atomic Absorption Analysis (if applicable)
- Analyte Quantitation and Reporting Limits
- Documentation Completeness

The following QA/QC parameters were evaluated for volatile, semivolatile and herbicide analyses:

- Holding Times and Preservation
- Gas Chromatography/Mass Spectrometry (GC/MS) Tuning
- Initial and Continuing Calibration
- Blank Analyses
- Surrogate Spikes

- MS/MSD Analysis
- LCS Analysis (the laboratory used the reference "PEM" for LCS)
- Internal Standards
- Field Duplicate Analysis
- Target Compound Identification
- Compound Quantitation and Reporting Limits

Data Qualifiers Used in Validation

The following data qualifiers are defined by the USEPA in the Data Validation Functional Guidelines for use in validating analytical data. The appropriate data qualifiers were added to the data packages during data validation and dated and initialed by the validator. Any necessary corrections to the data due to transcription errors or calculation errors were dated and initialed.

The following data validation qualifiers may be used during the validation of data:

R — Indicates that the reporting limit or sample result has been determined to be unusable due to a major excursion from specified QA/QC criteria. The data should not be used for qualitative or quantitative purposes.

U — Indicates that the analyte was analyzed for, but was not detected. The sample-specific reporting limit is presented and adjusted for dilution and percent solids, as appropriate. The qualifier is also used to signify that the reporting limit of an analyte was raised due to blank contamination.

J — The analyte was positively identified but the concentration should be considered approximate. This qualifier indicates that the data validation process identified a minor deficiency from specified QA/QC criteria.

UJ — Indicates that the sample-specific reporting limit for the analyte in this sample should be considered approximate. This qualifier is used when the data validation process identified a minor deficiency from specified QA/QC criteria.

N — The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

NJ — The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

Data Evaluation Results

This section describes the qualifiers that were added to sample data where QA/QC criteria were not met. QA/QC parameters that met criteria are not discussed. Samples that required qualification are identified in the following sections by the sample location documented on the field chain-of-custody record.

Volatile Organics

General Comments
Volatile organic analyses were performed in full scan and in the selected ion monitoring (SIM) mode. In order to meet the WAC limits the following compounds were analyzed in the SIM mode: vinyl chloride, 1,1-dichloroethene, carbon tetrachloride, and 1,1,2,2-tetrachloroethane.

Full scan volatile organic analysis was inadvertently not performed for sample location MW-42S. In addition, the SIM analysis was not performed for the trip blank received on February 28, 1997.

In some instances tuning reports for bromofluorobenzene (BFB) were provided periodically during the 12 hour sequence, rather than at the beginning of every 12 hour sequence. Data quality was not impacted since the laboratory did monitor BFB throughout the 12 hour sequence.

The internal standard criteria for the full scan analyses were often established using the latter continuing calibration standard rather than the initial calibration standard analyzed at the beginning of the 12 hour sequence. This was due to the reprocessing of the data after the initial generation. Data quality was not impacted since internal standards were well within the acceptance limits no matter which calibration standard was used to establish criteria.

In several instances internal standard summary forms were incorrectly reported for the SIM data. These forms were corrected and the internal standards were referenced from the latter calibration standard to be consistent with the full scan analysis. Data quality was not impacted since internal standards were well within the acceptance limits no matter which calibration standard was used to establish criteria.

Samples were analyzed undiluted to meet detection limits specified by WAC and the QAPP. The following samples were diluted and reanalyzed to obtain target compound concentrations within the linear calibration range:

- Full scan: MW10S, MW12S, MW912S, MW12ID, MW13S, and EE3
- SIM: MW10S, MW12S, MW912S, MW12ID, MW13S, EE3, and EE2.

As a result, two sets of analytical data were reported and validated for these samples. For ease of review, this report only discusses the qualifications performed for the final data reported following the completion of the data validation.

Blank Analysis
Acetone, methylene chloride, chloroform, and tentatively identified compounds (TICs) were detected in several blanks. Sample results reported at concentrations less than ten times the highest concentration detected in the associated blanks were qualified as not detected (U) with the reporting limit raised to the reported value. The following compounds and samples were affected:

- acetone result in sample location #4 was revised to 9.96U
- chloroform result in sample location MW41S was revised to 3.38U.

TICs that were affected were flagged with a "U" qualifier on their respective reporting forms.

Initial and Continuing Calibration

Initial and continuing calibration criteria were exceeded in several instances. Sample data that required qualification are tabulated below. It should be noted that non-detected results were not rejected for acetone and 2-butanone as recommended by EPA validation guidelines when relative response factors (RRFs) were less than 0.050 since these compounds are known to have poor purging efficiencies. Non-detected results for these compounds were qualified as approximate (UJ) in the associated samples since RRFs were > 0.010 and relative standard deviation (RSD) criteria were met. These compounds also had acceptable MS/MSD and PEM recoveries.

Calibration Date	Compound	Calibration Excursion	Criteria	Action	Samples Affected
3/7/97 15:12 to 18:24	acetone	RRF= 0.035	RRF ≥0.050	UJ	#5, #8, #6, #96, MW17SR, MW16S, #4, MW36S, MW37S, MW40S, MW32S, MW33S, MW41S, Trip Blank 2/27/97
	2-butanone	RRF=0.047	RRF ≥0.050	UJ	
3/8/97 01:23	methylene chloride	%D= 28.6	%D ≤25%	UJ, J	#5, #8, #6, #96, MW17SR, MW16S, #4, MW36S, MW37S, MW40S, MW32S, MW33S, MW41S, Trip Blank 2/27/97
	acrylonitrile	%D= 26.3	%D ≤25%	UJ	
	bromoform	%D=27.8	%D ≤25%	UJ	
3/14/97 14:52 3/14/97 23:19 3/15/97 08:55	trans-1,4-dichloro-2-butene	%Ds ranged from 40.0% to 104.6%	%D ≤25%	UJ	MW29S, MW38S, MW23S, EE7, EE8, MW26S, MW25S, MW10S, MW12S, MW912S, MW12ID, EE2, MW13S, EE3, Trip Blank 3/1/97, Trip Blank 3/5/97
3/12/97 15:11 3/13/97 00:37 3/13/97 06:32 3/13/97 13:23	carbon tetrachloride	%Ds ranged from 87.4% to 113.2%	%D ≤25%	UJ	MW22S, MW19S, MW24S, MW11S, MW12ID, MW13S, EE3, EE2, MW29S, EE7, MW38S, MW26S, MW25S, MW23S, EE8, MW10S, MW12S, MW912S, Trip Blank 3/1/97, Trip Blank 3/5/97

Table Notes:
RRF = relative response factor
RSD = relative standard deviation
%D = percent difference

Surrogate Recovery
Surrogate recoveries were above control limits for sample location EE3 due to interferences from elevated concentrations of toluene and other target compounds This sample was diluted and reanalyzed to obtain concentrations for several target compounds within the linear range. Surrogate recoveries were within control limits for the diluted analyses performed. Therefore, qualification of data was not required.

MS/MSD Analysis
MS/MSD results were slightly outside of control limits for the several compounds and MS/MSDs. Sample data that required qualification are tabulated below. MS/MSD excursions which did not impact data quality were not tabulated.

MS/MSD ID	Compound	%Recoveries	Control Limits	Action
#6	methylene chloride	69, 65	70-130	UJ
	4-methyl-2-pentanone	66, 69	70-130	UJ
	trans-1,4-dichloro-2-butene	56, 61	70-130	UJ

LCS Analysis
Percent recoveries were above control limits for vinyl acetate (recoveries ranged from 164% to 191%) for the LCSs analyzed. Qualification of data was not required since recoveries were biased high and vinyl acetate was not detected in the samples.

The percent recovery for trans-1,4-dichloro-2-butene (68.1%) was below laboratory control limits for the LCS analyzed on March 7, 1997 at 19:02. Non-detected results were qualified as approximate (UJ) for this compound in the following sample locations: #5, #8, #6, #96, MW17SR, MW16S, #4, MW36S, MW37S, MW40S, MW32S, MW33S, MW41S, and Trip blank received on February 27, 1997.

Compound Identification and Quantitation
Overall, the laboratory performed compound identification and quantitation in accordance with method requirements. The following revisions were made to the analytical data based a on review of raw chromatograms:

- The acetone result reported for sample MW26S (6.03 ug/L) was replaced with the method detection concentration (MDC) quantitation limit and flagged "U" because this compound was not detected (the originally reported value was a transcription error).

- Results for trichlorofluoromethane (15.6 ug/L) and cis-1,3-dichloropropene (0.522 ug/L) were replaced with their MDCs and flagged "U" for sample EE3 since GC/MS identification criteria were not met for these compounds.

Compounds that did not meet GC/MS ion ratio criteria for secondary mass ions were qualified as tentatively identified. This usually occurred due to low concentrations that were observed or in the case of sample EE3, sample matrix interferences. The compounds and samples that were affected are tabulated below.

Sample ID	Compound	Action
#6	1,1-dichloroethene	0.02 N
MW24S	1,1-dichloroethene	0.01 N
MW13S	vinyl chloride	0.09 N
EE3	styrene	33.1 N

As previously discussed, several samples were diluted and reanalyzed to obtain concentrations within the linear calibration range of the instrument. Sample dilutions were performed in accordance with method requirements. Correlation of the target compound concentrations between the undiluted and the diluted analyses was good. Upon completion of the validation, undiluted summary forms were revised to reflect concentrations from diluted runs where appropriate. The compounds and samples that were affected are tabulated below.

Sample ID	Dilution Performed	Compounds Reported from Diluted Run
MW10S	1:10	1,1-dichloroethene (SIM), cis-1,2-dichloroethene
MW12S	1:10	1,1-dichloroethene (SIM), 1,1-dichloroethane, cis-1,2-dichloroethene, 1,1,1-trichloroethane
MW912S	1:10	1,1-dichloroethene (SIM), 1,1-dichloroethane, cis-1,2-dichloroethene, 1,1,1-trichloroethane
MW12ID	1:10	cis-1,2-dichloroethene
	1:100	1,1-dichloroethene (SIM)
MW13S	1:10	cis-1,2-dichloroethene
	1:100	1,1-dichloroethene (SIM)
EE3	1:10	1,2-dichloroethane, trichloroethene, 4-methyl-2-pentanone, ethyl benzene, o-xylene, styrene
	1:100	acetone, 2-butanone, cis-1,2-dichloroethene, 1,1-dichloroethane, 1,1,1-trichloroethane, toluene, m/p xylenes
EE2	1:10	1,1-dichloroethene (SIM)

Semivolatile Organics

General Comments

Two ground water samples, one field duplicate, and one MS/MSD were analyzed for semivolatile organics in full scan and in the SIM mode. In order to meet the WAC limits the following compounds were analyzed in the SIM

mode: bis(2-chloroethyl)ether, n-nitroso-di-n-propylamine, hexachlorobenzene, 3,3'-dichlorobenzidine, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and dibenzo(a,h)anthracene.

The laboratory case narrative documented that base-neutral surrogates were added at two times the required concentration and that internal standards were added at one-half the required concentration. Data quality was not impacted. The amount of surrogates added was considered by the laboratory when performing surrogate recovery calculations. The amount of internal standards that were added were taken into account when assessing internal standard areas and when performing compound quantitation. Internal standard forms were corrected during the validation process to reflect this variation.

The internal standard criteria for the SIM mode were established using the latter continuing calibration standard rather than the initial midpoint calibration standard analyzed at the beginning of the 12 hour sequence. This was due to the reprocessing of the data after the initial generation. To be consistent with the full scan data, internal standard data were re-evaluated during the validation process using the midpoint initial calibration standard, rather than the latter continuing calibration standard.

Blank Analysis
Di-n-butylphthalate was detected at 1.09 ug/L in the method blank extracted on March 6, 1997 and analyzed on March 27, 1997. Sample results for di-n-butylphthalate were qualified as non-detected and detection limits were raised in samples MW26S (1.04U) and MW926S (0.991U).

Surrogate Recoveries
Surrogate recoveries were above laboratory control limits for nitrobenzene-d5 and 2-fluorobiphenyl (recoveries ranged from 118% to 170%) for the SIM analyses performed, including the method blank, environmental samples, and MS/MSDs. Qualification of data was not required since SIM target compounds were not detected in the samples.

MS/MSD Analysis
MS/MSD results were outside of control limits for the several compounds and MS/MSDs. Sample data that required qualification are tabulated below. MS/MSD excursions which did not impact data quality were not tabulated.

MS/MSD ID	Compound	%Recoveries	Control Limits	Action
MW25S	dibenzo(a,h)anthracene	38, 8	40-140	UJ

LCS Analysis
The percent recovery for di-nitrotoluene (101%) was above laboratory control limits for the LCS extracted on March 6, 1997 and analyzed on March 27, 1997. Qualification of data was not required since di-nitrotoluene was not detected in the samples.

Internal Standard Criteria
Internal standard areas were slightly below control limits (50% to 150%) in several instances for SIM analyses performed. Sample data quantitated using the internal standards that did not meet criteria were qualified as approximate. The affected samples and compounds are tabulated below.

Sample ID	Internal Standard	Area Recovery	Action	Compounds Affected
MW926S	naphthalene-d8 acenaphthene-d10 phenanthrene-d10 chrysene-d12	46 37 39 34	UJ	hexachlorobenzene, chrysene, 3,3'-dichlorobenzidine, benzo(a)anthracene
MW25S	naphthalene-d8 acenaphthene-d10 phenanthrene-d10 chrysene-d12 perylene-d12	46 39 37 34 46	UJ	hexachlorobenzene, chrysene, 3,3'-dichlorobenzidine, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene

Herbicides

General Comments
Two ground water samples, one field duplicate, and one MS/MSD were analyzed for herbicides by GC/MS which is a modification of USEPA 8151. Since GC/MS was used for sample analysis, calibration data were assessed using criteria which are routinely applied to GC/MS calibration data (RSDs <30% for initial calibration and %Ds <25% for continuing calibration). Herbicide data did not require qualification based on minor excursions that were observed from surrogate and MS/MSD criteria.

Surrogate Recoveries
The surrogate recovery (144%) was above laboratory control limits for MS sample MW26S. Qualification of data was not required since surrogate recovery was met for the unspiked analysis of sample MW26S.

MS/MSD Analysis
RPDs were outside of laboratory control limits for many of the compounds. The laboratory documented in the case narrative that elevated RPDs were likely a result of the MS being spiked twice. Qualification of data was not required since MSD and PEM recoveries were within control limits.

Metals

General Comments
Eleven samples were analyzed for Appendix I metals. Thirteen samples and two MS/MSDs were analyzed for Appendix I and II metals. Arsenic was analyzed by hydride atomic absorption (AA) in order to meet WAC detection limits. Thallium was analyzed by ICP (10x concentrate) and by furnace AA. Thallium results were

reported from furnace AA in order to meet WAC detection limit requirements of 0.001 mg/L. Beryllium, lead, and antimony were analyzed by ICP following 10x concentration digestion in order to meet WAC detection limits. The remaining metals were analyzed by ICP.

The laboratory documented in the case narrative that arsenic data were reported from five times (5x) dilution. This was based on sample matrix effects that were observed during serial dilutions performed for four samples , post-spike analyses performed for two samples, and historical data obtained from previous quarterly monitoring events. MS/MSD and post-spike recoveries for 5x dilutions had recoveries within control limits, therefore, data was not qualified. However, it is recommended that the laboratory perform post-spike analysis on all samples, blanks, MS/MSDs, and LCSs (method spikes) in order to more effectively assess accuracy and the matrix effects of individual samples. If post-spike recoveries are not within 85% to 115%, it is recommended that the samples be analyzed using the method of standard additions.

Metals data were not qualified based on minor deficiencies observed for calibration verification standard and method blank analysis.

Calibration Verification Standard

The laboratory documented that the calibration verification standard, which is an independent check standard, was not analyzed following the initial calibration performed for thallium on April 11, 1997. Data quality was not impacted since a post-digestion spike which also serves as an independent check of the initial calibration was analyzed and had recoveries within 90% to 110%. An MS/MSD sample was also analyzed on April 11, 1997 and had recoveries within 75% to 125%.

Blank Analysis

Calcium was detected at 0.061 mg/L (MDC= 0.050 mg/L) in method blank 0385MB2 for ICP analysis on March 14, 1997. Qualification of data was not required since calcium concentrations in the associated samples were greater than five times the method blank concentration.

Furnace Atomic Absorption (AA) Analysis

Thallium was analyzed by furnace AA for the first time based on a recommendation proposed following last quarterly sampling event (Memorandum dated March 5, 1997). Thallium was not detected in the samples. Post spike analysis was performed on one sample to assess sample matrix effects. Post-spike recovery was within 85% to 115% for this sample. It is recommended that the laboratory perform post-spike analysis on all samples, blanks, MS/MSDs, and LCSs (method spikes) in order to more effectively assess accuracy and the matrix effects of individual samples.

References

U.S. Environmental Protection Agency(USEPA). 1995. *Test Methods for Evaluating Solid Waste.* SW-846. Office of Solid Waste and Emergency Response.

_____. 1994a. *CLP National Functional Guidelines for Organic Data Review.* EPA-540/R-94/012. Office of Solid Waste and Emergency Response.

_____. 1994b. *CLP National Functional Guidelines for Inorganic Data Review.* EPA-540/R--94/013. Office of Solid Waste and Emergency Response.

_____. 1992. *Guidance for Data Usability in Risk Assessment (Part A),* Final 9285.7A, April.

Table 1
Pasco Landfill Quarterly Ground Water Monitoring Data Validation
Sample Cross Reference Table
February-March 1997

COC	Package ID	Collection Date	Client ID	Lab ID	Analytical Methods	Deviated Criteria
F2730	61156199	2/25/97	PLF-MW36S-0297	3810	VOCs	RRF, %D, LCS
			PLF-MW37S-0297	3811	VOCs	RRF, %D, LCS
			PLF-MW40S-0297	3812	VOCs	RRF, %D, LCS
			PLF-MW32S-0297	3813	VOCs	RRF, %D, LCS
			PLF-MW33S-0297	3814	VOCs	RRF, %D, LCS
			PLF-MW41S-0297	3815	VOCs	RRF, %D, LCS, MB
			PLF-MW42S-0297	3816	VOCs	Full scan VOCs not performed.
F2732	61156198	2/26/97	PLF-#5-0297	3800	VOCs App I-II Metals	RRF, %D, LCS None
			PLF-#8-0297	3801	VOCs App I-II Metals	RRF, %D, LCS None
			PLF-#6 MS MSD	3802 3803 3804	VOCs App I-II Metals	RRF, %D, LCS, MS/MSD, CI None
			PLF-#96-0297	3805	VOCs App I-II Metals	RRF, %D, LCS None
			PLF-MW17SR-0297	3806	VOCs App I-II Metals	RRF, %D, LCS None
			PLF-MW16S-0297	3807	VOCs App I-II Metals	RRF, %D, LCS None
			PLF-#4-0297	3808	VOCs App I-II Metals	RRF, %D, LCS, MB None
			Trip Blank 2/27/97	3809	VOCs	RRF, %D, LCS
F2734	61156653	2/27/97	PLF-MW27S-0297	3910	VOC App I Metals	None None
			PLF-MW28S-0297	3911	VOCs App I-II Metals	None None
			PLF-MW20S-0297	3912	VOC App I Metals	None None
			PLF-MW22S-0297	3913	VOC App I Metals	%D
			PLF-MW19S-0297	3914	VOC App I Metals	%D

Table 1
Pasco Landfill Quarterly Ground Water Monitoring Data Validation
Sample Cross Reference Table
February-March 1997

COC	Package ID	Collection Date	Client ID	Lab ID	Analytical Methods	Deviated Criteria
F2734	61156653	2/27/97	PLF-MW11S-0297	3915	VOC App I Metals	%D
			PLF-MW24S-0297	3916	VOC App I Metals	%D, CI
			Trip Blank 2/28/97	3917	VOCs	SIM analyses not performed
F2736	61156654	2/28/97	PLF-MW29S-0297	3962	VOCs	%D
			PLF-MW38S-0297	3963	VOCs	%D
			PLF-MW23S-0297	3964	VOC App I Metals	%D None
			PLF-EE7-0297	3965	VOCs App I-II Metals	%D None
			PLF-EE8-0297	3966	VOC App I Metals	%D None
			PLF-MW26S-0297 MS MSD	3967 3968 3969	VOCs SVOCs Herbicides	%D, CI MB None
			PLF-MW926S-0297	3970	SVOCs Herbicides	MB, IS None
			PLF-MW25S-0297	3971	VOCs SVOCs Herbicides	%D, MS/MSD IS None
			Trip Blank 3/1/97	3972	VOCs	%D
F2893	6115656	3/1/97	PLF-MW10S-0297	4245	VOC App I Metals	%D None
			PLF-MW12S-0297 MS MSD	4246 4247 4248	VOC App I-II Metals	%D None
			PLF-MW912S-0297	4249	VOC App I-II Metals	%D None
			PLF-MW12ID-0297	4250	VOC App I Metals	%D None
			PLF-MW13S-0297	4251	VOC App I Metals	%D, CI None

Table 1
Pasco Landfill Quarterly Ground Water Monitoring Data Validation
Sample Cross Reference Table
February-March 1997

COC	Package ID	Collection Date	Client ID	Lab ID	Analytical Methods	Deviated Criteria
F2893	6115656	3/1/97	PLF-EE3-0297	4252	VOC App I-II Metals	%D, CI None
			PLF-EE2-0297	4253	VOC App I-II Metals	%D, CI None
			Trip Blank 3/5/97	4254	VOCs	%D

Notes:

Method References:

"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986, and it's updates, (SW-846 / 8260, 8270, 8151, 6010, 7184), USEPA, 1995.

"Standard Methods for the Examination of Water and Wastewater and its updates, (Method 3114C), American Public Health Association.

SIM - Selected Ion Monitoring.
VOCs - Volatile Organic Compounds
SVOCs - Semi-volatile Organic Compounds
App I - Washington Administrative code (WAC) Appendix I Metals List.
App II - WAC Appendix II Metals List.

Excursion References:
MB - Method Blank
RRF - Relative Response Factor
%D - Percent Difference
IS - Internal Standard
LCS - Laboratory Control Sample
CI - Compound Identification
MS/MSD - Matrix Spike/Matrix Spike Duplicate
None - There were no excursions.

To: Dave Provance, Philip Environmental Services Corporation
From: Melissa Listman, O'Brien & Gere Engineers, Inc. MSL
Re: Data Validation for Samples Collected February 26 to March 1, 1997
File: 6127.003
Date: May 28, 1997

cc: Philip Environmental Services Corporation: Mike Caputo

O'Brien & Gere Engineers Inc.: Paul Steinberg

SUMMARY AND DATE USABILITY

Data Quality Project Summary

This report addresses data quality for drinking water samples collected on March 17, 1997. Sample collection activities were conducted by Philip Environmental Services Corporation (Philip).

Samples were analyzed for volatile organics. The analyte list and detection limits were specified by the Washington Administrative Code (WAC) Appendix I and II list, as described in the Quality Assurance Project Plan (QAPP). The chemical analyses were performed and reported by Philip Analytical Services (PAS) located in Burnaby, British Columbia, Canada. The samples were received by the laboratory on March 18, 1997 intact and at the required preservation. Sample chain of custody records were accurate and complete. Table 1 presents a summary of the validated samples, including their identification information, collection dates and methods of analysis performed.

The purpose of the data validation was to provide an opinion of the quality of the data generated from the measurement processes conducted during chemical analysis of the samples. The data validation focused on the data generation process and involved a detailed examination of the data packages. The purpose of the data validation was to assess the usability of the analytical results and to evaluate on the laboratory's compliance with the quality assurance/quality control (QA/QC) criteria outlined in the analytical methods referenced in Table 1. Table 1 also provides a summary of quality control deficiencies that were observed during the data validation.

Data Usability

The analytical data were reviewed and qualified in accordance with U.S. Environmental Protection Agency (USEPA) Data Validation Functional Guidelines (USEPA, 1994a,b). Rejected data are a result of a major excursion from QA/QC criteria and should not be used for either qualitative or quantitative purposes. Minor excursions from QA/QC criteria result in approximation of sample data. Approximation of a data point indicates uncertainty in the reported concentration of the chemical, but not its assigned identity. Approximated data can generally be used for either quantitative or qualitative purposes. This approach to the use of analytical data is consistent with USEPA (USEPA, 1992) risk assessment and data usability guidance. A summary of specific QA/QC excursions that resulted in qualification of sample data are presented in the following sections.

This section summarizes the analytical data in terms of its completeness and usability for characterization of the current water quality for engineering decisions and risk management. Data completeness is defined as the percentage of sample results that have been determined to meet quality control criteria during the data review process. The completeness of the data set was determined to be 100%. However, some volatile organic results were qualified due to minor deficiencies that were associated with surrogate criteria.
Data usability is an evaluation that utilizes the findings of the data validation review, historical information, regulatory guidance and other applicable information to provide an assessment of how the data set may be used.

The assessment was made with reference to using the data to characterize ground water for assessing engineering and risk management options. Data which do not meet completeness requirements are not considered usable, however, data which are complete are not necessarily usable. Issues which affect data usability were not observed.

DATA VALIDATION METHODS AND RESULTS

Data Validation Protocols

The criteria employed for data validation review (USEPA, 1994) provide differing quality control criteria from those specified in the methods. In cases where method requirements and validation requirements overlap, method quality control criteria were used and the validation guidelines were followed for applying data qualifiers, if required. QA/QC criteria outlined in the data validation guidelines were used when the method did not provide criteria. Data may be in full compliance with the method requirements, but may not meet data validation guidance.

Quality Control Parameters
The following QA/QC parameters were evaluated:

- Holding Times and Preservation
- Gas Chromatography/Mass Spectrometry (GC/MS) Tuning
- Initial and Continuing Calibration
- Blank Analyses
- Surrogate Spikes
- MS/MSD Analysis
- LCS Analysis (the laboratory used the reference "PEM" for LCS)
- Internal Standards
- Field Duplicate Analysis
- Target Compound Identification
- Compound Quantitation and Reporting Limits

Data Qualifiers Used in Validation
The following data qualifiers are defined by the USEPA in the Data Validation Functional Guidelines for use in validating analytical data. The appropriate data qualifiers were added to the data packages during data validation and dated and initialed by the validator. Any necessary corrections to the data due to transcription errors or calculation errors were dated and initialed.

The following data validation qualifiers may be used during the validation of data:

R — Indicates that the reporting limit or sample result has been determined to be unusable due to a major excursion from specified QA/QC criteria. The data should not be used for qualitative or quantitative purposes.

U — Indicates that the analyte was analyzed for, but was not detected. The sample-specific reporting limit is presented and adjusted for dilution and percent solids, as appropriate. The qualifier is also used to signify that the reporting limit of an analyte was raised due to blank contamination.

J The analyte was positively identified but the concentration should be considered approximate. This qualifier indicates that the data validation process identified a minor deficiency from specified QA/QC criteria.

UJ Indicates that the sample-specific reporting limit for the analyte in this sample should be considered approximate. This qualifier is used when the data validation process identified a minor deficiency from specified QA/QC criteria.

N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

NJ The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

Data Evaluation Results

This section describes the qualifiers that were added to sample data where QA/QC criteria were not met. QA/QC parameters that met criteria are not discussed. Samples that required qualification are identified in the following sections by the sample location documented on the field chain-of-custody record.

General Comments

Volatile organic analyses were performed in full scan and in the selected ion monitoring (SIM) mode. In order to meet the WAC limits the following compounds were analyzed in the SIM mode: vinyl chloride, 1,1-dichloroethene, carbon tetrachloride, and 1,1,2,2-tetrachloroethane.

The laboratory documented that LCSs (or PEMs) were not prepared from a source independent of the initial calibration curve. MS/MSD analyses were not required due to the limited number of samples collected. However, matrix spike analysis was performed for sample DW91.

In some instances tuning reports for bromofluorobenzene (BFB) were provided periodically during the 12 hour sequence, rather than at the beginning of every 12 hour sequence. Data quality was not impacted since the laboratory did monitor BFB throughout the 12 hour sequence.

The internal standard criteria for the full scan analyses were often established using the latter continuing calibration standard rather than the initial calibration standard analyzed at the beginning of the 12 hour sequence. This was due to the reprocessing of the data after the initial generation. Data quality was not impacted since internal standards were well within the acceptance limits no matter which calibration standard was used to establish criteria.

Blank Analysis

One tentatively identified compound (TIC) was detected in the method blank. This TIC was flagged "U" on sampling reporting forms for samples DW01 and DW91.

Initial Calibration

Initial calibration for SIM analyses was performed using three standards, rather than the required five. Data quality was not impacted since target compounds were not detected.

Surrogate Recovery

Surrogate recoveries for SIM analyses were below control limits for 4-bromofluorobenzene in method blank and in samples DW01 and DW91. Non-detected results were qualified as approximate for vinyl chloride, 1,1-dichloroethene, carbon tetrachloride and 1,1,2,2-tetrachloroethane since these compounds were analyzed in the SIM mode.

LCS Analysis

The percent recovery for vinyl acetate (196%) was above control limits for LCS analyzed on 3/18/97 at 21:40. Percent recovery for this compound was within control limits for the LCS analyzed on 3/19/97 at 04:04. Qualification of data was not required since the recovery was biased high and vinyl acetate was not detected in the samples.

References

U.S. Environmental Protection Agency(USEPA). 1995. *Test Methods for Evaluating Solid Waste.* SW-846. Office of Solid Waste and Emergency Response.

_____. 1994a. *CLP National Functional Guidelines for Organic Data Review.* EPA-540/R-94/012. Office of Solid Waste and Emergency Response.

_____. 1994b. *CLP National Functional Guidelines for Inorganic Data Review.* EPA-540/R--94/013. Office of Solid Waste and Emergency Response.

_____. 1992. *Guidance for Data Usability in Risk Assessment (Part A),* Final 9285.7A, April.

Table 1

PASCO LANDFILL DRINKING WATER SAMPLES DATA VALIDATION
SAMPLE CROSS REFERENCE
MARCH 1997

COC	Package ID	Collection Date	Client ID	Lab ID	Analytical Methods	Deviated Critéria
F2896	61156013	3/17/97	PLF-DW01-0397	5315	VOCs App I-II metals	SS
			PLF-DW91-0397	5316	VOCs App I and II metals	SS

Notes:

Method References:

"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986, and it's updates, (SW-846 / 8260, 8270, 8151, 6010, 7184), USEPA, 1995.

"Standard Methods for the Examination of Water and Wastewater and its updates, (Method 3114C), American Public Health Association.

VOCs - Volatile Organic Compounds
App I - Washington Administrative code (WAC) Appendix I Metals List.
App II - WAC Appendix II Metals List.

Excursion References:
SS - Surrogate
None - There were no excursions.

O'BRIEN & GERE ENGINEERS, INC. **MEMORANDUM**

To: Dave Provance
From: Melissa Listman Melissa Listman *cc:*
Re: Antimony data for work order 30111
File: 6127/21198
Date: June 15, 1998

Antimony results were reviewed for samples identified as GW-024 and GW-027 in laboratory deliverable 30111 Quality assurance/quality control (QA/QC) criteria were met based on a review of the Contract Laboratory Program (CLP) reporting forms. However, based on review of the raw data, antimony was detected in several laboratory method blanks at concentrations (approximately 30 to 50 ug/L) just below laboratory reporting limit of 60 ug/L. In accordance with USEPA validation guidelines, detected results reported in samples at concentration less than five times the highest blank value, are flagged as non-detected (U). Therefore, detected antimony results in samples GW-024 and GW-027 should be considered as blank contaminants and be flagged with the "U" qualifier. Additionally, detected antimony results were considered suspect based on the following observations:

- antimony was detected in ICP interference check solution AB at 50 ug/L (this solution does not contain antimony), indicating that the possibility of false positives exists if calcium, aluminum, magnesium, or iron are at high concentrations.

- raw data printouts for antimony, showed that this analyte line was very noisy with standard deviation of as high as 60 ug/L (reporting limit) for the 1 mg/L check standards.

Data Validation Memorandum

Date: September 2, 1998

To: Dave Provance, Philip Services Corp.

From: Melissa Listman, Obrien & Gere, Engineers, Inc.

Subject: Data Review for Lead Analysis, Sample PLF-EE2-1296
Pasco Landfill, Project Number 624419

The lead result for sample PLF-EE2-1296 collected on December 6, 1996 and reported by Zenon Laboratories on January 21, 1997 was reviewed for data quality. The lead result for this sample was 160 µg/L. This concentration appears to be a high outlier based on previous and subsequent data collected for this location. Based on a review of the data, the lead result in this sample was qualified as approximate during a previous validation based on percent recoveries for continuing calibration standards which were baised high.

Upon review of the analytical package, it was observed that two analytical sequences were performed for ICP metal analyses, both of which included lead. The lead result of 160 ug/L was reported from the analytical run in which samples were pre-concentrated by a factor of 10 during the digestion procedure prior to analysis). The other analytical sequence consisted of samples digested in the normal manner ("Regular ICP Run"). The lead result for sample PLF-EE2-1296 for the "Regular ICP Run" was 8.7 µg/L which is below the laboratory reporting limit for this analysis at 30 µg/L. The method required quality control requirements were reviewed for lead for the "Regular ICP Run" and met requirements. This suggests that lead for the "Preconcentrated ICP Run" may have been contaminated during the digestion procedure. The previous and subsequent data collected for this location support this hypothesis. Therefore, based on this review of the analytical package it is recommended that the lead results for sample PLF-EE2-1296 from the "Regular ICP Run" be used in place of those from the "Preconcentrated ICP Run".

B

APPENDIX B

STATISTICAL ANALYSES

Appendix B

Statistical Analyses for Groundwater and Soil

Pasco Landfill
Pasco, Washington

Inorganics detected in groundwater and soil samples from the Pasco Landfill (Pasco, Washington) were studied following the "Statistical Guidance for Ecology Site Managers" (Ecology, 1992), and Supplement S-6 (Ecology, 1993). The statistical program MTCA*Stat* was used to evaluate whether site concentrations exceeded background values. Sampling events through March 1997 were considered in these analyses.

1. Groundwater

Statistical procedures were used to compare data from shallow wells at the Pasco Landfill site to background wells, using methods recommended in the *Statistical Guidance for Ecology Site Managers*. The intermediate and deep wells did not contain sufficient data to compare the site to background using these statistical methods.

The use of standard statistical methods to analyze data containing non-detected values may lead to erroneous conclusions. Therefore, the percentage of non-detected samples in the shallow wells was determined for each chemical (Tables B-1 and B-2).

1.1 Background Data

Statistical analyses were conducted to evaluate whether the four background wells (NW-5, MW-21I, MW-25S and MW-28S) at the Pasco site were homogenous for the purpose of characterizing background analyte concentrations (Attachment 1). The results support the homogeneity hypothesis.

The total number of samples for the groundwater background data ranged from 16 to 21, and the percent of non-detected samples are shown in Table B-1. The data from the background shallow wells contain multiple detection limits. Therefore, the following criteria were used to calculate the 90th percentile:

- If < 50% are non-detected samples, the Background Module of MTCA*Stat* was used;
- If < 50% are non-detected samples, and the log-normal and normal distributions in the Background module of MTCA*Stat* are rejected, the non-parametric method was used;
- If > 50% are non-detected samples, the non-parametric method was used.

The non-parametric method followed Example 5 from the *Statistical Guidance for Ecology Site Managers* document.

MTCA*Stat* reports and non-parametric calculations are included as Attachment 2.

1.2 *Site Data*

Statistical analysis was conducted for each inorganic chemical detected in shallow wells. The number of data points used in each analysis was chemical-dependant, ranging from 28 to 284. The percentage of non-detected samples is shown in Table B-2. The data for the site shallow wells contain multiple detection limits. Therefore, the following criteria were used to calculate the site concentration from data sets:

- If < 15% are non-detected samples, the Site Module of MTCA*Stat* was used to calculate the 95% UCL;
- If < 15% are non-detected samples, and the log-normal and normal distributions in the Site module of MTCA*Stat* were rejected, the maximum value was used;
- If 15%-50% are non-detected samples, the Site Module of MTCA*Stat* was used to calculate the 95% UCL;
- If 15%-50% are non-detected samples and the log-normal and normal distributions in the Site module of MTCA*Stat* were rejected, the maximum value was used;
- If > 50% are non-detected samples, the maximum value was used.

MTCA*Stat* reports are included as Attachment 2.

The 95% UCLs (or maximum value) of site data sets were compared to 90th percentile background (Table B-3).

2. Soil

Site soil samples were divided in 8 areas: Zone A/BT-2/Balefill, B, C/D/BT-1, and E/TS-1/SL-1, SL-2 & SL-3, Sludge Management Area (SMA), Areas Not Immediately Adjacent, and Landspread Area (LSA). Background soil samples were divided into 2 areas: Background 1 (surface soil) and 2 (subsurface soil). MTCA*Stat* was used to compare the site soil in each area to the corresponding background data.

The use of standard statistical methods to analyze data containing non-detected values may lead to erroneous conclusions. Therefore, the percentage of non-detected samples in soil was determined for each metal (Tables B-4 and B-5).

2.1 *Background Data*

Statistical analysis was conducted for each inorganic chemical in soil background samples. The number of data points used in each analysis was chemical-dependant, ranging from 20 to 21. The percentage of non-detected samples is shown in Table B-4. The data from Background 1 and 2 contain multiple detection limits. Therefore the following criteria were used to calculate the 90th percentile:

- If < 50% are non-detected samples, the Background Module of MTCA*Stat* was used;
- If < 50% are non-detected samples, and the log-normal and normal distributions in the Background module of MTCA*Stat* were rejected, the non-parametric method was used;
- If > 50% are non-detected samples, the non-parametric method was used.

The non-parametric method followed Example 5 from the *Statistical Guidance for Ecology Site Managers* document.

MTCA*Stat* reports and non-parametric calculations are included as Attachment 3.

2.2 Site Data

Statistical analysis was conducted for each inorganic chemical detected in soil samples. The number of data points used in each analysis was chemical-dependant, ranging from 1 to 20. The percentage of non-detected samples is shown in Table B-5. The data for all the soil areas contain multiple detection limits. Therefore, the following criteria were used to calculate the site concentration from data sets:

- If < 50% are non-detected samples, the Site Module of MTCA*Stat* was used to calculate the 95% UCL;
- If < 50% are non-detected samples, and the log-normal and normal distributions in the Site module of MTC*Stat* were rejected, the maximum value was used;
- If > 50% are non-detected samples, the maximum value was used;
- If 100% are non-detected samples, the analyte was not selected further.

MTCA*Stat* reports are included in Attachment 3.

The 95% UCL (or maximum value) of site data sets was compared to the selected background (Table B-6).

Table B-1

BACKGROUND SHALLOW GROUNDWATER WELLS

Pasco Landfill
Pasco, Washington

Chemical	Total Number of Samples	Percent Non-detects	Background Concentration		
			Value	Method	Rationale
Antimony	16	69	11.4	NP	Z
Arsenic	16	0	7.2	P	X
Barium	13	0	68.1	P	X
Beryllium	16	88	0.9	NP	Z
Cadmium	16	100	2.2	NP	Z
Calcium	20	10	61,898	P	X
Chromium (total)	16	63	7.8	NP	Z
Cobalt	16	100	9	NP	Z
Copper	16	75	73.4	NP	Z
Iron	21	67	104	NP	Z
Lead	19	68	4	NP	Z
Magnesium	20	0	24,464	P	X
Manganese	21	81	7.0	NP	Z
Nickel	16	81	17.3	NP	Z
Potasium	20	0	7,967	P	X
Selenium	16	81	15	NP	Z
Silver	16	100	15	NP	Z
Sodium	20	0	34,713	P	X
Thallium	16	100	2.6	NP	Z
Vanadium	16	38	21.3	NP	Y
Zinc	17	65	32.8	NP	Z

Concentrations in ug/L.

Methods to calculate 90th percentile:

P - Parametric method.
NP - Non-parametric method.

Rationale for Selecting Concentration:

X - <50% non-detected: use parametric method to calculate 90th percentile.
Y - <50% non-detected log-normal and normal distributions rejected: use non-parametric method to calculate 90th percentile.
Z - >50% non-detected: use non-parametric method to calculate 90th percentile.

Background wells: MW-25S, MW-28S, NW-5, MW-21I.

Table B-2

STATISTICAL DATA - SHALLOW SITE GROUNDWATER WELLS

Pasco Landfill
Pasco, Washington

Chemical	Total Number of Samples	Percent Non-detects	Site Concentration		
			Value	Comment	Rationale
Antimony	260	67	15	MV	E
Arsenic	261	22	4.6	UCL	C
Barium	195	0	83	UCL	A
Beryllium	261	90	1.1	MV	E
Cadmium	261	96	13	MV	E
Calcium	198	3	136,000	MV	B
Chromium (total)	261	48	653	MV	B
Cobalt	233	98	4	MV	E
Copper	261	53	190	MV	E
Iron	221	59	15,800	MV	E
Lead	261	72	22.3	MV	E
Magnesium	198	3	40,400	MV	B
Manganese	221	75	2,680	MV	E
Mercury	28	100	NA	NA	
Nickel	261	76	63	MV	E
Potassium	198	3	11,000	MV	B
Selenium	261	84	4	MV	E
Silver	261	98	6	MV	E
Sodium	198	3	45,900	MV	B
Thallium	261	97	12	MV	E
Vanadium	233	38	16.5	UCL	C
Zinc	284	53	286	MV	E

Concentrations in ug/L

Comments:
MV - Maximum value.
UCL - 95% UCL.
NA - Not applicable.

Rationale for Selecting Concentration:
A - <15% non-detected on-site (ND as 1/2 MDL): use 95% UCL.
B - <15% non-detected on-site (ND as 1/2 MDL); log-normal and normal distributions rejected: use maximum value.
C - 15%-50% non-detected on-site with multiple detection limits (ND as 1/2 MDL): use 95% UCL.
D - 15%-50% non-detected on-site with multiple detection limits; log-normal and normal distributions rejected: use maximum values.
E - >50% non-detected on-site: use maximum value.

Shallow wells: #1 to #9; EE-2 to EE-8; MW-10S to MW-16S; MW-17R; MW-18S to MW-20S; MW-22S to MW-24S; MW26S; MW-27S; MW-29S to MW-39S.
Samples up to and including 3/97 sampling event.

Table B-3

ANALYSIS OF SHALLOW GROUNDWATER STATISTICAL DATA

Pasco Landfill
Pasco, Washington

Chemical	Background Value	Site Concentration			Exceeds Background?
		Value	Comment	Rationale	
Antimony	11.4	15	MV	E	Y
Arsenic	7.2	4.6	UCL	C	N
Barium	68.1	83	UCL	A	Y
Beryllium	0.9	1.1	MV	E	Y
Cadmium	2.2	13	MV	E	Y
Calcium	61,898	136,000	MV	B	Y
Chromium (total)	7.8	653	MV	B	Y
Cobalt	9	4	MV	E	N
Copper	73.43	190	MV	E	Y
Iron	104	15,800	MV	E	Y
Lead	4	22.3	MV	E	Y
Magnesium	24,464	40,400	MV	B	Y
Manganese	7.0	2,680	MV	E	Y
Nickel	17.3	63	MV	E	Y
Potassium	7,967	11,000	MV	B	Y
Selenium	15	4	MV	E	N
Silver	15	6	MV	E	N
Sodium	34,713	45,900	MV	B	Y
Thallium	2.6	12	MV	E	Y
Vanadium	21.3	16.5	UCL	C	N
Zinc	32.8	286	MV	E	Y

Concentrations in ug/L.

Background: from Table B-1.
Site: from Table B-2.

Comments:
MV - Maximum value.
UCL - 95% UCL.

Rationale for Selecting Site Concentrations:
A - <15% non-detected on-site (ND as 1/2 MDL): use 95% UCL.
B - <15% non-detected on-site (ND as 1/2 MDL); log-normal and normal distributions rejected: use maximum value.
C - 15%-50% non-detected on-site with multiple detection limits (ND as 1/2 MDL): use 95% UCL.
D - 15%-50% non-detected on-site with multiple detection limits; log-normal and normal distributions rejected: use maximum value.
E - >50% non-detected on-site: use maximum value.

Exceeds Background = Site concentration (95% UCL or maximum value) vs 90th percentile background.

Arsenic -As the 90th percentile is less than 4 X 50th percentile, natural background was used (Ex. 12, Statistical Guidance for Ecology Site Managers, Ecology 8/92).

Table B-4

AREA BACKGROUND SOIL

Pasco Landfill
Pasco, Washington

Chemical	Total Number of Samples	Percent Non-detects	Area Background		
			Value	Method	Rationale
Background 1: Surface Soil					
Antimony	21	52	3.28	NP	Z
Arsenic	21	0	7.88	P	X
Beryllium	21	100	0.06	NP	Z
Cadmium	21	0	2	NP	Y
Chromium (total)	21	0	6.78	P	X
Copper	21	0	12.27	P	X
Lead	21	0	8.5	P	X
Mercury	21	95	0.098	NP	Z
Nickel	21	0	9.58	P	X
Selenium	21	100	1.25	NP	Z
Silver	21	0	1.5	P	X
Thallium	21	100	1.85	NP	Z
Zinc	21	0	38.06	P	X
Backgound 2: Subsurface Soil					
Antimony	22	100	3	NP	Z
Arsenic	22	73	14.24	NP	Z
Barium	NA	NA	1,500	NA	
Beryllium	22	100	0.01	NP	Z
Cadmium	22	0	3.81	P	X
Chromium (total)	21	0	10.94	P	X
Copper	22	0	19.52	P	X
Lead	22	0	13.33	P	X
Mercury	22	100	0.028	NP	Z
Nickel	22	0	14.32	P	X
Selenium	22	100	7.48	NP	Z
Silver	22	0	1.78	P	X
Thallium	22	100	7.52	NP	Z
Zinc	22	0	51.29	P	X

Concentrations in mg/kg.

P - Parametric method used to calculate 90th percentile.

NP - Non-parametric method used to calculate 90th percentile.

Value for Barium - "Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States" (US Geological Survey Professional Paper 1270, 1984)

Rationale for Selecting Concentration:

X - <50% non-detected: use parametric method to calculate 90th percentile.

Y - <50% non-detected; log-normal and normal distributions rejected: use non-parametric method to calculate 90th percentile.

Z - >50% non-detected: use non-parametric method to calculate 90th percentile.

NA - Not available.

Table B-5

SITE SOIL STATISTICAL DATA

Pasco Landfill
Pasco, Washington

Chemical	Total Number of Samples	Percent Non-detects	Site Concentration		
			Value	Comment	Rationale
Zone A					
Antimony	3	67	1.6	MV	C
Arsenic	3	67	2.9	MV	C
Barium	1	0	53.4	MV	B
Beryllium	3	100			D
Cadmium	3	0	2.67	UCL	A
Chromium (total)	3	0	16.24	UCL	A
Copper	3	0	12.7	UCL	A
Lead	3	0	6.49	UCL	A
Mercury	3	100			D
Nickel	3	0	10.37	UCL	A
Selenium	3	100			D
Silver	3	0	5.3	UCL	A
Thallium	3	100			D
Zinc	3	0	39.89	UCL	A
Zone B					
Antimony	8	100			D
Arsenic	8	87.5	10.1	MV	C
Beryllium	8	100			D
Cadmium	8	0	2.98	UCL	A
Chromium (total)	8	0	10.23	UCL	A
Copper	8	0	15.65	UCL	A
Lead	8	12.5	11.17	UCL	A
Mercury	8	100			D
Nickel	8	0	13.46	UCL	A
Selenium	8	100			D
Silver	8	0	1.44	UCL	A
Thallium	8	100			D
Zinc	8	0	44.86	UCL	A

Table B-5

SITE SOIL STATISTICAL DATA

Pasco Landfill
Pasco, Washington

Chemical	Total Number of Samples	Percent Non-detects	Site Concentration		
			Value	Comment	Rationale
Zone C					
Antimony	9	89	6	MV	C
Arsenic	9	44	5.27	UCL	A
Beryllium	9	67	0.08	MV	C
Cadmium	9	0	2.5	MV	B
Chromium (total)	9	0	10.14	UCL	A
Copper	9	0	15.86	UCL	A
Lead	9	11	12.02	UCL	A
Mercury	9	11	0.12	MV	B
Nickel	9	0	14.98	UCL	A
Selenium	9	100			D
Silver	9	0	2.14	UCL	A
Thallium	9	100			D
Zinc	9	0	49.03	UCL	A
Zone E					
Antimony	12	100			D
Arsenic	12	17	10.76	UCL	A
Beryllium	12	67	0.46	MV	C
Cadmium	12	0	2.66	UCL	A
Chromium (total)	20	0	8.46	UCL	A
Copper	12	0	21.88	UCL	A
Lead	12	0	14.48	UCL	A
Mercury	12	25	4,690	UCL	A
Nickel	12	0	13.44	UCL	A
Selenium	12	100			D
Silver	12	0	1.91	UCL	A
Thallium	12	100			D
Zinc	12	0	52.91	UCL	A

Table B-5

SITE SOIL STATISTICAL DATA

Pasco Landfill
Pasco, Washington

Chemical	Total Number of Samples	Percent Non-detects	Site Concentration		
			Value	Comment	Rationale
SL2 & SL3					
Antimony	12	100			D
Arsenic	12	25	9.33	UCL	A
Beryllium	12	83	0.21	MV	C
Cadmium	12	0	2.5	UCL	A
Chromium (total)	12	0	9.7	MV	B
Copper	12	0	15.24	UCL	A
Lead	12	0	11.55	UCL	A
Mercury	12	83	0.96	MV	C
Nickel	12	0	12.88	UCL	A
Selenium	12	100			D
Silver	12	0	1.9	UCL	A
Thallium	12	100			D
Zinc	12	0	44.85	UCL	A
Outside					
Antimony	8	100			D
Arsenic	8	50	12.12	UCL	A
Barium	8	0	50.90	MV	B
Beryllium	8	63	0.13	MV	C
Cadmium	8	38	3.80	MV	B
Chromium (total)	8	0	9.80	MV	B
Copper	8	0	14.93	UCL	A
Lead	8	25	11.10	MV	B
Mercury	8	100			D
Nickel	8	0	9	UCL	A
Selenium	8	88	13.00	MV	C
Silver	8	38	46.85	UCL	A
Thallium	8	100			D
Zinc	8	0	49.12	UCL	A

Table B-5

SITE SOIL STATISTICAL DATA

Pasco Landfill
Pasco, Washington

Chemical	Total Number of Samples	Percent Non-detects	Site Concentration		
			Value	Comment	Rationale
Sludge Mgmt Area					
Antimony	20	60	3	MV	C
Arsenic	20	0	9.84	UCL	A
Beryllium	20	100			D
Cadmium	20	0	2.26	UCL	A
Chromium (total)	20	0	21.9	MV	B
Copper	20	0	13.83	UCL	A
Lead	20	0	8.19	UCL	A
Mercury	20	95	0.31	MV	C
Nickel	20	0	10.37	UCL	A
Selenium	20	100			D
Silver	20	0	1.4	UCL	A
Thallium	20	95	3.8	MV	C
Zinc	20	0	79.2	MV	B
Landspread Area					
Antimony	20	60	2.3	MV	C
Arsenic	20	0	6.98	UCL	A
Beryllium	20	100			D
Cadmium	20	0	2	MV	B
Chromium (total)	20	0	5.39	UCL	A
Copper	20	0	30.9	MV	B
Lead	20	0	8.01	UCL	A
Mercury	20	95	0.48	MV	C
Nickel	20	0	8.19	UCL	A
Selenium	20	100			D
Silver	20	0	0.97	UCL	A
Thallium	20	100			D
Zinc	20	0	38.61	UCL	A

Concentrations in mg/kg.

Barium - one sample taken, value presented.

Comments:
MV = Maximum value.
UCL = 95% UCL.

Rationale for the statistical method used:
A - <50% non-detected on-site: use 95% upper confidence limit.
B - <50% non-detected on-site; log-normal and normal distributions rejected: use maximum value.
C - >50% non-detected on-site: use maximum value.
D - 100% non-detected, analyte not selected.

Table B-6

SUMMARY OF SOIL STATISTICAL DATA

Pasco Landfill
Pasco, Washington

Chemical	Background 2	Site Concentration Value	Site Concentration Comment	Site Concentration Rationale	S vs BG Exceeds ?
Zone A					
Antimony	3	1.6	MV	C	N
Arsenic	14.24	2.9	MV	C	N
Barium	255 **	53.4	MV	B	N
Cadmium	3.81	2.67	UCL	A	N
Chromium (total)	10.94	16.24	UCL	A	Y
Copper	19.52	12.7	UCL	A	N
Lead	13.33	6.49	UCL	A	N
Nickel	14.32	10.37	UCL	A	N
Silver	1.78	5.3	UCL	A	Y
Zinc	51.29	39.89	UCL	A	N
Zone B					
Arsenic	14.24	10.1	MV	C	N
Cadmium	3.81	2.98	UCL	A	N
Chromium (total)	10.94	10.23	UCL	A	N
Copper	19.52	15.65	UCL	A	N
Lead	13.33	11.17	UCL	A	N
Nickel	14.32	13.46	UCL	A	N
Silver	1.78	1.44	UCL	A	N
Zinc	51.29	44.86	UCL	A	N
Zone C					
Antimony	3	6	MV	C	Y
Arsenic	14.24	5.27	UCL	A	N **
Beryllium	0.01	0.08	MV	C	Y
Cadmium	3.81	2.5	MV	B	N **
Chromium (total)	10.94	10.14	UCL	A	N
Copper	19.52	15.86	UCL	A	N
Lead	13.33	12.02	UCL	A	N
Mercury	0.028	0.12	MV	B	Y
Nickel	14.32	14.98	UCL	A	Y
Silver	1.78	2.14	UCL	A	Y
Zinc	51.29	49.03	UCL	A	N

Table B-6

SUMMARY OF SOIL STATISTICAL DATA

Pasco Landfill
Pasco, Washington

Chemical	Background 2	Site Concentration Value	Site Concentration Comment	Site Concentration Rationale	S vs BG Exceeds ?	
Zone E						
Arsenic	14.24	10.76	UCL	A	N	**
Beryllium	0.01	0.46	MV	C	Y	
Cadmium	3.81	2.66	UCL	A	N	
Chromium (total)	10.94	8.46	UCL	A	N	
Copper	19.52	21.88	UCL	A	Y	
Lead	13.33	14.48	UCL	A	Y	
Mercury	0.028	4,690	UCL	A	Y	**
Nickel	14.32	13.44	UCL	A	N	
Silver	1.78	1.91	UCL	A	Y	
Zinc	51.29	52.91	UCL	A	Y	
SL2 & SL3						
Arsenic	14.24	9.33	UCL	A	N	**
Beryllium	0.01	0.21	MV	C	Y	
Cadmium	3.81	2.5	UCL	A	N	
Chromium (total)	10.94	9.7	MV	B	N	**
Copper	19.52	15.24	UCL	A	N	
Lead	13.33	11.55	UCL	A	N	
Mercury	0.028	0.96	MV	C	Y	
Nickel	14.32	12.88	UCL	A	N	
Silver	1.78	1.9	UCL	A	Y	
Zinc	51.29	44.85	UCL	A	N	
Outside						
Arsenic	14.24	12.12	UCL	A	N	**
Barium	255 **	50.90	MV	B	N	
Beryllium	0.01	0.13	MV	C	Y	
Cadmium	3.81	3.80	MV	B	N	**
Chromium (total)	10.94	9.80	MV	B	N	**
Copper	19.52	14.93	UCL	A	N	
Lead	13.33	11.10	MV	B	N	**
Nickel	14.32	9	UCL	A	N	
Selenium	7.48	13.00	MV	C	Y	
Silver	1.78	46.85	UCL	A	Y	
Zinc	51.29	49.12	UCL	A	N	

Table B-6

SUMMARY OF SOIL STATISTICAL DATA

Pasco Landfill
Pasco, Washington

Chemical	Background 1	Site Concentration Value	Site Concentration Comment	Site Concentration Rationale	S vs BG Exceeds ?	
Sludge Mgmt Area						
Antimony	3.28	3	MV	C	N	
Arsenic	7.88	9.84	UCL	A	Y	
Cadmium	2.01	2.26	UCL	A	Y	**
Chromium (total)	6.78	21.9	MV	B	Y	**
Copper	12.27	13.83	UCL	A	N	
Lead	8.5	8.19	UCL	A	N	
Mercury	0.098	0.31	MV	C	Y	
Nickel	9.58	10.37	UCL	A	Y	
Silver	1.5	1.4	UCL	A	N	
Thallium	1.85	3.8	MV	C	Y	
Zinc	38.06	79.2	MV	B	Y	**
Landspread Area						
Antimony	3.28	2.3	MV	C	N	
Arsenic	7.88	6.98	UCL	A	N	
Cadmium	2.01	2	MV	B	N	
Chromium (total)	6.78	5.39	UCL	A	N	
Copper	12.27	30.9	MV	B	Y	**
Lead	8.5	8.01	UCL	A	N	
Mercury	0.098	0.48	MV	C	Y	
Nickel	9.58	8.19	UCL	A	N	
Silver	1.5	0.97	UCL	A	N	
Zinc	38.06	38.61	UCL	A	Y	

Concentrations in mg/kg.

Background:
1 = Surface soil (from Table B-4).
2 = Subsurface soil (from Table B-4), except Barium from "Natural Background Soil Metals Concentrations in Washington State", Toxic Cleanup Program, Dept. of Ecology (10/94).

Site Concentration: from Table B-5.

Comments:
MV = Maximum value.
UCL = 95% UCL.

Rationale for Selecting Concentration:
A = <50% non-detected on-site: use 95% upper confidence limit.
B = <50% non-detected on-site; log-normal and normal distributions rejected: use maximum value.
C = >50% non-detected on-site: use maximum value.

S vs BG = Comparison of site concentration (95% UCL or maximum) vs 90th percentile background.
** - Comparing parametric with non-parametric results in S vs BG.

ATTACHMENT 1

ASSESSMENT OF HOMOGENEITY OF CONTROL WELLS

Assessment of Homogeneity of Control Wells at Pasco

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20 March 1998

Introduction:

The purpose of this inquiry was to provide information useful in assessing whether four wells at the Pasco site, NW-5, MW-21I, MW-25S, and MW-28S, were essentially homogeneous for the purpose of characterizing control analyte ground water concentrations. It was desirable to address this question using information from these four wells alone rather than in comparison to other wells on the site.

Toward this end, this report presents two types of statistical analysis. First, time plots were created showing the ground water concentrations of each analyte vs date for each well. For a given analyte, a lack of homogeneity might be manifested as a departure from parallelism among the lines for the 4 wells. Second, it is possible to characterize levels of variation both within wells through time and between for each analyte. If there were heterogeneity among wells, one would expect that the variability among wells would be greater than that within wells. Therefore, the levels of within-well and between-well variation were tabulated for comparison.

Methods:

The data were imported from the Excel spreadsheet provided on diskette into the SAS statistical software environment. Concentrations below the detection limit of an assay were estimated as one-half the lower detection limit. Plots of each analyte's ground water concentration vs date were then plotted using SAS/GRAPH software. The levels of within-well and between-well variability were obtained by fitting a 2-way analysis of variance model with ground water concentration as the response and well and date as the predictor variables. For this purpose, concentrations from sampling dates close together were pooled: 31 March 1995 and 3 June 1995 were pooled, 22, 23, 24, and 26 September 1995 were pooled, 5, 6, and 8 December 1995 were pooled, and 21 and 23 March 1996 were pooled.

Results:

The concentrations through time for each analyte are shown in the plots accompanying this report. Several analytes showed strikingly parallel time courses for different wells (arsenic, barium, beryllium, cadmium, calcium, magnesium, potassium, selenium, silver, and sodium). Other time curves, while not parallel for each well, were concordant in terms of direction. That is, wells tended to increase and decrease at the same time, though by different amounts (antimony, copper, lead, thallium, and zinc). The time plots for the remaining 6 analytes (cobalt, chromium, iron, manganese, nickel, and vanadium) were somewhat divergent among wells. It does not appear that any one well accounts for the observed heterogeneity among wells for these analytes.

Table 1 shows the within-well and between-well variation (model mean squares) for each analyte. For only 3 analytes (barium, magnesium, and potassium) is the between-

well variability greater than the within-well variability. The remainder show the opposite trend.

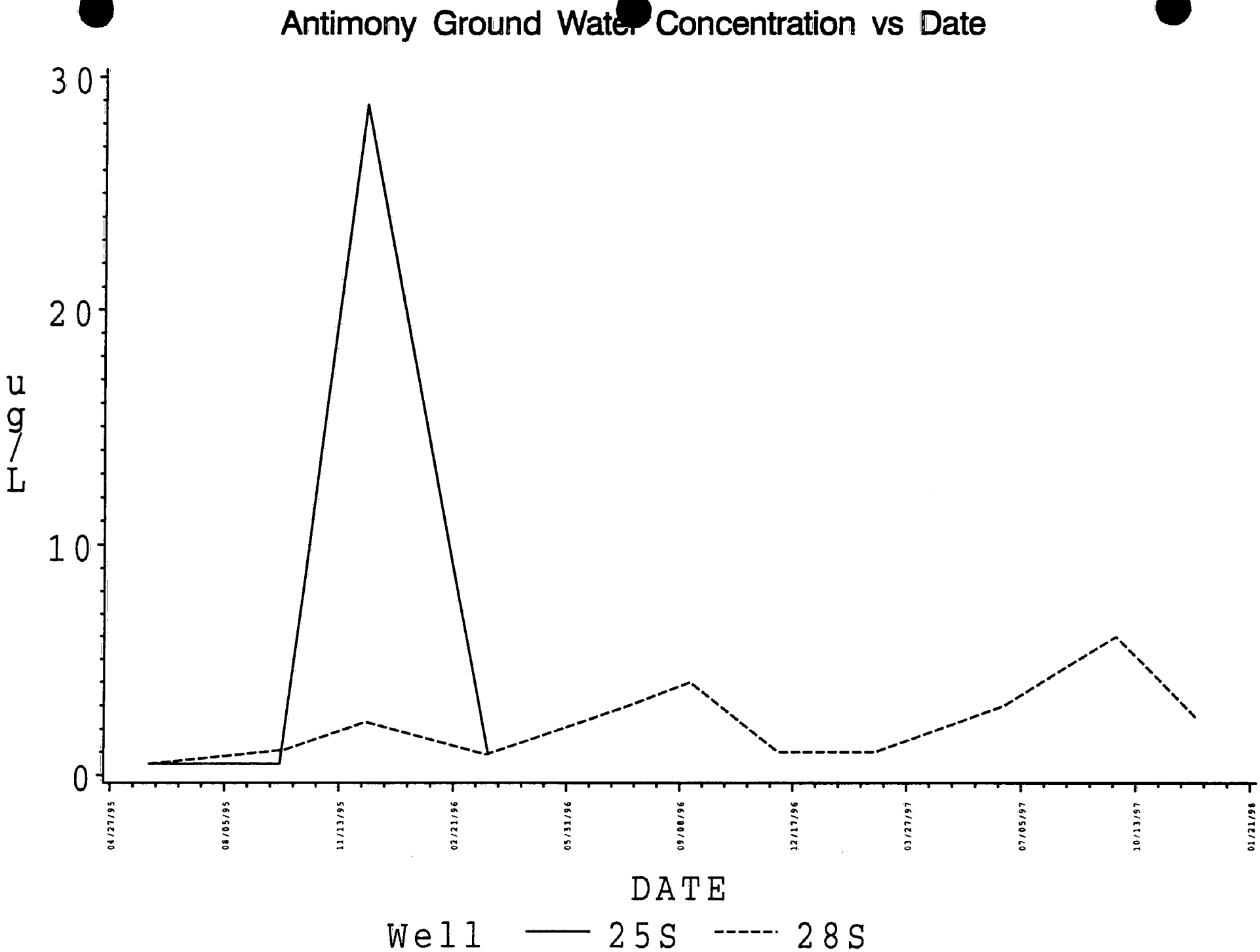
Discussion:

For the majority of analytes, the wells tested shows no clear evidence of heterogeneity. That is, the time plots for the different wells are either parallel or concordant and the between-well mean square is less than the within-well mean square. While this result does not in itself prove that the wells are homogeneous with respect to these analytes, there is at least no striking evidence to the contrary. These observations should lend support to the homogeneity hypothesis based on water flow at the site and locations of wells relative to known contaminants. Some analytes showed less consistency among the wells. It is possible that 1) the wells truly are heterogeneous with respect to these analytes, or 2) the wells are homogeneous but the samples are naturally highly variable so that parallelism is not observed in the time plots.

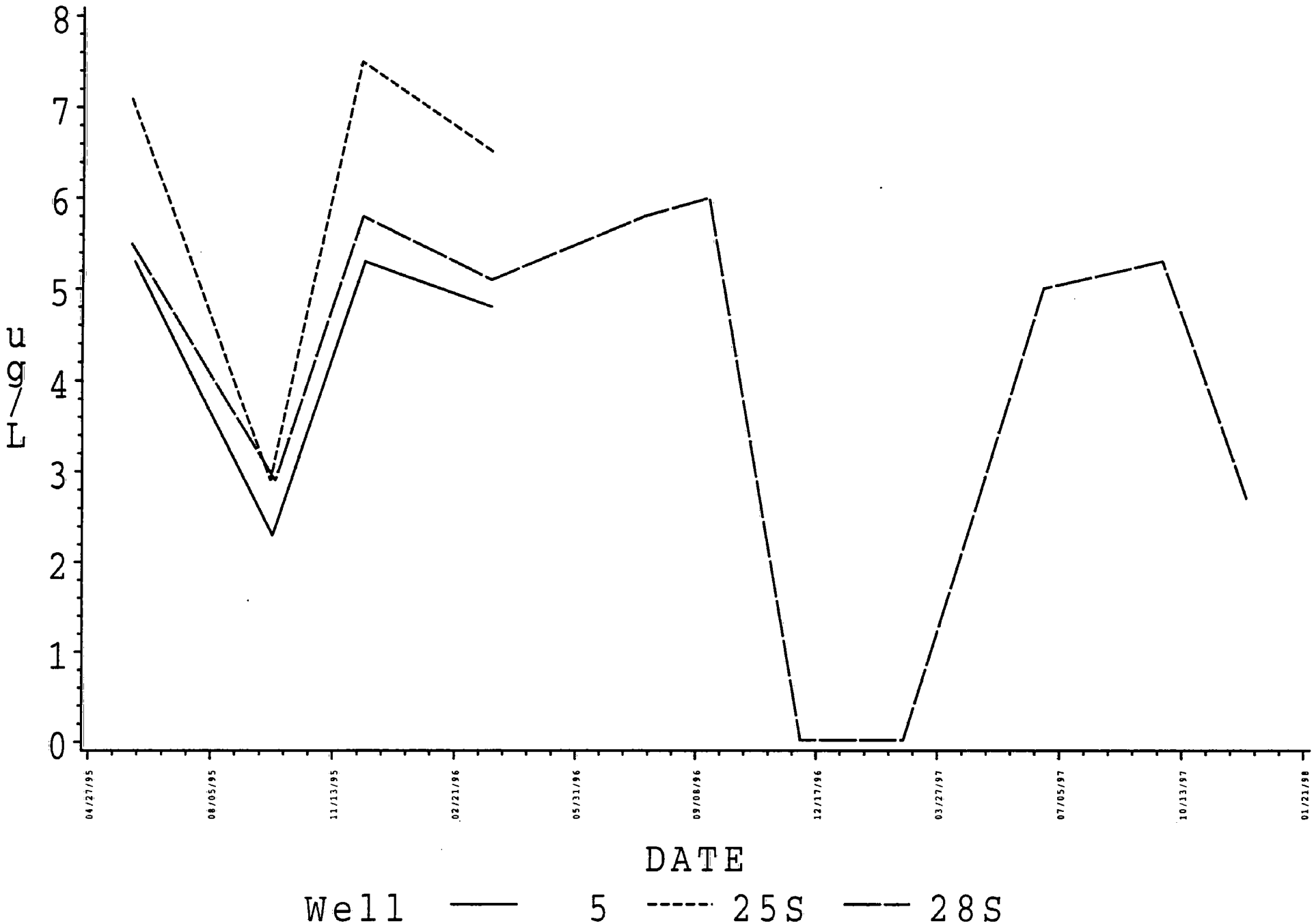
Further sampling, including multiple samples for each well on each day, would aid in distinguishing these possibilities. In addition, it might be possible to characterize site wells as homogeneous on the basis of proximity to each other and to sources of contaminants. If the between-well variability of these wells was similar to that of the putative control wells, one might for practical purposes consider the control wells homogeneous.

Table 1. Within-well and between-well levels of variation (mean squares) for each analyte.

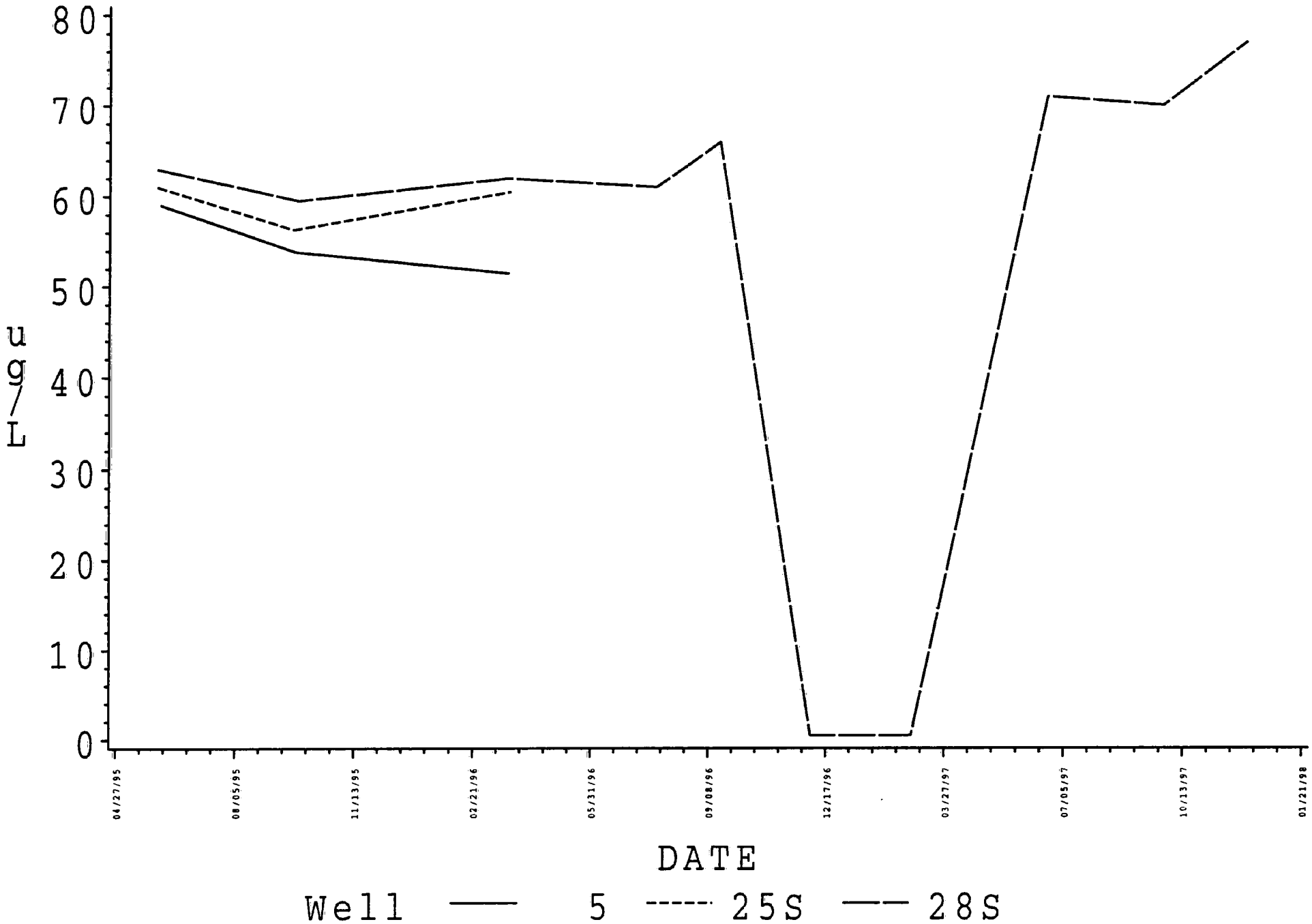
Analyte	Between-Well Mean Square (a)	Within-Well Mean Square (b)	Ratio (a/b)
Antimony	83.8	109.8	0.76
Arsenic	2.68	7.85	0.34
Barium	34.9	15.4	2.27
Beryllium	0.0	0.18	0.00
Cadmium	0.0	2.34	0.00
Calcium	3452292	32132292	0.11
Chromium	0.29	3.90	0.07
Cobalt	2.25	42.7	0.05
Copper	204	2203	0.09
Iron	1623	1872	0.87
Lead	2.68	14.1	0.19
Magnesium	5955625	5902292	1.01
Manganese	0.28	4.98	0.06
Nickel	22.0	124	0.18
Potassium	2515042	1247642	2.02
Selenium	0.50	3.38	0.15
Silver	0.05	4.63	0.01
Sodium	2685625	16692292	0.16
Thallium	0.78	4.11	0.19
Vanadium	14.4	42.4	0.34
Zinc	35.1	214	0.16


Antimony Ground Water Concentration vs Date
30
20
10
0
ug/L
04/27/95
08/05/95
11/13/95
02/21/96
05/31/96
09/08/96
12/17/96
03/27/97
07/05/97
10/13/97
01/21/98
DATE
Well 25S 28S

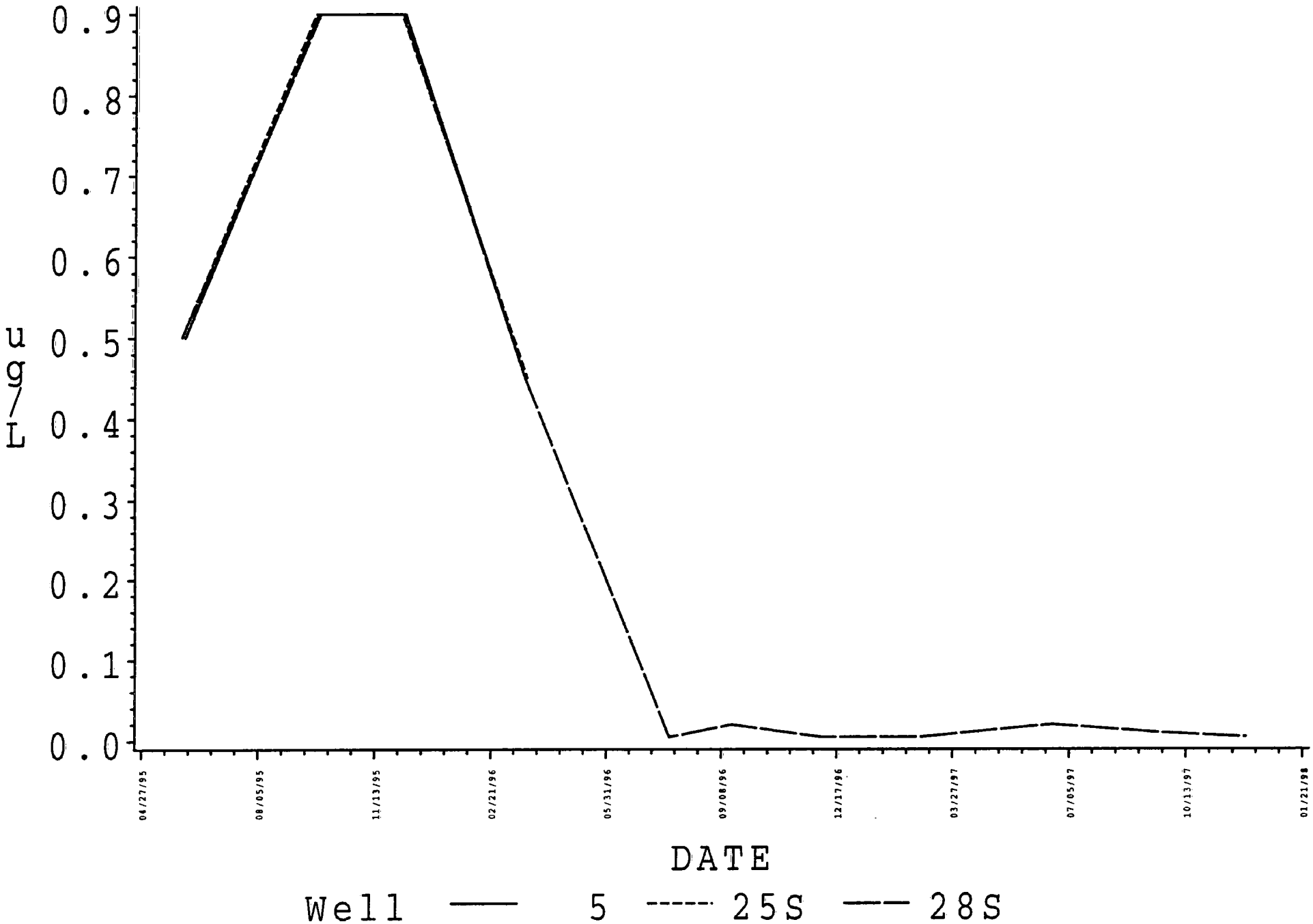
Arsenic Ground Water Concentration vs Date



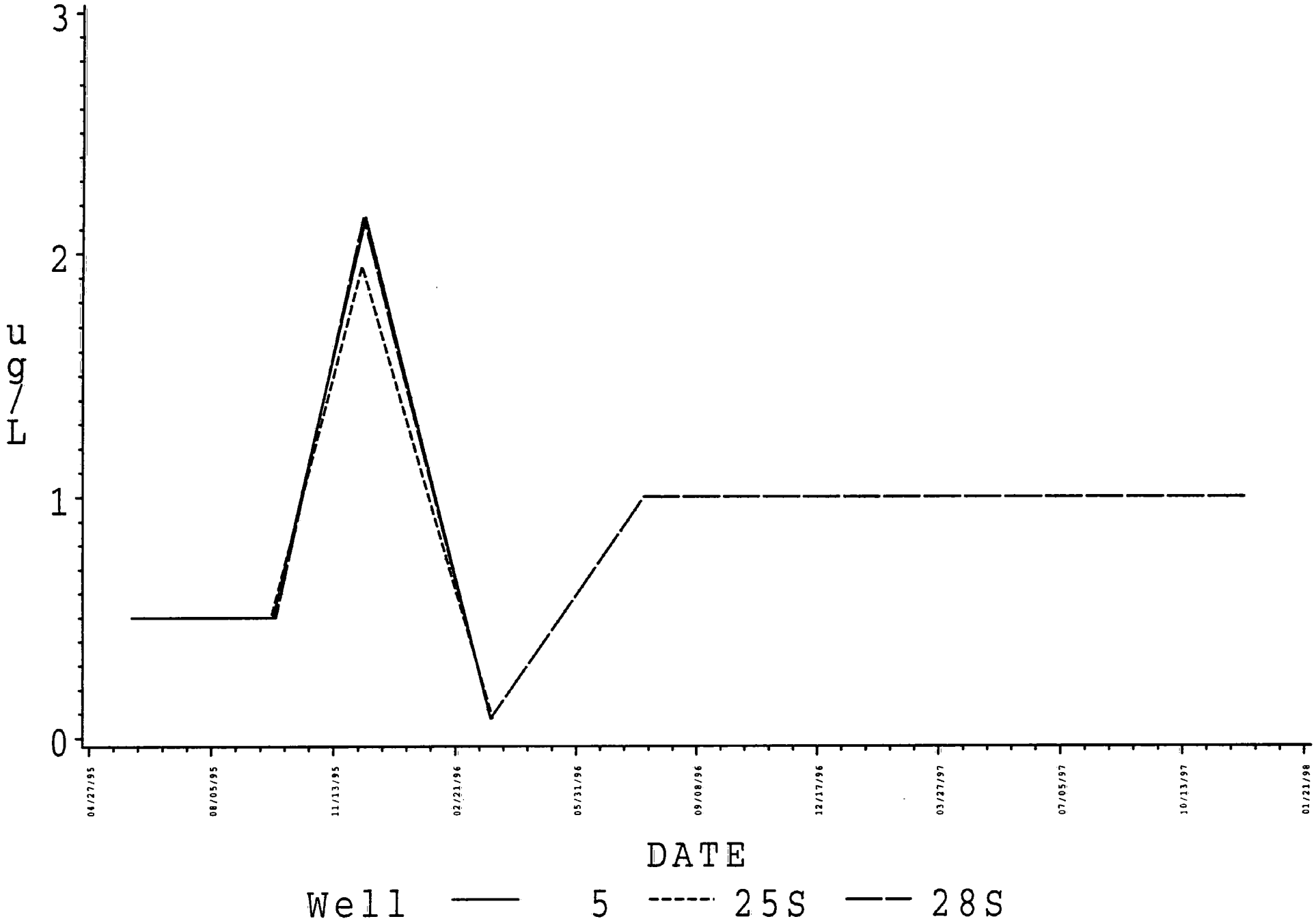
Barium Ground Water Concentration vs Date



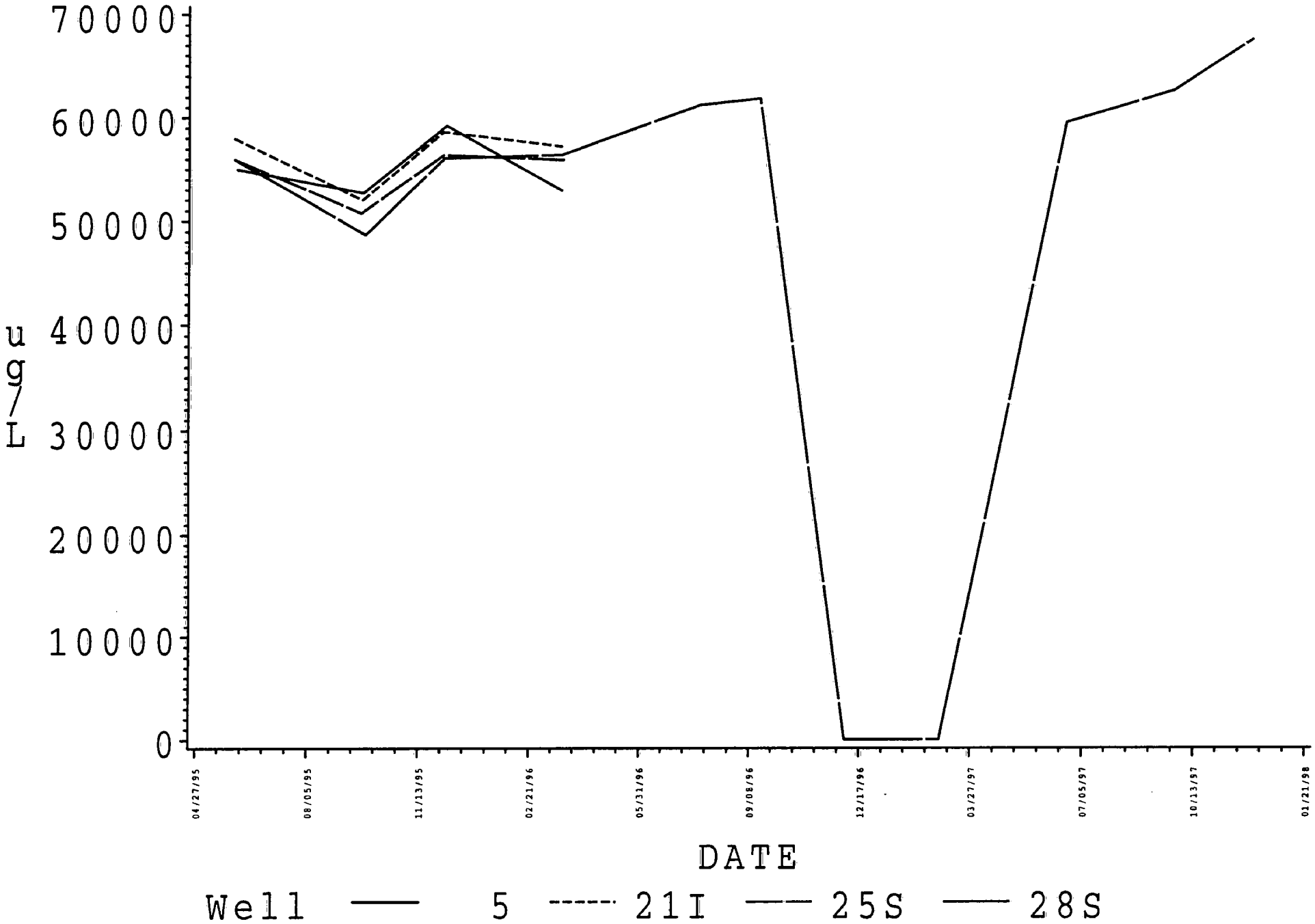
Beryllium Ground Water Concentration vs Date



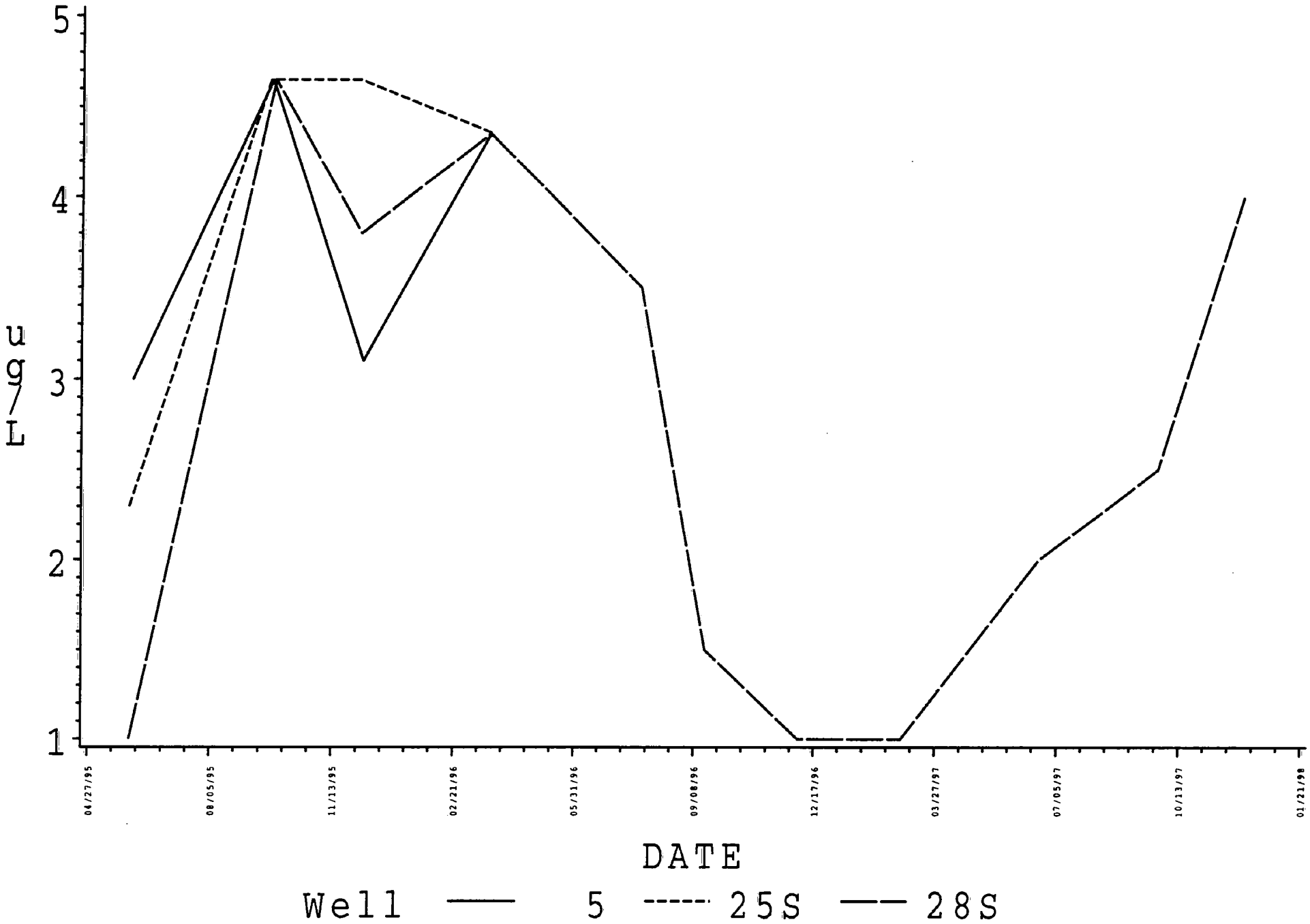
Cadmium Ground Water Concentration vs Date



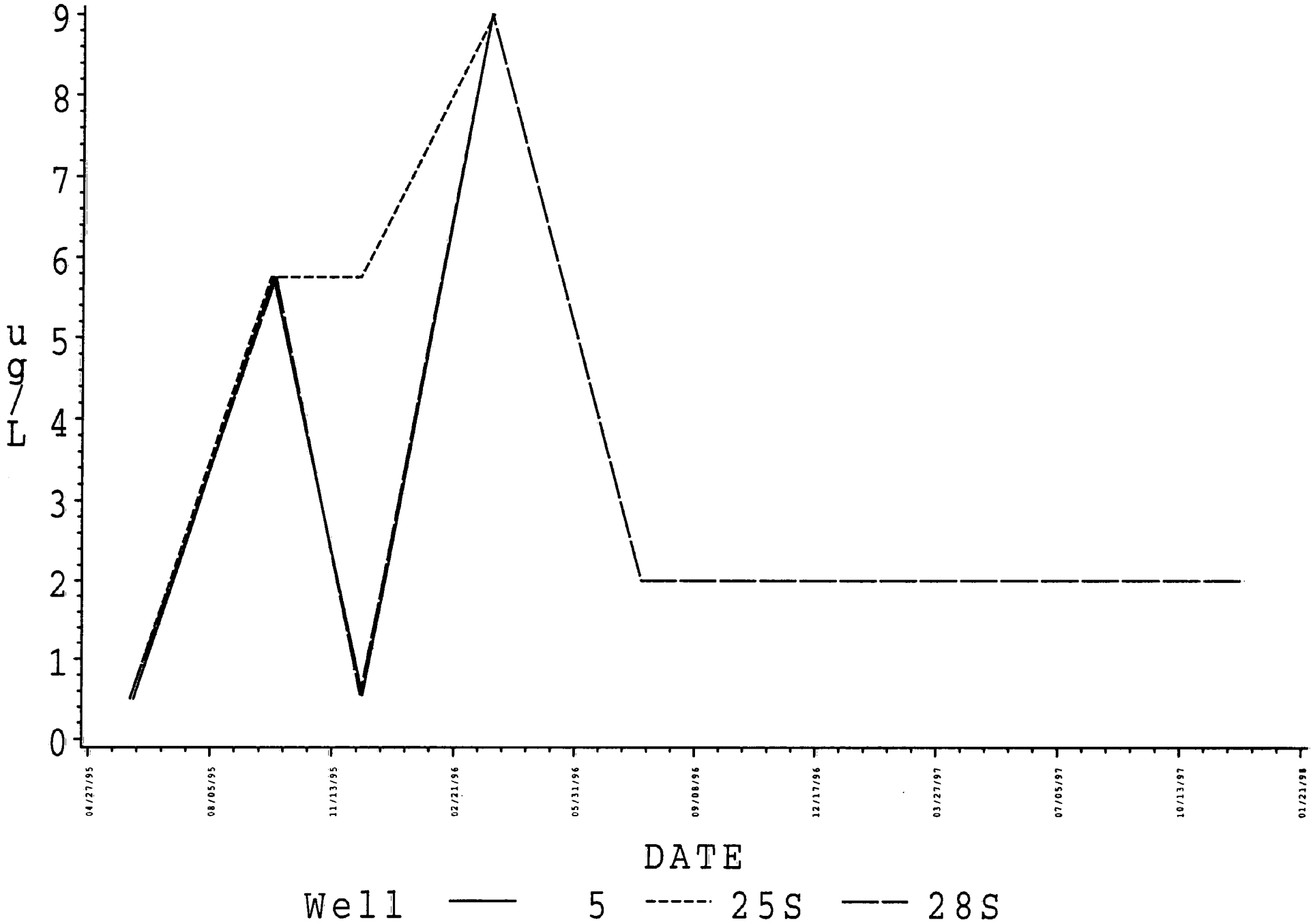
Calcium Ground Water Concentration vs Date



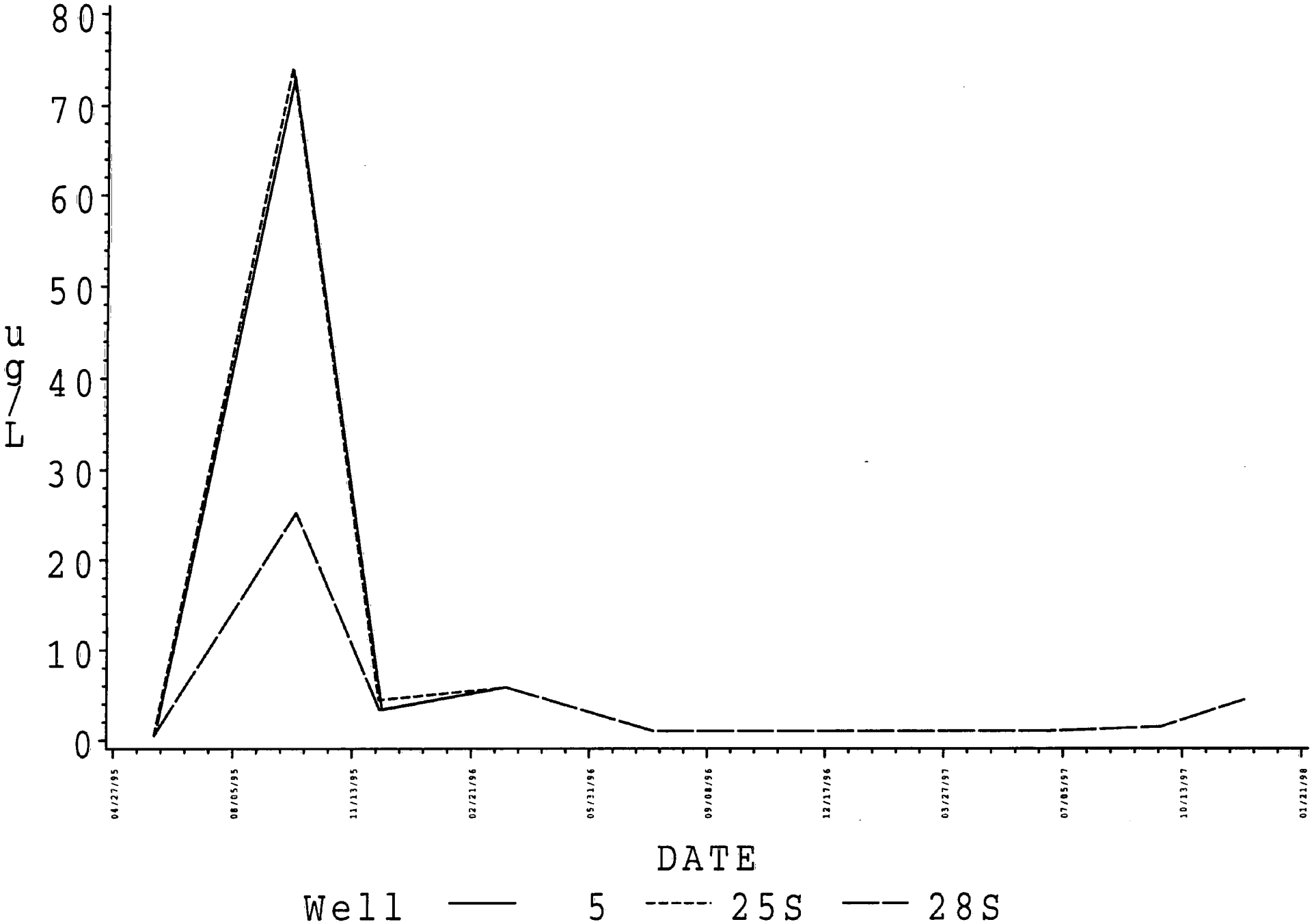
Chromium Ground Water Concentration vs Date



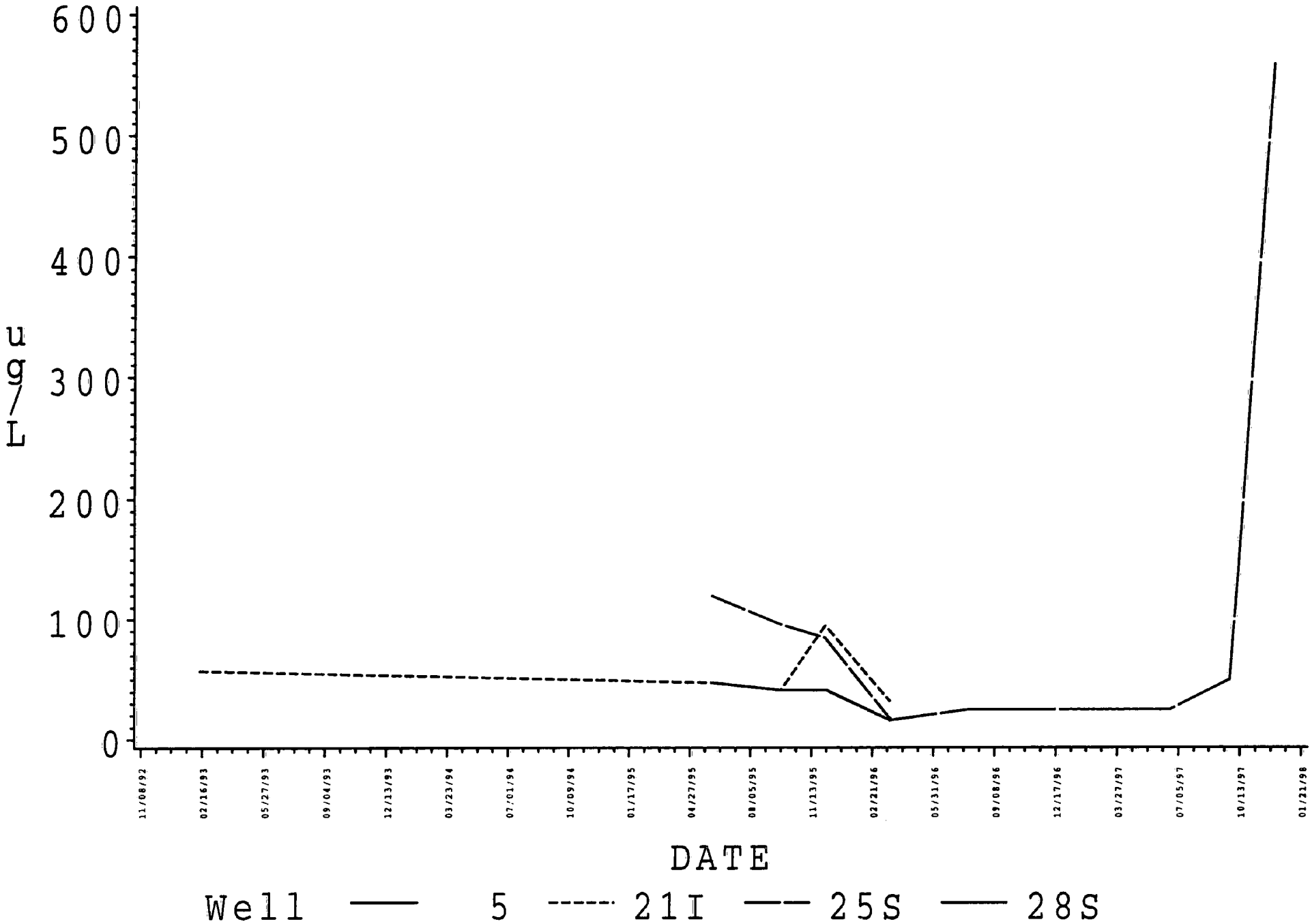
Cobalt Ground Water Concentration vs Date



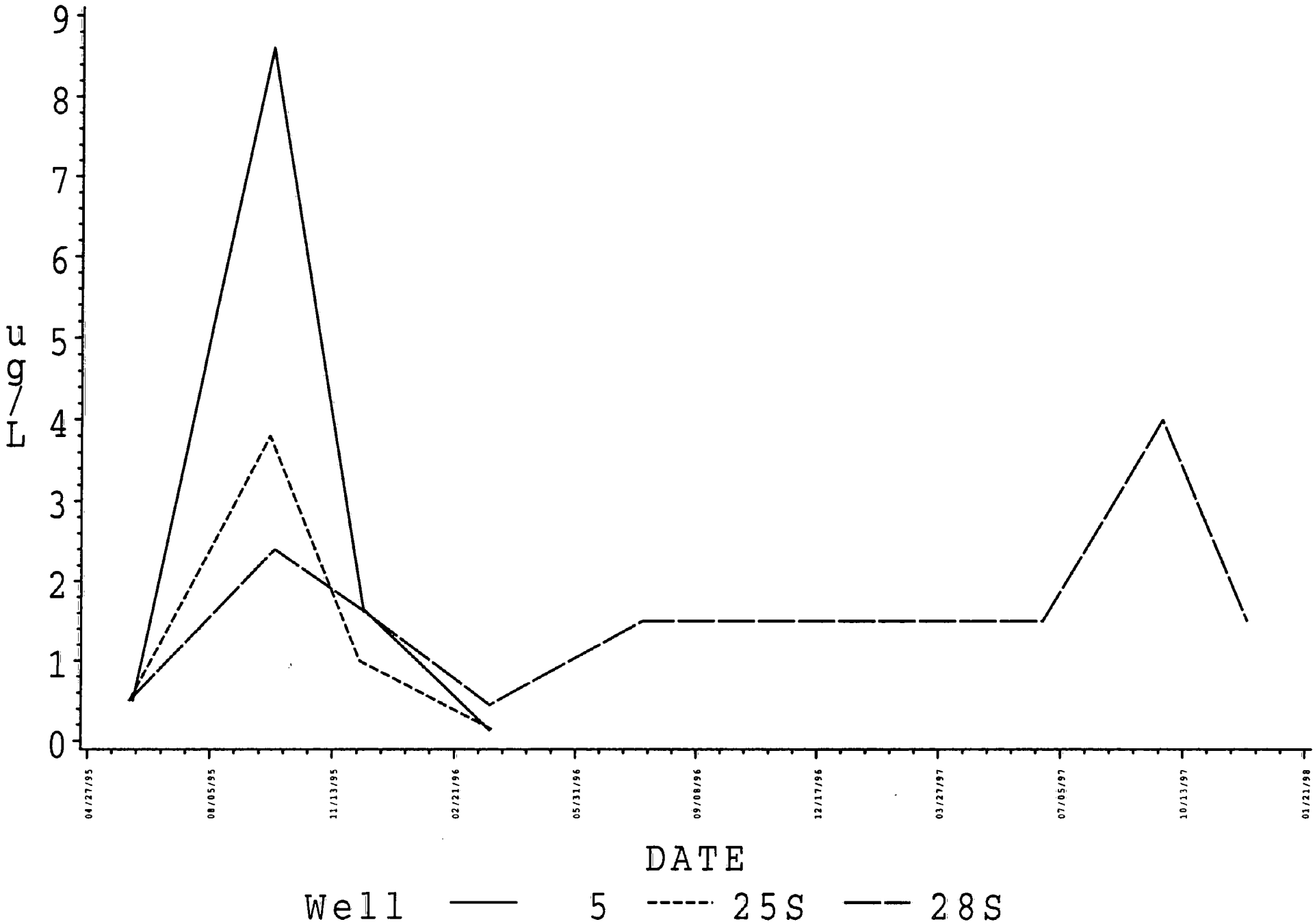
Copper Ground Water Concentration vs Date



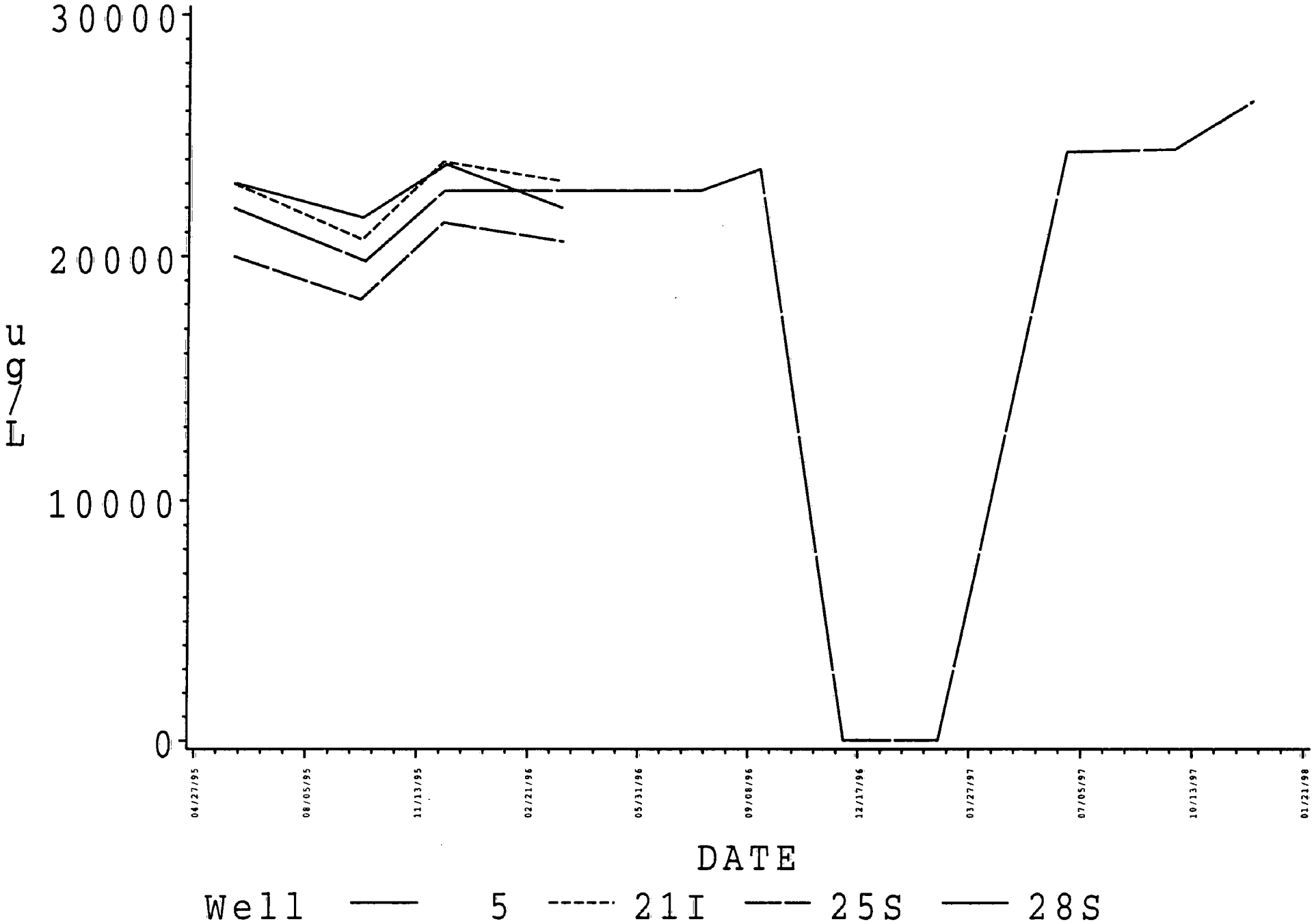
Iron Ground Water Concentration vs Date



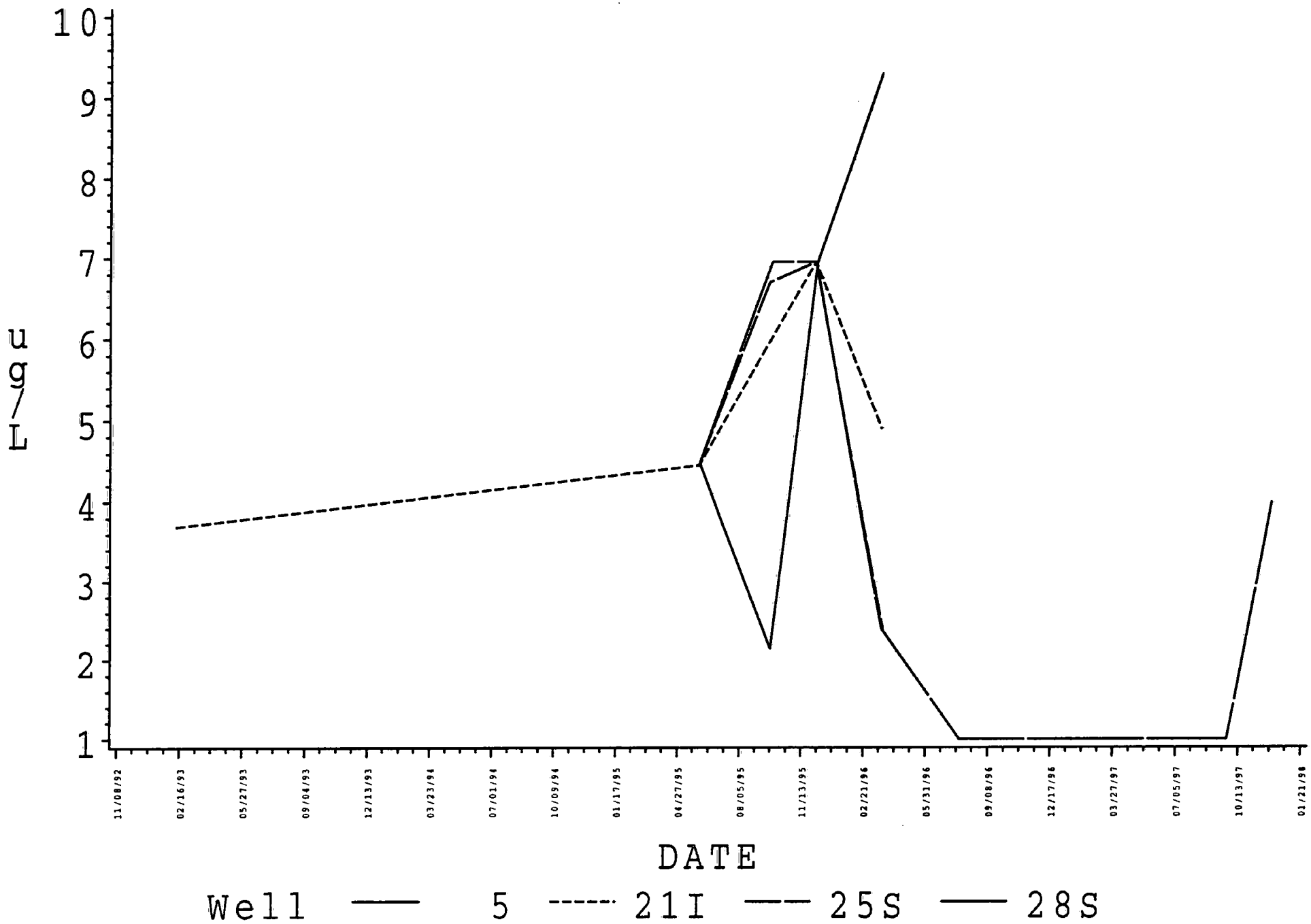
Lead Ground Water Concentration vs Date



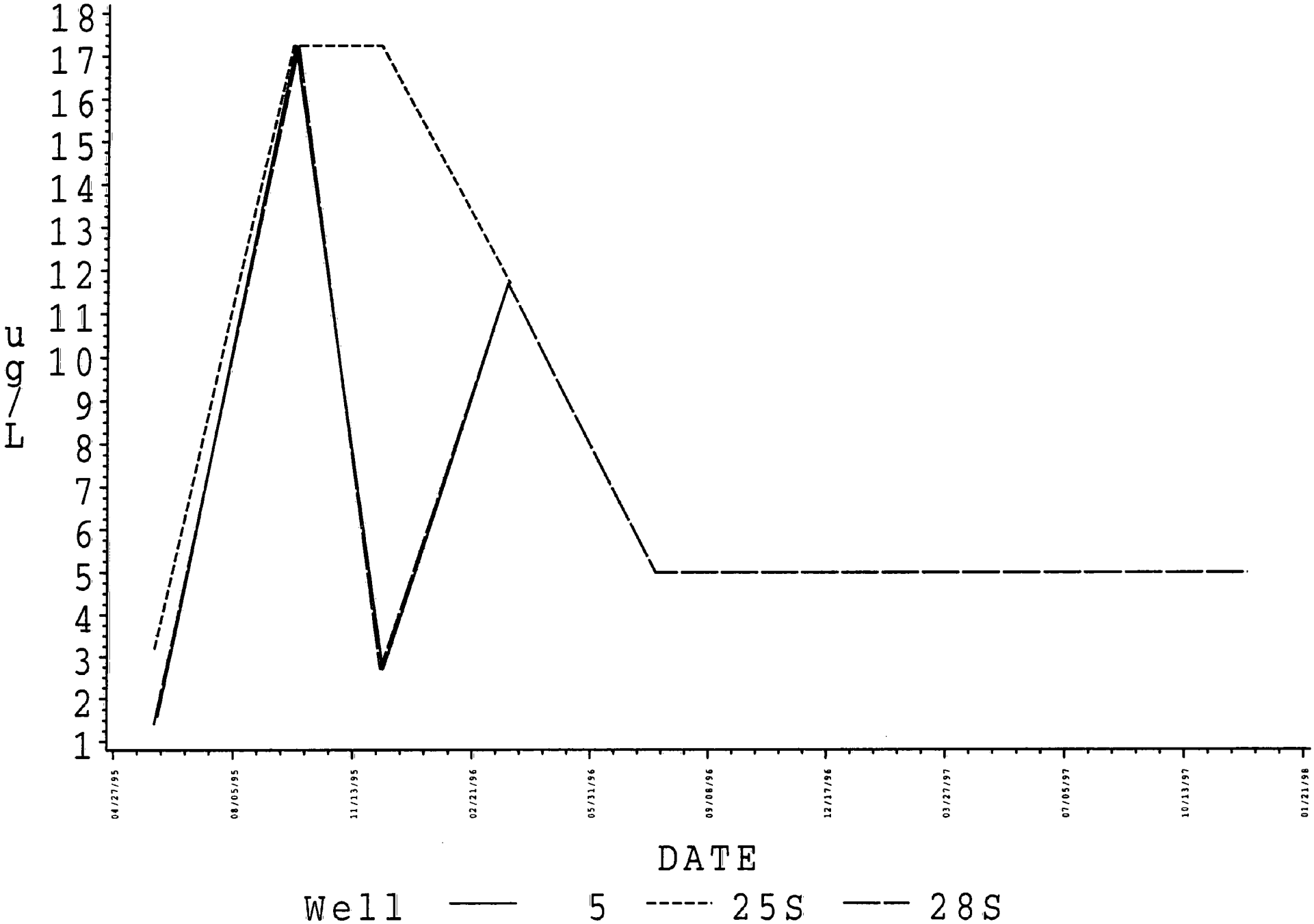
Magnesium Ground Water Concentration vs Date



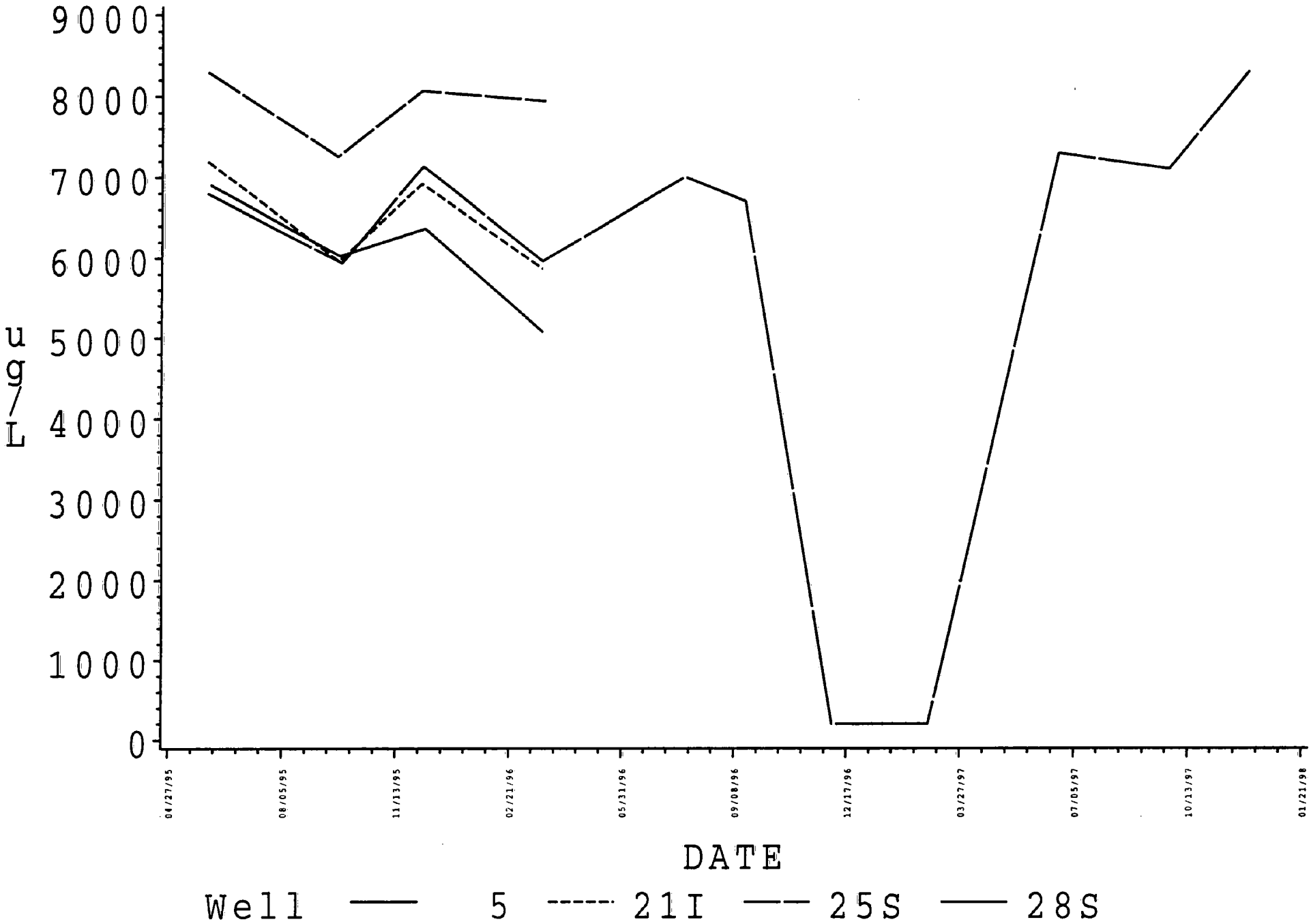
Manganese Ground Water Concentration vs Date



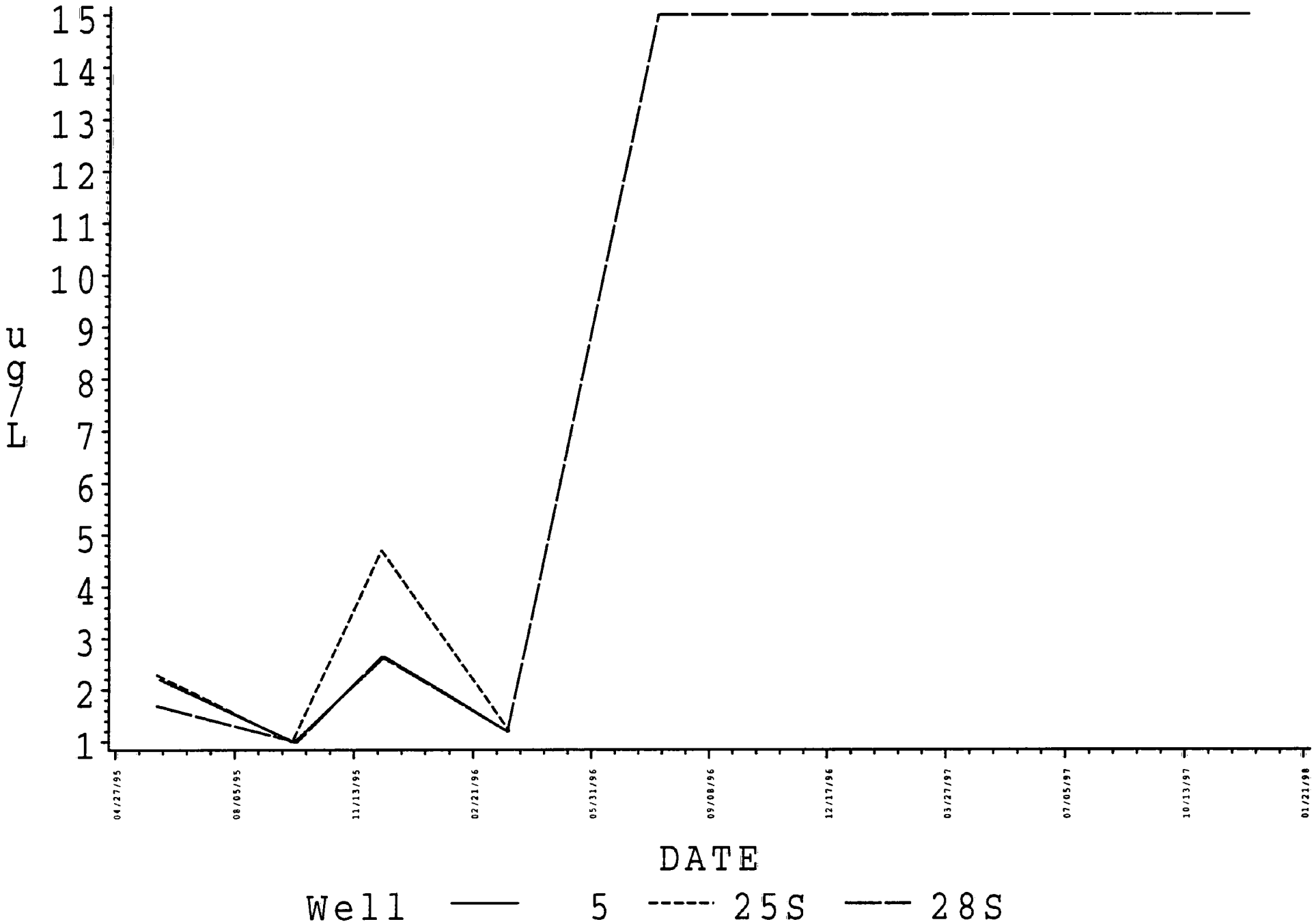
Nickel Ground Water Concentration vs Date



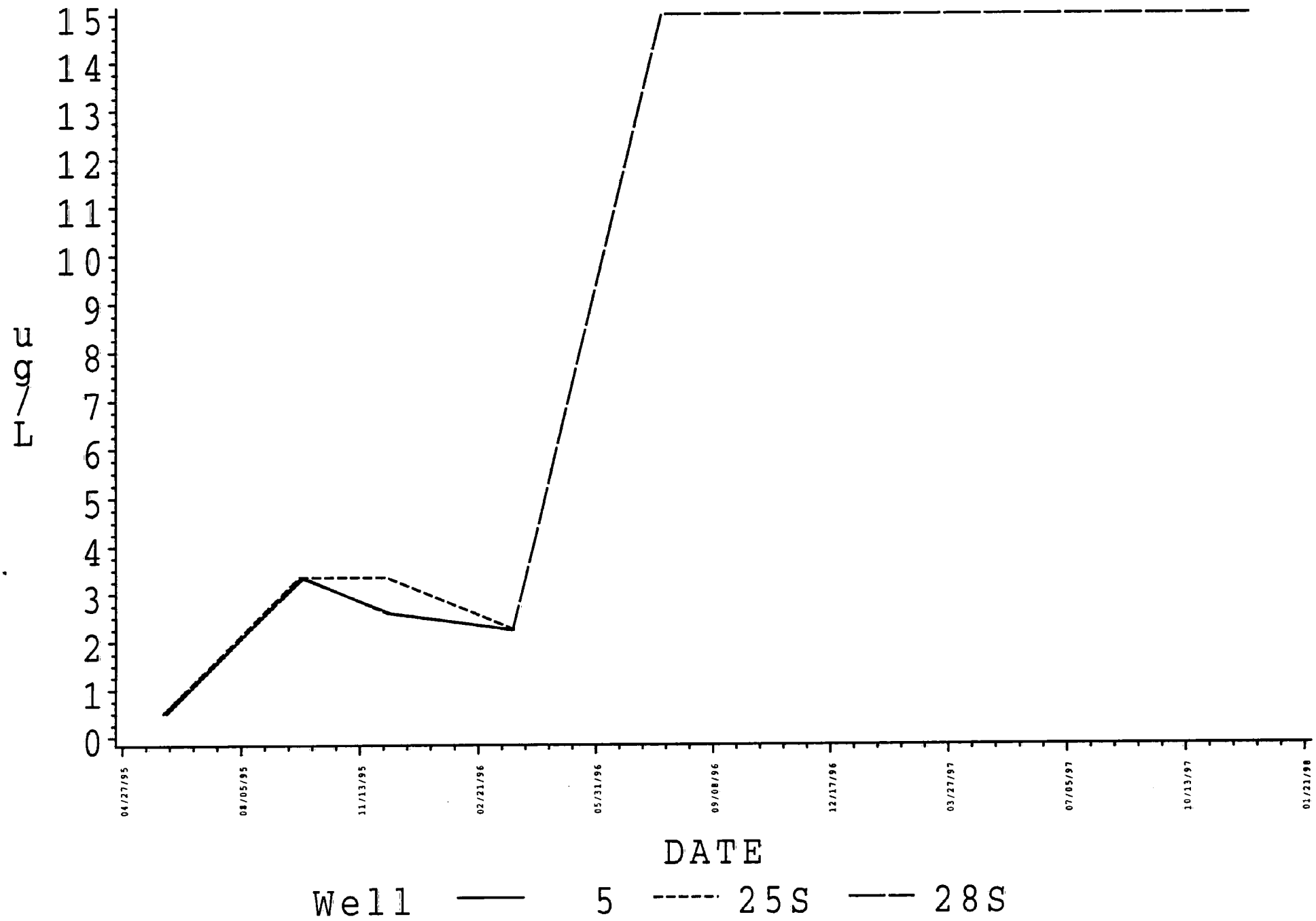
Potassium Ground Water Concentration vs Date



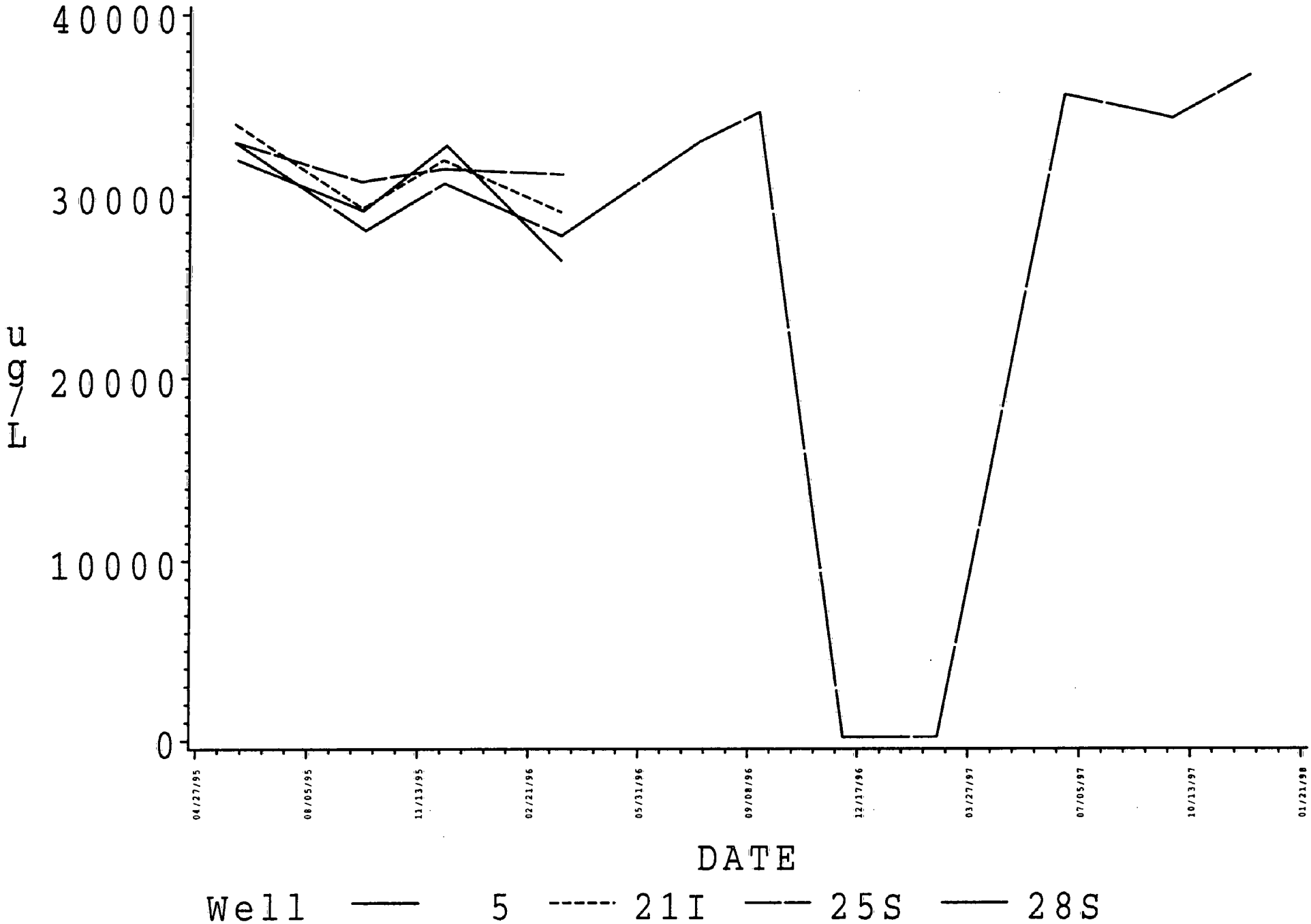
Selenium Ground Water Concentration vs Date



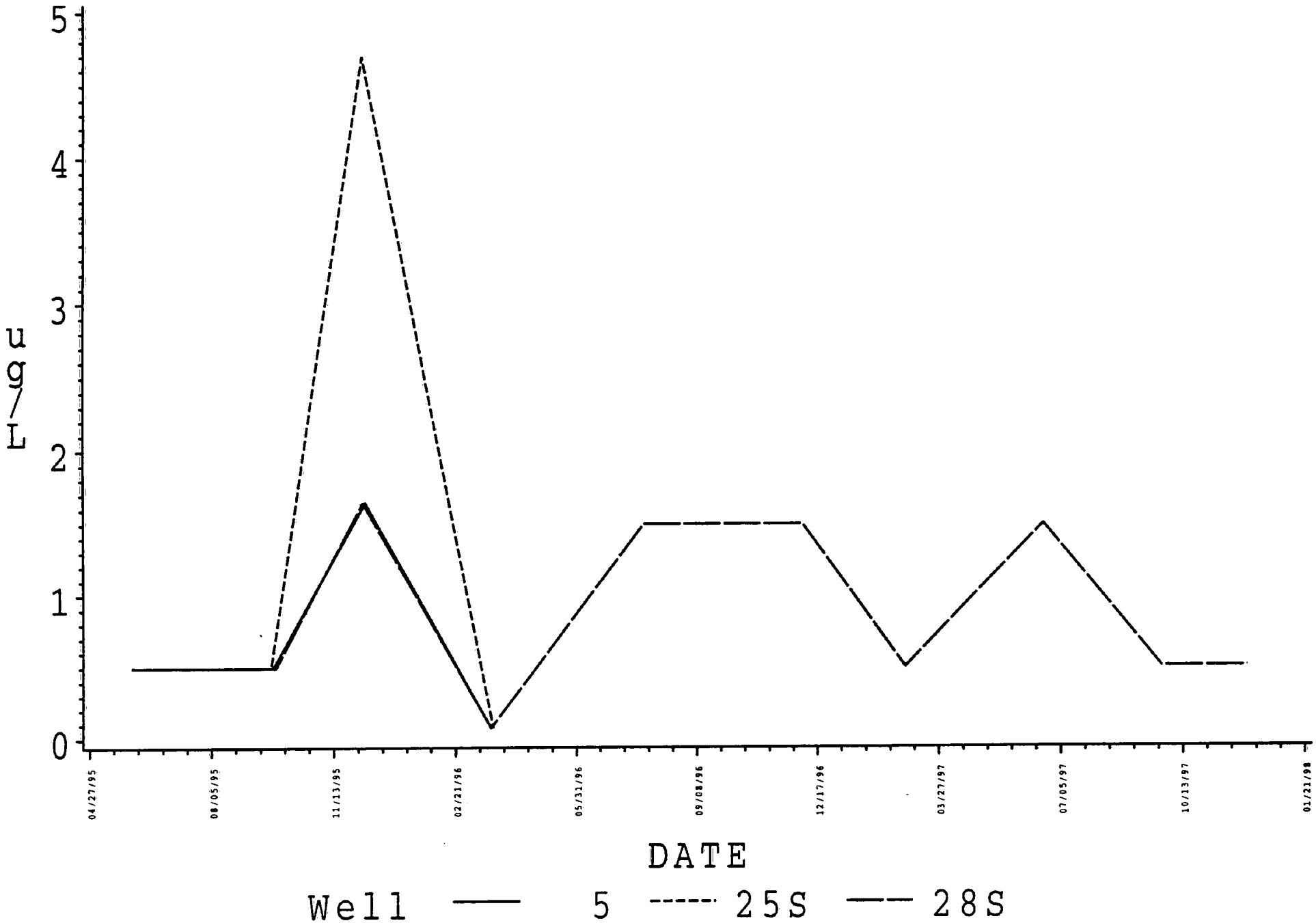
Silver Ground Water Concentration vs Date



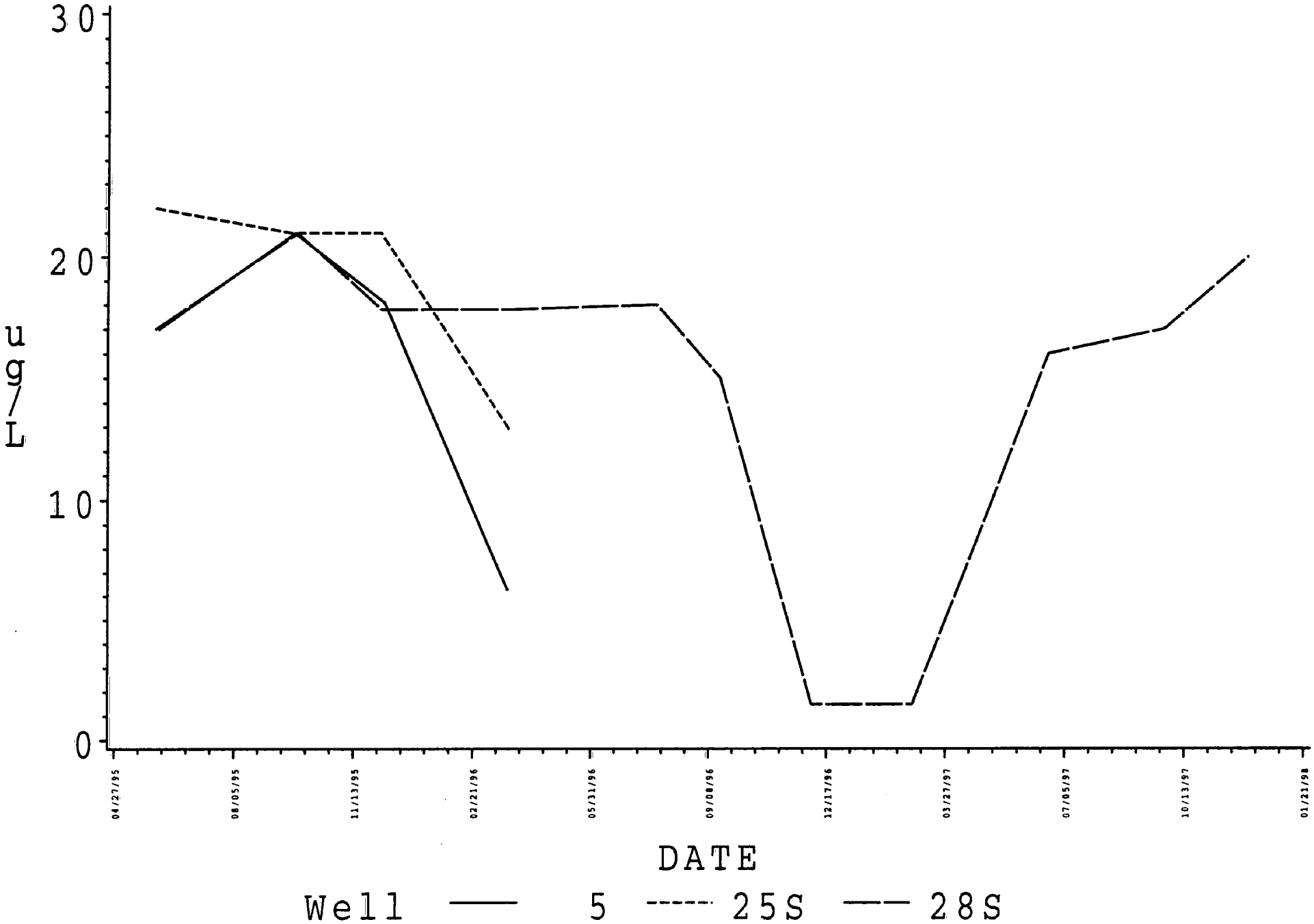
Sodium Ground Water Concentration vs Date



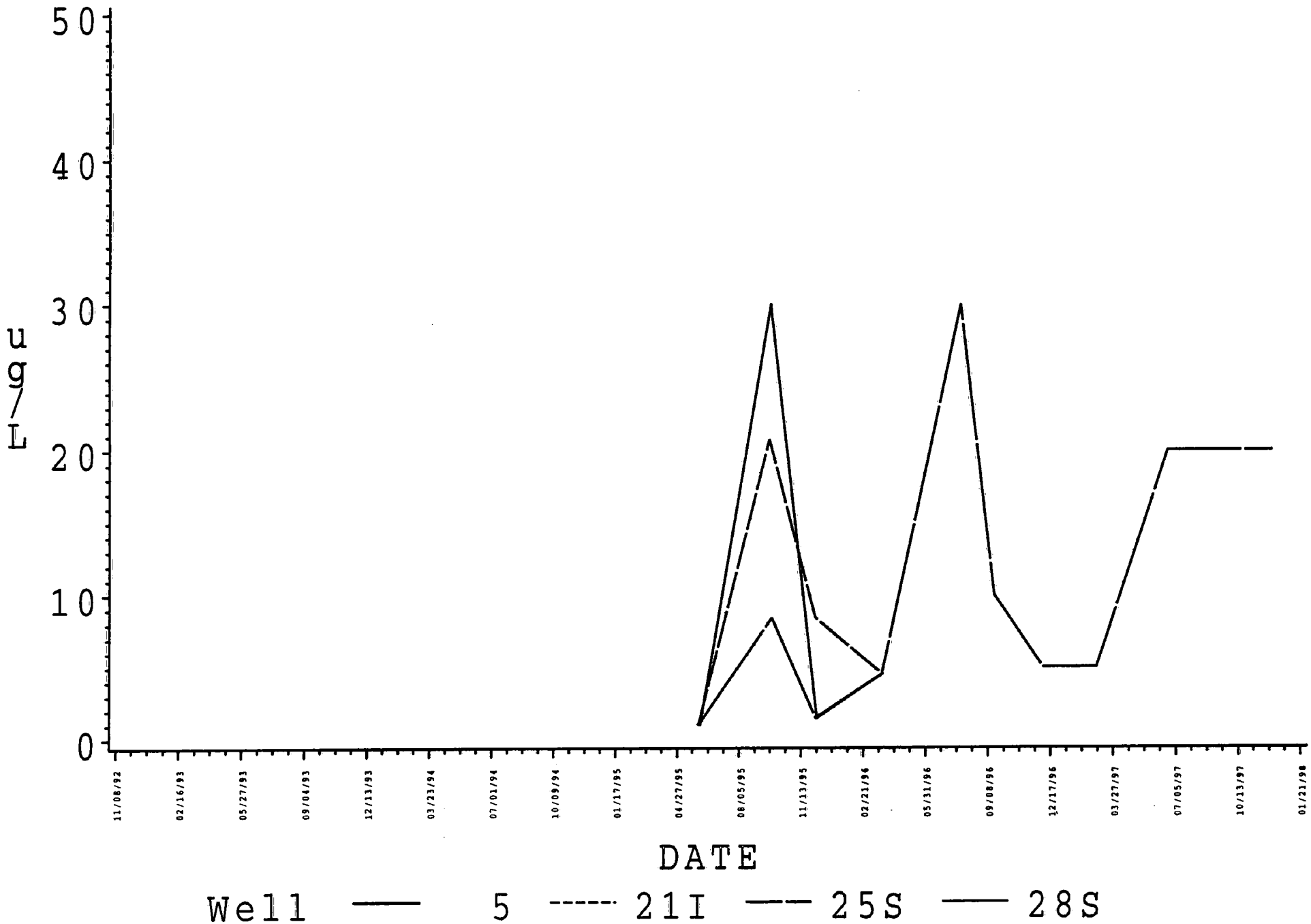
Thallium Ground Water Concentration vs Date



Vanadium Ground Water Concentration vs Date



Zinc Ground Water Concentration vs Date



ATTACHMENT 2

GROUNDWATER DATA

2.3 Shallow background wells - Arsenic (up to 3/97)

2.9
2.9
4.6
4.8
5.1
5.3
5.3
5.5
5.7
5.8
5.8
6
6.5
7.1
7.5

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	16	Mean	5.19
Censored	0	Lognormal mean	5.24
TOTAL	16	Std. devn.	1.46
		Median	5.4
		Min.	2.3
		Max.	7.5

Lognormal distribution?	Normal distribution?
r-squared is: 0.85	r-squared is: 0.93

Recommendations:

Use normal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
2	90	7.22
1 = Lognormal	50th	5.19
2 = Normal	4 X 50th	20.78
3 = Nonparametric method	Coefficient of Variation = 0.3	

51.5
53.9
56.3
59
59.5
60.5
61
61
62
63
66
67
70

Shallow background wells - Barium (up to 3/97)

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	13	Mean	60.82
Censored	0	Lognormal mean	60.84
TOTAL	13	Std. devn.	5.13
		Median	61
		Min.	51.5
		Max.	70

Lognormal distribution?	Normal distribution?
r-squared is: 0.97	r-squared is: 0.98

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	68.10
1 = Lognormal	50th	60.62
2 = Normal	4 X 50th	242.49
3 = Nonparametric method	Coefficient of Variation = 0.09	

48700
50800
52000
52700
52900
55000
55900
56000
56000
56100
56400
56400
57200
58000
58600
59200
61200
61800
62600
62700

Shallow background wells - Calcium (up to 3/97)

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	20	Mean	56510.00
Censored	0	Lognormal mean	56517.48
TOTAL	20	Std. devn.	3869.84
		Median	56250
		Min.	48700
		Max.	62700

Lognormal distribution?	Normal distribution?
r-squared is: 0.97	r-squared is: 0.97

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	61898.18
1 = Lognormal	50th	56382.97
2 = Normal	4 X 50th	225531.88
3 = Nonparametric method	Coefficient of Variation = 0.07	

18200
19800
20000
20600
20700
21400
21600
22000
22000
22700
22700
22700
23000
23000
23100
23400
23600
23800
23900
24100

Shallow background wells - Magnesium (up to 3/97)

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	20	Mean	22115.00
Censored	0	Lognormal mean	22119.40
TOTAL	20	Std. devn.	1583.56
		Median	22700
		Min.	18200
		Max.	24100

Lognormal distribution?	Normal distribution?
r-squared is: 0.91	r-squared is: 0.93

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	24463.69
1 = Lognormal	50th	22058.66
2 = Normal	4 X 50th	88234.63
3 = Nonparametric method	Coefficient of Variation = 0.08	

5080
5870
5940
5960
5960
6030
6370
6700
6800
6900
6900
6920
7000
7140
7200
7260
7400
7940
8070
8300

Shallow background wells - Potassium (up to 3/97)

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	20	Mean	6787.00
Censored	0	Lognormal mean	6790.23
TOTAL	20	Std. devn.	822.15
		Median	6900
		Min.	5080
		Max.	8300

Lognormal distribution?	Normal distribution?
r-squared is: 0.96	r-squared is: 0.97

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	7967.32
1 = Lognormal	50th	6738.83
2 = Normal	4 X 50th	26955.33
3 = Nonparametric method	Coefficient of Variation = 0.13	

26400
27800
28100
29100
29200
29300
30700
30800
31200
31500
32000
32000
32800
33000
33000
33000
33000
34000
34600
35100

Shallow background wells Sodium (up to 3/97)

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	20	Mean	31330.00
Censored	0	Lognormal mean	31335.89
TOTAL	20	Std. devn.	2381.97
		Median	31750
		Min.	26400
		Max.	35100

Lognormal distribution?	Normal distribution?
r-squared is: 0.96	r-squared is: 0.97

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	34712.93
1 = Lognormal	50th	31241.88
2 = Normal	4 X 50th	124967.54
3 = Nonparametric method	Coefficient of Variation = 0.08	

6.3
12.9
15
17
17
17
17.8
17.8
18
18
18.1
21
21
21
21
22

Shallow background wells - Vanadium (up to 3/97)

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	16	Mean	17.56
Censored	0	Lognormal mean	17.75
TOTAL	16	Std. devn.	3.86
		Median	17.9
		Min.	6.3
		Max.	22

Lognormal distribution?	Normal distribution?
r-squared is: 0.66	r-squared is: 0.81

Recommendations:

Use nonparametric method.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	
1 = Lognormal	50th	
2 = Normal	4 X 50th	
3 = Nonparametric method		

NON-PARAMETRIC CALCULATIONS FOR GROUNDWATER BACKGROUND EVENTS

Pasco Landfill
Pasco, Washington

Antimony	Ranks
0.50	1
0.50	2
0.50	3
0.50	4
0.50	5
0.90	6
0.90	7
0.90	8
1.10	9
2.30	10
2.30	11
3.00	12
3.00	13
3.00	14
4.00	15
28.80	16

Rank of 90th percentile data (v) = 15.3

The 90th percentile is = **11.44**

Beryllium	Ranks
0.01	1
0.01	2
0.01	3
0.02	4
0.45	5
0.45	6
0.45	7
0.50	8
0.50	9
0.50	10
0.90	11
0.90	12
0.90	13
0.90	14
0.90	15
0.90	16

Rank of 90th percentile data (v) = 15.3

The 90th percentile is = **0.9**

Cadmium	Ranks
0.08	1
0.08	2
0.08	3
0.50	4
0.50	5
0.50	6
0.50	7
0.50	8
0.50	9
1.00	10
1.00	11
1.00	12
1.00	13
1.95	14
2.15	15
2.15	16

Rank of 90th percentile data (v) = 15.3

The 90th percentile is = **2.15**

NON-PARAMETRIC CALCULATIONS FOR GROUNDWATER BACKGROUND EVENTS

Pasco Landfill
Pasco, Washington

Chromium	Ranks
1.00	1
1.50	2
2.30	3
3.00	4
3.00	5
3.10	6
3.50	7
3.80	8
4.35	9
4.35	10
4.35	11
4.65	12
4.65	13
4.65	14
4.65	15
15.00	16

Rank of 90th percentile data (v) = 15.3

The 90th percentile is = **7.76**

Cobalt	Ranks
0.50	1
0.50	2
0.50	3
0.55	4
0.55	5
2.00	6
2.00	7
2.00	8
2.00	9
5.75	10
5.75	11
5.75	12
5.75	13
9.00	14
9.00	15
9.00	16

Rank of 90th percentile data (v) = 15.3

The 90th percentile is = **9**

Copper	Ranks
0.50	1
0.50	2
1.00	3
1.00	4
1.00	5
1.00	6
1.70	7
3.35	8
3.35	9
4.45	10
5.85	11
5.85	12
5.85	13
25.30	14
73.10	15
74.20	16

Rank of 90th percentile data (v) = 15.3

The 90th percentile is = **73.43**

NON-PARAMETRIC CALCULATIONS FOR GROUNDWATER BACKGROUND EVENTS

Pasco Landfill
Pasco, Washington

Iron	Ranks
15.90	1
15.90	2
15.90	3
25.00	4
25.00	5
25.00	6
31.80	7
41.20	8
41.20	9
41.20	10
41.20	11
41.20	12
47.50	13
47.50	14
47.50	15
57.30	16
84.40	17
94.80	18
95.90	19
100.00	20
120.00	21

Rank of 90th percentile data (v) = 19.8

The 90th percentile is = **104**

Lead	Ranks
0.14	1
0.15	2
0.45	3
0.50	4
0.50	5
0.50	6
1.00	7
1.50	8
1.50	9
1.50	10
1.50	11
1.50	12
1.65	13
1.65	14
2.40	15
3.00	16
3.80	17
4.00	18
8.60	19

Rank of 90th percentile data (v) = 18

The 90th percentile is = **4**

Manganese	Ranks
1.00	1
1.00	2
1.00	3
1.00	4
2.15	5
2.40	6
2.40	7
3.70	8
4.45	9
4.45	10
4.45	11
4.45	12
4.90	13
6.70	14
6.95	15
6.95	16
6.95	17
6.95	18
6.95	19
6.95	20
9.30	21

Rank of 90th percentile data (v) = 19.8

The 90th percentile is = **6.95**

NON-PARAMETRIC CALCULATIONS FOR GROUNDWATER BACKGROUND EVENTS

Pasco Landfill
Pasco, Washington

Nickel	Ranks
1.40	1
1.60	2
2.70	3
2.70	4
3.20	5
5.00	6
5.00	7
5.00	8
5.00	9
11.70	10
11.70	11
11.70	12
17.25	13
17.25	14
17.25	15
17.25	16

Rank of 90th percentile data (v) = 15.3

The 90th percentile is = **17.25**

Selenium	Ranks
1.00	1
1.00	2
1.00	3
1.20	4
1.20	5
1.20	6
1.70	7
2.20	8
2.30	9
2.65	10
2.65	11
4.70	12
15.00	13
15.00	14
15.00	15
15.00	16

Rank of 90th percentile data (v) = 15.3

The 90th percentile is = **15**

Silver	Ranks
0.50	1
0.50	2
0.50	3
2.25	4
2.25	5
2.25	6
2.60	7
2.60	8
3.35	9
3.35	10
3.35	11
3.35	12
15.00	13
15.00	14
15.00	15
15.00	16

Rank of 90th percentile data (v) = 15.3

The 90th percentile is = **15**

NON-PARAMETRIC CALCULATIONS FOR GROUNDWATER BACKGROUND EVENTS

Pasco Landfill
Pasco, Washington

Thallium	Ranks
0.08	1
0.08	2
0.08	3
0.50	4
0.50	5
0.50	6
0.50	7
0.50	8
0.50	9
0.50	10
1.50	11
1.50	12
1.50	13
1.65	14
1.65	15
4.70	16

Rank of 90th percentile data (v) = 15.3

The 90th percentile is = **2.57**

Vanadium	Ranks
6.30	1
12.90	2
15.00	3
17.00	4
17.00	5
17.00	6
17.80	7
17.80	8
18.00	9
18.00	10
18.10	11
21.00	12
21.00	13
21.00	14
21.00	15
22.00	16

Rank of 90th percentile data (v) = 15.3

The 90th percentile is = **21.3**

Zinc	Ranks
1.00	1
1.00	2
1.00	3
1.50	4
1.50	5
4.50	6
4.50	7
4.50	8
5.00	9
8.45	10
8.45	11
10.00	12
20.00	13
20.80	14
30.00	15
30.00	16
43.90	17

Rank of 90th percentile data (v) = 15.3

The 90th percentile is = **21.5**

Shallow site wells - Arsenic (up to 3/97 data)

6.1
6.3
4.2
2
2.25
2.6
3.2
1.8
3.5
4.6
4.7
4.7
4.8
7.5
2.4
3.9
4.2
4.4
5.3
5.3
6
1.4
5.8
0.55
0.55
0.55
5.4
6.4
5
5.8
3.3
4
4.6
5
4.3
4.9
4.9
4.9
5
5.1
5.2
5.2
5.6
8.8
0.5
4.7
4.9
5
5.1
5.6
5.7
5.7
5.9
6.1
7.5

Number of samples		Uncensored values	
Uncensored	261	Mean	4.43
Censored		Lognormal mean	4.80
Detection limit or PQL		Std. devn.	1.67304694
Method detection limit		Median	4.7
TOTAL	261	Min.	0.5
		Max.	8.9

Lognormal distribution?		Normal distribution?	
r-squared is:	0.670	r-squared is:	0.903

Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 4.60311826746749

7.9
4.4
4.7
4.8
5
5.2
6
4.6
1.1
1.5
2.4
0.5
0.5
0.5
0.5
2.1
3.4
4.1
0.5
0.5
0.5
0.5
3.2
4.7
0.5
0.5
0.5
0.5
1.2
1.4
1.6
1.7
3.3
3.8
5.2
0.5
0.5
0.5
1.3
1.7
2
3.4
0.5
3.7
4.8
6.1
5.1
5.8
6
6.2
6.6
6.7
5.1
5.1
5.3

5.3
5.3
5.8
2
4
4.9
5
5.2
5.2
5.2
5.4
5.6
5.9
4.1
4.8
5.6
2
4.6
4.9
5.1
5.1
5.3
2
4.6
4.6
5.4
5.7
7.5
4
4.1
4.1
4.4
4.7
4.9
5
5.1
5.5
5.7
3.7
3.7
4.5
4.9
3.2
4
4.2
4.4
4.4
4.5
4.5
4
4.4
4.7
5.2
5.3
5.7

4.2
4.2
4.4
4.6
4.7
4.7
4.9
5.1
5.2
6.6
5.4
5.7
3.8
5.2
5.2
8.9
4.5
4.9
5.4
6.2
4
4.2
4.5
4.6
6.4
3.4
4.1
4.3
4.7
4.8
4.9
4.3
4.3
4.6
4.9
5.7
5.2
5.7
6.7
4.6
5
5.4
7.2
4.5
5.4
7.3
4
4.7
5.1
5.1
5.4
5.5
5.5
6.2
6.3

7.5
4.7
4.3
4.5
4.5
5.7
4.5
4.5
6
4.1
4.1
4.5
4.7
6.5
3.4
4
4.4
4.6
4.8
5
6.7
3.1
4.2
4.4
4.7
4.7
4.7
3.7
4.5
4.8
4.8
5.1
5.7
4.4
4.6
7.3
4.8
5.1
5.2
5.3
6.4

44
72
58
89
100
130
47
55
62
70
72
75
82
87
89
91
110
53
59
64
66
70
70
72
80
80
91
200
61
62
67
78
79
88
88
61
63.4
66.9
68.8
76.5
80
87.2
47.6
47.7
48
54.9
60.9
63.9
72.1
52.2
65.7
73.3
79.7
81.2
93.6

Shallow site wells - Barium (up to 3/97)

Number of samples		Uncensored values	
Uncensored	195	Mean	80.52
Censored		Lognormal mean	80.02
Detection limit or PQL		Std. devn.	32.2431154
Method detection limit		Median	74
TOTAL	195	Min.	39
		Max.	251

Lognormal distribution?		Normal distribution?	
r-squared is:	0.934	r-squared is:	0.742

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 83.2475369613487

49.8
59.6
62.6
63
67
80.7
84.4
93.6
119
161
50.6
63.5
67.3
69
93.9
48.9
66.9
82.5
47.4
60.7
64.4
66.6
72.6
80.4
81
86.1
93.7
61
79.4
92.6
128
49.3
72.1
73.6
76.5
90.1
91.2
144
55.2
57.2
60.1
70.9
74.1
74.2
43.7
56.7
65
68.9
71.9
73.9
76.4
79.3
95.1
212
44.4

74.8
64
74.6
80
104
39
44
71
83
64
67
69
81
89
50
69
71
83
101
103
63
63
64
69
211
47
73
94
48
75
75
115
69
76
94
55
81
97
112
130
64
79
82
94
239
80
48
78
91
125
50
66
83
46
70

72
76
88
72
74
95
104
108
131
194
45
84
96
98
119
134
50
53
77
79
83
93
72
75
136
59
67
73
77
251

68000
93000
110000
120000
59000
59000
61000
65000
66000
69000
70000
72000
84000
85000
90000
56000
56000
56000
56000
57000
60000
60000
61000
62000
63000
72000
110000
63000
4000
68000
70000
73000
74000
73000
62500
63000
63700
64000
66800
69900
72500
49300
54400
55500
59200
60300
60600
66400
51900
55000
63200
65200
65500
80300
9100
52600

Shallow site wells - Calcium (up to 3/97)

Number of samples		Uncensored values	
Uncensored	198	Mean	71629.55
Censored		Lognormal mean	147864.17
Detection limit or PQL		Std. devn.	23214.2636
Method detection limit		Median	67600
TOTAL	198	Min.	25
		Max.	136000

Lognormal distribution?		Normal distribution?	
r-squared is:	0.295	r-squared is:	0.861

Recommendations:

Reject lognormal distribution.

Y value is -72.196. This lies outside the tabled values of 1.4931 and -2.3934

Reject normal distribution.

Y value is -15.9713. This lies outside the tabled values of 1.4931 and -2.3934

53400
57200
61000
73000
78500
78600
88300
115000
48500
50600
52700
52900
71500
58400
65200
66000
57100
58200
58300
60900
61000
73900
65100
66300
67700
68500
70000
84500
118000
61900
63600
65300
65700
66100
66300
67800
68200
73600
12700
71400
72300
81200
61700
62300
62800
73700
82800
97700
58000
64200
64800
68200
101000
36000
66600

67100
67500
69200
70500
71200
72700
74300
78300
58000
66900
101000
115000
60600
62600
65600
68800
78600
88900
134000
55800
57600
57800
59700
62200
62800
54300
60500
66900
68700
70800
73800
74500
77300
78600
111000
58500
61500
65300
66600
67300
88700
64400
66300
76500
90500
81800
98200
123000
73900
76600
121000
25
25
25
68000

25
25
67400
74800
79100
85600
98900
123000
134000
78500
110000
25
60800
66500
76300
76600
81600
74900
80400
92200
97500
122000
135000
70800
74500
76600
93600
8000
132000
66900
73400
80300
124000

Shallow site wells - Chromium (up to 3/97)

2
2.9
2.3
12.4
30.8
0.9
0.9
2.4
3.7
3.9
5.4
24.5
63.8
0.9
2.2
4.2
5.2
12.6
33.9
42.8
0.9
3.4
3.5
14.6
34.2
0.9
1.9
3.3
1
1
1.5
2.7
2.8
5.8
1.3
2.5
3.8
4.1
5.9
6.2
16
210
1
1
1
1
1.4
1.4
1.4
1.9
3
3.4
22
31
31

Number of samples		Uncensored values		
Uncensored	261	Mean	19.25	
Censored		Lognormal mean	10.74	
Detection limit or PQL		Std. devn.	64.2975251	
Method detection limit		Median	4.4	
TOTAL	261	Min.	0.9	
		Max.	653	

Lognormal distribution?		Normal distribution?	
r-squared is:	0.815	r-squared is:	0.264

Recommendations:
Reject lognormal distribution.
Y value is -21.9549. This lies outside the tabled values of 1.552 and -2.341
Reject normal distribution.
Y value is -89.0274. This lies outside the tabled values of 1.552 and -2.341

290
1.2
1.6
1.7
2
2.2
2.4
3.7
4.7
4.7
4.7
4.7
4.7
4.7
4.7
653
4.7
4.7
4.7
4.7
4.7
4.7
4.7
4.7
4.7
4.7
4.7
11
18.2
4.7
4.7
4.7
4.7
4.7
4.7
4.7
4.7
224
4.7
4.7
4.7
4.7
4.7
4.7
4.7
13
4.7
4.7
4.7
4.7
4.7
3.6
3.6
3.9

4.4
4.5
5.8
6
3.4
3.5
3.6
4.1
4.1
4.3
6
6.6
7.4
3.1
3.3
4
7.5
3.7
4
4.1
5
5.1
5.3
5.7
23
119
1.5
1.5
1.5
4.4
4.4
4.4
4.4
4.4
4.4
4.4
4.4
4.4
4.4
4.4
4.4
4.4
10.7
4.4
4.4
4.4
4.4
4.4
4.4
16.1
4.4
4.4
4.4
4.4
4.4

4.4
4.4
4.4
4.4
4.4
4.4
4.4
4.4
4.4
4.4
79.2
4.4
4.4
4.4
4.4
4.4
21
236
4
5
47
343
8
8
3.5
5
6
3.5
4
5
5
5
6
6
2.5
5
36
1
3.5
203
1
1
4
18
359
2
10
1.5
1.5
3
3.5
1
1
1
1

2
4
3
3
4
4
3
6
81
6
7
10
13
313
3
3
5
5
5
15
1
3
5
6
7
20
26
4
4
5
5
6
84
13
14
257
3
7
9
26
1

24000
25000
28000
29000
22000
22000
22000
23000
24000
24000
25000
26000
26000
27000
32000
19000
21000
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27000
23000
24000
24000
24000
25000
26000
27000
22800
23600
24700
24800
24800
25800
26200
19000
20400
21000
21500
21700
22900
24800
20300
21000
22800
23500
23900
26100
19400
20100

Shallow site wells - Magnesium (up to 3/97)

Number of samples		Uncensored values	
Uncensored	198	Mean	23864.44
Censored		Lognormal mean	47712.34
Detection limit or PQL		Std. devn.	5145.99657
Method detection limit		Median	24300
TOTAL	198	Min.	10
		Max.	40400

Lognormal distribution?		Normal distribution?	
r-squared is:	0.222	r-squared is:	0.685

Recommendations:
Reject lognormal distribution.
Y value is -82.0453. This lies outside the tabled values of 1.4931 and -2.3934
Reject normal distribution.
Y value is -32.7006. This lies outside the tabled values of 1.4931 and -2.3934

20500
20900
21100
21200
22100
22400
24200
33600
20100
20200
20900
21600
25700
19600
22100
24300
23200
23500
23600
23700
24300
26900
23200
23600
24900
25600
27100
28000
40400
23200
23300
24200
24400
24700
25000
25100
25500
26300
24300
24400
26300
29800
23400
23900
24100
24200
26400
29700
23200
24100
24800
25100
25300
23100
23600

24300
25100
26000
26100
26300
26700
27300
28400
22300
25500
25600
36800
22400
23300
23900
24000
24300
24500
29200
20200
21800
22300
22600
22800
24600
21400
22700
23000
23900
24600
25200
26200
26300
26800
27800
22700
22900
18700
24300
24800
27800
16300
23400
24000
25600
23900
28000
29500
23600
25200
26000
10
10
10
25100

10
10
24500
26200
26200
26300
28200
28900
29000
26000
27200
10
22300
24500
24600
26100
28000
21100
23900
25400
25500
26600
26600
24100
25300
26800
27900
28600
29800
25000
24500
24900
27100

7400
7900
8200
11000
6700
7400
7700
7900
8100
8100
8300
8400
8600
9000
10000
6900
6900
7100
7200
7200
7400
7500
7700
7900
7900
9300
7700
7800
8400
8600
8600
9600
7500
7410
7520
7570
7640
7840
8170
8180
6290
6510
6710
7180
7490
7690
9230
6130
6570
6610
6780
7080
7760
5850
5890

Shallow site wells - Potassium (up to 3/97)

Number of samples		Uncensored values	
Uncensored	198	Mean	7572.83
Censored		Lognormal mean	8507.28
Detection limit or PQL		Std. devn.	1623.50535
Method detection limit		Median	7700
TOTAL	198	Min.	200
		Max.	11000

Lognormal distribution?		Normal distribution?	
r-squared is:	0.317	r-squared is:	0.740

Recommendations:

Reject lognormal distribution.

Y value is -68.8692. This lies outside the tabled values of 1.4931 and -2.3934

Reject normal distribution.

Y value is -25.9403. This lies outside the tabled values of 1.4931 and -2.3934

6190
6330
6730
7070
7100
7210
7700
9110
6110
6230
6380
6990
7050
7940
8260
8510
7160
7280
7400
7590
8090
8510
7700
7770
7790
8050
8210
8310
0100
6720
7030
7440
7690
7790
7890
9090
9220
9440
7490
7750
8310
9080
6230
6390
6680
6970
7110
7780
6130
6140
7420
8340
9180
6940
7460

7670
7810
8210
8340
8360
8410
8660
8890
5760
6250
7720
8380
6650
6820
7000
7080
8130
8800
8980
6300
6680
6960
7060
7380
7600
6390
7400
7750
8110
8300
8510
8640
8790
9080
10200
7280
8520
7640
7640
8990
10400
7000
7100
7500
7800
7600
8300
10300
8100
8300
9100
200
200
200
7400

200
200
7100
7300
7600
8200
8400
9500
10500
8900
9600
200
6900
7200
7500
8300
9200
7300
7400
7400
8000
8100
8200
7500
8000
8100
8100
8600
9200
7600
8000
8400
9500

28000
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32000
36000
28000
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34000
35000
35000
36000
36000
37000
37000
37000
35000
31700
33400
34500
34700
34800
34900
36200
30600
30700
31000
31500
32600
33800
36700
29500
29900
30700
31000
31300
34400
25100
26900

Shallow site wells - Sodium (up to 3/97)

Number of samples		Uncensored values	
Uncensored	198	Mean	31649.49
Censored		Lognormal mean	41001.89
Detection limit or PQL		Std. devn.	6328.87788
Method detection limit		Median	32800
TOTAL	198	Min.	200
		Max.	45900

Lognormal distribution?		Normal distribution?	
r-squared is:	0.238	r-squared is:	0.597

Recommendations:
Reject lognormal distribution.
Y value is -79.5945. This lies outside the tabled values of 1.4931 and -2.3934
Reject normal distribution.
Y value is -39.4545. This lies outside the tabled values of 1.4931 and -2.3934

26900
27600
28400
28500
29600
31000
31200
31400
28700
29200
29700
30100
30200
34200
34300
34600
29200
30100
31600
32400
32800
33500
28800
30600
30600
30900
32400
32900
33300
28600
29400
31000
31700
31900
32600
32600
33100
35100
29500
33100
35100
35700
30200
31100
32200
32900
34300
36700
29900
31500
32500
32600
34100
36000
32600

33600
34200
34300
34300
35400
35900
36300
36600
25200
28400
29200
30500
22100
29300
29600
29900
30600
31600
31700
28100
29100
29900
30900
31300
32100
29500
30400
31200
32600
32700
32900
33900
34900
35800
38300
33100
33200
33000
33700
35700
45900
31400
32900
33000
34600
24700
32600
34400
28800
34000
35900
200
200
200
34900

200
200
33300
35100
30600
34800
35000
37900
43200
34900
40500
200
32500
32800
33600
34200
34300
26700
31500
31600
33400
33400
35500
29300
32900
33500
33600
35700
37600
32800
32900
33500
35100

Shallow site wells - Vanadium (up to 3/97)

Number of samples		Uncensored values	
Uncensored	233	Mean	15.97
Censored		Lognormal mean	16.73
Detection limit or PQL		Std. devn.	5.17888833
Method detection limit		Median	16.3
TOTAL	233	Min.	0.5
		Max.	31.8

Lognormal distribution?		Normal distribution?	
r-squared is:	0.689	r-squared is:	0.938

Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 16.536131319549

21
21
21
21
21
21
21
21
21
21
21
21
21
21
21
21
21
21
21
21
21
21
21
16.3
16.6
17.3
17.4
17.6
19.5
31.8
14.3
16.1
16.8
17.1
17.6
17.6
19
19.2
19.9
12.9
14.6
18.1
18.5
14.2
15.2
16.6
17.1
17.6
18.1
16.2
17.2
18
19
2.1

13.6
8.15
8.8
10.4
12.15
12.25
12.7
13.25
14.3
15
15.9
16.2
18.9
6.3
6.3
6.3
6.3
13.7
17.7
18.25
25.1
6.3
9.1
10.45
10.85
11.1
15.7
6.3
6.3
6.3
6.3
6.3
6.3
6.3
6.3
6.3
6.3
6.3
6.3
14.4
6.3
6.3
12.6
15
18
19
23
13
15
16
16
27
12
14
15

15
17
18
14
17
17
18
1.5
14
15
18
12
13
15
23
14
15
28
10
12
14
15
17
16
16
16
16
1.5
17
14
14
15
19
15
16
21
14
14
15
17
27
11
13
14
15
17
18
1.5
10
14
14
15
16
17
15

16
18
18
19
22
14
15
29
14
17
18
18
1.5

ATTACHMENT 3

SOIL DATA

4.4 Soil Background 1- Arsenic

5.1
5.3
5.7
5.7
5.7
5.8
5.8
5.8
6
6.2
6.4
6.5
6.7
6.8
7
7.1
7.3
7.8
8.4
8.7

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	21	Mean	6.39
Censored	0	Lognormal mean	6.39
TOTAL	21	Std. devn.	1.07
		Median	6.2
		Min.	4.4
		Max.	8.7

Lognormal distribution?	Normal distribution?
r-squared is: 0.97	r-squared is: 0.96

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	7.88
1 = Lognormal	50th	6.31
2 = Normal	4 X 50th	25.23
3 = Nonparametric method	Coefficient of Variation = 0.18	

1.5 Soil Background 1- Cadmium
1.5
1.5
1.5
1.5
1.5
1.5
1.6
1.6
1.7
1.7
1.7
1.8
1.8
1.9
1.9
1.9
2
2
2
2

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	21	Mean	1.72
Censored	0	Lognormal mean	1.72
TOTAL	21	Std. devn.	0.20
		Median	1.7
		Min.	1.5
		Max.	2

Lognormal distribution?	Normal distribution?
r-squared is: 0.88	r-squared is: 0.88

Recommendations:

Use nonparametric method.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	
1 = Lognormal	50th	
2 = Normal	4 X 50th	
3 = Nonparametric method		

1.9 Soil Background 1- Cadmium- Site Module

2
2
1.7
1.9
1.6
1.6
1.8
1.9
1.7
1.5
1.5
1.5
1.5
1.5
1.5
1.5
1.7
2
2
1.8

Number of samples		Uncensored values	
Uncensored	21	Mean	1.72
Censored		Lognormal mean	1.72
Detection limit or PQL		Std. devn.	0.19904534
Method detection limit		Median	1.7
TOTAL	21	Min.	1.5
		Max.	2

Lognormal distribution?		Normal distribution?	
r-squared is:	0.876	r-squared is:	0.876

Recommendations:
Reject lognormal distribution.
W value is 0.8521. This is less than the tabled value of 0.908
Reject normal distribution.
W value is 0.8527. This is less than the tabled value of 0.908

4.6 Soil Background 1- Chromium
4.8
5
5.1 MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	21	Mean	5.85
Censored	0	Lognormal mean	5.85
TOTAL	21	Std. devn.	0.66
		Median	5.9
		Min.	4.6
		Max.	7.1

5.4
5.5
5.5
5.5
5.9
5.9
5.9
5.9
6.1

Lognormal distribution?	Normal distribution?
r-squared is: 0.97	r-squared is: 0.97

6.1
6.2
6.2
6.2
6.3
6.6
7
7.1

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	6.78
1 = Lognormal	50th	5.81
2 = Normal	4 X 50th	23.25
3 = Nonparametric method	Coefficient of Variation = 0.12	

7.8
8.1
8.4
8.4
8.6
8.8
9.5
9.9
10.1
10.2
10.3
10.4
10.5
10.6
10.7
10.9
11.5
11.6
11.9
12.2
13.4

Soil Background 1- Copper

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	21	Mean	10.18
Censored	0	Lognormal mean	10.19
TOTAL	21	Std. devn.	1.48
		Median	10.3
		Min.	7.8
		Max.	13.4

Lognormal distribution?	Normal distribution?
r-squared is: 0.97	r-squared is: 0.97

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	12.27
1 = Lognormal	50th	10.08
2 = Normal	4 X 50th	40.32
3 = Nonparametric method	Coefficient of Variation = 0.15	

5.5 Background 1- Lead
5.8
6.2
6.4
6.4
6.5
6.6
7.1
7.2
7.2
7.2
7.3
7.3
7.4
7.4
7.5
7.9
8.1
8.5
8.7
9.1

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	21	Mean	7.20
Censored	0	Lognormal mean	7.21
TOTAL	21	Std. devn.	0.92
		Median	7.2
		Min.	5.5
		Max.	9.1

Lognormal distribution?	Normal distribution?
r-squared is: 0.98	r-squared is: 0.97

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	8.50
1 = Lognormal	50th	7.15
2 = Normal	4 X 50th	28.59
3 = Nonparametric method	Coefficient of Variation = 0.14	

7 Soil Background 1-Nickel

7.4
7.5
7.7
7.7
7.8
8.2
8.3
8.3
8.3
8.5
8.5
8.8
8.8
8.9
9.1
9.2
9.4
9.4
9.7
9.7

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	21	Mean	8.49
Censored	0	Lognormal mean	8.49
TOTAL	21	Std. devn.	0.78
		Median	8.5
		Min.	7
		Max.	9.7

Lognormal distribution?	Normal distribution?
r-squared is: 0.97	r-squared is: 0.98

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	9.58
1 = Lognormal	50th	8.45
2 = Normal	4 X 50th	33.80
3 = Nonparametric method	Coefficient of Variation = 0.1	

0.81
0.83
0.83
0.86
0.86
0.93
0.95
0.97
1
1
1.2
1.3
1.3
1.3
1.3
1.3
1.3
1.4
1.4
1.5
1.5

Soil Background 1 - Silver

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	21	Mean	1.14
Censored	0	Lognormal mean	1.14
TOTAL	21	Std. devn.	0.24
		Median	1.2
		Min.	0.81
		Max.	1.5

Lognormal distribution?	Normal distribution?
r-squared is: 0.90	r-squared is: 0.90

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	1.50
1 = Lognormal	50th	1.11
2 = Normal	4 X 50th	4.44
3 = Nonparametric method	Coefficient of Variation = 0.24	

27.7
29.5
29.5
31.9
32
32.4
32.9
33.4
34.2
34.3
34.5
34.7
34.8
35
35.4
35.9
36.2
36.3
36.7
36.8
39.7

Soil Background 1-Zinc

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	21	Mean	33.99
Censored	0	Lognormal mean	34.00
TOTAL	21	Std. devn.	2.82
		Median	34.5
		Min.	27.7
		Max.	39.7

Lognormal distribution?	Normal distribution?
r-squared is: 0.94	r-squared is: 0.96

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	38.06
1 = Lognormal	50th	33.88
2 = Normal	4 X 50th	135.50
3 = Nonparametric method	Coefficient of Variation = 0.09	

2 Soil Background 2-Cadmium

2.2
2.2
2.3
2.3
2.4
2.5
2.6
3
3
3
3.1
3.1
3.2
3.2
3.3
3.3
3.4
3.4
3.4
4
4.1

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	22	Mean	2.95
Censored	0	Lognormal mean	2.96
TOTAL	22	Std. devn.	0.58
		Median	3.05
		Min.	2
		Max.	4.1

Lognormal distribution?	Normal distribution?
r-squared is: 0.95	r-squared is: 0.95

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	3.81
1 = Lognormal	50th	2.90
2 = Normal	4 X 50th	11.60
3 = Nonparametric method	Coefficient of Variation = 0.21	

2.7
3.3
3.9
4
4.2
4.4
4.4
5
5.8
6.2
6.8
7.6
7.7
7.8
8
9.2
9.5
9.6
9.9
10
10.7

Soil Background 2-Chromium

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	21	Mean	6.70
Censored	0	Lognormal mean	6.76
TOTAL	21	Std. devn.	2.53
		Median	6.8
		Min.	2.7
		Max.	10.7

Lognormal distribution?	Normal distribution?
r-squared is: 0.94	r-squared is: 0.95

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	10.94
1 = Lognormal	50th	6.21
2 = Normal	4 X 50th	24.83
3 = Nonparametric method	Coefficient of Variation = 0.46	

9.9
12.8
12.8
13.8
13.9
14.3
15.4
15.4
15.7
16
16.2
16.2
16.4
16.5
16.7
17.2
17.2
17.2
17.9
18.1
18.9
20.6

Soil Background 2-Copper

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	22	Mean	15.87
Censored	0	Lognormal mean	15.89
TOTAL	22	Std. devn.	2.32
		Median	16.2
		Min.	9.9
		Max.	20.6

Lognormal distribution?	Normal distribution?
r-squared is: 0.91	r-squared is: 0.95

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	19.52
1 = Lognormal	50th	15.69
2 = Normal	4 X 50th	62.77
3 = Nonparametric method	Coefficient of Variation = 0.17	

7.1
7.9
8.3
8.7
8.9
9.3
9.4
9.5
9.8
9.9
10.1
10.1
10.3
10.3
10.7
10.8
11.2
11.5
11.6
14.4
14.7
15.4

Soil Background 2- Lead

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	22	Mean	10.45
Censored	0	Lognormal mean	10.45
TOTAL	22	Std. devn.	2.11
		Median	10.1
		Min.	7.1
		Max.	15.4

Lognormal distribution?	Normal distribution?
r-squared is: 0.95	r-squared is: 0.90

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	13.33
1 = Lognormal	50th	10.26
2 = Normal	4 X 50th	41.05
3 = Nonparametric method	Coefficient of Variation = 0.21	

8
8.6
8.6
8.7
9
9.4
9.5
9.6
10
10.3
11.2
11.6
11.7
11.9
12.1
12.2
12.4
13
13.6
14.1
14.8
16.1

Soil Background 2-Nickel

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	22	Mean	11.20
Censored	0	Lognormal mean	11.21
TOTAL	22	Std. devn.	2.23
		Median	11.4
		Min.	8
		Max.	16.1

Lognormal distribution?	Normal distribution?
r-squared is: 0.97	r-squared is: 0.96

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	14.32
1 = Lognormal	50th	10.99
2 = Normal	4 X 50th	43.98
3 = Nonparametric method	Coefficient of Variation = 0.21	

0.75
0.83
0.91
0.95
0.95
0.98
1
1
1.1
1.1
1.2
1.2
1.2
1.2
1.3
1.3
1.4
1.5
1.7
1.8
2
2.3

Soil Background 2-Silver

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	22	Mean	1.26
Censored	0	Lognormal mean	1.26
TOTAL	22	Std. devn.	0.39
		Median	1.2
		Min.	0.75
		Max.	2.3

Lognormal distribution?

r-squared is: 0.96

Normal distribution?

r-squared is: 0.89

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	1.78
1 = Lognormal	50th	1.21
2 = Normal	4 X 50th	4.83
3 = Nonparametric method	Coefficient of Variation = 0.31	

31.8
32
32.7
36.4
37.9
38.4
38.9
41.8
42
42
42.1
43.7
44.1
44.3
44.7
45.4
46.4
47.5
48.2
49.4
49.8
55.2

Soil Background 2- Zinc

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	22	Mean	42.49
Censored	0	Lognormal mean	42.52
TOTAL	22	Std. devn.	6.04
		Median	42.9
		Min.	31.8
		Max.	55.2

Lognormal distribution?	Normal distribution?
r-squared is: 0.96	r-squared is: 0.97

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	51.29
1 = Lognormal	50th	42.06
2 = Normal	4 X 50th	168.25
3 = Nonparametric method	Coefficient of Variation = 0.16	

NON-PARAMETRIC CALCULATIONS FOR SOIL BACKGROUND EVENTS

Pasco Landfill
Pasco, Washington

BG-1 Antimony	Ranks
0.50	1
0.55	2
0.55	3
0.55	4
0.55	5
0.55	6
0.60	7
0.60	8
0.60	9
0.65	10
0.65	11
1.50	12
1.70	13
2.00	14
2.30	15
2.40	16
2.50	17
2.60	18
3.20	19 *
3.30	20 *
3.60	21

Rank of 90th percentile data (v)= 19.8

The 90th percentile is = **3.28**

BG-1 Berrylium	Ranks
0.05	1
0.06	2
0.06	3
0.06	4
0.06	5
0.06	6
0.06	7
0.06	8
0.06	9
0.06	10
0.06	11
0.06	12
0.06	13
0.06	14
0.06	15
0.06	16
0.06	17
0.06	18
0.06	19 *
0.06	20 *
0.07	21

Rank of 90th percentile data (v) = 19.8

The 90th percentile is = **0.06**

BG-1 Cadmium	Ranks
1.50	1
1.50	2
1.50	3
1.50	4
1.50	5
1.50	6
1.50	7
1.60	8
1.60	9
1.70	10
1.70	11
1.70	12
1.80	13
1.80	14
1.90	15
1.90	16
1.90	17
2.00	18
2.00	19
2.00	20
2.00	21

Rank of 90th percentile data = 19.8

The 90th percentile is = **2**

NON-PARAMETRIC CALCULATIONS FOR SOIL BACKGROUND EVENTS

Pasco Landfill
Pasco, Washington

BG-1 Mercury	Ranks
0.04	1
0.04	2
0.04	3
0.04	4
0.04	5
0.04	6
0.04	7
0.04	8
0.04	9
0.04	10
0.04	11
0.05	12
0.05	13
0.05	14
0.05	15
0.05	16
0.05	17
0.05	18
0.05	19
0.05	20
0.53	21

Rank of 90th percentile data = 19.8

The 90th percentile is = **0.05**

BG-1 Thallium	Ranks
1.55	1
1.55	2
1.60	3
1.60	4
1.65	5
1.65	6
1.65	7
1.65	8
1.70	9
1.70	10
1.70	11
1.75	12
1.75	13
1.75	14
1.75	15
1.75	16
1.85	17
1.85	18
1.85	19
1.85	20
2.00	21

Rank of 90th percentile data = 19.8

The 90th percentile is = **1.85**

BG-1 Selenium	Ranks
1.00	1
1.00	2
1.05	3
1.05	4
1.10	5
1.10	6
1.10	7
1.10	8
1.10	9
1.10	10
1.15	11
1.15	12
1.15	13
1.15	14
1.15	15
1.20	16
1.25	17
1.25	18
1.25	19
1.25	20
1.30	21

Rank of 90th percentile data = 19.8

The 90th percentile is = **1.25**

NON-PARAMETRIC CALCULATIONS FOR SOIL BACKGROUND EVENTS

Pasco Landfill
Pasco, Washington

BG-2 Antimony	Ranks
2.40	1
2.40	2
2.50	3
2.60	4
2.60	5
2.60	6
2.65	7
2.70	8
2.75	9
2.75	10
2.75	11
2.80	12
2.80	13
2.80	14
2.85	15
2.85	16
2.85	17
2.90	18
2.90	19
3.00	20 *
3.00	21 *
3.00	22

Rank of 90th percentile data = 20.7

The 90th percentile is = **3**

BG-2 Arsenic	Ranks
3.95	1
4.20	2
4.30	3
4.35	4
4.40	5
4.55	6
4.55	7
4.65	8
4.70	9
4.75	10
4.75	11
4.80	12
4.85	13
4.95	14
5.00	15
5.00	16
8.80	17
10.80	18
12.10	19
12.70	20 *
14.90	21 *
18.90	22

Rank of 90th percentile data = 20.7

The 90th percentile is = **14.24**

BG-2 Berrylium	Ranks
0.01	1
0.01	2
0.01	3
0.01	4
0.01	5
0.01	6
0.01	7
0.01	8
0.01	9
0.01	10
0.01	11
0.01	12
0.01	13
0.01	14
0.01	15
0.01	16
0.01	17
0.01	18
0.01	19
0.01	20 *
0.01	21 *
0.01	22

Rank of 90th percentile data = 20.7

The 90th percentile is = **0.01**

NON-PARAMETRIC CALCULATIONS FOR SOIL BACKGROUND EVENTS

Pasco Landfill
Pasco, Washington

BG-2 Mercury	Ranks
0.02	1
0.02	2
0.02	3
0.02	4
0.02	5
0.02	6
0.02	7
0.02	8
0.02	9
0.02	10
0.02	11
0.02	12
0.02	13
0.02	14
0.02	15
0.02	16
0.02	17
0.02	18
0.02	19
0.02	20 *
0.03	21 *
0.03	22

Rank of 90th percentile data = 20.7

The 90th percentile is = **0.028**

BG-2 Selenium	Ranks
4.30	1
4.95	2
5.95	3
6.05	4
6.20	5
6.45	6
6.50	7
6.60	8
6.75	9
6.85	10
6.85	11
6.90	12
6.95	13
7.05	14
7.05	15
7.10	16
7.10	17
7.15	18
7.25	19
7.30	20 *
7.55	21 *
7.55	22

Rank of 90th percentile data = 20.7

The 90th percentile is = **7.48**

BG-2 Thallium	Ranks
5.95	1
6.05	2
6.20	3
6.45	4
6.45	5
6.50	6
6.60	7
6.75	8
6.85	9
6.85	10
6.90	11
6.95	12
7.05	13
7.05	14
7.10	15
7.10	16
7.15	17
7.25	18
7.30	19
7.45	20 *
7.55	21 *
7.55	22

Rank of 90th percentile data = 20.7

The 90th percentile is = **7.52**

2.1
1.8
2.3

ENTER TITLE HERE Site Soil - Zone A - Cadmium

Number of samples		Uncensored values	
Uncensored	3	Mean	2.07
Censored		Lognormal mean	2.07
Detection limit or PQL		Std. devn.	0.25166115
Method detection limit		Median	2.1
TOTAL	3	Min.	1.8
		Max.	2.3

Lognormal distribution? Normal distribution?
r-squared is: r-squared is:

Recommendations:
Assume lognormal distribution.
W value is 0.977. This exceeds the tabled value of 0.767

UCL (Land's method) is 2.66691525898436

2.5
2.4
5

ENTER TITLE HERE Site Soil - Zone A - Chromium

Number of samples		Uncensored values	
Uncensored	3	Mean	3.30
Censored		Lognormal mean	3.38
Detection limit or PQL		Std. devn.	1.47309199
Method detection limit		Median	2.5
TOTAL	3	Min.	2.4
		Max.	5

Lognormal distribution? Normal distribution?
r-squared is: r-squared is:

Recommendations:
Assume lognormal distribution.
W value is 0.7917. This exceeds the tabled value of 0.767

UCL (Land's method) is 16.2436651702681

11.6
12.2
12.3

ENTER TITLE HERE Site Soil - Zone A - Copper

Number of samples		Uncensored values	
Uncensored	3	Mean	12.03
Censored		Lognormal mean	12.04
Detection limit or PQL		Std. devn.	0.37859389
Method detection limit		Median	12.2
TOTAL	3	Min.	11.6
		Max.	12.3

Lognormal distribution? Normal distribution?
r-squared is: r-squared is:

Recommendations:
Assume lognormal distribution.
W value is 0.8439. This exceeds the tabled value of 0.767

UCL (Land's method) is 12.6950768056874

5.1
4.5
5.7

ENTER TITLE HERE Site Soil - Zone A - Lead

Number of samples		Uncensored values	
Uncensored	3	Mean	5.10
Censored		Lognormal mean	5.11
Detection limit or PQL		Std. devn.	0.6
Method detection limit		Median	5.1
TOTAL	3	Min.	4.5
		Max.	5.7

Lognormal distribution?		Normal distribution?	
r-squared is:	0.999	r-squared is:	

Recommendations:
Use lognormal distribution.

Unable to analyze probability plot for normal case.

UCL (Land's method) is 6.48750734267388

4.9
6.1
7.5

ENTER TITLE HERE Site Soil - Zone A - Nickel

Number of samples		Uncensored values	
Uncensored	3	Mean	6.17
Censored		Lognormal mean	6.21
Detection limit or PQL		Std. devn.	1.30128142
Method detection limit		Median	6.1
TOTAL	3	Min.	4.9
		Max.	7.5

Lognormal distribution?		Normal distribution?	
r-squared is:	1.000	r-squared is:	0.998

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 10.3658339014361

0.93
1.8
1.7

ENTER TITLE HERE Site Soil - Zone A - Silver

Number of samples		Uncensored values	
Uncensored	3	Mean	1.48
Censored		Lognormal mean	1.52
Detection limit or PQL		Std. devn.	0.47606022
Method detection limit		Median	1.7
TOTAL	3	Min.	0.93
		Max.	1.8

Lognormal distribution? Normal distribution?
r-squared is: r-squared is:

Recommendations:
Assume lognormal distribution.
W value is 0.8143. This exceeds the tabled value of 0.767

UCL (Land's method) is 5.30125215193128

25.8
30.3
33.8

ENTER TITLE HERE Site Soil - Zone A - Zinc

Number of samples		Uncensored values	
Uncensored	3	Mean	29.97
Censored		Lognormal mean	30.06
Detection limit or PQL		Std. devn.	4.01040314
Method detection limit		Median	30.3
TOTAL	3	Min.	25.8
		Max.	33.8

Lognormal distribution?	Normal distribution?	
r-squared is:	r-squared is:	0.995

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 39.8920887956597

2.3 ENTER TITLE HERE Site Soil - Zone B - Cadmium
3
3.1
2.3
2.9
3.1
2.5
2.2

Number of samples		Uncensored values	
Uncensored	8	Mean	2.68
Censored		Lognormal mean	2.68
Detection limit or PQL		Std. devn.	0.38821938
Method detection limit		Median	2.7
TOTAL	8	Min.	2.2
		Max.	3.1

Lognormal distribution?		Normal distribution?	
r-squared is:	0.875	r-squared is:	0.875

Recommendations:
Assume lognormal distribution.
W value is 0.8431. This exceeds the tabled value of 0.818

UCL (Land's method) is 2.97547878891025

7
7.3
3.6
1.8
9.6
8
2.4
3.6

ENTER TITLE HERE Site Soil - Zone B - Chromium

Number of samples		Uncensored values	
Uncensored	8	Mean	5.41
Censored		Lognormal mean	5.63
Detection limit or PQL		Std. devn.	2.90341548
Method detection limit		Median	5.3
TOTAL	8	Min.	1.8
		Max.	9.6

Lognormal distribution?		Normal distribution?	
r-squared is:	0.926	r-squared is:	0.929

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 10.2324818386361

16.5
12.5
12.3
11.1
16.5
17.1
11.3
10.4

ENTER TITLE HERE Site Soil - Zone B - Copper

Number of samples		Uncensored values	
Uncensored	8	Mean	13.46
Censored		Lognormal mean	13.49
Detection limit or PQL		Std. devn.	2.76712202
Method detection limit		Median	12.4
TOTAL	8	Min.	10.4
		Max.	17.1

Lognormal distribution?		Normal distribution?	
r-squared is:	0.878	r-squared is:	0.859

Recommendations:
Assume lognormal distribution.
W value is 0.852. This exceeds the tabled value of 0.818

UCL (Land's method) is 15.6540396198092

13
9.3
8.4
2.5
10.5
13.2
6
7.2

ENTER TITLE HERE Site Soil - Zone B - Lead

Number of samples		Uncensored values	
Uncensored	8	Mean	8.76
Censored		Lognormal mean	9.14
Detection limit or PQL		Std. devn.	3.59322279
Method detection limit		Median	8.85
TOTAL	8	Min.	2.5
		Max.	13.2

Lognormal distribution?		Normal distribution?	
r-squared is:	0.852	r-squared is:	0.967

Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 11.1699006088323

Compliance calculations

12.1
12.7
8.8
7.5
15.1
14
8
8.3

ENTER TITLE HERE Site Soil - Zone B - Nickel

Number of samples		Uncensored values	
Uncensored	8	Mean	10.81
Censored		Lognormal mean	10.87
Detection limit or PQL		Std. devn.	3.00020833
Method detection limit		Median	10.45
TOTAL	8	Min.	7.5
		Max.	15.1

Lognormal distribution?		Normal distribution?	
r-squared is:	0.907	r-squared is:	0.906

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 13.4640950443932

1.5
0.77
1.4
1.7
0.99
1
1
0.97

ENTER TITLE HERE Site Soil - Zone B - Silver

Number of samples		Uncensored values	
Uncensored	8	Mean	1.17
Censored		Lognormal mean	1.17
Detection limit or PQL		Std. devn.	0.32354896
Method detection limit		Median	1
TOTAL	8	Min.	0.77
		Max.	1.7

Lognormal distribution?		Normal distribution?	
r-squared is:	0.902	r-squared is:	0.882

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 1.43967891337885

47.3
42.1
34.1
25.1
48.2
48.6
33.2
33.2

ENTER TITLE HERE Site Soil - Zone B - Zinc

Number of samples		Uncensored values	
Uncensored	8	Mean	38.98
Censored		Lognormal mean	39.15
Detection limit or PQL		Std. devn.	8.78143334
Method detection limit		Median	38.1
TOTAL	8	Min.	25.1
		Max.	48.6

Lognormal distribution?		Normal distribution?	
r-squared is:	0.895	r-squared is:	0.904

Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 44.8584169795206

5
6.2
6.1
2
1.4
4.6
5.5
4.3
1.8

ENTER TITLE HERE Site Soil - Zone C - Arsenic

Number of samples		Uncensored values	
Uncensored	9	Mean	4.10
Censored		Lognormal mean	4.26
Detection limit or PQL		Std. devn.	1.88613361
Method detection limit		Median	4.6
TOTAL	9	Min.	1.4
		Max.	6.2

Lognormal distribution?		Normal distribution?	
r-squared is:	0.847	r-squared is:	0.897

Recommendations:
Reject lognormal distribution.
W value is 0.8271. This is less than the tabled value of 0.829
Assume normal distribution.
W value is 0.8711. This exceeds the tabled value of 0.829

UCL (based on t-statistic) is 5.26940283905932

1.5 ENTER TITLE HERE Site Soil - Zone C - Cadmium
2.2
2
2.4
2.4
2.1
2.5
2.4
2.4

Number of samples		Uncensored values	
Uncensored	9	Mean	2.21
Censored		Lognormal mean	2.22
Detection limit or PQL		Std. devn.	0.31402406
Method detection limit		Median	2.4
TOTAL	9	Min.	1.5
		Max.	2.5

Lognormal distribution?		Normal distribution?	
r-squared is:	0.746	r-squared is:	0.793

Recommendations:
Reject lognormal distribution.
W value is 0.7622. This is less than the tabled value of 0.829
Reject normal distribution.
W value is 0.8048. This is less than the tabled value of 0.829

3.3
9.9
10
8.5
4.2
11.7
12.1
8.3
5.4

ENTER TITLE HERE Site Soil - Zone C - Chromium

Number of samples		Uncensored values	
Uncensored	9	Mean	8.16
Censored		Lognormal mean	8.34
Detection limit or PQL		Std. devn.	3.19222145
Method detection limit		Median	8.5
TOTAL	9	Min.	3.3
		Max.	12.1

Lognormal distribution?		Normal distribution?	
r-squared is:	0.896	r-squared is:	0.943

Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 10.1347328537726

11.7
15.8
16.4
14.2
13.9
15.4
17.3
13.7
11.5

ENTER TITLE HERE Site Soil - Zone C - Copper

Number of samples		Uncensored values	
Uncensored	9	Mean	14.43
Censored		Lognormal mean	14.45
Detection limit or PQL		Std. devn.	1.99499373
Method detection limit		Median	14.2
TOTAL	9	Min.	11.5
		Max.	17.3

Lognormal distribution?		Normal distribution?	
r-squared is:	0.949	r-squared is:	0.963

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 15.862938544941

2.25
9.8
12.7
8.8
7
10.6
17.3
8.2
8.7

ENTER TITLE HERE Site Soil - Zone C - Lead

Number of samples		Uncensored values	
Uncensored	9	Mean	9.48
Censored		Lognormal mean	9.94
Detection limit or PQL		Std. devn.	4.09282909
Method detection limit		Median	8.8
TOTAL	9	Min.	2.25
		Max.	17.3

Lognormal distribution?		Normal distribution?	
r-squared is:	0.803	r-squared is:	0.925

Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 12.0208873721668

0.02
0.12
0.12
0.11
0.09
0.12
0.12
0.1
0.1

ENTER TITLE HERE Site Soil - Zone C - Mercury

Number of samples		Uncensored values	
Uncensored	9	Mean	0.10
Censored		Lognormal mean	0.11
Detection limit or PQL		Std. devn.	0.03201562
Method detection limit		Median	0.11
TOTAL	9	Min.	0.02
		Max.	0.12

Lognormal distribution?		Normal distribution?	
r-squared is:	0.516	r-squared is:	0.657

Recommendations:
Reject lognormal distribution.
W value is 0.5438. This is less than the tabled value of 0.829
Reject normal distribution.
W value is 0.6707. This is less than the tabled value of 0.829

7.3
13.7
13.4
13.3
9.6
15.6
15.7
13.6
9.7

ENTER TITLE HERE Site Soil - Zone C - Nickel

Number of samples		Uncensored values	
Uncensored	9	Mean	12.43
Censored		Lognormal mean	12.51
Detection limit or PQL		Std. devn.	2.89827535
Method detection limit		Median	13.4
TOTAL	9	Min.	7.3
		Max.	15.7

Lognormal distribution?		Normal distribution?	
r-squared is:	0.859	r-squared is:	0.894

Recommendations:
Assume lognormal distribution.
W value is 0.8553. This exceeds the tabled value of 0.829

UCL (Land's method) is 14.9826962102555

2.5
1.6
1.3
1.8
2.5
1.3
1.4
1.2
2.1

ENTER TITLE HERE Site Soil - Zone C - Silver

Number of samples		Uncensored values	
Uncensored	9	Mean	1.74
Censored		Lognormal mean	1.75
Detection limit or PQL		Std. devn.	0.51261855
Method detection limit		Median	1.6
TOTAL	9	Min.	1.2
		Max.	2.5

Lognormal distribution?		Normal distribution?	
r-squared is:	0.921	r-squared is:	0.894

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 2.14146683834845

33.8
46.2
49.5
45.9
49
47.7
53.3
43.4
40.8

ENTER TITLE HERE Site Soil - Zone C - Zinc

Number of samples		Uncensored values	
Uncensored	9	Mean	45.51
Censored		Lognormal mean	45.57
Detection limit or PQL		Std. devn.	5.67856594
Method detection limit		Median	46.2
TOTAL	9	Min.	33.8
		Max.	53.3

Lognormal distribution?		Normal distribution?	
r-squared is:	0.888	r-squared is:	0.927

Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 49.0318219926109

2
9.4
11.5
3.1
7.7
6.5
7.5
3.5
11.8
7.9
5
1.7

ENTER TITLE HERE Site Soil - Zone E - Arsenic

Number of samples		Uncensored values	
Uncensored	12	Mean	6.47
Censored		Lognormal mean	6.76
Detection limit or PQL		Std. devn.	3.46392666
Method detection limit		Median	7
TOTAL	12	Min.	1.7
		Max.	11.8

Lognormal distribution?		Normal distribution?	
r-squared is:	0.928	r-squared is:	0.961

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 10.7641834162017

2
2.5
2.4
2.6
3
2.7
2.5
2.4
2.5
1.5
2.2
3

ENTER TITLE HERE Site Soil - Zone E - Cadmium

Number of samples		Uncensored values	
Uncensored	12	Mean	2.44
Censored		Lognormal mean	2.45
Detection limit or PQL		Std. devn.	0.41221868
Method detection limit		Median	2.5
TOTAL	12	Min.	1.5
		Max.	3

Lognormal distribution?		Normal distribution?	
r-squared is:	0.852	r-squared is:	0.911

Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 2.65538578824752

8.4
7.8
8.4
3.4
9.4
8.4
7.8
4.6
10.7
7.9
12.1
6
5.28
7.72
7.68
6.14
7.37
7.11
6.68
6.62

ENTER TITLE HERE Site Soil - Zone E - Chromium

Number of samples		Uncensored values	
Uncensored	20	Mean	7.48
Censored		Lognormal mean	7.51
Detection limit or PQL		Std. devn.	1.96966601
Method detection limit		Median	7.7
TOTAL	20	Min.	3.4
		Max.	12.1

Lognormal distribution?		Normal distribution?	
r-squared is:	0.928	r-squared is:	0.956

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 8.46031946631437

33.3
24.5
15.4
20.7
17.2
19
18.1
14.9
19.5
14.2
17.2
14.4

ENTER TITLE HERE Site Soil- Zone E - Copper

Number of samples		Uncensored values	
Uncensored	12	Mean	19.03
Censored		Lognormal mean	19.03
Detection limit or PQL		Std. devn.	5.38623386
Method detection limit		Median	17.65
TOTAL	12	Min.	14.2
		Max.	33.3

Lognormal distribution?		Normal distribution?	
r-squared is:	0.884	r-squared is:	0.791

Recommendations:
Assume lognormal distribution.
W value is 0.8889. This exceeds the tabled value of 0.859

UCL (Land's method) is 21.8807303419457

26.8
9.7
14.5
5.5
11.2
10.7
7.9
6.5
13.3
9.6
11.3
6.7

ENTER TITLE HERE Site Soil - Zone E - Lead

Number of samples		Uncensored values	
Uncensored	12	Mean	11.14
Censored		Lognormal mean	11.14
Detection limit or PQL		Std. devn.	5.63599767
Method detection limit		Median	10.2
TOTAL	12	Min.	5.5
		Max.	26.8

Lognormal distribution?		Normal distribution?	
r-squared is:	0.935	r-squared is:	0.766

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 14.4830217027609

180
2.6
0.2
0.13
15.6
2.4
0.02
0.02
0.12
0.1
0.11
0.12

ENTER TITLE HERE Site Soil - Zone E - Mercury

Number of samples		Uncensored values	
Uncensored	12	Mean	16.79
Censored		Lognormal mean	18.72
Detection limit or PQL		Std. devn.	51.5885416
Method detection limit		Median	0.125
TOTAL	12	Min.	0.02
		Max.	180

Lognormal distribution?		Normal distribution?	
r-squared is:	0.864	r-squared is:	0.343

Recommendations:
Assume lognormal distribution.
W value is 0.8646. This exceeds the tabled value of 0.859

UCL (Land's method) is 4690.45278151585

12.2
13.2
12.4
9
13.3
12.5
12.5
9.1
14.9
11.7
15.4
10.8

ENTER TITLE HERE Site Soil - Zone E - Nickel

Number of samples		Uncensored values	
Uncensored	12	Mean	12.25
Censored		Lognormal mean	12.27
Detection limit or PQL		Std. devn.	1.95378421
Method detection limit		Median	12.45
TOTAL	12	Min.	9
		Max.	15.4

Lognormal distribution?		Normal distribution?	
r-squared is:	0.925	r-squared is:	0.947

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 13.4396970628869

1.2
1.6
1.7
1.9
2
1.5
1.7
1.8
1.6
1.7
1.2
2.5

ENTER TITLE HERE Site Soil - Zone E - Silver

Number of samples		Uncensored values	
Uncensored	12	Mean	1.70
Censored		Lognormal mean	1.70
Detection limit or PQL		Std. devn.	0.34902461
Method detection limit		Median	1.7
TOTAL	12	Min.	1.2
		Max.	2.5

Lognormal distribution?		Normal distribution?	
r-squared is:	0.931	r-squared is:	0.911

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 1.90620299083085

66.6
45.1
53.4
39.3
48.5
48.7
49.2
39.9
53.1
41.3
52
48.7

ENTER TITLE HERE Site Soil - Zone E - Zinc

Number of samples		Uncensored values	
Uncensored	12	Mean	48.82
Censored		Lognormal mean	48.85
Detection limit or PQL		Std. devn.	7.42475385
Method detection limit		Median	48.7
TOTAL	12	Min.	39.3
		Max.	66.6

Lognormal distribution?		Normal distribution?	
r-squared is:	0.922	r-squared is:	0.889

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 52.9114859339364

2
8.8
4.4
3.1
4.55
8
6.8
3.7
1.8
12.6
10.2
4.9

ENTER TITLE HERE Site Soil - SL2&SL3 - Arsenic

Number of samples		Uncensored values	
Uncensored	12	Mean	5.90
Censored		Lognormal mean	6.07
Detection limit or PQL		Std. devn.	3.39494667
Method detection limit		Median	4.725
TOTAL	12	Min.	1.8
		Max.	12.6

Lognormal distribution?		Normal distribution?	
r-squared is:	0.975	r-squared is:	0.945

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 9.32710194211769

2.3
2.9
2
2.3
2.4
2.1
2.4
2.3
2.4
2.4
2.4
2.6

ENTER TITLE HERE Site Soil - SL2&SL3 - Cadmium

Number of samples		Uncensored values	
Uncensored	12	Mean	2.38
Censored		Lognormal mean	2.38
Detection limit or PQL		Std. devn.	0.22613351
Method detection limit		Median	2.4
TOTAL	12	Min.	2
		Max.	2.9

Lognormal distribution?		Normal distribution?	
r-squared is:	0.882	r-squared is:	0.866

Recommendations:
Assume lognormal distribution.
W value is 0.9055. This exceeds the tabled value of 0.859

UCL (Land's method) is 2.49738387093833

8.2
8.7
8.3
4.2
8.7
7.3
9.7
5
8.2
9.6
8.5
4.5

ENTER TITLE HERE Site Soil - SL2&SL3 - Chromium

Number of samples		Uncensored values	
Uncensored	12	Mean	7.58
Censored		Lognormal mean	7.63
Detection limit or PQL		Std. devn.	1.92737457
Method detection limit		Median	8.25
TOTAL	12	Min.	4.2
		Max.	9.7

Lognormal distribution?		Normal distribution?	
r-squared is:	0.797	r-squared is:	0.844

Recommendations:
Reject lognormal distribution.
W value is 0.7859. This is less than the tabled value of 0.859
Reject normal distribution.
W value is 0.8313. This is less than the tabled value of 0.859

12.6
14.7
13.8
11.4
14.1
13.4
16.3
11.6
12.9
19.1
16.1
12.1

ENTER TITLE HERE Site Soil - SL2&SL3 - Copper

Number of samples		Uncensored values	
Uncensored	12	Mean	14.01
Censored		Lognormal mean	14.02
Detection limit or PQL		Std. devn.	2.25447367
Method detection limit		Median	13.6
TOTAL	12	Min.	11.4
		Max.	19.1

Lognormal distribution?		Normal distribution?	
r-squared is:	0.954	r-squared is:	0.920

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 15.242877016852

7.4
9.6
8.6
7.8
15
9.6
10.6
8.1
8.2
14.8
12.6
6.9

ENTER TITLE HERE Site Soil - SL2&SL3 - Lead

Number of samples		Uncensored values	
Uncensored	12	Mean	9.93
Censored		Lognormal mean	9.95
Detection limit or PQL		Std. devn.	2.78709146
Method detection limit		Median	9.1
TOTAL	12	Min.	6.9
		Max.	15

Lognormal distribution?		Normal distribution?	
r-squared is:	0.924	r-squared is:	0.875

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 11.5552838721465

11.5
12.9
12.6
8.3
12.1
11.8
15.1
9.8
11.9
13.4
12.2
9.4

ENTER TITLE HERE Site Soil - SL2&SL3 - Nickel

Number of samples		Uncensored values	
Uncensored	12	Mean	11.75
Censored		Lognormal mean	11.77
Detection limit or PQL		Std. devn.	1.84956997
Method detection limit		Median	12
TOTAL	12	Min.	8.3
		Max.	15.1

Lognormal distribution?		Normal distribution?	
r-squared is:	0.926	r-squared is:	0.948

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 12.88081163793

1.5 ENTER TITLE HERE Site Soil - SL2&SL3 - Silver
1.3
1.7
2.1
1.5
1.9
1.3
2.4
1.6
1.8
1.5
1.9

Number of samples		Uncensored values	
Uncensored	12	Mean	1.71
Censored		Lognormal mean	1.71
Detection limit or PQL		Std. devn.	0.32879486
Method detection limit		Median	1.65
TOTAL	12	Min.	1.3
		Max.	2.4

Lognormal distribution?		Normal distribution?	
r-squared is:	0.964	r-squared is:	0.942

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 1.89669503442573

40.8
44.9
42.5
39
44.2
40.8
47.9
38.7
42.3
50.5
44.3
37.6

ENTER TITLE HERE Site Soil - SI2&SL3 - Zinc

Number of samples		Uncensored values	
Uncensored	12	Mean	42.79
Censored		Lognormal mean	42.80
Detection limit or PQL		Std. devn.	3.82038987
Method detection limit		Median	42.4
TOTAL	12	Min.	37.6
		Max.	50.5

Lognormal distribution?		Normal distribution?	
r-squared is:	0.971	r-squared is:	0.958

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 44.8522367910606

6.2
6.9
6.3
8.3
7.3
9.9
8.9
9
8.9
10.7
10.5
8.2
11.4
8
8.7
12.2
10
10.1
10.8
9.7

ENTER TITLE HERE Site Soil - Sludge Area - Arsenic

Number of samples		Uncensored values	
Uncensored	20	Mean	9.10
Censored		Lognormal mean	9.11
Detection limit or PQL		Std. devn.	1.66005707
Method detection limit		Median	8.95
TOTAL	20	Min.	6.2
		Max.	12.2

Lognormal distribution?		Normal distribution?	
r-squared is:	0.968	r-squared is:	0.986

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 9.84466189714346

2.1 ENTER TITLE HERE Site Soil - Sludge Area - Cadmium
2.3
2.5
2.4
2.3
2.5
2.6
2
1.9
1.6
2
2.1
1.9
2.1
1.9
2.1
2
2
2.3
2.4

Number of samples		Uncensored values	
Uncensored	20	Mean	2.15
Censored		Lognormal mean	2.15
Detection limit or PQL		Std. devn.	0.25443436
Method detection limit		Median	2.1
TOTAL	20	Min.	1.6
		Max.	2.6

Lognormal distribution?		Normal distribution?	
r-squared is:	0.946	r-squared is:	0.954

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 2.2566153886298

6.6	ENTER TITLE HERE Site Soil - Sludge Area - Chromium
9	
21.9	
6.4	
5.9	
7.2	
7.1	
6.2	
5.1	
5.1	
6.6	
6.4	
6.1	
7.5	
7	
7.1	
5.9	
7.5	
8.5	
7	

Number of samples		Uncensored values	
Uncensored	20	Mean	7.51
Censored		Lognormal mean	7.42
Detection limit or PQL		Std. devn.	3.52322744
Method detection limit		Median	6.8
TOTAL	20	Min.	5.1
		Max.	21.9

Lognormal distribution?		Normal distribution?	
r-squared is:	0.662	r-squared is:	0.456

Recommendations:

Reject lognormal distribution.

W value is 0.6912. This is less than the tabled value of 0.905

Reject normal distribution.

W value is 0.4871. This is less than the tabled value of 0.905

12.4 ENTER TITLE HERE Site Soil - Sludge Area - Copper
13.6
12.4
12.4
10.9
13.1
12.1
12.4
11.8
11.4
12.1
12.6
12.7
12.7
15.1
16.4
14.6
17.7
13.8
13.5

Number of samples		Uncensored values	
Uncensored	20	Mean	13.19
Censored		Lognormal mean	13.19
Detection limit or PQL		Std. devn.	1.67025841
Method detection limit		Median	12.65
TOTAL	20	Min.	10.9
		Max.	17.7

Lognormal distribution?		Normal distribution?	
r-squared is:	0.908	r-squared is:	0.868

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 13.8280181639078

7.1 ENTER TITLE HERE Site Soil - Sludge Area - Lead
7.1
6.8
6.9
6.1
8.1
6.4
7.2
8
8
7.6
8.4
7.6
6.7
8.6
9.3
8.6
10.6
8
8.2

Number of samples		Uncensored values	
Uncensored	20	Mean	7.77
Censored		Lognormal mean	7.77
Detection limit or PQL		Std. devn.	1.06042444
Method detection limit		Median	7.8
TOTAL	20	Min.	6.1
		Max.	10.6

Lognormal distribution?		Normal distribution?	
r-squared is:	0.970	r-squared is:	0.942

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 8.19055076670028

10.1
11.2
9.9
9.8
9.8
10.9
10.4
9.4
8.3
8
10.3
9.7
9.5
11.7
9.4
9.9
9.2
10.8
11.3
10.1

ENTER TITLE HERE Site Soil - Sludge Area - Nickel

Number of samples		Uncensored values	
Uncensored	20	Mean	9.99
Censored		Lognormal mean	9.99
Detection limit or PQL		Std. devn.	0.92978492
Method detection limit		Median	9.9
TOTAL	20	Min.	8
		Max.	11.7

Lognormal distribution?		Normal distribution?	
r-squared is:	0.956	r-squared is:	0.969

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 10.3704551194483

0.91
1.3
1.6
1.4
1.4
1.4
1.3
0.94
1.4
1.4
1.5
1
1.1
0.95
1.3
1.4
1.3
1.3
1.8
1.5

ENTER TITLE HERE Site Soil - Sludge Area - Silver

Number of samples		Uncensored values	
Uncensored	20	Mean	1.31
Censored		Lognormal mean	1.31
Detection limit or PQL		Std. devn.	0.23081093
Method detection limit		Median	1.35
TOTAL	20	Min.	0.91
		Max.	1.8

Lognormal distribution?		Normal distribution?	
r-squared is:	0.898	r-squared is:	0.920

Recommendations:
Use normal distribution.

UCL (based on t-statistic) is 1.39923523289598

35.4
46
79.2
41.4
39.2
46.2
43.4
37.4
34.7
36.4
40
37.4
37.5
37.5
43.2
43.4
37.4
43.9
43.2
39.7

ENTER TITLE HERE Site Soil - Sludge Area - Zinc

Number of samples		Uncensored values	
Uncensored	20	Mean	42.13
Censored		Lognormal mean	42.05
Detection limit or PQL		Std. devn.	9.39556866
Method detection limit		Median	39.85
TOTAL	20	Min.	34.7
		Max.	79.2

Lognormal distribution?		Normal distribution?	
r-squared is:	0.679	r-squared is:	0.553

Recommendations:
Reject lognormal distribution.
W value is 0.7041. This is less than the tabled value of 0.905
Reject normal distribution.
W value is 0.582. This is less than the tabled value of 0.905

9.7
4.8
4.55
5
4.75
0.92
1.4
1.1

ENTER TITLE HERE Site Soil - Outside Area - Arsenic

Number of samples		Uncensored values	
Uncensored	8	Mean	4.03
Censored		Lognormal mean	4.40
Detection limit or PQL		Std. devn.	2.91903482
Method detection limit		Median	4.65
TOTAL	8	Min.	0.92
		Max.	9.7

Lognormal distribution?		Normal distribution?	
r-squared is:	0.873	r-squared is:	0.852

Recommendations:
Assume lognormal distribution.
W value is 0.8612. This exceeds the tabled value of 0.818

UCL (Land's method) is 12.1236934157728

3.8
1.4
3.6
3.6
2.9
0.05
0.05
0.05

ENTER TITLE HERE Site Soil - Outside Area - Cadmium

Number of samples		Uncensored values	
Uncensored	8	Mean	1.93
Censored		Lognormal mean	6.00
Detection limit or PQL		Std. devn.	1.72790904
Method detection limit		Median	2.15
TOTAL	8	Min.	0.05
		Max.	3.8

Lognormal distribution?		Normal distribution?	
r-squared is:	0.752	r-squared is:	0.839

Recommendations:
Reject lognormal distribution.
W value is 0.7187. This is less than the tabled value of 0.818
Reject normal distribution.
W value is 0.8026. This is less than the tabled value of 0.818

4.3
3.3
9.8
4.1
2.8
3.7
3.6
4.2

ENTER TITLE HERE Site Soil - Outside Area - Chromium

Number of samples		Uncensored values	
Uncensored	8	Mean	4.48
Censored		Lognormal mean	4.46
Detection limit or PQL		Std. devn.	2.20891053
Method detection limit		Median	3.9
TOTAL	8	Min.	2.8
		Max.	9.8

Lognormal distribution?		Normal distribution?	
r-squared is:	0.750	r-squared is:	0.610

Recommendations:
Reject lognormal distribution.
W value is 0.7799. This is less than the tabled value of 0.818
Reject normal distribution.
W value is 0.6412. This is less than the tabled value of 0.818

17.5
10.8
14.4
15
11.1
9.6
13
9.5

ENTER TITLE HERE Site Soil - Outside Area - Copper

Number of samples		Uncensored values	
Uncensored	8	Mean	12.61
Censored		Lognormal mean	12.65
Detection limit or PQL		Std. devn.	2.86028845
Method detection limit		Median	12.05
TOTAL	8	Min.	9.5
		Max.	17.5

Lognormal distribution?		Normal distribution?	
r-squared is:	0.954	r-squared is:	0.941

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 14.9286149453856

8.1
2.1
11.1
7.8
2.35
2.1
2.2
2.5

ENTER TITLE HERE Site Soil - Outside Area - Lead

Number of samples		Uncensored values	
Uncensored	8	Mean	4.78
Censored		Lognormal mean	4.88
Detection limit or PQL		Std. devn.	3.62943694
Method detection limit		Median	2.425
TOTAL	8	Min.	2.1
		Max.	11.1

Lognormal distribution?		Normal distribution?	
r-squared is:	0.778	r-squared is:	0.766

Recommendations:
Reject lognormal distribution.
W value is 0.7546. This is less than the tabled value of 0.818
Reject normal distribution.
W value is 0.7525. This is less than the tabled value of 0.818

7.9
5
12
8.4
6.7
4.7
6
5.5

ENTER TITLE HERE Site Soil - Outside Area - Nickel

Number of samples		Uncensored values	
Uncensored	8	Mean	7.03
Censored		Lognormal mean	7.05
Detection limit or PQL		Std. devn.	2.40223111
Method detection limit		Median	6.35
TOTAL	8	Min.	4.7
		Max.	12

Lognormal distribution?		Normal distribution?	
r-squared is:	0.946	r-squared is:	0.872

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 9.00206515802526

2.5
0.37
1.9
2.5
0.76
0.05
0.05
0.12

ENTER TITLE HERE Site Soil - Outside Area - Silver

Number of samples		Uncensored values	
Uncensored	8	Mean	1.03
Censored		Lognormal mean	1.72
Detection limit or PQL		Std. devn.	1.09126974
Method detection limit		Median	0.565
TOTAL	8	Min.	0.05
		Max.	2.5

Lognormal distribution?		Normal distribution?	
r-squared is:	0.902	r-squared is:	0.837

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 46.8478091322204

50.4
24.8
50.2
54.8
28.3
34
35
35

ENTER TITLE HERE Site Soil - Outside Area - Zinc

Number of samples		Uncensored values	
Uncensored	8	Mean	39.06
Censored		Lognormal mean	39.28
Detection limit or PQL		Std. devn.	11.2003747
Method detection limit		Median	35
TOTAL	8	Min.	24.8
		Max.	54.8

Lognormal distribution?		Normal distribution?	
r-squared is:	0.926	r-squared is:	0.908

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 49.1193392210513

7.1
5.1
6.7
5.9
5.7
7.8
7.5
6.1
7.7
4.2
5
8.5
6.2
5.2
6.2
6.4
6.7
8.2
7.4
5.9

ENTER TITLE HERE Site Soil - Landspread Area - Arsenic

Number of samples		Uncensored values	
Uncensored	20	Mean	6.48
Censored		Lognormal mean	6.48
Detection limit or PQL		Std. devn.	1.15068629
Method detection limit		Median	6.3
TOTAL	20	Min.	4.2
		Max.	8.5

Lognormal distribution?		Normal distribution?	
r-squared is:	0.975	r-squared is:	0.987

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 6.98483235567945

2 ENTER TITLE HERE Site Soil - Landspread Area - Cadmium

1
2
2
2
2
2
1
1
1
1
1
1
1
1
1
1
1
1
1
2
2

Number of samples		Uncensored values	
Uncensored	20	Mean	1.35
Censored		Lognormal mean	1.35
Detection limit or PQL		Std. devn.	0.48936048
Method detection limit		Median	1
TOTAL	20	Min.	1
		Max.	2

Lognormal distribution?		Normal distribution?	
r-squared is:	0.628	r-squared is:	0.628

Recommendations:
Reject lognormal distribution.
W value is 0.6077. This is less than the tabled value of 0.905
Reject normal distribution.
W value is 0.6077. This is less than the tabled value of 0.905

4.7
4.9
6
5.6
5.4
5.2
4.4
5.1
4.8
5.3
3.7
5.3
5.2
4.5
3.9
5.2
5.5
5.8
6.2
5.5

ENTER TITLE HERE Site Soil - Landspread Area - Chromium

Number of samples		Uncensored values	
Uncensored	20	Mean	5.11
Censored		Lognormal mean	5.11
Detection limit or PQL		Std. devn.	0.64146215
Method detection limit		Median	5.2
TOTAL	20	Min.	3.7
		Max.	6.2

Lognormal distribution?		Normal distribution?	
r-squared is:	0.933	r-squared is:	0.963

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 5.3916223894377

12.9
13.4
30.9
13.6
12.9
13.6
16.8
13
15.1
16.8
11.2
11.5
11.8
21.4
9.9
11
12.1
11.5
12.6
11.9

ENTER TITLE HERE Site Soil - Landspread Area - Copper

Number of samples		Uncensored values	
Uncensored	20	Mean	14.20
Censored		Lognormal mean	14.14
Detection limit or PQL		Std. devn.	4.71040003
Method detection limit		Median	12.9
TOTAL	20	Min.	9.9
		Max.	30.9

Lognormal distribution?		Normal distribution?	
r-squared is:	0.798	r-squared is:	0.659

Recommendations:
Reject lognormal distribution.
W value is 0.8144. This is less than the tabled value of 0.905
Reject normal distribution.
W value is 0.6816. This is less than the tabled value of 0.905

6.9
6.9
11.3
7.5
8
6.6
8.2
7.3
7.4
9
5.7
6.9
6.2
10
6.3
6.1
7.2
6.4
6.6
8.8

ENTER TITLE HERE Site Soil - Landspread Area - Lead

Number of samples		Uncensored values	
Uncensored	20	Mean	7.47
Censored		Lognormal mean	7.47
Detection limit or PQL		Std. devn.	1.40909639
Method detection limit		Median	7.05
TOTAL	20	Min.	5.7
		Max.	11.3

Lognormal distribution?		Normal distribution?	
r-squared is:	0.934	r-squared is:	0.881

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 8.0127007981581

7.7
7.6
8.5
8.8
7.9
8.2
7.3
7.8
7.4
7.8
6.8
7.9
8.2
7
7.1
8
8.7
8.5
8.8
8.7

ENTER TITLE HERE Site Soil - Landspread Area - Nickel

Number of samples		Uncensored values	
Uncensored	20	Mean	7.94
Censored		Lognormal mean	7.94
Detection limit or PQL		Std. devn.	0.61582209
Method detection limit		Median	7.9
TOTAL	20	Min.	6.8
		Max.	8.8

Lognormal distribution?		Normal distribution?	
r-squared is:	0.965	r-squared is:	0.968

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 8.18546810612819

0.75
0.69
1.1
0.71
0.95
0.75
0.82
0.81
0.77
0.99
0.97
0.62
0.59
1
0.65
1.1
0.83
1.1
1.1
1.3

ENTER TITLE HERE Site Soil - Landspread Area - Silver

Number of samples		Uncensored values	
Uncensored	20	Mean	0.88
Censored		Lognormal mean	0.88
Detection limit or PQL		Std. devn.	0.19681677
Method detection limit		Median	0.825
TOTAL	20	Min.	0.59
		Max.	1.3

Lognormal distribution?		Normal distribution?	
r-squared is:	0.968	r-squared is:	0.954

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 0.966061663965042

34.2
33.4
54.9
36.9
37.6
36.5
38.7
33.6
38.3
41.7
30.5
31.7
31.2
44.5
28.2
33.5
34.2
34.6
37.9
36.1

ENTER TITLE HERE Site Soil - Landspread Area - Zinc

Number of samples		Uncensored values	
Uncensored	20	Mean	36.41
Censored		Lognormal mean	36.41
Detection limit or PQL		Std. devn.	5.79581519
Method detection limit		Median	35.35
TOTAL	20	Min.	28.2
		Max.	54.9

Lognormal distribution?		Normal distribution?	
r-squared is:	0.909	r-squared is:	0.840

Recommendations:
Use lognormal distribution.

UCL (Land's method) is 38.6094234921469

C

APPENDIX C

METHOD B GROUNDWATER CLEANUP LEVELS

Appendix C - Method B Groundwater Cleanup Levels

1.0 Unadjusted Cleanup Levels for Preliminary Indicator Hazardous Substances

MTCA Method B cleanup levels were developed for each Preliminary Indicator Hazardous Substance (PIHS) in groundwater and soil (for evaluating protection of groundwater) using the following procedure presented in WAC 173-340-720 (3):

- **Step 1** - Federal Maximum Contaminant Levels (MCLs), MCL goals (MCLGs) for non-carcinogens, and secondary MCLs (SMCLs) were identified (Table C-1).
- **Step 2** -MCLs established by the state board of health were identified (Table C-1).
- **Step 3** - Human-health based levels were calculated for potential carcinogenic (Table C-2) and non-carcinogenic (Table C-3) effects using equations presented in WAC 173-340-720 (3)(A) and (B). These levels incorporate ingestion and inhalation exposures from groundwater.
- **Step 4** - The lowest value identified in Steps 1 through 3 was selected as the unadjusted Method B level (Table C-1).

Method B cleanup levels for individual PIHSs must be adjusted downward, if necessary, to meet the total risk and hazard index (HI) goals identified in WAC 173-340-720 (5)(a). The HI cannot exceed one and the total excess cancer risk cannot exceed one in 100,000 (1×10^{-5}).

<u>Chromium</u>

At the direction of Ecology, the chromium concentrations detected in groundwater were assumed to be hexavalent. In addition, when developing cleanup levels for soil that are protective of groundwater, the target chromium concentration in groundwater were the Method B groundwater level developed for hexavalent chromium.

We do not believe the assumption that chromium concentrations in groundwater are hexavalent is valid at this site. Although we acknowledge certain difficulties in the determination of hexavalent/trivalent chromium, we believe the analytical procedure to be adequate to establish that hexavalent chromium is not present.

Groundwater samples from the Pasco Landfill site were analyzed for Appendix I and II metals, including total chromium. In accordance with Task I.A.4 of

Exhibit B of the Agreed Order (DE94TC-E103) for the site, all metals analyses were performed on unfiltered samples.

The MTCA Method B cleanup Level for hexavalent chromium is 80 μg/L. As discussed in the Phase II RI Report (Sections 2.6.3, 2.6.4), only two groundwater monitoring wells (EE-8 and MW-19S) at the site have contained total chromium concentrations greater than 80 μg/L.

Groundwater samples from wells EE-8 and MW-19S and soil samples from borings B-17 and B-18 were analyzed for both total and hexavalent chromium during March 1996 as part of the 1st Quarter 1996 RI quarterly monitoring event. As noted in Sections 3.6.3.2 and 3.6.4.3 of the Phase II RI Report, no hexavalent chromium was detected in either boring or either well.

Development of soil and groundwater cleanup levels based on the assumption that all chromium in solution is present as the hexavalent form rather than the trivalent form appears to be contrary to the analytical results of the RI groundwater monitoring program and therefore inappropriate.

2.0 Adjusted Cleanup Levels for Preliminary Indicator Hazardous Substances

Potential Carcinogenic Effects

Using MTCA Method B standard methods, because 20 PIHSs were identified which may pose carcinogenic effects, the approximate risk at the unadjusted cleanup levels is 20×10^{-6} (2×10^{-5}). Since the total site risk goal (1×10^{-5}) is exceeded, unadjusted cleanup levels were adjusted downward to achieve this goal. Cleanup levels were adjusted downward in an iterative process, resulting in four PIHSs each being adjusted downward by dividing by 10 (i.e., a 90% reduction), and three PIHSs each being adjusted downward by dividing by 2 (i.e., a 50% reduction). Potential intakes associated with ingestion and inhalation exposures to adjusted cleanup levels are presented in Table C-4, and the potential risk from the adjusted cleanup levels is calculated in Table C-5. Since the potential risk is 1×10^{-5}, the adjusted cleanup levels meet the risk criteria for MTCA Method B.

Potential Non-Carcinogenic Effects

The potential non-cancer effects from exposure to adjusted cleanup levels were also evaluated. The potential non-carcinogenic effects were evaluated by comparing exposure intakes (Table C-4) over a specified time period with reference doses (RfDs) derived for similar exposure periods. According to USEPA methodology (USEPA, 1989a), this ratio of exposure intake to toxicity is called a hazard quotient (HQ). The HQ assumes that there is a level of

exposure below which it is unlikely for even sensitive populations to experience adverse health effects. If the exposure intake exceeds this threshold, there may be concern for potential non-cancer health effects.

To assess the overall potential for non-carcinogenic effects posed by more than one PIHS, an HI approach was used. The HI is equal to the sum of the HQs for all PIHSs. When the total HI for a receptor exceeds unity (one), the approach utilized indicates that there may be concern for non-cancer health effects. This method assumes that the cumulative effect of multiple subthreshold exposures is additive, and may result in an adverse health effect to a particular target organ or system, or cause a critical effect.

The following target organs or systems and critical effects were identified for the PIHSs:

- central nervous system;
- circulatory system;
- developmental;
- gastrointestinal system;
- growth rate;
- immune system;
- kidney;
- liver;
- lung;
- mortality;
- musculoskeletal system;
- reproductive system; and
- skin.

PIHSs were grouped by each of their target organ/system or critical effect, and HIs were calculated for each target organ/system or critical effect. To achieve an HI of less than one for each target organ/system and critical effect, unadjusted cleanup levels were adjusted downward in an iterative process. The adjustments resulted in the following (Table C-4):

- 10 PIHSs each being adjusted downward by dividing by 2;
- 18 PIHSs each being adjusted downward by dividing by 10;
- three PIHSs each being adjusted downward by dividing by 20; and
- one PIHS being adjusted downward by dividing by 30.

Potential intakes associated with ingestion and inhalation exposures to the adjusted cleanup levels are presented in Table C-4, and HIs associated with the adjusted cleanup levels are calculated in Tables C-6 through C-18.

The following HIs were calculated for ingestion and inhalation exposures to the adjusted cleanup levels:

- central nervous system - 0.9 (Table C-6);
- circulatory system - 0.9 (Table C-7);
- developmental effects - 1.0 (Table C-8);
- gastrointestinal system - 1.0 (Table C-9);
- growth rate - 0.7 (Table C-10);
- immune system - 0.03 (Table C-11);
- kidney - 0.9 (Table C-12);
- liver - 0.8 (Table C-13);
- lung - 0.2 (Table C-14);
- mortality - 0.5 (Table C-15);
- musculoskeletal system - 0.0003 (Table C-16);
- reproductive system - 1.0 (Table C-17); and
- skin - 0.7 (Table C-18).

Since all HIs do not exceed one, the adjusted cleanup levels for the PIHSs meet the HI criteria for MTCA Method B.

3.0 Adjusted Cleanup Levels for Final Indicator Hazardous Substances

Final IHSs were selected in Section 2.5 of the Risk Assessment/Cleanup Level Analysis. Subsequently, the need for adjusting cleanup levels to achieve the total site risk and HI criteria for MTCA Method B was re-evaluated for the 13 final IHSs. Potential intakes associated with ingestion and inhalation exposures to the unadjusted cleanup levels for the 13 final IHSs were calculated (Table C-19), and were subsequently adjusted downward in an iterative process, resulting in four final IHSs being adjusted downward by dividing by 2.

Potential Carcinogenic Effects

Potential risks associated with intakes at re-adjusted groundwater cleanup levels were calculated. As shown in Table C-20, the total potential risk is 7×10^{-6}, which meets the total site risk goal (1×10^{-5}).

Potential Non-Carcinogenic Effects

Potential non-cancer effects from intakes at re-adjusted cleanup levels were also evaluated. Final IHSs were grouped by target organ/system, and HIs were calculated for each target organ/system. The following HIs were calculated for ingestion and inhalation exposures to the re-adjusted cleanup levels:

- central nervous system - 1.0 (Table C-21);
- circulatory system - 0.8 (Table C-22);
- immune system - 0.06 (Table C-23);
- kidney - 0.9 (Table C-24);
- liver - 0.9 (Table C-25);
- lung - 0.002 (Table C-26); and,
- reproductive - 1.0 (Table C-27).

Since all HIs do not exceed one, the re-adjusted Method B levels meet the HI criteria for MTCA Method B.

Table C-1

UNADJUSTED MTCA METHOD B CLEANUP LEVELS
FOR PRELIMINARY GROUNDWATER IHSs

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS		Federal			State	Calculated		Lowest Value
		MCL	MCLG	SMCL	MCL	Non-Car.	Car.	
VOCs								
Acetone		NA	NA	NA	NA	0.8	—	**0.8**
Benzene		0.005	—	—	0.005	0.024	0.002	**0.002**
Carbon disulfide		NA	NA	NA	NA	0.8	—	**0.8**
Chlorobenzene		NA	NA	NA	NA	0.16	—	**0.16**
Chloroethane		NA	NA	NA	NA	—	—	**NA**
Chloroform		0.1	—	NA	0.1	0.08	0.007	**0.007**
Chloromethane		NA	—	NA	NA	—	0.003	**0.003**
1,2-Dichlorobenzene		0.6	0.6	—	0.6	0.72	—	**0.6**
1,4-Dichlorobenzene		0.075	—	—	0.075	1.6	0.002	**0.002**
1,1-Dichloroethane		NA	NA	NA	NA	0.8	—	**0.8**
1,2-Dichloroethane		0.005	—	—	0.005	0.24	0.0005	**0.0005**
1,1-Dichloroethene		0.007	—	—	0.007	0.072	0.00007	**0.00007**
1,2-Dichloroethene (cis)		0.07	0.07	—	0.07	0.08	—	**0.07**
1,2-Dichloroethene (trans)		0.1	0.1	—	0.1	0.16	—	**0.1**
1,2-Dichloropropane		0.005	—	—	0.005	—	0.0006	**0.0006**
Ethylbenzene		0.7	0.7	—	0.7	0.8	—	**0.7**
Methylene chloride		0.005	—	—	0.005	0.48	0.006	**0.005**
Methyl butyl ketone		NA	NA	NA	NA	—	—	**NA**
Methyl ethyl ketone		NA	NA	NA	NA	4.8	—	**4.8**
Methyl isobutyl ketone	S	NA	NA	NA	NA	0.64	—	**0.64**
Tetrachloroethene		0.005	—	—	0.005	0.08	0.0008	**0.0008**
Toluene		1	1	—	1	1.6	—	**1**
1,1,1-Trichloroethane		0.2	0.2	—	0.2	0.16	—	**0.2**
1,1,2-Trichloroethane		0.005	—	—	0.005	0.032	0.0008	**0.0008**
Trichloroethene		0.005	—	—	0.005	0.05	0.004	**0.004**
Trichlorofluoromethane		NA	NA	NA	NA	2.4	—	**2**
Vinyl chloride		0.002	—	—	0.002	0.56	0.00002	**0.00002**
Xylenes		10	10	—	10	16	—	**10**
SVOCs								
Benzoic acid		NA	NA	NA	NA	64	—	**64**
Bis(2-ethylhexyl)phthalate	S	0.006	—	—	0.006	0.32	0.006	**0.006**
Butyl benzyl phthalate		NA	NA	NA	NA	3.2	—	**3**
Dimethyl phthalate		NA	NA	NA	NA	16	—	**16**
Di-n-butyl phthalate		NA	NA	NA	NA	1.6	—	**2**
Di-n-octyl phthalate	S	NA	NA	NA	NA	0.32	—	**0.3**
2,6-Dinitrotoluene		NA	—	NA	NA	0.016	0.0001	**0.0001**
Hexachlorobenzene	S	0.001	—	—	0.001	0.013	0.00005	**0.00005**
Hexachloroethane	S	NA	—	NA	NA	0.016	0.006	**0.006**
Naphthalene		NA	NA	NA	NA	0.640	—	**0.6**

Table C-1

UNADJUSTED MTCA METHOD B CLEANUP LEVELS
FOR PRELIMINARY GROUNDWATER IHSs

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS		Federal			State	Calculated		Lowest Value
		MCL	MCLG	SMCL	MCL	Non-Car.	Car.	
Pesticides								
4,4-DDT	S	NA	—	NA	NA	0.008	0.0003	**0.0003**
Endrin	S	0.002	0.002	—	0.002	0.005	—	**0.002**
Endrin aldehyde	S	NA	NA	NA	NA	—	—	**NA**
Endrin ketone	S	NA	NA	NA	NA	—	—	**NA**
Dioxins/Furans								
2,3,7,8-TCDD	S	3.0E-08	—	—	3.0E-08	–	5.8E-10	**6E-10**
Metals								
Antimony		0.006	0.006	—	0.006	0.006	—	**0.006**
Arsenic	S	0.05	—	—	0.05	0.005	0.00006	**0.00006**
Barium		2	2	—	2.0	1.1	—	**1**
Beryllium		0.004	—	—	0.004	0.08	0.00002	**0.00002**
Cadmium	S	0.005	0.005	—	0.005	0.008	—	**0.005**
Calcium		NA	NA	NA	NA	NA	—	**NA**
Chromium (III)	S	NA	NA	NA	NA	16.00	—	**16.00**
Chromium (VI)		NA	NA	NA	NA	0.08	—	**0.08**
Copper		1.3 AL	1.3	1	1.3	0.59	—	**0.59**
Iron		NA	NA	NA	NA	NA	—	**NA**
Lead		0.015 AL	zero	—	NA	—	—	**0.015**
Magnesium		NA	NA	NA	NA	NA	—	**NA**
Manganese		NA	NA	0.05	NA	2.2	—	**0.05**
Mercury	S	0.002	0.002	—	0.002	0.0048	—	**0.002**
Nickel		NA	NA	—	NA	0.32	—	**0.32**
Potassium		NA	NA	NA	NA	NA	—	**NA**
Selenium	S	0.05	0.05	—	0.05	0.08	—	**0.05**
Silver	S	NA	NA	0.10	NA	0.08	—	**0.08**
Sodium		NA	NA	NA	NA	NA	—	**NA**
Thallium	S	0.002	0.0005	—	0.002	0.001	—	**0.0005**
Zinc		NA	NA	5	NA	4.8	—	**4.8**

All concentrations presented in mg/L.
AL - Action level (40 CFR 141).
Car. - Carcinogenic effects.
IHS - Indicator Hazardous Substance.
MCL - Maximum contaminant level (40 CFR 141).
MCLG - Maximum contaminant level goal for non-carcinogens (40 CFR 141).
NA - Not available.
Non-Car. - Non-carcinogenic effects.
S - Detected in soil above background; included for use in calculating protection of groundwater values for soil.
SMCL - Secondary maximum contaminant level (40 CFR 143).

Table C-2

UNADJUSTED METHOD B CLEANUP LEVELS FOR PRELIMINARY IHSs - POTENTIAL CARCINOGENIC EFFECTS

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CPF	INH	GWCL (ug/L)	GWCL (mg/L)
VOCs				
Acetone	NA		----	----
Benzene	2.9E-2	2	2	**0.002**
Carbon disulfide	NA		----	----
Chlorobenzene	NA		----	----
Chloroethane	NA		----	----
Chloroform	6.1E-3	2	7	**0.007**
Chloromethane	1.3E-2	2	3	**0.003**
1,2-Dichlorobenzene	NA		----	----
1,4-Dichlorobenzene	2.4E-2	2	2	**0.002**
1,1-Dichloroethane	NA		----	----
1,2-Dichloroethane	9.1E-2	2	0.5	**0.0005**
1,1-Dichloroethene	6.0E-1	2	0.07	**0.00007**
1,2-Dichloroethene (cis)	NA		----	----
1,2-Dichloroethene (trans)	NA		----	----
1,2-Dichloropropane	6.8E-2	2	0.6	**0.0006**
Ethylbenzene	NA		----	----
Methylene chloride	7.5E-3	2	6	**0.006**
Methyl butyl ketone	NA		----	----
Methyl ethyl ketone	NA		----	----
Methyl isobutyl ketone	NA		----	----
Tetrachloroethene	5.2E-2	2	0.8	**0.0008**
Toluene	NA		----	----
1,1,1-Trichloroethane	NA		----	----
1,1,2-Trichloroethane	5.7E-2	2	0.8	**0.0008**
Trichloroethene	1.1E-2	2	4	**0.004**
Trichlorofluoromethane	NA		----	----
Vinyl chloride	1.9E+0	2	0.02	**0.00002**
Xylenes	NA		----	----
SVOCs				
Benzoic acid	NA		----	----
Bis(2-ethylhexyl)phthalate	1.40E-02	1	6.25	**0.006**
Butyl benzyl phthalate	NA		----	----
Dimethylphthalate	NA		----	----
Di-n-butyl phthalate	NA		----	----
Di-n-octyl phthalate	NA		----	----
2,6-Dinitrotoluene	6.8E-01	1	0.13	**0.0001**
Hexachlorobenzene	1.6E+00	1	0.05	**0.00005**
Hexachloroethane	1.4E-02	1	6.25	**0.006**
Naphthalene	NA		----	----

Table C-2

UNADJUSTED METHOD B CLEANUP LEVELS FOR PRELIMINARY IHSs - POTENTIAL CARCINOGENIC EFFECTS

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CPF	INH	GWCL (ug/L)	GWCL (mg/L)
Pesticides				
4,4-DDT	3.4E-01	1	0.3	**0.0003**
Endrin	NA		----	----
Endrin aldehyde	NA		----	----
Endrin ketone	NA		----	----
Dioxins/Furans				
2,3,7,8-TCDD	1.5E+05	1	5.83E-07	**6E-10**
Metals				
Antimony	NA		----	----
Arsenic	1.5E+0	1	0.06	**0.00006**
Barium	NA		----	----
Beryllium	4.3E+0	1	0.02	**0.00002**
Cadmium	NA		----	----
Calcium	NA		----	----
Chromium (III)	NA		----	----
Chromium (VI)	NA		----	----
Copper	NA		----	----
Iron	NA		----	----
Lead	NA		----	----
Magnesium	NA		----	----
Manganese	NA		----	----
Mercury	NA		----	----
Nickel	NA		----	----
Potassium	NA		----	----
Selenium	NA		----	----
Silver	NA		----	----
Sodium	NA		----	----
Thallium	NA		----	----
Zinc	NA		----	----

ABW - Average body weight during the period of exposure (70 kilograms).
CPF - Carcinogenic potency factor (kg-day/mg).
DUR - Duration of exposure (30 years).
DWIR - Drinking water ingestion rate (2 liters/day).
GWCL - Ground water cleanup level.
INH - Inhalation correction factor.
IHS - Indicator Hazardous Substance.
Life - Lifetime (75 years).
NA - Not Available.
Risk - Acceptable cancer risk level (1 in 1,000,000).
UCF - Unit conversion factor (1,000 ug/mg).

Equation:

$$\text{GWCL (ug/L)} = \frac{\text{Risk x ABW x Life x UCF}}{\text{CPF x DWIR x DUR x INH}}$$

Table C-3

UNADJUSTED METHOD B CLEANUP LEVELS FOR PRELIMINARY IHSs - POTENTIAL NON-CARCINOGENIC EFFECTS

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	RfD	INH	GWCL (ug/L)	GWCL (mg/L)
VOCs				
Acetone	1E-01	2	800	0.8
Benzene	3E-03	2	24	0.02
Carbon disulfide	1E-01	2	800	0.8
Chlorobenzene	2E-02	2	160	0.2
Chloroethane	NA		---	---
Chloroform	1E-02	2	80	0.08
Chloromethane	NA		---	---
1,2-Dichlorobenzene	9E-02	2	720	0.7
1,4-Dichlorobenzene	2E-01	2	1600	2
1,1-Dichloroethane	1E-01	2	800	0.8
1,2-Dichloroethane	3E-02	2	240	0.2
1,1-Dichloroethene	9E-03	2	72	0.07
1,2-Dichloroethene (cis)	1E-02	2	80	0.08
1,2-Dichloroethene (trans)	2E-02	2	160	0.2
1,2-Dichloropropane	NA		---	---
Ethylbenzene	1E-01	2	800	0.8
Methylene chloride	6E-02	2	480	0.5
Methyl butyl ketone	NA		---	---
Methyl ethyl ketone	6E-01	2	4800	5
Methyl isobutyl ketone	8E-02	2	640	0.6
Tetrachloroethene	1E-02	2	80	0.08
Toluene	2E-01	2	1600	2
1,1,1-Trichloroethane	2E-02	2	160	0.2
1,1,2-Trichloroethane	4E-03	2	32	0.03
Trichloroethene	6E-03	2	48	0.05
Trichlorofluoromethane	3E-01	2	2400	2
Vinyl chloride	7E-02	2	560	0.6
Xylenes	2E+00	2	16000	16
SVOCs				
Benzoic acid	4E+00	1	64000	64
Bis(2-ethylhexyl)phthalate	2E-02	1	320	0.3
Butyl benzyl phthalate	2E-01	1	3200	3
Dimethyl phthalate	1E+00	1	16000	16
Di-n-butyl phthalate	1E-01	1	1600	2
Di-n-octyl phthalate	2E-02	1	320	0.3
2,6-Dinitrotoluene	1E-03	1	16	0.02
Hexachlorobenzene	8E-04	1	13	0.01
Hexachloroethane	1E-03	1	16	0.02
Naphthalene	4E-02	1	640	0.6

Table C-3

UNADJUSTED METHOD B CLEANUP LEVELS FOR PRELIMINARY IHSs - POTENTIAL NON-CARCINOGENIC EFFECTS

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	RfD	INH	GWCL (ug/L)	GWCL (mg/L)
Pesticides				
4,4-DDT	5E-04	1	8	0.008
Endrin	3E-04	1	5	0.005
Endrin aldehyde	NA		---	---
Endrin ketone	NA		---	---
Dioxins/Furans				
2,3,7,8-TCDD Equivalents	NA		---	---
Metals				
Antimony	4E-04	1	6	0.006
Arsenic	3E-04	1	5	0.005
Barium	7E-02	1	1120	1
Beryllium	5E-03	1	80	0.08
Cadmium	5E-04	1	8	0.008
Calcium	NA		---	---
Chromium (III)	1E+00	1	16000	16.00
Chromium (VI)	5E-03	1	80	0.08
Copper	4E-02	1	592	0.6
Iron	NA		---	---
Lead	NA		---	---
Magnesium	NA		---	---
Manganese	1E-01	1	2240	2
Mercury	3E-04	1	4.8	0.005
Nickel	2E-02	1	320	0.3
Potassium	NA		---	---
Selenium	5E-03	1	80	0.08
Silver	5E-03	1	80	0.08
Sodium	NA		---	---
Thallium	7E-05	1	1	0.001
Zinc	3E-01	1	4800	5

ABW - Average body weight during the period of exposure (16 kilograms).
DWIR - Drinking water ingestion rate (1 liter/day).
GWCL - Ground water cleanup level.
HQ - Hazard quotient (1).
IHS - Indicator Hazardous Substance.
INH - Inhalation correction factor.
NA - Not Available.
RfD - Oral Reference dose (mg/kg-day).
UCF - Unit conversion factor (1,000 ug/mg).

Equation:

$$GWCL\ (ug/L) = \frac{RfD \times ABW \times UCF \times HQ}{DWIR \times INH}$$

Table C-4

INTAKES FROM INGESTION AND INHALATION EXPOSURES TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	Adjusted Cleanup Level (mg/L)	Notes		AT	Intake-NC	AT	Intake-C
VOCs							
Acetone	0.08	a	N	2,190	**1.00E-02**		
Benzene	0.0008	d	C	2,190	**9.43E-05**	27,375	**1.72E-05**
Carbon disulfide	0.4	d	N	2,190	**5.00E-02**		
Chlorobenzene	0.008	b	N	2,190	**1.00E-03**		
Chloroethane	NA						
Chloroform	0.0007	a	C	2,190	**8.97E-05**	27,375	**1.64E-05**
Chloromethane	0.002	d	C	2,190	**2.10E-04**	27,375	**3.85E-05**
1.2-Dichlorobenzene	0.06	a	N	2,190	**7.50E-03**		
1,4-Dichlorobenzene	0.0018		C	2,190	**2.28E-04**	27,375	**4.17E-05**
1,1-Dichloroethane	0.08	a	N	2,190	**9.63E-03**		
1,2-Dichloroethane	0.0005		C	2,190	**6.01E-05**	27,375	**1.10E-05**
1,1-Dichloroethene	0.00007		C	2,190	**9.11E-06**	27,375	**1.67E-06**
1,2-Dichloroethene (cis)	0.007	a	N	2,190	**8.75E-04**		
1,2-Dichloroethene (trans)	0.01	a	N	2,190	**1.25E-03**		
1,2-Dichloropropane	0.0006		C	2,190	**8.04E-05**	27,375	**1.47E-05**
Ethylbenzene	0.04	b	N	2,190	**4.38E-03**		
Methylene chloride	0.0005	a	C	2,190	**6.25E-05**	27,375	**1.14E-05**
Methyl butyl ketone	NA						
Methyl ethyl ketone	2.4	d	N	2,190	**3.00E-01**		
Methyl isobutyl ketone	0.03	b	N	2,190	**4.00E-03**		
Tetrachloroethene	0.00008	a	C	2,190	**1.05E-05**	27,375	**1.92E-06**
Toluene	0.1	a	N	2,190	**1.25E-02**		
1,1,1-Trichloroethane	0.02	a	N	2,190	**2.00E-03**		
1,1,2-Trichloroethane	0.0008		C	2,190	**9.59E-05**	27,375	**1.75E-05**
Trichloroethene	0.0020	d	C	2,190	**2.49E-04**	27,375	**4.55E-05**
Trichlorofluoromethane	0.2	a	N	2,190	**3.00E-02**		
Vinyl chloride	0.00002		C	2,190	**2.88E-06**	27,375	**5.26E-07**
Xylenes	1	a	N	2,190	**1.25E-01**		
SVOCs							
Benzoic acid	6	a	N	2,190	**4.00E-01**		
Bis(2-ethylhexyl)phthalate	0.006		C	2,190	**3.75E-04**	27,375	**6.86E-05**
Butyl benzyl phthalate	0.3	a	N	2,190	**2.00E-02**		
Dimethyl phthalate	8	d	N	2,190	**5.00E-01**		
Di-n-butyl phthalate	0.8	d	N	2,190	**5.00E-02**		
Di-n-octyl phthalate	0.01	c	N	2,190	**6.67E-04**		
2,6-Dinitrotoluene	0.00013		C	2,190	**8.04E-06**	27,375	**1.47E-06**
Hexachlorobenzene	0.00005		C	2,190	**3.42E-06**	27,375	**6.25E-07**
Hexachloroethane	0.0063		C	2,190	**3.91E-04**	27,375	**7.14E-05**
Naphthalene	0.06	a	N	2,190	**4.00E-03**		

Table C-4

INTAKES FROM INGESTION AND INHALATION EXPOSURES TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	Adjusted Cleanup Level (mg/L)	Notes		AT	Intake-NC	AT	Intake-C
Pesticides							
4,4-DDT	0.00003	a	C	2,190	**1.61E-06**	27,375	**2.94E-07**
Endrin	0.0002	a	N	2,190	**1.25E-05**		
Endrin aldehyde	NA						
Endrin ketone	NA						
Dioxins/Furans							
2,3,7,8-TCDD	6E-10		C	2,190	**3.65E-11**	27,375	**6.67E-12**
Metals							
Antimony	0.0006	a	N	2,190	**3.75E-05**		
Arsenic	0.00006		C	2,190	**3.65E-06**	27,375	**6.67E-07**
Barium	0.11	a	N	2,190	**7.00E-03**		
Beryllium	0.00002		C	2,190	**1.27E-06**	27,375	**2.33E-07**
Cadmium	0.0005	a	N	2,190	**3.13E-05**		
Calcium	NA						
Chromium (III)	8.00	d	N	2,190	**5.00E-01**		
Chromium (VI)	0.040	d	N	2,190	**2.50E-03**		
Copper	0.30	d	N	2,190	**1.85E-02**		
Iron	NA						
Lead	0.015		N	2,190	**9.38E-04**		
Magnesium	NA						
Manganese	0.05		N	2,190	**3.13E-03**		
Mercury	0.0010	d	N	2,190	**6.25E-05**		
Nickel	0.16	d	N	2,190	**1.00E-02**		
Potassium	NA						
Selenium	0.050		N	2,190	**3.13E-03**		
Silver	0.008	a	N	2,190	**5.00E-04**		
Sodium	NA						
Thallium	0.00025	d	N	2,190	**1.56E-05**		
Zinc	0.5	a	N	2,190	**3.00E-02**		

Notes:
a - divided by 10; **b** - divided by 20; **c** - divided by 30; **d** - divided by 2.
C - cleanup level based on carcinogenic effects; **N** - cleanup level based on non-carcinogenic effects.
NA - Not available.
AT - Averaging time (2,190 days for non-carc. effects and 27,375 for carc. effects).
BW - Body weight (16 kg for non-carc. effects and 70 kg for carc. effects).
C - Carcinogenic effects.
CW - Concentration in groundwater (mg/L) (Method B value).
EF - Exposure frequency (365 days/year).
ED - Exposure duration (6 yrs for non-carc. effects & 30 yrs for carc. effects).
ICV - Inhalation correction value (2 for VOCs, 1 for all others).
Intake - (mg/kg-day).
IR - Ingestion rate (1 L/day for non-carc. effects & 2 L/day for carc. effects).
NC - Non-carcinogenic effects.

Equation:
Source: USEPA, 1989

$$\text{Intake} = \frac{CW \times IR \times EF \times ED \times ICV}{BW \times AT}$$

Table C-5

CANCER RISK ESTIMATES AT ADJUSTED METHOD B LEVELS
FOR PRELIMINARY IHSs

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	CPF	Chemical-Specific Risk	Total Groundwater Risk
VOCs				
Acetone	----	NA		
Benzene	1.72E-05	2.90E-02	5.00E-07	
Carbon disulfide	----	NA		
Chlorobenzene	----	NA		
Chloroethane	----	NA		
Chloroform	1.64E-05	6.10E-03	1.00E-07	
Chloromethane	3.85E-05	1.30E-02	5.00E-07	
1,2-Dichlorobenzene	----	NA		
1,4-Dichlorobenzene	4.17E-05	2.40E-02	1.00E-06	
1,1-Dichloroethane	----	NA		
1,2-Dichloroethane	1.10E-05	9.10E-02	1.00E-06	
1,1-Dichloroethene	1.67E-06	6.00E-01	1.00E-06	
1,2-Dichloroethene (cis)	----	NA		
1,2-Dichloroethene (trans)	----	NA		
1,2-Dichloropropane	1.47E-05	6.80E-02	1.00E-06	
Ethylbenzene	----	NA		
Methylene chloride	1.14E-05	7.50E-03	8.57E-08	
Methyl butyl ketone	----	NA		
Methyl ethyl ketone	----	NA		
Methyl isobutyl ketone	----	NA		
Tetrachloroethene	1.92E-06	5.20E-02	1.00E-07	
Toluene	----	NA		
1,1,1-Trichloroethane	----	NA		
1,1,2-Trichloroethane	1.75E-05	5.70E-02	1.00E-06	
Trichloroethene	4.55E-05	1.10E-02	5.00E-07	
Trichlorofluoromethane	----	NA		
Vinyl chloride	5.26E-07	1.90E+00	1.00E-06	
Xylenes	----	NA		
SVOCs				
Benzoic acid	----	NA		
Bis(2-ethylhexyl)phthalate	6.86E-05	1.40E-02	9.60E-07	
Butyl benzyl phthalate	----	NA		
Di-n-butyl phthalate	----	NA		
Di-n-octyl phthalate	----	NA		
Dimethyl phthalate	----	NA		
2,6-Dinitrotoluene	1.47E-06	6.80E-01	1.00E-06	
Hexachlorobenzene	6.25E-07	1.60E+00	1.00E-06	
Hexachloroethane	7.14E-05	1.40E-02	1.00E-06	
Naphthalene	----	NA		

Table C-5

CANCER RISK ESTIMATES AT ADJUSTED METHOD B LEVELS
FOR PRELIMINARY IHSs

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	CPF	Chemical-Specific Risk	Total Groundwater Risk
Pesticides				
4,4-DDT	2.94E-07	3.40E-01	1.00E-07	
Endrin	----	NA		
Endrin aldehyde	----	NA		
Endrin ketone	----	NA		
Dioxins/Furans				
2,3,7,8-TCDD Equivalents	6.67E-12	1.50E+05	1.00E-06	
Metals				
Antimony	----	NA		
Arsenic	6.67E-07	1.50E+00	1.00E-06	
Barium	----	NA		
Beryllium	2.33E-07	4.30E+00	1.00E-06	
Cadmium	----	NA		
Calcium	----	NA		
Chromium (III)	----	NA		
Chromium (VI)	----	NA		
Copper	----	NA		
Iron	----	NA		
Lead	----	NA		
Magnesium	----	NA		
Manganese	----	NA		
Mercury	----	NA		
Nickel	----	NA		
Potassium	----	NA		
Selenium	----	NA		
Silver	----	NA		
Sodium	----	NA		
Thallium	----	NA		
Zinc	----	NA		
Total estimated risk				**1E-05**

IHS - Indicator Hazardous Substance.
NA - Not Available.
CDI - Chronic daily intake for carcinogenic effects (mg/kg-day).
CPF - Cancer potency factor $(mg/kg\text{-}day)^{-1}$.

Equation (USEPA, 1989b):

$$\text{Risk} = \text{CDI} \times \text{CPF}$$

Table C-6

HAZARD INDEX FOR EXPOSURES
TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs
TARGET SYSTEM = CENTRAL NERVOUS SYSTEM

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	RfD	HQ	Pathway HI
VOCs				
1,1,1-Trichloroethane	2.00E-03	2.00E-02	0.10	
Xylenes	1.25E-01	2.00E+00	0.06	
SVOCs				
Dimethyl phthalate	5.00E-01	1.00E+00	0.50	
2,6-Dinitrotoluene	8.04E-06	1.00E-03	0.0080	
Metals				
Manganese	3.13E-03	1.40E-01	0.022	
Mercury	6.25E-05	3.00E-04	0.21	
Hazard Index				**0.9**

CDI - Chronic daily intake for non-carcinogenic effects (mg/kg-day).
HI - Hazard Index.
HQ - Hazard Quotient.
IHS - Indicator Hazardous Substance.
RfD - Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-7

HAZARD INDEX FOR EXPOSURES
TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs
TARGET SYSTEM = CIRCULATORY

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	RfD	HQ	Pathway HI
VOCs				
Benzene	9.43E-05	3.00E-03	0.031	
cis-1,2-Dichloroethene	8.75E-04	1.00E-02	0.09	
trans-1,2-Dichloroethene	1.25E-03	2.00E-02	0.06	
1,1,2-Trichloroethane	9.59E-05	4.00E-03	0.02	
Trichlorofluoromethane	3.00E-02	3.00E-01	0.10	
SVOCs				
2,6-Dinitrotoluene	8.04E-06	1.00E-03	0.0080	
Naphthalene	4.00E-03	4.00E-02	0.10	
Metals				
Antimony	3.75E-05	4.00E-04	0.09	
Barium	7.00E-03	7.00E-02	0.10	
Thallium	1.56E-05	7.00E-05	0.223	
Zinc	3.00E-02	3.00E-01	0.10	
Hazard Index				**0.9**

CDI - Chronic daily intake for non-carcinogenic effects (mg/kg-day).
HI - Hazard Index.
HQ - Hazard Quotient.
IHS - Indicator Hazardous Substance.
RfD - Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ = CDI / Oral RfD

HI = Sum of HQs

Table C-8

HAZARD INDEX FOR EXPOSURES
TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs
CRITICAL EFFECT = DEVELOPMENTAL

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	RfD	HQ	Pathway HI
VOCs				
Carbon disulfide	5.00E-02	1.00E-01	0.50	
Methyl ethyl ketone	3.00E-01	6.00E-01	0.50	
Hazard Index				**1.0**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.
RfD - Oral Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-9

HAZARD INDEX FOR EXPOSURES
TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs
TARGET SYSTEM = GASTROINTESTINAL

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	RfD	HQ	Pathway HI
SVOCs				
Dimethyl phthalate	5.00E-01	1.00E+00	0.50	
Metals				
Copper	1.85E-02	4.00E-02	0.46	
Hazard Index				**1.0**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.
RfD - Oral Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-10

HAZARD INDEX FOR EXPOSURES
TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs
CRITICAL EFFECT = GROWTH RATE

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	RfD	HQ	Pathway HI
SVOCs				
Benzoic acid	4.00E-01	4.00E+00	0.10	
Bis(2-ethylhexyl)phthalate	3.75E-04	2.00E-02	0.019	
Butyl benzyl phthalate	2.00E-02	2.00E-01	0.10	
Metals				
Nickel	1.00E-02	2.00E-02	0.50	
Hazard Index				**0.7**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.
RfD - Oral Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-11

HAZARD INDEX FOR EXPOSURES
TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs
TARGET SYSTEM = IMMUNE

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	RfD	HQ	Pathway HI
VOCs				
Benzene	9.43E-05	3.00E-03	0.031	
Hazard Index				**0.03**

CDI - Chronic daily intake for non-carcinogenic effects (mg/kg-day).
HI - Hazard Index.
HQ - Hazard Quotient.
IHS - Indicator Hazardous Substance.
RfD - Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-12

HAZARD INDEX FOR EXPOSURES
TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs
TARGET ORGAN = KIDNEY

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	RfD	HQ	Pathway HI
VOCs				
Acetone	1.00E-02	1.00E-01	0.10	
1,4-Dichlorobenzene	2.28E-04	2.00E-01	0.00114	
1,1-Dichloroethane	9.63E-03	1.00E-01	0.10	
Ethylbenzene	4.38E-03	1.00E-01	0.04	
Methyl isobutyl ketone	4.00E-03	8.00E-02	0.05	
Toluene	1.25E-02	2.00E-01	0.06	
Trichloroethene	2.49E-04	6.00E-03	0.041	
SVOCs				
2,6-Dinitrotoluene	8.04E-06	1.00E-03	0.0080	
Hexachloroethane	3.91E-04	1.00E-03	0.39	
Metals				
Cadmium	3.13E-05	5.00E-04	0.06	
Hazard Index				**0.9**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.
RfD - Oral Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-13

HAZARD INDEX FOR EXPOSURES
TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs
TARGET ORGAN = LIVER

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	RfD	HQ	Pathway HI
VOCs				
Acetone	1.00E-02	1.00E-01	0.10	
Chlorobenzene	1.00E-03	2.00E-02	0.050	
Chloroform	8.97E-05	1.00E-02	0.009	
1,2-Dichlorobenzene	7.50E-03	9.00E-02	0.08	
1,1-Dichloroethene	9.11E-06	9.00E-03	0.0010	
Ethylbenzene	4.38E-03	1.00E-01	0.04	
Methylene chloride	6.25E-05	6.00E-02	0.0010	
Methyl isobutyl ketone	4.00E-03	8.00E-02	0.050	
Tetrachloroethene	1.05E-05	1.00E-02	0.0011	
Toluene	1.25E-02	2.00E-01	0.06	
1,1,2-Trichloroethane	9.59E-05	4.00E-03	0.02	
Trichloroethene	2.49E-04	6.00E-03	0.041	
Vinyl chloride	2.88E-06	7.00E-02	0.00004	
SVOCs				
Di-n-octyl phthalate	6.67E-04	2.00E-02	0.033	
Hexachlorobenzene	3.42E-06	8.00E-04	0.0043	
Pesticides				
4,4'-DDT	1.61E-06	5.00E-04	0.003	
Endrin	1.25E-05	3.00E-04	0.04	
Metals				
Thallium	1.56E-05	7.00E-05	0.22	
Hazard Index				**0.8**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.
RfD - Oral Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-14

HAZARD INDEX FOR EXPOSURES
TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs
TARGET ORGAN = LUNG

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	RfD	HQ	Pathway HI
VOCs				
1,2-Dichloroethane	6.01E-05	3.00E-02	0.00200	
Trichlorofluoromethane	3.00E-02	3.00E-01	0.1000	
SVOCs				
Naphthalene	4.00E-03	4.00E-02	0.10	
Hazard Index				**0.2**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.
RfD - Oral Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-15

HAZARD INDEX FOR EXPOSURES
TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs
CRITICAL EFFECT = MORTALITY

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	RfD	HQ	Pathway HI
SVOCs				
Di-n-butyl phthalate	5.00E-02	1.00E-01	0.500	
Hazard Index				**0.5**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.
RfD - Oral Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-16

HAZARD INDEX FOR EXPOSURES
TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs
TARGET SYSTEM = MUSCULOSKELETAL

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	RfD	HQ	Pathway HI
Metals				
Beryllium	1.27E-06	5.00E-03	0.00025	
Hazard Index				**0.0003**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.
RfD - Oral Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-17

HAZARD INDEX FOR EXPOSURES
TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs
TARGET SYSTEM = REPRODUCTIVE

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	RfD	HQ	Pathway HI
Metals				
Chromium (III)	5.00E-01	1.00E+00	0.5000	
Chromium (VI)	2.50E-03	5.00E-03	0.5000	
Hazard Index				**1.0**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.
RfD - Oral Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-18

HAZARD INDEX FOR EXPOSURES
TO ADJUSTED METHOD B LEVELS FOR PRELIMINARY IHSs
TARGET ORGAN = SKIN

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	CDI	RfD	HQ	Pathway HI
Metals				
Arsenic	3.65E-06	3.00E-04	0.01	
Selenium	3.13E-03	5.00E-03	0.63	
Silver	5.00E-04	5.00E-03	0.10	
Hazard Index				**0.7**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.
RfD - Oral Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-19

FINAL INDICATOR HAZARDOUS SUBSTANCES -
INTAKES FROM EXPOSURES TO METHOD B LEVELS

PASCO LANDFILL
PASCO, WASHINGTON

Final IHS	Cleanup Level (mg/l)			AT	Intake-NC	AT	Intake-C
Acetone	0.4	a	n	2,190	**5.00E-02**		
Benzene	0.002		c	2,190	**1.89E-04**	27,375	**3.45E-05**
Chromium (hexavalent)	0.08		n	2,190	**5.00E-03**		
1,2-Dichloroethane	0.0005		c	2,190	**6.01E-05**	27,375	**1.10E-05**
1,1-Dichloroethene	0.00007		c	2,190	**9.11E-06**	27,375	**1.67E-06**
1,2-Dichloroethene (cis)	0.04	a	n	2,190	**4.38E-03**		
1,2-Dichloroethene (trans)	0.05	a	n	2,190	**6.25E-03**		
Tetrachloroethene	0.0008		c	2,190	**1.05E-04**	27,375	**1.92E-05**
Toluene	0.5	a	n	2,190	**6.25E-02**		
1,1,1-Trichloroethane	0.2		n	2,190	**2.00E-02**		
1,1,2-Trichloroethane	0.0008		c	2,190	**9.59E-05**	27,375	**1.75E-05**
Trichloroethene	0.004		c	2,190	**4.97E-04**	27,375	**9.09E-05**
Vinyl chloride	0.00002		c	2,190	**2.88E-06**	27,375	**5.26E-07**

a - adjusted by dividing by 2.
c - cleanup level based on carcinogenic effects; **n** - cleanup level based on non-carcinogenic effects.
AT - Averaging time (2,190 days for non-carc. effects and 27,375 for carc. effects).
BW - Body weight (16 kg for non-carc.effects and 70 kg for carc. effects).
C - Carcinogenic effects.
CW - Concentration in groundwater (mg/L) (unadjusted Method B value).
EF - Exposure frequency (365 days/year).
ED - Exposure duration (6 yrs for non-carc. effects and 30 yrs for carc. effects).
ICV - Inhalation correction value (2 for VOCs, 1 for all others).
IHS - Indicator Hazardous Substance.
Intake - (mg/kg-day).
IR - Ingestion rate (1 L/day for non-carc. effects and 2 L/day for carc. effects).
NC - Non-carcinogenic effects.

Chromium in solution is assumed to be hexavalent (at the direction of Ecology).

Equation:
Source: USEPA, 1989

$$\text{Intake} = \frac{CW \times IR \times EF \times ED \times ICV}{BW \times AT}$$

Table C-20

FINAL INDICATOR HAZARDOUS SUBSTANCES -
CANCER RISK ESTIMATES AT METHOD B LEVELS

PASCO LANDFILL
PASCO, WASHINGTON

Final IHS	CDI	CPF	Chemical-Specific Risk	Total Groundwater Risk
Acetone	----	NA		
Benzene	3.45E-05	2.9E-02	1.0E-06	
Chromium (hexavalent)	----	NA		
1,2-Dichloroethane	1.10E-05	9.1E-02	1.0E-06	
1,1-Dichloroethene	1.67E-06	6.0E-01	1.0E-06	
1,2-Dichloroethene (cis)	----	NA		
1,2-Dichloroethene (trans)	----	NA		
Tetrachloroethene	1.92E-05	5.2E-02	1.0E-06	
Toluene	----	NA		
1,1,1-Trichloroethane	----	NA		
1,1,2-Trichloroethane	1.75E-05	5.7E-02	1.0E-06	
Trichloroethene	9.09E-05	1.1E-02	1.0E-06	
Vinyl chloride	5.26E-07	1.9E+00	1.0E-06	
Total estimated risk				**7E-06**

NA - Not Available.
CDI - Chronic daily intake for carcinogenic effects (mg/kg-day).
CPF - Cancer potency factor $(mg/kg\text{-}day)^{-1}$.
IHS - Indicator Hazardous Substance.

Chromium in solution is assumed to be hexavalent (at the direction of Ecology).

Equation (USEPA, 1989b):

$$\text{Risk} = \text{CDI} \times \text{CPF}$$

Table C-21

FINAL INDICATOR HAZARDOUS SUBSTANCES -
HAZARD INDEX FOR EXPOSURES TO METHOD B LEVELS
TARGET SYSTEM = CENTRAL NERVOUS SYSTEM

PASCO LANDFILL
PASCO, WASHINGTON

Final IHS	CDI	RfD	HQ	Pathway HI
1,1,1-Trichloroethane	2.00E-02	2E-02	1.00	
Hazard Index				**1.0**

CDI - Chronic daily intake for non-carcinogenic effects (mg/kg-day).
HI - Hazard Index.
HQ - Hazard Quotient.
IHS - Indiactor Hazardous Substance.
RfD - Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-22

FINAL INDICATOR HAZARDOUS SUBSTANCES -
HAZARD INDEX FOR EXPOSURES TO METHOD B LEVELS
TARGET SYSTEM = CIRCULATORY

PASCO LANDFILL
PASCO, WASHINGTON

Final IHS	CDI	RfD	HQ	Pathway HI
Benzene	1.89E-04	3E-03	0.06	
cis-1,2-Dichloroethene	4.38E-03	1E-02	0.44	
trans-1,2-Dichloroethene	6.25E-03	2E-02	0.31	
1,1,2-Trichloroethane	9.59E-05	4E-03	0.02	
Hazard Index				**0.8**

CDI - Chronic daily intake for non-carcinogenic effects (mg/kg-day).
HI - Hazard Index.
HQ - Hazard Quotient.
IHS - Indicator Hazardous Substance.
RfD - Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ = CDI / Oral RfD

HI = Sum of HQs

Table C-23

FINAL INDICATOR HAZARDOUS SUBSTANCES -
HAZARD INDEX FOR EXPOSURES TO METHOD B LEVELS
TARGET SYSTEM = IMMUNE

PASCO LANDFILL
PASCO, WASHINGTON

Final IHS	CDI	RfD	HQ	Pathway HI
Benzene	1.89E-04	3E-03	0.06	
Hazard Index				**0.06**

CDI - Chronic daily intake for non-carcinogenic effects (mg/kg-day).
HI - Hazard Index.
HQ - Hazard Quotient.
IHS - Indiactor Hazardous Substance.
RfD - Reference dose (mg/kg-day).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-24

FINAL INDICATOR HAZARDOUS SUBSTANCES -
HAZARD INDEX FOR EXPOSURES TO METHOD B LEVELS
TARGET ORGAN = KIDNEY

PASCO LANDFILL
PASCO, WASHINGTON

Final IHS	CDI	RfD	HQ	Pathway HI
Acetone	5.00E-02	1E-01	0.50	
Toluene	6.25E-02	2E-01	0.31	
Trichloroethene	4.97E-04	6E-03	0.083	
Hazard Index				**0.9**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
RfD - Oral Reference dose (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-25

FINAL INDICATOR HAZARDOUS SUBSTANCES -
HAZARD INDEX FOR EXPOSURES TO METHOD B LEVELS
TARGET ORGAN = LIVER

PASCO LANDFILL
PASCO, WASHINGTON

Final IHS	CDI	RfD	HQ	Pathway HI
Acetone	5.00E-02	1E-01	0.500	
1,1-Dichloroethene	9.11E-06	9E-03	0.00101	
Tetrachloroethene	1.05E-04	1E-02	0.0105	
Toluene	6.25E-02	2E-01	0.31	
1,1,2-Trichloroethane	9.59E-05	4E-03	0.02	
Trichloroethene	4.97E-04	6E-03	0.083	
Vinyl chloride	2.88E-06	7E-02	0.00004	
Hazard Index				**0.9**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
RfD - Oral Reference dose (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-26

FINAL INDICATOR HAZARDOUS SUBSTANCES -
HAZARD INDEX FOR EXPOSURES TO METHOD B LEVELS
TARGET ORGAN = LUNG

PASCO LANDFILL
PASCO, WASHINGTON

Final IHS	CDI	RfD	HQ	Pathway HI
1,2-Dichloroethane	6.01E-05	3E-02	0.002	
Hazard Index				**0.002**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
RfD - Oral Reference dose (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

Table C-27

FINAL INDICATOR HAZARDOUS SUBSTANCES -
HAZARD INDEX FOR EXPOSURES TO METHOD B LEVELS
TARGET SYSTEM = REPRODUCTIVE

PASCO LANDFILL
PASCO, WASHINGTON

Final IHS	CDI	RfD	HQ	Pathway HI
Chromium (hexavalent)	5.00E-03	5E-03	1.0	
Hazard Index				**1.0**

CDI - Chronic Daily Intake for non-carcinogenic effects (mg/kg-day).
RfD - Oral Reference dose (mg/kg-day).
HQ - Hazard quotient.
HI - Hazard Index.
IHS - Indicator Hazardous Substance.

Chromium in solution is assumed to be hexavalent (at the direction of Ecology).

Equations:
Source: USEPA, 1989

HQ =	CDI / Oral RfD
HI =	Sum of HQs

D

APPENDIX D

METHOD C SOIL CLEANUP LEVELS

Appendix D – Method C Soil Cleanup Levels

1.0 Cleanup Levels for Preliminary Indicator Hazardous Substances

MTCA Method C cleanup levels for industrial exposures were developed for each Preliminary Indicator Hazardous Substance (PIHS) in soil using procedures presented in WAC 173-340-740 (4).

- Method C cleanup levels were identified for most PIHSs for protection of groundwater. Due to the lack of standards and toxicity data, Method B groundwater levels could not be identified for one VOC (methyl butyl ketone) and two pesticides (endrin aldehyde and endrin ketone). Levels protective of groundwater could not be developed for these compounds.
- Method C cleanup levels were identified for all PIHSs for protection of direct contact exposures.
- Method C cleanup levels were identified for protection of air in the Sludge Management Area (SMA) and Landspread Area (LSA); levels protective of air were developed for those PIHSs detected in these areas.

1.1 Protection of Groundwater

The procedure presented in WAC 173-340-740 (4)(b)(ii)(A) was used to identify Method C soil levels that are protective of adjusted MTCA Method B groundwater levels. Soil levels protective of groundwater were developed in a step-wise manner.

- **Step 1** - Soil concentrations equal to 100 times the Method B groundwater cleanup level were identified. Maximum detected concentrations in soil were compared to this value. As shown in Table D-1, two VOCs, one SVOC, two pesticides, dioxins/furans, and 11 metals exceeded 100 times Method B levels. Therefore, these 17 PIHSs were evaluated further.

- **Step 2** – A less conservative screening method was used. Generic USEPA Soil Screening Levels for migration to groundwater (using a default dilution and attenuation factor of 1 [i.e., no dilution or attenuation]) were identified. Subsequently, maximum detected concentrations in soil were compared to this value. As shown in Table D-1, two VOCs, one SVOC, and seven metals exceeded generic SSLs, and therefore were evaluated further. In addition, dioxins/furans and copper were evaluated further.

- **Step 3** – An even less conservative screening method was used. Site-specific SSLs for migration to groundwater were calculated using guidance presented in *Soil Screening Guidance: User's Guide* (USEPA 1996c) and *Soil Screening Guidance: Technical Background Document* (USEPA,

1996a). Calculations are presented in Appendix E of the Risk Assessment/ Cleanup Level Analysis and are summarized in Table D-1.

1.2 Direct Contact

MTCA Method C cleanup levels that are protective of direct contact exposures at industrial sites were identified for each PIHS in soil. Method C values were obtained from Ecology's CLARC table (Table D-2) (Ecology, 1996b).

1.3 Protection of Air

Method C soil levels that are protective of air were identified for PIHSs detected in soil in the SMA and LSA. Soil levels protective of air were developed in a step-wise manner (Table D-3).

- **Step 1** – Generic USEPA SSLs for residential exposures via inhalation of volatiles (for SVOCs and mercury) and inhalation of fugitive particulates (metals) were identified in *Soil Screening Guidance: Technical Background Document* (USEPA, 1996a). Generic USEPA residential levels were used since industrial values are not available in this source; levels protective of residential exposures are very conservative values for screening potential industrial exposures. Subsequently, maximum detected concentrations in soil were compared to SSLs. Due to the lack of generic residential SSLs for copper and zinc, these metals were evaluated further.

- **Step 2** – A less conservative screening method was used. SSLs for industrial exposures via inhalation of volatiles and fugitive particulates were sought for copper and zinc. Industrial SSLs are higher than residential SSLs since various exposure factors are lower for industrial exposures (e.g., exposure time per day and exposure duration in years). Using standard default exposure factors, USEPA Region 6 has calculated the SSLs (based on ingestion, inhalation, and dermal exposures at industrial sites) in *EPA Region 6 Human Health Media-Specific Screening Levels* (USEPA, 1996b). The SSLs are presented in Table D-3.

2.0 Adjusted Cleanup Levels for Final Indicator Hazardous Substances

Method C soil cleanup levels in Tables D-1 through D-3 must be adjusted downward, if necessary, to meet the total risk and HI goal identified in WAC 173-340-740 (5)(a). The HI cannot exceed one and the total excess cancer risk cannot exceed one in 100,000 (1×10^{-5}). However, only one final IHS was identified for soil (acetone; see Section 2.6 of the Risk Assessment/Cleanup Level Analysis). Therefore, it was not necessary to adjust the Method C cleanup level for acetone.

Table D-1

UNADJUSTED MTCA METHOD C CLEANUP LEVELS
FOR PRELIMINARY IHSs IN SOIL - PROTECTION OF GROUNDWATER

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	Maximum Detected Conc. (mg/kg)	Adjusted Method B GW Level (mg/L)	*Protection of Groundwater*				
			Step #1 (100 x GW Level) (mg/kg)	Site Conc. Exceeds?	Step #2 Generic SSL (mg/kg)	Site Conc. Exceeds?	Step #3 Site-Specific SSL (mg/kg)
VOCs							
Acetone	630.00	0.08	8	**yes**	0.8	**yes**	80.31
Chloroform	0.001	0.0007	0.07	no	--	--	--
Ethylbenzene	0.0005	0.04	3.5	no	--	--	--
Methylene chloride	2.30	0.0005	0.05	**yes**	0.001	**yes**	0.16
Methyl butyl ketone	0.015	NA	--	--	--	--	--
Methyl ethyl ketone	2.70	2	240	no	--	--	--
Methyl isobutyl ketone	1.10	0.03	3	no	--	--	--
Toluene	0.078	0.1	10	no	--	--	--
Xylenes	0.0085	1	100	no	--	--	--
SVOCs							
Bis(2-ethylhexyl)phthalate	0.52	0.006	0.6	no	--	--	--
Butyl benzyl phthalate	0.93	0.3	32	no	--	--	--
Di-n-butyl phthalate	3.00	0.8	80	no	--	--	--
Di-n-octyl phthalate	0.16	0.01	1	no	--	--	--
Hexachlorobenzene	0.160	0.00005	0.005	**yes**	0.1	**yes**	5.66
Hexachloroethane	0.085	0.006	0.6	no	--	--	--
Pesticides							
4,4-DDT	0.0303	0.00003	0.003	**yes**	2	no	--
Endrin	0.0418	0.0002	0.02	**yes**	0.05	no	--
Endrin aldehyde	0.00504	NA	--	--	--	--	--
Endrin ketone	0.00379	NA	--	--	--	--	--
Dioxins/Furans							
2,3,7,8-TCDD Equivalents	6.25E-06	6E-10	6E-08	**yes**	NA	--	0.0031

Table D-1

UNADJUSTED MTCA METHOD C CLEANUP LEVELS
FOR PRELIMINARY IHSs IN SOIL - PROTECTION OF GROUNDWATER

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	Maximum Detected Conc. (mg/kg)	Adjusted Method B GW Level (mg/L)	***Protection of Groundwater***				
			Step #1 (100 x GW Level) (mg/kg)	Site Conc. Exceeds?	Step #2 Generic SSL (mg/kg)	Site Conc. Exceeds?	Step #3 Site-Specific SSL (mg/kg)
Metals							
Antimony	6.00	0.0006	0.06	yes	0.3	yes	126
Arsenic	12.60	0.00006	0.006	yes	1	yes	3
Beryllium	0.46	0.00002	0.002	yes	3	no	--
Cadmium	3.80	0.0005	0.05	yes	0.4	yes	3,769
Chromium	21.90	0.04	4	yes	2	yes	997
Copper	33.30	0.3	30	yes	NA	--	59,017
Lead	26.80	0.015	1.5	yes	400	no	--
Mercury	180.00	0.001	0.1	yes	0.1	yes	351
Nickel	15.70	0.16	16	no	--	--	--
Selenium	13.00	0.05	5	yes	0.3	yes	560
Silver	2.50	0.008	0.8	yes	2	yes	1,547
Zinc	79.20	0.5	48	yes	620	no	--

Chemicals exceeding background in at least one area and detected at a frequency of >5% are presented.
IHS - Indicator Hazardous Substance.
GW - Groundwater.
NA - Not available.
SSL - Soil Screening Level.

Adjusted Method B GW levels from Table C-4.
Generic SSLs obtained from Table A-1 (1 DAF) in *Soil Screening Guidance: Technical Background Document* (USEPA, 1996).
Site-specific SSLs calculated in Appendix E.

Chromium in solution is assumed to be hexavalent (at the direction of Ecology).

Table D-2

UNADJUSTED MTCA METHOD C CLEANUP LEVELS
FOR PRELIMINARY IHSs IN SOIL - DIRECT CONTACT

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	Unadjusted Method C Cleanup Level - Direct Contact (mg/kg)
VOCs	
Acetone	350,000
Chloroform	21,500
Ethylbenzene	350,000
Methylene chloride	17,500
Methyl butyl ketone	NA
Methyl ethyl ketone	2,100,000
Methyl isobutyl ketone	280,000
Toluene	700,000
Xylenes	7,000,000
SVOCs	
Bis(2-ethylhexyl)phthalate	9,380
Butyl benzyl phthalate	700,000
Di-n-butyl phthalate	350,000
Di-n-octyl phthalate	70,000
Hexachlorobenzene	82
Hexachloroethane	3,500
Pesticides	
4,4-DDT	386
Endrin	1,050
Endrin aldehyde	NA
Endrin ketone	NA
Dioxins/Furans	
2,3,7,8-TCDD	8.75E-04
Metals	
Antimony	1,400
Arsenic	219
Beryllium	30.5
Cadmium	3,500
Chromium (total)	3,500,000
Copper	130,000
Lead	NA
Mercury	1,050
Nickel	70,000
Selenium	17,500
Silver	17,500
Zinc	1,050,000

IHS - Indicator Hazardous Substance.
NA - Not available.

Method C Soil levels from Ecology's CLARC Table.

Table D-3

UNADJUSTED MTCA METHOD C CLEANUP LEVELS
FOR PRELIMINARY IHSs IN SMA AND LSA - PROTECTION OF AIR

PASCO LANDFILL
PASCO, WASHINGTON

Preliminary IHS	Maximum Detected Conc.	Protection of Air		
		Step #1 Generic SSL (Residential)	Max. Conc. Exceeds?	Step #2 EPA Region 6 MSL (Industrial)
SVOCs				
Butyl benzyl phthalate	0.93	930	no	--
Di-n-butyl phthalate	2.70	2,300	no	--
Metals				
Arsenic	12.2	750	no	--
Cadmium	2.6	1,800	no	--
Chromium (total)	21.9	270	no	--
Copper	30.9	NA	--	63,000
Mercury	0.48	10	no	--
Nickel	11.7	13,000	no	--
Zinc	79.2	NA	--	>saturation

Concentrations presented in mg/kg.
Chemicals exceeding background and detected at a frequency of >5% in the SMA or LSA are presented.
IHS - Indicator Hazardous Substance.
MSA - Media-specific level.
NA - Not available.
SSL - Soil Screening Level.

Generic SSLs obtained from Table A-1 in *Soil Screening Guidance: Technical Background Document* (USEPA, 1996).
EPA Region 6 MSL obtained from *EPA Region 6 Human Health Media-Specific Screening Levels* (USEPA, 1996).

E

APPENDIX E

SITE-SPECIFIC MIGRATION TO GROUNDWATER LEVELS

APPENDIX E

SITE-SPECIFIC MIGRATION TO GROUNDWATER

Step 3 of the screening process in selecting Indicator Hazardous Substances (IHSs) in soil was evaluating site-specific migration to groundwater. The method used to evaluate the potential for migration from soil to groundwater is described in *Soil Screening Guidance: User's Guide* (USEPA 1996c) and *Soil Screening Guidance: Technical Background Document* (USEPA 1996a).

1.0 Definition of Partitioning Equation

To calculate the concentration of a preliminary IHS that could be left in soil without exceeding MTCA Method B groundwater levels, USEPA's soil screening level (SSL) partitioning equation for migration of chemicals from soil to groundwater was used. This equation is:

$$\mathbf{SSL\ (mg/kg) = C_w[K_d + ((\theta_w + \theta_a H')/p_b)]}$$

Where:

C_w = target soil leachate concentration (mg/L) (Method B groundwater level);
K_d = chemical-specific soil-water partition coefficient;
θ_w = water-filled soil porosity (L_{water}/L_{soil});
θ_a = air-filled soil porosity (L_{air}/L_{soil});
H' = Henry's Law Constant (unitless); and
p_b = dry soil bulk density (kg/L);

and where:

C_w = Target groundwater concentration times a dilution and attenuation factor (DAF);
K_d = $K_{oc} \times f_{oc}$;
where:
K_{oc} = soil organic carbon/water partition coefficient (L/kg); and
f_{oc} = fraction organic carbon in soil (g/g).
θ_w = $n(I/K_s)^{1/(2b+3)}$;
where:
n = total soil porosity (L_{pore}/L_{soil}) = $1-(p_b/p_s)$;
p_s = soil particle density = 2.65 kg/L;
I = infiltration rate (m/yr);
K_s = saturated hydraulic conductivity (m/yr); and
b = soil-specific exponential parameter (unitless).
θ_a = $n - \theta_w$; and

DAF is calculated by the following relationship:

$$DAF = 1 + Kid/IL$$

where:

K = aquifer hydraulic conductivity (m/yr);
I = hydraulic gradient (m/m);
d = mixing zone depth (m);

d is calculated by the following relationship:

$$d=(0.0112L^2)^{0.5} + d_a\{1-\exp[(-LI)/(Kid_a)]\}$$

where:

d_a = aquifer thickness (m);
i = hydraulic gradient (m/m);
I = infiltration rate (m/yr); and
L = source length parallel to groundwater flow (m).

If the calculated mixing zone thickness exceeds the aquifer thickness, the mixing zone thickness is set equal to the aquifer thickness.

2.0 Input Parameter Selection

The methods used in calculating site-specific values and the rationale for selecting specific input values are presented below.

2.1 Source Length Parallel to Groundwater Flow (L)

The potential source areas for preliminary IHSs are:

- Sludge Management Area;
- Landspread Area;
- Zones A/BT-2 & Balefill;
- Zone B;
- Zones C & D & BT-1;
- Zones E & TS-1/SL-1;
- Zones SL-2 & SL-3; and
- other areas not immediately adjacent to the zones listed above.

Preliminary IHSs carried to Step 3 of the Protection of Groundwater screening step (Appendix D) were categorized by area in which they were detected above background. Methylene chloride was detected in one sample outside the designated areas/zones listed above. Because the sample was collected nearest to SL-2, the length of SL-2 parallel to groundwater flow was used in this case. Selenium was detected in one sample outside the designated areas/zones listed above. Because the sample containing selenium was nearest to Zone A, the length of Zone A parallel to groundwater flow was used in this case. For silver, the lengths of Zones A/BT-2 & Balefill, Zones C & D & BT-1, Zones E & TS-1/SL-1, and Zones SL-2 & SL-3 were summed because silver was either detected in these areas or was detected outside but nearest to these areas.

The lengths of all source areas parallel to groundwater flow (northeast to southwest) in which a chemical was detected above background were summed for each chemical. The sums of the source lengths are provided in Table E-1.

2.2 Infiltration Rate (I)

An infiltration rate of 0.0127 meters per year (m/yr) was used. This value was reported in the Phase II RI Report (Philip, 1996).

2.3 Hydraulic Conductivity (K_h)

The horizontal hydraulic conductivity value estimated from the pumping test conducted as part of the Phase I RI was used in the SSL calculations. The value used was 135,605 m/yr (0.43 cm/sec).

2.4 Aquifer Thickness (d_a)

The value used for aquifer thickness was 18.29 meters (60 feet). The average aquifer thickness was interpreted from cross section B-B' presented in the Phase II RI Report (Philip, 1996).

2.5 Hydraulic Gradient (i)

A groundwater hydraulic gradient value of 0.0041 meter/meter was used. This value was reported in the Phase II RI Report (Philip, 1996).

2.6 Concentration Standard

The concentration standards were set equal to the adjusted Method B groundwater levels presented in Table C-4 of Appendix C.

2.7 Soil Organic Carbon & Water Partition Coefficient (K_{oc})

Soil organic carbon and water partition coefficient were obtained from Attachment C (Table C-1) of the *Soil Screening Guidance: User's Guide* (USEPA, 1996a) for all chemicals except dioxins/furans. For dioxins/furans, this value was obtained from Table 2-3 of *Estimating Exposure to Dioxin-Like Compounds. Volume II: Properties, Sources, Occurrence and Background Exposures* (USEPA, 1994a).

2.8 Fraction Organic Carbon (f_{oc})

The fraction organic carbon value used for input in the SSL equation was the average Total Organic Compound (TOC) concentrations (by ASTM Method D4129-82) in soil samples from 12 locations as reported by Columbia Analytical Services in a report dated May 30, 1995. The sample names, TOC concentrations, and their averages are presented in Table E-2.

2.9 Soil-Water Partition Coefficient (K_d)

For organic compounds, K_d was calculated by multiplying K_{oc} and f_{oc}. For all metals except copper, K_d was obtained directly from Attachment C (Table C-4) of *Soil Screening Guidance: Users Guide* (USEPA, 1996c). The K_d values for metals are pH-dependent. Because the geometric mean of the pH for soil at the site (Table E-3) was above the highest value of pH (8.0) in Table C-4 of Attachment C, the K_d value reported for each metal at a pH of 8.0 was used.

The *Soil Screening Guidance: Users Guide* did not provide a K_d value for copper. The value for copper was obtained from the Minnesota Pollution Control Agency, Ground Water and Solid Waste Division (GWSWD) Office memorandum dated May 28, 1992. The GWSWD reported a pH-dependent range for K_d of copper between 1.4 and 333 ml/g. Due to the high pH (9.1) at the site (geometric mean, Table E-3), the GWSWD suggests selecting a value from the upper third of the range. Because the cation exchange capacity (CEC) can also have a bearing on the K_d value (and the CEC for site soil is unknown), a conservative estimate for K_d was calculated at the lower end of the middle third of the K_d range (112 ml/g).

2.10 Average Soil Moisture Content (θ_w)

The average soil moisture content was calculated by the relationship presented in Section 1.0 above and described in Attachment A of *Soil Screening Guidance: User's Guide* (USEPA, 1996c). The calculated value for θ_w is 0.32 (Table E-4).

2.11 Dry Soil Bulk Density (p_b)

Dry soil bulk density (dry unit weight) was set equal to the geometric mean of 12 laboratory recompacted soil samples (Table E-5). The value used was 1.48 kg/L.

2.12 Soil Porosity (n)

Soil porosity was set equal to the geometric mean of 12 laboratory recompacted soil samples (Table E-5). The value used was 0.43.

2.13 Vertical Hydraulic Conductivity (K_v)

The vertical hydraulic conductivity was set equal to the geometric mean of 12 laboratory recompacted soil samples (Table E-5). The value used was 3321 m/yr.

2.14 Henry's Law Constant (H')

Henry's Law Constant values were obtained from Attachment C (Table C-1) of *Soil Screening Guidance: User's Guide* (USEPA, 1996c) for all chemicals except dioxins/furans. For dioxins/furans, this value was obtained from Table 2-3 of *Estimating Exposure to Dioxin-Like Compounds. Volume II: Properties, Sources, Occurrence and Background Exposures* (USEPA, 1994a).

3.0 Results

Table E-6 presents calculations of site-specific SSLs that are protective of the adjusted Method B levels for groundwater.

Table E-1

SOURCE LENGTHS
SSL - MIGRATION TO GROUNDWATER
PASCO LANDFILL
PASCO, WASHINGTON

Source	Source Length (Feet)	Source Length (Meters)
Sludge Management Area	1500	457
Landspread Area	650	198
Zone A/BT-2/Balefill	850	259
Zone B	120	37
Zones C & D & BT-1	300	91
Zones E & TS-1/SL-1	345	105
SL-2 &SL-3	380	116
Other Areas Not Desig. for MeCl (SL-2)	240	73
Other Areas Not Desig. for Se (Zone A)	350	107
Other Areas Not Desig. for Ag	1575	480

Analyte	ZONES/SOURCE LENGTHS (Meters)								Total Source Length (Meters)	Adjusted Total Source Length (Meters)
	1 Sludge Management	2 Landspread Area	3 Zone A/BT-2 Balefill	4 Zone B	5 Zones C&D & BT-1	6 Zones E & TS-1/SL-1	7 SL-2 &SL-3	8 Areas Not Immed. Adjacent to Designated Zones		
ORGANICS										
Acetone					91				91	91
Methylene Chloride			259		91	105	116	73	644	571
Hexachlorobenzene						105			105	105
Dioxins/furans				37					37	37
METALS										
Antimony					91				91	91
Arsenic	457	198							655	457
Cadmium	457								457	457
Chromium VI	457		259						716	457
Copper	457	198				105			760	457
Mercury	457	198			91	105	116		967	457
Selenium								107	107	107
Silver			259		91	105	116	480	1051	571

Table E-2

TOTAL ORGANIC CARBON
SSL - MIGRATION TO GROUNDWATER
PASCO LANDFILL
PASCO, WASHINGTON

Sample Location	Depth (Feet)	TOC (%)	TOC (unitless)	TOC After Averaging Duplicates (unitless)
PLF-VEW01-32	32	0.12	0.0012	0.0012
PLF-VEW01-12	12	0.1	0.001	0.001
PLF-23S-14	14	0.09	0.0009	0.00085
PLF-MW23S-914	14	0.08	0.0008	
PLF-MW23S-934	34	0.05	0.0005	
PLF-MW23S-34	34	0.12	0.0012	0.00085
PLF-MW24S-47	47	0.00	0	0
PLF-MW26S-14	14	0.00	0	0
PLF-MW26S-35	35	0.00	0	0
PLF-MW-27S-26.5	26.5	0.05	0.0005	0.0005
PLF-MW-27S-52	52	0.00	0	0
PLF-MW28S-20	20	0.00	0	0
PLF-MW28S-55	55	0.00	0	0
PLF-MW28S-22	22	0.09	0.0009	0.0009
			Average	0.00044

Table E-3

pH
SSL - MIGRATION TO GROUNDWATER
PASCO LANDFILL
PASCO, WASHINGTON

Sample Location	Depth (Feet)	pH
PLF-VEW01	10	8.7
PLF-VEW01	20	8.9
PLF-VEW01	30	9.2
PLF-VEW02	10	9.2
PLF-VEW02	20	9.1
PLF-VEW02	30	9.1
PLF-VEW03	5	8.9
PLF-VEW03	15	9.0
PLF-VEW03	25	9.3
PLF-MW26S	5	9.2
PLF-MW26S	15	9.4
PLF-MW26S	25	9.3
PLF-SB13	10	8.7
PLF-SB13	20	9.4
PLF-SB13	25	9.5
PLF-SB14	10	8.9
PLF-SB14	20	9.2
PLF-SB14	25	9.0
PLF-SB15	10	9.1
PLF-SB15	20	9.3
PLF-SB15	25	9.4
	Geometric Mean	9.1

Table E-4

SOIL MOISTURE CALCULATION
SSL - MIGRATION TO GROUNDWATER
PASCO LANDFILL
PASCO, WASHINGTON

$Theta_w$ (unitless)	n (unitless)	I (m/yr)	K_s (m/yr)	1/(2b+3) (unitless)	p_b (Kg/L)	p_s (Kg/L)
0.32	0.44	0.0127	3320.91	0.085	1.48	2.65

Where: $Theta_w = n(I/K_s)^{1/(2b+3)}$

and $Theta_w$ = average soil moisture content

n = total soil porosity = $1-(p_b/p_s)$

I = infiltration rate

K_s = saturated vertical hydraulic conductivity

b = soil-specific exponential parameter from Table A-2 of Soil Screening Guidance: User's Guide.

Table E-5

PHYSICAL PARAMETERS
SSL - MIGRATION TO GROUNDWATER
PASCO LANDFILL
PASCO, WASHINGTON

Sample Location	Depth (Feet)	Dry Unit Weight (pcf)	Dry Unit Weight (Kg/L)	Total Porosity unitless	Vertical Hydraulic Conductivity (cm/sec)	Vertical Hydraulic Conductivity (m/yr)
PLF-MW-23S	30.5-31.5	86.4	1.38	0.478	1.80E-02	5676
PLF-MW-23S	32.0-32.5	103	1.65	0.378	1.00E-02	3154
PLF-MW-24S	45.5-46.5	63.4	1.02	0.616	7.90E-03	2491
PLF-MW-24S	13.0-13.5	78.4	1.26	0.526	1.40E-03	442
PLF-MW-26S	34.0-35.0	102.1	1.64	0.383	2.20E-02	6938
PLF-MW-26S	25.5-26.0	111.9	1.79	0.324	1.40E-02	4415
PLF-MW-27S	50.5-51.5	84.7	1.36	0.488	1.30E-02	4100
PLF-MW-27S	18.5-19.0	95.2	1.52	0.425	7.50E-02	23652
PLF-MW-28S	57.5-58.5	85.9	1.38	0.481	1.00E-02	3154
PLF-MW-28S	57.5-58.5	102	1.63	0.383	3.60E-03	1135
PLF-VEW01	32.5-33.5	95	1.52	0.426	1.60E-02	5046
PLF-VEW01	32.5-33.5	112.2	1.80	0.322	5.40E-03	1703
	Geometric Mean		1.48	0.43	1.05E-02	3321

Ta

SSL CALCULATION
SSL - MIGRATION TO GROUNDWATER
PASCO LANDFILL
PASCO, WASHINGTON

Compound Name	Soil Screening Level (mg/kg)	L Source Length Parallel to to GW flow (m)	I Infil. Rate (m/yr)	K Hydraulic Cond. (m/yr)	d_a Aquifer Thickness (m)	i Hydraulic Gradient (m/m)	d_{calc} Mixing Zone Depth Calculated (m)	d_{max} Maximum Mixing Zone Depth = Aquifer Thickness (m)	Standard Conc Standard Method B GW Level (mg/L)	DAF Dil. Atten. Factor (unitless)	C_w Target Soil Leachate Conc. (mg/L)	K_d Soil Water Partition Coefficient (L/kg)	K_{oc} Soil Organic Carbon & Water Partition Coeffient (L/kg)	f_{oc} Fraction Organic Carbon (unitless)	$Theta_w$ Water-Filled Soil Porosity (unitless)	p_b Dry Soil Bulk Density (kg/L)	n Soil Porosity (unitless)	$Theta_a$ Air Filled Soil Porosity (unitless)	H' Henry's Law Constant (unitless)
Acetone	80.31	91	0.01270	135605	18.29	0.0041	9.6	18.29	0.08	4635	370.80	0.000253	5.75E-01	0.00044	0.32	1.48	0.43	0.11	1.59E-03
Methylene Chloride	0.16	571	0.01270	135605	18.29	0.0041	60.4	18.29	0.0005	1403	0.70	0.005148	1.17E+01	0.00044	0.32	1.48	0.43	0.11	8.98E-02
Hexachorobenzene	5.66	105	0.01270	135605	18.29	0.0041	11.1	18.29	0.00005	4635	0.23	24.2	5.50E+04	0.00044	0.32	1.48	0.43	0.11	5.41E-02
Dioxins/furans	0.0031	37	0.01270	135605	18.29	0.0041	3.9	18.29	6E-10	4635	3E-06	1105	2.51E+06	0.00044	0.32	1.48	0.43	0.11	6.54E-07
Antimony	125.75	91	0.01270	135605	18.29	0.0041	9.6	18.29	0.0006	4635	2.78	45	NA	0.00044	0.32	1.48	0.43	0.11	0.00E+00
Arsenic	3.28	457	0.01270	135605	18.29	0.0041	48.4	18.29	0.00006	1753	0.11	3.10E+01	NA	0.00044	0.32	1.48	0.43	0.11	0.00E+00
Cadmium	3769.31	457	0.01270	135605	18.29	0.0041	48.4	18.29	0.0005	1753	0.88	4.30E+03	NA	0.00044	0.32	1.48	0.43	0.11	0.00E+00
Chromium VI	996.89	457	0.01270	135605	18.29	0.0041	48.4	18.29	0.04	1753	70.12	1.40E+01	NA	0.00044	0.32	1.48	0.43	0.11	0.00E+00
Copper	59017.12	457	0.01270	135605	18.29	0.0041	48.4	18.29	0.3	1753	525.92	1.12E+02	NA	0.00044	0.32	1.48	0.43	0.11	0.00E+00
Mercury	351.06	457	0.01270	135605	18.29	0.0041	48.4	18.29	0.001	1753	1.75	2.00E+02	NA	0.00044	0.32	1.48	0.43	0.11	4.67E-01
Selenium	559.96	107	0.01270	135605	18.29	0.0041	11.3	18.29	0.05	4635	231.75	2.20E+00	NA	0.00044	0.32	1.48	0.43	0.11	0.00E+00
Silver	1548.64	571	0.01270	135605	18.29	0.0041	60.4	18.29	0.01	1403	14.03	1.10E+02	NA	0.00044	0.32	1.48	0.43	0.11	0.00E+00

Example calculations for mixing zone depth, dilution factor and soil screening concentrations are provided below for selenium.

Mixing Zone Depth (d_{calc})

$d_{calc} = (0.0112L^2)^{0.5} + d_a(1-\exp[(-LI)/(Kid_a)])$

where: d_{calc} = calculated mixing zone depth (m)
L = source length parallel to ground water flow (m)
I = Infiltration rate (m/yr)
K = aquifer hydraulic conductivity (m/yr)
d_a = aquifer thickness (m)
i = hydraulic gradient (m/m)

EX. CALC. d_{calc} = ((0.0112 x ((107m)^{2})$^{0.5}$) + 18.29m{1-exp[((-107m x 0.0127m))/(135605 m/yr x 0.0041 m/m x 18.29 m)]}) = 11.3

Dilution Factor (DAF)

DAF = 1 + [(Kid)/(IL)]

where: DAF=dilution factor (unitless)
K = aquifer hydraulic conductivity (m/yr)
i = hydraulic gradient (m/m)
d = mixing zone depth (m) = d_{calc} if $d_{calc} < d_a$; If $d_{calc} > d_a$, d = d_a
I = Infiltration Rate (m/yr)
L = source length parallel to ground water flow (m)

EX. CALC. DAF = 1 + [(135605 m/yr x 0.0041 m/m x 3.7 m)/(0.0127 m x 107 m)] = 4635

Soil Screening Level (SSL)

SSL = $C_w[K_d + ((theta_w + theta_a H')/p_b)]$

where: C_w = target soil leachate concentration (mg/L) = *DAF x Concentration Standard*
K_d = soil-water partition coefficient (L/kg) = *Koc [soil organic carbon/water partition coefficient (L/kg)] x foc [faction organic carbon (L/kg)]*
$theta_w$ = water-filled soil porosity (L_{water}/L_{soil}) = $n(I/K_s)^{1/(2b+3)}$
where: n = total soil porosity (L_{pore}/L_{soil}) = $1-(p_b/p_s)$
p_b = dry soil bulk density (kg/L)
p_s = soil particle density = 2.65 kg/L
I = infiltration rate (m/yr)
K_s = satruated vertical hydraulic conductivity (m/yr)
b = soil-specific exponential parameter (value of *1/(2b+3)* from Table A-2 of Soil Screening Guidance: User's Guide) (unitless)
$theta_a$ = air-filled soil porosity (L_{air}/L_{soil})
H' = Henry's law constant (unitless)

EX. CALC. SSL= 231.75 mg/L [2.2E+00 L/kg + {(0.32 + (0.11 x 0.00 E+00))/1.48 kg/L)}] = 559.96

F

APPENDIX F

EXCERPT FROM
FRANKLIN COUNTY COMPREHENSIVE PLAN

Within the Rural Settlement a mixture of zoning categories allowing for single and multi-family dwellings, mobile homes, duplexes, tri-plexes, commercial uses, and some industrial uses would be permitted. Standards in the Zoning Ordinance would govern outright permitted uses and conditional uses.

This land use category applies to areas meeting the following criteria:

a. The area is an existing "named" rural center which has at least one retail or service business (excluding home occupations) and at least one public use (church, school, fire station, grange hall, etc).

b. The area is served by a rural fire district. Unincorporated rural communities within Franklin County which meet or could meet the criteria for this land use category include, but are not limited to, Basin City and Eltopia.

Resource Lands - Agriculture

Franklin County has approximately 645,000 acres of agricultural lands. The Franklin County Soil Survey Team has estimated this total to include 28 percent prime, 29 percent unique, 26 percent of state and local importance, and 17 percent rangeland.

There are several thousand acres of prime farmland under pressure from urbanization within Franklin County. If these lands are removed from agricultural production, less productive lands will be utilized, thereby requiring more expensive farming methods.

The Franklin County Soil Survey Team is currently in the process of updating the County Soil Survey. Because of present gaps in the data for the entire County, only the urban areas within the County (where most of the soils data have been collected) were classified. Soils units in these study areas were classified using the U.S. Soil Conservation Service (Homes Pers. Comm.) national classification of agricultural lands. There are three classifications: Prime, unique, and those of state and local importance.

Prime Agricultural Lands

Prime agricultural lands are lands with soils best suited for producing food, feed, forage, fiber, and oilseed crops, and are also available for these uses. They have the soil qualities, growing season, and moisture supply required to produce

economically sustained high yields of crops when managed according to modern farming methods.

Unique Agricultural Lands

Farmland soil units other than prime farmland used for the production of specific high value food and fiber crops are classified as unique agricultural lands. These lands have the special combination of soil quality, location, growing season, and moisture supply needed to economically sustain high quality and yields when managed according to modern farming methods.

Areas shown in agricultural uses will be in, or already are in productive crop agriculture (these areas also include grazing lands). With water availability, the soils are sufficiently deep for irrigated cropping. Soils are also sufficiently deep for non-irrigated cropping.

Areas within this designation should be conserved, insofar as is practicable and desirable, for the continued economic welfare of the farm industry and residents of the County. Farm labor housing, farm supplies, and agricultural storage/processing are compatible uses.

Farmland of State and Local Significance

In addition to prime and unique farmland there are those lands that are of state and local significance in the production of food, feed, fiber, and forage.

According to the Franklin County Conservation District, consideration should be given for the inclusion of Quincy soils under pivot irrigation for this category based upon their production capability. Crop yields in this area are usually found to be the highest in the state. Common yields include: Eight tons of hay per acre, 110 bushels of wheat per acre, 3,000 pounds of beans per acre, 30 tons of potatoes per acre, and six tons of corn per acre.

These soils have coarse to fine sandy textures that makes them susceptible to wind and water erosion. Management is, therefore, very important. Center pivot and lateral moves give the farm manager the opportunity for top yields and a protected resource base. These soils also show the potential for low pressure (energy) irrigation systems. Most of the county's Quincy soils are located in lower blocks 16 and 17. Farmland considered as state and local significance includes approximately 20,000 acres of Quincy soils under pivot irrigation.

G

APPENDIX G

EXCERPT FROM
CITY OF PASCO COMPREHENSIVE PLAN

CLASSIFICATION	DESCRIPTION	CRITERIA FOR ALLOCATION
Open Space/Nature	Land where development will be severely restricted - park lands, trails and critical areas	• Land owned and reserved by the Port of Pasco to preclude development that is not compatible with airport operations. • State park land and lands along the shoreline that are critical for habitat. • Franklin County Irrigation District canal rights-of-way when canal is converted to a pressure pipe.
Low Density Residential	Residential development at a density of 2 to 5 dwelling units per acre with -in the City and the Riverview area. Columbia Bend north of the City wil have density of 1 dwelling unit per 1 to 5 acres.	• Need for facility • Sewer availability • Market demand • Land suitable for home sites. • Sites approved by the Benton-Franklin Health District when sewer is not available.
Mixed Residential	Single-family dwellings, patio homes, townhouses, apartments and condominiums at a density of 5-12 dwelling units per acre.	• Sewer availability • Market demand • Location convenient to major circulation routes • Transition areas between more intense uses and low density uses • Land suitable for homesites.
High Density Residential	Multiple unit apartments or condominiums at a density exceeding 12 units per acre	• Sewer availability • Market demand • Located on or near circulation routes

Mixed Residential/ Commercial	Allows either residential or commercial to develop depending on community need. It is not intended for these uses to develop in a mixed fashion. They are to be separate and independent of each other. Residential will consist of single family through apartments at a density of 5-12 units per acre. Commercial will consist of offices, neighbor, community and regional shopping as well as business parks.	• Located on or near circulation routes • Transition areas between more intense uses and low density uses • Sewer availability • Market demand
Commercial	Neighborhood, community and regional shopping and specialty centers, business parks, service and office uses.	• Size consistent with market demand • Location conducive to convenient access on major circulation routes • Sewer availability • Relatively level land suitable for heavy building sites
Industrial	Manufacturing, food processing, storage and wholesale distribution of equipment and products, hazardous material storage and transportation related facilities	• Port of Pasco properties • Land convenient to rail yards • land convenient to the industrial waste water treatment facility • Land convenient to the regional transportation system • Availability of necessary utilities to serve the use • Relatively level land suitable for heavy building sites.

H

APPENDIX H

TOXICITY VALUES OBTAINED FROM NCEA

Attachment 1 (96-021/07-02-96)

Risk Assessment Issue Paper for:
Derivation of a Provisional Oral RfD for Benzene (CASRN 71-43-2)

INTRODUCTION

A chronic RfD for benzene is not available on IRIS (U.S. EPA, 1996) or HEAST (U.S. EPA, 1995a). Documents on the CARA list which discuss the toxicity of benzene (U.S. EPA, 1991, 1994) include an AWQCD (U.S. EPA, 1980, 1989a) and HEA (U.S. EPA, 1984, 1989b). None of these documents derived non-carcinogenic estimates of risk from benzene exposure. The one- and ten-day drinking water health advisories for a 10 kg child is 0.2 mg/l (U.S. EPA, 1995b). Longer-term health advisories for a child, health advisories for adults, and an RfD for benzene have not been derived by the Office of Water (U.S. EPA, 1995b). ATSDR has prepared a toxicological profile on benzene (ATSDR, 1995). This document did not derive acute, intermediate, or chronic oral MRLs for benzene. In addition, an RfC for benzene is not available on IRIS (U.S. EPA, 1996).

To identify research reports pertinent to the derivation of a provisional chronic RfD for benzene, EPA and ATSDR documents (as cited above) were reviewed; in addition, a computer search of the literature was conducted from the HSDB, RTECS, TSCATS, and TOXLINE (July 1990 to April 1993, oral strategy) databases. Update literature searches TOXLINE, MEDLINE, TSCATS, and DART were conducted in May 1996.

REVIEW OF PERTINENT LITERATURE

Data regarding the toxicity of ingested benzene in humans were limited to reports on single exposures (ATSDR, 1995). Several studies reported very serious effects, including death, but did not report dose levels. One study reported very serious neurological effects and death in humans from a single oral dose of approximately 125 mg/kg (Theines and Haley, 1972; as cited in ATSDR, 1991).

Chronic oral studies. Chronic oral studies have been conducted in F344 rats and B6C3F1 mice (NTP, 1986; Huff et al., 1989), and Sprague-Dawley and Wistar rats and Swiss and RF/J mice (Maltoni et al., 1983, 1985, 1989).

In the NTP (1986) study, F344 rats and B6C3F1 mice of both sexes were treated by gavage with benzene, 5 days/week for 103 weeks. Results of this study have also been reported by Huff et al. (1989). For rats, males (60/group) were administered doses of 0, 50, 100, or 200 mg/kg (0, 36, 71, or 143 mg/kg/day) and females (60/group) were administered doses of 0, 25, 50, or 100 mg/kg (0, 18, 36, or 71 mg/kg/day). Survival decreased with increasing dose in rats of both sexes, and was significantly decreased ($p<0.05$) at 200 mg/kg in males and at 50 and 100 mg/kg in females. Body weight depression of ≥ 10% relative to controls was observed in male rats treated with 200 mg/kg/day and female rats treated with 100 mg/kg. Dose-related leucopenia was significant ($p<0.05$) in female rats treated with 25 mg/kg or higher for 3, 6, 9, and 12 months; leukocyte levels were comparable to

controls after 15, 18, 21, and 24 months of treatment. In male rats, dose-related leucopenia was significant ($p<0.05$) at 50 mg/kg or higher for 3, 6, 9, 12, 15, and 18 months. A similar pattern of significant ($p<0.05$), dose-related decrease, followed by eventual return to control levels, was observed for lymphocyte levels in female rats treated with 25 mg/kg or higher and in male rats treated with 50 mg/kg or higher. Lymphoid depletion was observed in the thymus of 0/44, 4/42, 8/41, and 10/34 male rats treated with 0, 50, 100,and 200 mg/kg benzene, respectively. In the spleen, lymphoid depletion was observed in 0/49, 19/58, 8/47, and 23/47 male rats treated with 0, 50, 100, and 200 mg/kg benzene, respectively, and in 0/50, 11/50, 8/49, and 10/49 female rats treated with 0, 25, 50, and 100 mg/kg benzene, respectively. Increased ($p<0.05$) incidences of malignant tumors were observed at dose levels of 50 mg/kg or greater in male rats (Zymbal gland carcinomas, squamous cell papillomas and squamous cell carcinomas of the oral cavity, and squamous cell papillomas and squamous cell carcinomas of the skin) and at 25 mg/kg or greater in female rats (Zymbal gland carcinomas, squamous cell papillomas and squamous cell carcinomas of the oral cavity). This study identified a LOAEL of 25 mg/kg (18 mg/kg/day) for leukopenia and lymphocytopenia in female F344 rats treated by gavage for 103 weeks. A LOAEL of 50 mg/kg (36 mg/kg/day) was identified for leukopenia and lymphocytopenia in male F344 rats treated by gavage for 103 weeks. The observed LOAELs were at the lowest dose level tested. Thus, no NOAELs for hematological effects in rats were identified in this study.

In the NTP (1986) study, mice (60/sex/group) were treated by gavage with doses of 0, 25, 50, or 100 mg/kg benzene (0, 18, 36, or 71 mg/kg/day). Survival decreased with increasing dose in mice of both sexes and was significantly decreased ($p<0.05$) at 100 mg/kg. Body weight depression of $\geq 10\%$ relative to controls was observed in mice of both sexes treated with 100 mg/kg. Significantly ($p<0.05$) decreased leukocyte counts were observed in males after 3, 6, 9, 12, 15, 18, and 21 months of treatment with 50 and/or 100 mg/kg, but males treated with 25 mg/kg had significantly decreased leukocyte counts only after 6 and 21 months of treatment. In female mice, leucopenia was observed only at 12 and 18 months, in both cases significant ($p<0.05$) at all treatment levels. Significantly ($p<0.05$) decreased lymphocyte counts were observed in males after 3, 6, 9, 12, 15, 18, and 21 months of treatment with 50 and/or 100 mg/kg, but males treated with 25 mg/kg had significantly ($p<0.05$) decreased lymphocyte counts only after 12 months of treatment. In female mice, significant ($p<0.05$) lymphocytopenia was observed at 25 mg/kg or higher at 12 and 18 months, and at 100 mg/kg at 3 months. Hematopoietic hyperplasia of the bone marrow was observed in 0/49, 11/48, 10/50, and 25/49 male mice treated with 0, 25, 50, or 100 mg/kg, respectively, and in 3/49, 14/45, 8/50, and 13/49 female mice treated with 0, 25, 50, or 100 mg/kg, respectively. Increased splenic hematopoiesis was observed in 5/49, 9/48, 19/49, and 24/47 male mice treated with 0, 25, 50, or 100 mg/kg, respectively, and in 9/49, 10/45, 6/50, and 14/49 female mice treated with 0, 25, 50, or 100 mg/kg, respectively. In the female mice, increased incidences of epithelial hyperplasia of the ovary occurred at all three doses and of senile atrophy of the ovary occurred at the lower two doses compared with controls. Increased ($p<0.05$) incidences of malignant tumors were observed at 25 mg/kg or higher in both sexes of mice (Zymbal gland squamous cell carcinomas, malignant lymphomas, alveolar/bronchiolar carcinomas, alveolar/bronchiolar carcinomas and adenomas (combined), Harderian gland adenomas, and squamous cell carcinomas of the preputial gland in males and Zymbal gland squamous cell carcinomas, malignant lymphomas, ovarian granulosa cell tumors, ovarian benign mixed tumors, carcinomas and carcinosarcomas of the mammary gland, alveolar/bronchiolar carcinomas, and alveolar/bronchiolar adenomas in females). This study identified a LOAEL of 25

mg/kg (18 mg/kg/day) for leukopenia and lymphopenia in male and female B6C3F1 mice treated by gavage for 103 weeks. The observed LOAELs were at the lowest dose level tested. Thus, no NOAELs for hematological effects in mice were identified in this study.

Beginning in 1976, a series of carcinogenicity studies on oral treatment of rodents with benzene were performed at the Bologna Institute of Oncology, including 52-104 week studies on Sprague-Dawley and Wistar rats and Swiss and RF/J mice. The results of the studies from this laboratory were reported in numerous publications, including Maltoni et al. (1983, 1985, 1989). Limited information regarding non-carcinogenic effects were reported in the various publications since the major emphasis of the studies was the carcinogenic effects of benzene. No statistical information was included in the various publications, making interpretation of the data difficult.

Maltoni et al. (1985) treated Sprague-Dawley rats (13 weeks of age, 30-35/sex/group) by gavage with 0, 50, or 250 mg/kg benzene in oil, 4-5 days/week for 52 weeks, then observed until death; the expanded doses, assuming that the rats were treated an average of 4.5 times/week, were 0, 32, and 161 mg/kg/day, respectively. In addition, Sprague-Dawley rats (7 weeks of age, 40-50/sex/group) were treated by gavage with 0 or 500 mg/kg benzene in oil, 4-5 days/week for 104 weeks, then observed until death; the expanded doses, assuming that the rats were treated an average of 4.5 times/week, were 0 and 321 mg/kg/day, respectively (Maltoni et al., 1985). Maltoni et al. (1983) reported some preliminary information on these studies, including some non-carcinogenic endpoints. Mortality was higher in benzene treated groups and appeared to be dose-related; body weights were not affected. Maltoni et al. (1983) stated that mortality in the first portion of the study was due to direct (toxic) effects of treatment and in the later portion, was partially due to tumors. Mortality was similar to that of controls during treatment with 500 mg/kg for 92 weeks (Maltoni et al., 1983); body weight appeared to be somewhat depressed relative to controls. No further information regarding survival or body weight was provided in the later reports on these studies (Maltoni et al., 1985, 1989). In Sprague-Dawley rats exposed to 500 mg/kg for 84 or 92 weeks, decreased total RBC (only at 92 weeks), WBC, and lymphocytes were observed (Maltoni et al., 1983, 1985). Multiple-site carcinomas developed at 50, 250, and/or 500 mg/kg in rats in these studies. Zymbal gland, oral cavity, nasal cavity, and skin carcinomas, forestomach tumors, subcutaneous angiosarcoma, mammary gland tumors, hepatomas, non-myeloid leukemias, and other tumors were observed, with greater incidence and more types of malignancies observed at the higher treatment levels.

Additional gavage studies of benzene (at 500 mg/kg, 4-5 days/week) by Maltoni et al. (1989) in Wistar rats, Swiss mice, and RF/J mice focussed entirely on carcinogenic effects, which were similar to those reported in the above studies and occurred in all three strains/species. The report of these studies did not discuss non-carcinogenic effects.

Subchronic oral studies. Subchronic oral studies have been conducted in F344 rats and B6C3F1 mice of both sexes (NTP, 1986; Huff et al., 1989), female Wistar rats (Wolf et al., 1956); CD-1 male mice (Hsieh et al., 1988), C57BL/6 male mice (Fan, 1992), and B6C3F1 female mice (White et al., 1984).

NTP (1986) treated F344 rats and B6C3F1 mice (10/species/group/sex; 6-8 weeks of age) with 0, 25, 50, 100, 200, 400, or 600 mg/kg benzene, by gavage in corn oil, 5 days/week for 17

weeks; the expanded doses were 0, 18, 36, 71, 143, 286, or 429 mg/kg/day. An additional 5 animals/species/group/sex were tested at the 0, 200 and 600 mg/kg dose levels and killed at 60 days of treatment. Hematological analyses were performed on all the animals killed at 60 days and on 5 animals/species/group/sex at the end of the study. Comprehensive histopathologic examinations were performed on all the animals killed at 60 days and on animals in the control and 600 mg/kg groups at the end of the study. In addition, necropsies were performed on all animals and the spleens of all animals were examined histopathologically. Results of this study have also been reported by Huff et al. (1989).

No compound-related deaths were observed for rats. Final body weight depression of ≥ 10% relative to controls was observed in male and female rats at dose levels of 200 mg/kg and greater. Significant ($p<0.05$) leukopenia and lymphocytopenia were observed in male and female rats after 60 days of treatment with 200 or 600 mg/kg (the only treatment groups tested on day 60). On day 120 of treatment, significant ($p<0.05$) leucopenia and lymphocytopenia were observed in female rats at 25 mg/kg and higher and significant ($p<0.05$) lymphocytopenia was observed in male rats at 400 mg/kg (blood counts were performed on only 1 male given 600 mg/kg for 120 days). Lymphoid depletion of B-cells in the spleen was observed in 100% of male and female rats exposed to 600 mg/kg for 60 or 120 days, and in 3/5 male and 4/5 female rats exposed to 200 mg/kg for 60 days. Increased extramedullary hematopoiesis in the spleen was observed in 4/5 male and 3/5 female rats treated with 600 mg/kg for 120 days. Incidences of lymphoid depletion of B cells and extramedullary hematopoiesis in the spleen were not reported for controls (or other groups); the implication was that these conditions were seen only in the groups for which incidences were given. This study identified a LOAEL of 25 mg/kg (18 mg/kg/day) in female rats and LOAEL of 200 mg/kg (143 mg/kg/day) in male rats for hematological effects following treatment by gavage for 17 weeks. The observed LOAEL for female rats was at the lowest dose level tested. Thus, the study does not define a NOAEL for hematological effects in rats.

NTP (1986) reported no compound-related deaths in the mice; final body weight depression of ≈ 7% was seen at > 100 mg/kg. Tremors were observed intermittently in male and female mice treated with 400 or 600 mg/kg. No leukopenia or lymphocytopenia was observed in male or female mice after 60 days of treatment with 200 or 600 mg/kg. At 120 days, significant ($p<0.05$) leukopenia and lymphocytopenia were observed in male mice at dose levels of 50 mg/kg and greater, and in female mice at 400 (only lymphocytopenia) and 600 mg/kg. A NOAEL of 25 mg/kg (18 mg/kg/day) and a LOAEL of 50 mg/kg (36 mg/kg/day) for hematological effects were identified in male mice treated by gavage for 17 weeks. A NOAEL of 200 mg/kg (143 mg/kg/day) and a LOAEL of 400 mg/kg (286 mg/kg/day) for hematological effects were identified in female mice treated by gavage for 17 weeks.

White et al. (1984) exposed female B6C3F1 mice (12/group; 6-7 weeks of age) to benzene in drinking water (containing emulphor to increase solubility of benzene) at exposure levels of 0, 50, 1000, and 2000 mg/L (0, 12, 195, or 350 mg/kg/day, respectively) for 30 days. Body weight was significantly ($p<0.05$) decreased, relative to controls, at the high-exposure level. A dose-related ($p<0.01$) decrease in absolute and relative spleen weight was observed, significant at the high-exposure level ($p<0.01$). In one test, spleen cellularity was reported to be significantly ($p<0.05$) decreased at all exposure levels, and in a separate test, at only the mid- and high-exposure levels. Dose-related ($p<0.05$) leukopenia and lymphocytopenia were observed, significant ($p<0.05$) at the

mid- and high-exposure level. A dose-related ($p<0.01$) decrease in eosinophils was observed, significant ($p<0.05$) at the high-exposure level. At the high-exposure level, significant ($p<0.05$) decreases in levels of erythrocytes and hemoglobin, and significant ($p<0.05$) increases in mean corpuscular volume and mean corpuscular hemoglobin were observed. No exposure-related effects were observed for levels of blood urea nitrogen, serum creatinine, serum glutamic oxaloacetic transaminase, or serum glutamic pyruvic transaminase, indicators of renal and hepatic damage. Dose-related ($p<0.05$) changes were observed in immunological tests on spleen cells and in assays of bone marrow: decreases were observed with respect to IgM antibody forming cells/spleen in response to sheep RBC, lymphocyte proliferation response to the T cell mitogen Con A and the B cell mitogen LPS, number of T lymphocytes, and femoral CFU-GM; an increase was observed in bone marrow cell DNA synthesis. These effects were not significant at 12 mg/kg/day, but were dose-related ($p<0.05$) and significant ($p<0.05$) at 195 and/or 350 mg/kg/day. Of all the immunological indices tested, only one endpoint (stimulation index for lymphocyte proliferation of spleen cells in response to medium containing 0.5 µg/ml of Con A) was significantly ($p<0.05$) decreased at 12 mg/kg/day. The number of B lymphocytes was not affected, but the investigators commented that the number of B lymphocytes in the controls was lower than for historical controls for their laboratory. This study identifies a marginal NOAEL of 12 mg/kg/day and a LOAEL of 195 mg/kg/day for hematological and immunological effects in mice exposed to benzene in drinking water for 30 days; the 12 mg/kg/day exposure level may approach the threshold of toxicity, as significance ($p<0.05$) was seen for two effects at this exposure level, and numerous hematological and immunological effects that were dose-related, but not significant at the 12 mg/kg level, were observed.

Hsieh et al. (1988) treated male Charles River CD-1 mice (5/group; 6-7 weeks of age) with benzene in the drinking water at exposure levels of 0, 40, 200, or 1000 mg/L (0, 8, 40, or 180 mg/kg/day, respectively) for 28 days. The treatment had no adverse effects with respect to mortality, clinical signs, body weight change, liver weight, or gross necropsy. A dose-related decrease in relative spleen weight was observed, significant ($p<0.05$) at the high-exposure level. In one test, spleen cellularity was reported to be significantly ($p<0.05$) decreased at all exposure levels, and in a separate test, only at the high-exposure level. Although relative thymus weights were decreased at all exposure levels, the values were not statistically significantly different from controls. Dose-related hematological effects (erythrocytopenia, leucopenia, lymphocytopenia, increased mean corpuscular volumes) were observed at all exposure levels, significant at $p<0.05$; hematocrit was significantly ($p<0.05$) decreased at the mid- and high-exposure levels. The authors indicated that the increased mean corpuscular volume, and decreased hematocrit and numbers of RBC were indicative of severe macrocytic anemia. Biphasic responses were observed in immunological tests [mitogen-stimulated (LPS, PWM, Con A, PHA) splenic lymphocyte proliferation, mixed splenic lymphocyte culture response to allogenic YAC-1 cells, cytotoxic splenic T-lymphocyte response to allogenic YAC-1 cells], with a significantly ($p<0.05$) increased response at the low-exposure level, and significantly ($p<0.05$) decreased responses at the mid- and/or high-exposure level. Using several methods to determine primary antibody response to sheep RBC, significantly ($p<0.05$) decreased responsiveness was observed at the mid- and/or high-exposure levels; this response was either significantly ($p<0.05$) increased or not different from controls in mice exposed to the low-exposure level. This study identifies a LOAEL of 8 mg/kg/day (the lowest treatment level tested) for hematological and immunological effects in male mice exposed to benzene in drinking water for 30 days. No NOAEL for hematological effects in mice were identified in this study.

Wolf et al. (1956) treated female Wistar rats (10/group) by gavage with benzene in olive oil, 5 days/week for 6 months. The reported doses were 0, 1, 10, 50, or 100 mg/kg/day, but it was not clear whether these represented the dose on treatment days or the dose expanded from 5 to 7 days/week. The usual practice in the primary literature is to report the actual gavage doses given on treatment days. Assuming that the usual practice was followed for this study, the expanded doses would be 0, 0.7, 7.1, 35.7, and 71.4 mg/kg/day, respectively. Parameters measured included mortality, clinical signs, body and organ weights, hematology, blood biochemistry, bone marrow counts, and gross and microscopic pathology of lungs, heart, liver, kidneys, spleen, testes, adrenals and pancreas. Leucopenia (described as "very slight") was reported for 10 mg/kg; at higher dose levels erythrocytopenia and leucopenia were observed. No quantitative data or statistical analysis were reported. The authors reported that rats fed 1 mg/kg had "no evidence of ill effects" with respect to gross appearance, growth, periodic blood counts, blood urea nitrogen, average final body and organ weights, histopathological examination, and bone marrow counts. For higher treatment levels, only adverse effects were described, requiring the assumption that no adverse effects were observed with respect to the other tested parameters. This study identified a NOAEL of 1 mg/kg (0.7 mg/kg/day) and a LOAEL of 10 mg/kg (7.1 mg/kg/day) for hematological effects in female rats treated by gavage for 6 months.

In a subchronic study conducted by Fan (1992), groups of male C57BL/6 mice were exposed via drinking water to 0, 152, or 852 mg/L benzene for 7-28 days; using estimated daily water intakes, the authors calculated benzene dosages of 27 and 154 mg/kg-day. Five mice per group were killed after 7, 14, 21, or 28 days of exposure to benzene. An unspecified number of mice were exposed to 152 mg/L for 28 days and killed 7, 14, or 21 days after the last dosage. The focus of this study was to determine the toxicity of benzene on NK cells involved in non-specific host resistance, and interleukin-2 which is the primary growth factor of T cells, a growth factor for B cells and NK cells, and is involved in the regulation of granulocyte and eosinophil production that occurs in response to natural killer (NK) cell activity and interleukin-2 production. No overt signs of toxicity were observed in the benzene-exposed mice. Significant decreases in the number of spleen cells were observed in both groups of benzene-exposed mice. This effect was observed after 21 and 28 days of exposure in the 152 mg/kg-day group and after 14, 21, and 28 days in the 852 mg/kg-day group. After 21 days of exposure, a significant increase in splenic NK cell activity was observed in both benzene-exposed groups, however, after 28 days of exposure, the activity did not significantly differ from that observed in controls. Splenic interleukin-2 production was significantly depressed after 28 days of exposure to either benzene dosage. Spleen cell numbers and interleukin-2 production were also depressed in the mice exposed to 152 mg/kg-day benzene for 28 days and killed after 7 and 14 days (interleukin-2 levels only) after exposure termination. Thus, this study identified a LOAEL of 152 mg/kg-day (lowest dose tested) for effects on the immune system in male mice.

Developmental and reproductive toxicity studies. Developmental toxicity studies of orally administered benzene have been conducted in rats (Exxon Chemical Company, 1986) and mice (Nawrot and Staples, 1980; Seidenberg et al., 1986, as cited in ATSDR, 1995; BASF, 1975).

Exxon Chemical Company (1986) treated bred female Sprague-Dawley rats (20-22/group) by gavage with 0, 50, 250, 500, or 1000 mg/kg/day on gestation days 6-15. No dose-related mortality

was observed. Significant ($p \leq 0.05$) findings in the treated dams as compared with controls were decreased food consumption at 250, 500 and 1000 mg/kg, decreased body weights and body weight gains at 500 or 1000 mg/kg/day, and increased incidence of alopecia at 1000 mg/kg. Developmental toxicity was limited to decreased ($p \leq 0.05$) fetal body weights in the 500 and 1000 mg/kg/day groups. Fetuses were examined only for external malformations, not for skeletal and visceral malformations. This study identified a NOAEL of 50 mg/kg/day and LOAEL of 250 mg/kg/day for maternal toxicity and tentative NOAEL of 250 mg/kg/day and LOAEL of 500 mg/kg/day for developmental toxicity in Sprague-Dawley rats.

Nawrot and Staples (1980) treated bred CD-1 mice (23-105/group) by gavage with benzene in cottonseed oil at dose levels of 0, 0.3, 0.5, or 1 ml/kg/dose, 3 times daily, on gestation days 6-15. Using a specific gravity of 0.8765 g/ml (ATSDR, 1995) and multiplying by 3 doses/day results in doses of 0, 789, 1315, and 2630 mg/kg/day, respectively. Additional groups of mice were similarly treated with 0 or 1 ml/kg/dose (0 or 2630 mg/kg/day) on gestation days 12-15. Mortality rates in dams treated with 0, 789, 1315, and 2630 mg/kg/day were 2/105, 0/27, 6/48, and 7/23, respectively. Significant ($p<0.05$) findings in the dams included the increased mortality at the mid- and high doses, increased liver weights at the mid- and high doses, increased relative liver weights at all three doses, and a reduction in maternal weight gain only at the low dose. A dose-related decrease in apparent pregnancy rate at sacrifice was observed, significantly different ($p<0.05$) from controls at all dose levels; at the mid and high doses, this effect resulted from early resorption of entire litters ($p<0.05$). The decrease in apparent pregnancy rate at the low dose was attributed to an unusually high pregnancy rate in vehicle controls. Fetal body weights were decreased in all dose groups treated on days 6-15. In dams exposed on gestation days 12-15, no deaths occurred; significant ($p<0.05$) results included increased absolute maternal liver weight, decreased maternal weight gain and fetal body weight and increased number of resorptions. No increases relative to controls in external, visceral or skeletal defects were seen in any of the treatment groups. This study identified a LOAEL of 789 mg/kg/day for developmental toxicity and possible maternal toxicity resulting from treatment on gestation days 6-15, and a LOAEL of 2630 mg/kg/day for maternal and developmental toxicity resulting from treatment on gestation days 12-15. The LOAELs were at the lowest (or only) treatment level used and no NOAELs were identified in this study.

In a developmental toxicity screening study, Seidenberg et al. (1986, as cited in ATSDR, 1995) treated bred mice by gavage with benzene in oil at dose levels of 0 or 1300 mg/kg/day on gestation days 8-12. Fetal body weights were decreased; no other effects were reported. This study identifies a LOAEL of 1300 mg/kg/day for developmental toxicity in mice.

In a mouse developmental toxicity study, groups of 19-23 pregnant NMRI mice were administered via gavage 0, 563, or 1688 mg/kg-day benzene in olive oil on gestational days 6-15 (BASF, 1975; English summary of study). On gestational day 18, the mice were killed and the fetuses were examined. Decreased maternal body weight gain, unrest, tremor, and apathy were observed in the benzene-exposed dams. The onset of maternal toxicity appeared to be dose-related; observed from day 11-12 in the 563 mg/kg-day group and days 8-12 in the 1688 mg/kg-day group. Increased mortality (23% as compared with 14% in the control group) and decreased fetal body weights were observed in the fetuses of the dams treated with 1688 mg/kg-day benzene. An increase in malformations (6.86% of the fetuses versus 2.97% of fetuses in the control group) also was

observed in the 1688 mg/kg-day group; the authors noted that 9 of the 12 fetuses with malformations were from the same litter. No evidence of fetal toxicity was observed in the 563 mg/kg-day group. Thus, this study identified a LOAEL of 563 mg/kg-day for maternal toxicity in mice and a NOAEL of 563 mg/kg-day and FEL of 1688 mg/kg-day for developmental toxicity.

Additional developmental toxicity studies of benzene have been conducted in animals using inhalation exposure. These studies identify hematopoietic effects in the animal fetus (Keller and Snyder, 1986, 1988) as a sensitive developmental toxicity endpoint for inhalation exposure to benzene.

Data on the potential of benzene to induce reproductive toxicity following oral exposure is limited to the report of increased incidences of hyperplasia and senile atrophy of the ovary in female mice administered ≥ 18 mg/kg-day benzene for 2 years (NTP, 1986). Following inhalation exposure, histological alterations in the testes and ovarian cysts have been observed in mice exposed to relatively high concentrations of benzene (Ward et al., 1985). Data on the effect of benzene on reproductive performance is limited to a one-generation inhalation reproductive toxicity study in which female mice were exposed to benzene prior to mating and during gestation (Bio/dynamics, 1980; Kuna et al., 1992).

In the one-generation reproductive toxicity study, groups of 26 female Sprague-Dawley rats were exposed to vapor concentrations of 0, 1, 10, 30, or 300 ppm benzene (0, 3, 32, 96, or 958 mg/m^3) for 6 hours/day, 5 days/week during premating (10 weeks) and mating periods, then 6 hours/day, 7 days/week on gestational days 1-20 and lactational days 5-21 (Bio/dynamics, 1980; Kuna et al., 1992). No deaths, abnormal clinical signs, or alterations in body weight gain were observed in the dams. Additionally, benzene did not affect the pregnancy rate or the gestation length. The number of pups per litter, sex ratio, and viability were not affected by prenatal exposure to benzene. Male and female pups from the 300 ppm group tended to have lower body weights than controls, however, the differences in body weight was only significant in the female pups on lactational day 21. Alterations in liver and kidney weights also were observed in the female pups: a significant decrease in absolute liver weight in the 300 ppm group and increases in relative kidney weights in the 10, 30, and 300 ppm groups. No alterations in organ weights were observed in the male pups. This study identifies a NOAEL of 300 ppm for maternal toxicity and reproductive toxicity, and a NOAEL and LOAEL of 30 and 300 ppm, respectively, for developmental toxicity (decreased body weight gain).

DERIVATION OF PROVISIONAL CHRONIC RfD

The critical effects of orally administered benzene were determined to be hematotoxicity and immunotoxicity, probably related to the adverse effects of benzene on hematopoiesis (Wolf et al., 1956; White et al., 1984; NTP, 1986; Hsieh et al., 1988; Huff et al., 1989). This was not unexpected, because the extensive database on inhalation toxicity of benzene identifies hematological, hematopoietic and immunological toxicity as the critical effect, supported by human and animal data. The Health Risk Technical Support Center has derived a provisional RfC based on a free-standing NOEL of 0.045 ppm for hematological effects in occupationally exposed humans (Collins et al., 1991). Although no LOAEL was identified in this study, other occupational exposure studies reported hematological and/or hematopoietic effects at higher concentrations (Aksoy et al., 1971; Fishbeck et al., 1978), as did inhalation studies in experimental animals. Immunological effects have been reported in short-term inhalation studies of benzene in animals.

The NTP (1986) chronic and subchronic toxicity studies on rats and mice were not used as the basis for the RfD because the lowest dose tested, 18 mg/kg/day, was a LOAEL for hematological effects, and is higher than LOAELs for similar effects observed in other studies of subchronic duration. Wolf et al. (1956) reported very slight leukopenia in rats treated by gavage for 6 months with 10 mg/kg (7.1 mg/kg/day) and leukopenia and erythrocytopenia at higher dose levels; no effects were observed at 1 mg/kg (0.7 mg/kg/day). Hsieh et al. (1988) reported hematological and immunological effects in male CD-1 mice exposed to 8 mg/kg/day benzene in the drinking water. A marginal NOAEL of 12 mg/kg/day was identified for hematological and immunological effects in female B6C3F1 mice exposed to benzene in the drinking water (White et al., 1984); the 12 mg/kg/day exposure level may approach the threshold of toxicity, as discussed previously.

The Hsieh et al. (1988) study was selected as the principal study because it demonstrated significant ($p<0.05$) hematological and immunological toxicity in mice exposed to relatively low doses of benzene. This study found a biphasic response to immunological challenges (e.g., mitogens, sheep RBCs) in male mice exposed to benzene in the drinking water for 28 days. At the lowest dose tested (8 mg/kg-day), there was a significant increase in the response; at the two higher doses (40 and 180 mg/kg-day), significant decreases in response were observed. Erythryoctyopenia, leukocytopenia, and lymphocytopenia were also observed at doses of 8 mg/kg-day or higher. The 6-month study by Wolf et al. (1956) was selected as a co-principal study because it provides supporting information for the critical effect and threshold for toxicity. The LOAEL for hematological effects was 7.1 mg/kg/day, with a NOAEL of 0.7 mg/kg/day. No adverse effects were observed for non-hematological endpoints, including blood biochemistry, bone marrow counts, and gross and microscopic pathology of major tissues and organs. The Wolf et al. (1956) study was not chosen as the principal study because the results were presented only as a summary; actual data and statistical analysis were not reported. Results from the other subchronic studies (White et al., 1984; NTP, 1986) and the chronic (NTP, 1986) study support the critical effects (hematological, immunological) identified in the principal and co-principal studies.

A provisional RfD of 3E-3 mg/kg/day was determined based on the LOAEL of 8 mg/kg/day from the study by Hsieh et al. (1988). An uncertainty factor of 3000 was applied because some

uncertainty exists in all 5 areas (variation within and between species, use of a LOAEL, extrapolation to chronic duration, and deficiencies in the database). Uncertainty regarding extrapolation to chronic duration is mitigated by the 6-month duration of the co-principal study and by the supporting chronic oral study (NTP, 1986); some uncertainty remains because the dosages in the chronic study were higher than the LOAELs in the key subchronic studies and did not overlap with the threshold for toxicity based on Hsieh et al. (1988). Uncertainty regarding deficiencies in the database is small because of the reasonably adequate oral database, which includes developmental toxicity studies, and the extensive supporting inhalation database, but some uncertainty remains due to the lack of a two-generation reproductive study.

Confidence in the principal study is medium to low. The critical effect (hematological and immunological) was investigated through the use of a battery of tests and a range of dose levels, appropriate statistical analyses were performed, a dose-effect relationship was established, and the LOAEL is consistent with the LOAEL and NOAEL from a 6 month study (Wolf et al., 1956) measuring hematological effects and other endpoints of toxicity. Confidence in the principal study is limited by the small group sizes (5 animals/dose), testing of only one sex, short duration, and limited range of endpoints examined. Confidence in the database is medium because the critical effect is supported by numerous studies on benzene by the oral and inhalation routes and for various durations, including chronic; confidence in the database is not higher because of the lack of a two-generation reproductive study. Reflecting the medium to low confidence in the key study and medium confidence in the database, confidence in this provisional RfD is medium.

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Attachment 2

(97-002c/04-29-97)

Risk Assessment Issue Paper for:
Derivation of a Provisional Oral RfD
for 1,4-Dichlorobenzene (CASRN 106-46-7)

INTRODUCTION

A chronic oral RfD for 1,4-dichlorobenzene (1,4-DCB) is unavailable on IRIS (U.S. EPA, 1997) or HEAST (U.S. EPA, 1995), although IRIS (U.S. EPA, 1997) lists a verified chronic inhalation RfC of 8E-1 mg/m^3 for the compound. The carcinogenic potential of 1,4-DCB has not been officially evaluated by the U.S. EPA as reported in IRIS (U.S. EPA, 1997), although HEAST (U.S. EPA, 1995) lists the compound as a possible human carcinogen [C] with an oral slope factor of 2.4E-2 mg/kg/day and an oral unit risk of 6.8E-7 µg/L. Documents relating to 1,4-DCB on the CARA list (U.S. EPA, 1994) include AWQCDs for the dichlorobenzenes (1980 and 1989), an HEA (1987), and an RQTOX for 1,4-DCB (1983). ATSDR (1993) has prepared a toxicological profile for 1,4-DCB. ACGIH recommends a TLV-TWA of 10 ppm (60 mg/m^3) but has taken no position on a potential TLV-STEL (ACGIH, 1993). The OSHA (1989, 1993) standard PEL is 75 ppm (450 mg/m^3), whereas NIOSH (1992) recommends an exposure level of no greater than 1.7 ppm, the limit of quantification, based on the substance's potential role as a carcinogen.

To identify research papers pertinent to the derivation of a provisional chronic RfD for 1,4-DCB, computer searches of the literature were conducted from the HSDB, RTECS, TSCATS, MEDLINE, and TOXLINE (and its subfiles) databases, the overall retrieval effort taking place between December 1996 and January 1997.

REVIEW OF PERTINENT LITERATURE

The U.S. EPA has promulgated an MCL of 0.075 mg/L for 1,4-DCB in drinking water under the SDWA.

The verified RfC value of 8E-1 mg/m^3 (U.S. EPA, 1997) was based on a multi-generational reproductive study in Sprague-Dawley rats that identified consistent elevations in liver weights associated with the middle and high exposure levels, and a sub-threshold exposure level of 50 ppm (301 mg/m^3) that could serve as a NOAEL for deriving the RfC (U.S. EPA, 1997). Similarly, a number of chronic or subchronic oral toxicity studies on 1,4-DCB have identified consistent toxicological responses in the livers of exposed animals, and, for male rats, consistent evidence of hyaline droplet ($\alpha_{2\mu}$-globulin) nephropathy, though this endpoint is considered inappropriate for determining RfDs or RfCs (U.S. EPA, 1991). Of more relevance for provisional RfD development would be the LOAEL (the lowest dose tested) of 214 mg/kg/day for the appearance of histopathological lesions in the kidneys of female F-344/N rats exposed chronically to 1,4-DCB by gavage (NTP, 1987). Since these symptoms are unlikely to be associated with $\alpha_{2\mu}$-globulin

nephropathy, a response associated exclusively with male rats, the derived RfD would have clear applicability as a chronic toxicity benchmark for human health, although the use of a LOAEL for deriving the RfD would confer a lower level of confidence in the derived value (2E-1), because a sub-threshold exposure level (NOAEL) for the toxicological responses could not be unequivocally identified in the study. Such a degree of uncertainty lends justification to the reevaluation and update of the provisional oral RfD herein considered.

Among the limited amount of new toxicological information was a two-generation subchronic developmental toxicity study which identified dose-dependant fetal responses independent of maternal toxicity, and a clear sub-threshold exposure level that could serve as a NOAEL (Bornatowicz et al., 1994). In this issue paper, a provisional RfD derived from the NOAEL in the Bornatowicz et al. (1994) study is compared with the 2E-1 mg/kg/day value derivable from the NTP (1987) study, and with a chronic daily intake (CDI) calculated from the verified RfC of 8E-1 mg/m^3 (U.S. EPA, 1997). Such comparisons, taken with the expansion of the toxicological database resulting from the inclusion of additional developmental toxicity information associated with 1,4-DCB exposure, and with the emerging mechanistic insights afforded by recent studies documenting the cell proliferation responses of tissues challenged (in vivo) with 1,4-DCB, have allowed the uncertainty bounding the RfD values to be explicitly considered.

Developmental and reproductive toxicity study. In the two generation fertility study, Bornatowicz et al. (1994) administered 1,4-DCB (99% pure) by gavage to Sprague-Dawley rats. The experiment was carried out following Organization for Economic Cooperation and Development (OECD) Guideline 416, "Two-Generation Reproduction Toxicity Study." Dose rates of 30, 90, and 270 mg/kg-day were administered daily throughout the study, while 0 mg/kg-day groups received olive oil as a vehicle control. Male rats in the F_0 ("P")-generation were dosed for 77 days before the beginning of mating and female rats were dosed for 14 days prior to mating. Individual male and female rats were paired together for mating over a period of 21 days until the first births occurred. The F_0 generation rats remained in the study and were administered 1,4-DCB until the young were weaned at 21 days after birth. Male rats of the F_0-generation were exposed for a period of 119 days and female rats for 56 days.

After weaning, 24 F_1 rats of each sex from each dosage level were selected to receive 1,4-DCB at the same exposure levels, from weaning until the end of the experiment. After 84 days, rats of the F_1 generation were individually paired for mating over a period of 21 days until the first births occurred. The experiment ended at weaning, 21 days after the birth of the F_2 generation. Therefore, the F_1 rats were exposed to the experimental dose levels for a period of 126 days. (In addition these rats had been exposed for 21 days *in utero* and via maternal milk for 21 days pre-weaning).

In the 270 mg/kg-day dose group, multiple toxic responses to the test substance were apparent. In the litters born to F_0 generation dams, the proportion of still births was increased from 4% in the control dose group to 17% in the 270 mg/kg-day dose group and the proportion of pups which died between birth and the fourth day was increased from 1% to 27%. In the litters born to the F_1 generation dams the proportion of still births was increased from 3% in the control group to 11% in the 270 mg/kg-day dose group and the proportion of pups which died between birth and the fourth day was increased from 1% to 12%. Other effects at this dose level included, reduced mean body weight

in pups, and signs of delayed maturation such as, retarded erection of ears and opening of eyes, and reduced percentage of pups with positive draw up tests. Almost all litters in both generations had dry scaly skin until 7 days after birth, and, with few exceptions, constrictions around the tail "ring tail" appeared, which in some cases led to loss of parts of the tail. Absolute and relative liver and kidney weight in adult males were higher, and absolute and relative spleen weights were reduced in the high dose group. Minor histopathological damage to the kidneys of both generations of male rats receiving 270 mg/kg-day may also have been test substance related.

In the 90 mg/kg-day dose group toxic responses were limited to an increase in the relative liver weights of the F_1 generation males. However, in the litters born to F_1 generation dams, the proportion of still births was increased from 3% in the control dose group to 5% in the 90 mg/kg-day dose group and the proportion of pups which died between birth and the fourth day was increased from 1% to 5%. The birth weight and growth rates of the young rats in both generations were consistently lower than in the control group, although the differences did not reach statistical significance. In addition, approximately 70% of the litters displayed dry scaly skin until 7 days after birth, and "ring tail" also occurred frequently.

In both generations the test substance had no effects on: time between beginning of mating and evidence of copulation, time of gestation, fertility index, gestational index, percentage of dams with only dead pups, total number of pups at birth, percentage of pups with positive ear reflex, grasping reflex and orientation reaction, absolute and relative weights of testes, epididymis and ovaries, absolute and relative weights of female kidneys, spleens and livers.

At the low dose of 30 mg/kg-day, no effects of the test substance were detected on either paternal or developmental parameters of rats compared to the significant damage in pups caused by the 90 mg/kg-day dose. Therefore, the 30 mg/kg-day represents a NOAEL for developmental effects with 90 mg/kg-day as a LOAEL.

Other studies. Earlier reports document studies of the oral toxicity of 1,4-DCB, with a number capable of serving as a source of quantitative dose-response data suitable for deriving a provisional RfD. For example, the oral systemic toxicity database for 1,4-DCB included subchronic and/or chronic studies in rats, mice, and rabbits (Hollingsworth et al., 1956; NTP, 1987; Bomhard et al., 1988), studies that consistently identified the kidneys and/or liver as target organs in these species, with data on rats providing the most extensive information on dose-response levels. As mentioned above, the occurrence of kidney pathology in male rats was interpreted in the context of the accumulating body of evidence that has associated nephropathy (in male rats) with the unique occurrence of renal protein $\alpha_{2\mu}$-globulin, with resultant hyaline droplet formation in the tubular region (Charbonneau et al., 1989; Dietrich and Swenberg, 1991; Saito et al., 1992). Such a response would not be considered relevant to human toxicity (and thus, for RfD development) since humans lack the capacity to synthesize this metabolite (U.S. EPA, 1991). Significantly, under 1,4-DCB exposure conditions that clearly induced $\alpha_{2\mu}$-globulin nephropathy in male F344 rats, no renal lesions, hyaline droplets or $\alpha_{2\mu}$-globulin were found in treated male NBR rats, a strain that has been shown not to synthesize $\alpha_{2\mu}$-globulin (Dietrich and Swenberg, 1991). However, because $\alpha_{2\mu}$-globulin is only produced in minimal quantities by female rats or by males and females of many other species, the renal effects observed in female F344/N rats and in male and female B6C3F1 mice exposed to 1,4-

DCB (NTP, 1987) are probably not associated with hyalin droplet formation and are thus considered suitable for consideration in risk assessment.

A LOAEL of 214 mg/kg/day can be identified as a threshold exposure level for the onset of histopathological lesions in the kidneys of female F344/N rats, and as a basis for deriving a provisional RfD for 1,4-DCB in the absence of identifiable (or suitable) NOAELs (NTP, 1987). The dosages in the 2 year chronic F344/N rat study were 0, 150 or 300 mg/kg (0, 107 or 214 mg/kg-day) in males and 0, 300, or 600 mg/kg (0, 214, or 429 mg/kg-day) in females (NTP 1987). In the high dose males and females, mean body weights were generally slightly lower than those of controls (5-8% after week 38 and 5-7% after week 55, respectively). Survival of the high dose males was significantly (p=0.005) lower than controls after week 97 (30% lower than controls at the end of the study). Treatment-related non-neoplastic pathological responses were evident in the kidneys in both sexes. For example, renal effects in males included increased epithelial hyperplasia of the renal pelvis (1/50, 30/50, 31/50 in the control, low, and high dose groups, respectively), mineralization of the collecting tubules in the renal medulla (4/50, 46/50, 47/50), and focal hyperplasia of renal tubular epithelium (0/50, 1/50, 9/50). The severity of nephropathy was increased in the treated males although the incidences of this kidney lesion were similar in the control and treated male groups. In females, treatment-related nephropathy was characterized by the occurrence of several interrelated changes, including degeneration and regeneration of the tubular epithelium, tubular dilatation with attenuation and atrophy of the epithelium, granular casts in tubules, thickening of basement membranes, and minimal accumulation of interstitial collagen. 1,4-DCB treatment also produced neoplastic changes, including a dose-related increase in the incidence of kidney tubular cell adenocarcinomas and a marginal increase in the incidence of mononuclear cell leukemia in male rats, information of clear relevance to the issue of the carcinogenicity of 1,4-DCB. However, LOAELs of 107 mg/kg-day in male rats and 214 mg/kg-day in female rats (lowest tested dosages) may be considered to be the threshold exposure levels for non-neoplastic kidney pathology.

Mechanistic studies. Separate research groups examined the potential for 1,4-DCB to induce liver and/or kidney cell proliferation in vivo in rats exposed to the compound under conditions similar to the NTP (1987) subchronic gavage study. In the first set of experiments, a Chemical Industry Institute for Toxicology (CIIT) group (Eldridge et al., 1992) explored the relationship between cell proliferation responses and the compound's systemic toxicity or potential carcinogenicity. Time-course and dose-response studies revealed a sharp increase in liver cell proliferation 24 h after treatment in female mice and rats, and at 48 h in male mice. During 13 weeks of 1,4-DCB administration, a statistically significant transient peak of liver cell proliferation was observed during week 1 at 600 mg/kg-day, but not at 300 mg/kg-day in male and female mice. An increase in liver weight as a percentage of body weight was observed in high dose male and female mice and female rats at all time points. No significant elevations in liver-associated plasma enzymes were found at any time point, indicating a lack of overt hepatotoxicity.

Umemura et al. (1992) examined the acute effects of 1,4-DCB on cell proliferation in the kidneys and livers of both sexes of rats and mice. Male F344 rats were dosed by gavage with 1,4-DCB in corn oil with 150 and 300 mg/kg for 4 days and female F344 rats and male and female B6C3F1 mice were dosed at the rates of 300 and 600 mg/kg for 4 days. Cell proliferation was evaluated by immunohistochemical measurement of bromodeoxyuridine incorporation into nuclei of

DNA-synthesizing cells. The cumulative fraction of proliferating cells was increased in the proximal tubule epithelial cells of male rats at the high dosage, but not at the low dose nor in females at either dose. In addition, no increase in cell proliferation was found in mouse kidneys. Conversely the fractions of proliferating cells in the livers of rats and mice of both sexes were increased, and the increased cell proliferation in male rat kidneys and in the livers of mice of both sexes were correlated with the potential carcinogenic effects of 1,4-DCB in those tissues. However, the finding that 1,4-DCB also induced cell proliferation in female mice (or in rats of both sexes) at doses that were not associated with tumor development (NTP, 1987), suggests that transient increases in cell proliferation may be insufficient to induce tumor development. Such responses would explain the observed changes in absolute and relative liver weights.

DERIVATION OF PROVISIONAL CHRONIC RfD

This derivation of a provisional RfD from the Hornatowicz et al. (1994) two generation subchronic fertility study uses as its point of departure the NOAEL of 30 mg/kg-day, a clear sub-threshold level for liver perturbations and developmental toxicity effects. The updated provisional RfD was calculated as follows:

RfD = NOAEL/UF

where

NOAEL = 30 mg/kg-day

UF = Uncertainty Factor = 1000 (10 for interspecies extrapolation, 10 for the protection of sensitive humans, and 10 for extrapolation from subchronic to chronic effects)

thus,

RfD = 30 mg/kg-day/1000 = 3E-2 mg/kg-day

As mentioned above, a chronic provisional RfD for 1,4-DCB may also be derived from the NTP (1987) chronic study. Using a LOAEL of 214 mg/kg-day for the onset of kidney lesions in female F344/N rats, a provisional RfD can be calculated as follows:

RfD = LOAEL/UF

where

LOAEL = 214 mg/kg-day

UF = Uncertainty Factor = 1000 (10 for interspecies extrapolation, 10 for intrahuman variability, and 10 to reflect the uncertainty associated with a LOAEL)

thus,

RfD = 214 mg/kg-day/1000 = **2E-1** mg/kg-day

The IRIS record for 1,4-DCB contains a verified RfC of 8E-1 mg/m^3 that was derived from a NOAEL of 50 ppm in the two generation subchronic inhalation study in Sprague-Dawley rats for which increases in liver weights were the critical effect (U.S. EPA, 1997).

Using default values of 20 mg/m^3 and 70 kg for inhalation rate and body weight in human adults, a CDI equivalent to the RfC of 8E-1 can be derived, thus:

8E-1 x 20/70 mg/kg-day = **2E-1** mg/kg-day.

Confidence in the provisional chronic oral RfD derived from the two-generation fertility study of Bornatowicz et al. (1994) may be judged by the extent to which the critical study was thoroughly carried out, documented, and audited, and by how much it serves to build consensus with other reports and toxicity information about the target compound. The report by Bornatowicz et al. (1994) is an important addition to the oral toxicity database for 1,4-DCB. The study was thoroughly documented and followed an apparently standardized experimental protocol (OECD Guideline 416). The study may also be considered to fill a gap in the previously available database, by providing data from a two generation subchronic oral toxicity test that targeted systemic and developmental toxicity effects across two generations. The study displayed a dose-dependent range of toxicological responses, with the clearly defined NOAEL of 30 mg/kg-day representing the point of departure for deriving the provisional RfD.

The suitability of the derived RfD may be judged by the consistency between the toxic responses observed in the Bornatowicz et al. (1994) study at its higher exposure levels, with those kidney and liver pathology effects observed in other toxicological studies featuring 1,4-DCB (Hollingsworth et al., 1956; NTP, 1987; Bomhard et al., 1988).

If this consistency in toxic responses lends support to the Bornatowicz et al. (1994) study as a valid statement of 1,4-DCB toxicity, the sub-threshold exposure level used as a basis for the provisional RfD may also be regarded as justifiable. That the developmental effects protected by this sub-threshold exposure level occur in a presumptive sensitive subpopulation (i.e., fetuses) might also explain the lower derived RfD value (of 3E-2 mg/kg-day) compared to the provisional RfD (of 2E-1) which protected against histopathological kidney lesions in adult female rats. A similar argument could be made in comparing the 3E-2 mg/kg-day RfD derived here with the CDI of 2E-1 mg/kg-day derived from the verified inhalation RfC, a value derived to protect adult rats against increases in liver weights (perhaps associated with cell proliferation).

By contrast, a clear discrepancy exists between the results of the Bornatowicz et al. (1994) study and those of a previous oral developmental study that did not indicate developmental toxicity as a critical effect of 1,4-DCB exposure in Sprague-Dawley rats (giving a NOAEL of 250 mg/kg-day) (Giavini et al., 1986). Similarly the two-generation inhalation study in Sprague-Dawley rats did not indicate reproductive toxicity to be a critical effect of 1,4-DCB (Tyl and Neeper-Bradley, 1989).

In light of these discrepancies the overall level of confidence associated with the principal study, it's developed RfD, and the overall database associated with the systemic toxicity of 1,4-DCB, is considered to be medium. Such a judgement may be further justified by the uncertain relationship between the cell proliferative responses induced by the target compound in liver and kidney, and their physiological consequences in relation to systemic toxicity versus induction of tumor formation.

Uncertainties surrounding the carcinogenic potential of 1,4-DCB are presently unresolved, as judged by the lack of verified slope factor/unit risk values for 1,4-DCB on IRIS (U.S. EPA, 1997), in contrast to those values reported [of 2.4E-2 $(mg/kg\text{-}day)^{-1}$ and 6.8E-7 $(\mu g/L)^{-1}$ for slope factor and unit risk, respectively] in HEAST (U.S. EPA, 1995). These values were derived from the incidence of neoplastic changes, including a dose-related increase in the incidence of kidney tubular cell adenocarcinomas and a marginal increase in the incidence of mononuclear cell leukemia in male rats, in response to oral 1,4-DCB administration (NTP, 1987). This derivation has served as the basis for ascribing 1,4-DCB to carcinogen category C, a possible human carcinogen, as indicated by limited evidence of carcinogenicity in animals in the absence of human data.

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Attachment 3

(93-22/4-05-93)

Risk Assessment Issue Paper for:
Derivation of a Provisional RfD for
1,2-Dichloroethane (CASRN 107-06-2)

We have derived a provisional chronic oral RfD of 0.03 mg/kg-day for 1,2-dichloroethane. The RfD is based on a NOAEL of 26 mg/kg-day in rats in a subchronic gavage study by NTP (1991).

The following sources were consulted for information. IRIS (U.S. EPA, 1996), HEAST (U.S. EPA, 1995a), CARA (U.S. EPA, 1994a), Drinking Water Regulations and Health Advisories (U.S. EPA, 1994b), RfD and CRAVE Work Group Status Reports (U.S. EPA, 1995b,c), NTP Status Report (1993a,b) and the ATSDR list of Toxicological Profiles. The following documents were obtained: Health Effects Assessment for 1,2-Dichloroethane (U.S. EPA, 1984), Health and Environmental Effects Profile for Dichloroethanes (U.S. EPA, 1985a), Quantification of Toxicological Effects of 1,2-Dichloroethane (U.S. EPA, 1985b), a Health Assessment Document (U.S. EPA, 1985c), 1,2-Dichloroethane Health Advisory (U.S. EPA, 1987) and Toxicological Profile for 1,2-Dichloroethane (ATSDR, 1989). The NTP Status Report indicates that recently completed 90-day toxicity studies in rats and mice exposed via drinking water and rats exposed via gavage have been published. These studies are cited herein as Morgan et al. (1990) and NTP (1991). In addition, a literature search of TOXLINE from 1985-1991, RTECS, HSDB and TSCATS was conducted on January 2-6, 1992; update searches of TOXLINE (1991-1993, inhalation and oral) and TSCATS were performed in March 1993. In addition to identifying the studies by Morgan et al. (1990) and NTP (1991), the search identified an Environmental Health Criteria for 1,2-Dichloroethane (WHO, 1987).

U.S. EPA (1984, 1985a) reviewed chronic and subchronic oral studies (NCI, 1978; Alumot et al., 1976; Munson et al., 1982; Lane et al., 1982) but did not attempt to derive an oral RfD because 1,2-dichloroethane is carcinogenic. U.S. EPA (1985b) presented interim RfD derivations based on the oral multigeneration study by Lane et al. (1982) and on inhalation data, but U.S. EPA (1987) concluded that no appropriate data were available for determining an RfD, and therefore, did not estimate a lifetime health advisory for this chemical. However, the NCI (1978) study was considered only for carcinogenic effects in the analysis by U.S. EPA (1987). Therefore, no RfD or DWEL for 1,2-dichloroethane appears in the Drinking Water Regulations and Health Advisories (U.S. EPA, 1994b). A slope factor for 1,2-dichloroethane is on IRIS (U.S. EPA, 1996), but no oral RfD is listed, nor has 1,2-dichloroethane been considered by the RfD Work Group.

Chronic Oral Studies

In a NCI (1978) carcinogenicity study, Osborne-Mendel rats (50/sex/group) were treated with

1,2-dichloroethane in corn oil by gavage at TWA (time-weighted average) doses of 47 or 95 mg/kg-day, 5 days/week for 78 weeks. B6C3F1 mice (50/sex/group) were similarly treated with 97 or 195 mg/kg-day (male mice) and 149 or 299 mg/kg-day (female mice), 5 days/week. In rats, there was no effect on body weight gain, but mortality was significantly ($p<0.001$) increased in high dose males and females compared with controls. At 55-57 weeks, 50% of the high dose rats died, while 20-65% of the controls survived until the end of the study. Survival of low dose rats appeared to be intermediate between that of the untreated (20 rats/sex) and vehicle controls (20 rats/sex). The high mortality in the rats was due to toxic effects and bronchopneumonia, rather than to cancer. Several rats in both the low and high dose groups had a hunched appearance and transient labored breathing beginning during the 6th week of treatment. Although one or two control rats started to show these signs, the incidence was substantially higher in the treated groups than in the control groups. High dose female mice also had significantly increased mortality, possibly related to cancer, but mortality was not affected in the other groups of mice. The clinical signs of toxicity exhibited at higher incidences in both groups of treated rats were serious enough to preclude the use of the low dose of 47 mg/kg-day in the derivation of an RfD. Furthermore, other parameters such as hematological and clinical chemistry determinations were not conducted.

In a 2-year study, groups of 18 male and 18 female rats of unspecified strain were fed a food mash fumigated with 1,2-dichloroethane that resulted in concentrations of 0, 250 or 500 ppm (Alumot et al., 1976). No effects were found on mortality, growth, food consumption or feed efficiency, or liver or kidney function, determined by analysis of serum chemistry indices. Histological examinations were not performed. The author calculated that the 500 ppm level was equal to approximately 25 mg/kg-day. U.S. EPA (1985b) considered this study inappropriate for the use in the derivation of an RfD because of inadequacies in protocol and reporting procedures.

Subchronic Oral Studies

In a study to determine the possible immunotoxicity of 1,2-dichloroethane, male CD-1 mice were treated by gavage at doses of 0, 4.9 or 49 mg/kg-day for 14 days or with drinking water containing 0, 20, 200 or 2000 ppm 1,2-dichloroethane (0, 3, 24 or 189 mg/kg-day, as calculated by the authors) for 90 days (Munson et al., 1982). The number of mice used in the 14-day study was not clear from the report. Groups of 32 male mice were used in the 90-day study. In the 14-day study, there were no changes in body weight gain, organ weights (liver, spleen, lung, thymus, kidney and brain) and no effects on the serum chemistry indices of liver and kidney function. A 30% decrease in leukocyte count was found in the 49 mg/kg-day group, but other hematological parameters were not affected. The number of splenic antibody-forming cells (AFC) in response to sheep erythrocytes (a measure of humoral immunity) was significantly ($p<0.05$) reduced at 4.9 and 49 mg/kg-day. Cell-mediated immunity (delayed hypersensitivity to sheep erythrocytes and T-lymphocyte response to concanavalin A) was also significantly reduced at both dose levels, but not in a dose-related manner. In the 90-day study, reduced water consumption was seen at 24 and 189 mg/kg-day, and an appreciable decrease in growth was seen in the high-dose group. No significant effects were seen on organ weights, hematological parameters or immunological function. The

presence of effects on the immune system in the mice treated by gavage with 1,2-dichloroethane for 14 days and the lack of such effects in rats exposed in the drinking water for 90 days may be due to a higher dose reaching the target cells after a bolus dose compared with smaller intermittent doses as a result of drinking water exposure. Another explanation is that metabolism of 1,2-dichloroethane over the longer exposure periods may reduce the amount of the compound reaching the effector site. Since this study was mainly concerned with immunological end points, histological examination of organs and tissues was not conducted, which limits its usefulness for a RfD derivation.

WHO (1987) briefly reviewed a study by Van Esch et al. (1977), whereby rats (number, strain and sex not specified) were treated by gavage with 1,2-dichloroethane at 0, 10, 30 or 90 mg/kg-day for 5 days/week for 90 days. Increased relative kidney weight occurred in both sexes at 90 mg/kg-day, but increased relative liver and brain weight was seen only in the females at 90 mg/kg-day. Clinical chemistry parameters were normal, and there were no treatment-related histopathological lesions. Sporadic hematological changes were seen, but not in a dose-related manner.

Recently, NTP completed 90-day toxicity studies in rats and mice (Morgan et al., 1990; NTP, 1991), which have not been reviewed in any secondary sources. In order to study strain difference in sensitivity to 1,2-dichloroethane, groups of 10 male and 10 female F344/N, Sprague-Dawley and Osborne-Mendel rats were exposed to the compound via drinking water at 0, 500, 1000, 2000, 4000 or 8000 ppm for 13 weeks. The authors estimated daily doses based on drinking water consumption and average body weights as follows:

DOSES IN MG/KG-DAY IN RATS

CONCENTRATION	F344/N		Sprague-Dawley		Osborne-Mendel	
IN WATER (ppm)	Male	Female	Male	Female	Male	Female
500	49	58	60	76	54	82
1000	86 102	99	106	88	126	
2000	147 182	165	172	146	213	
4000	259 320	276	311	266	428	
8000	515 601	518	531	492	727	

At the end of exposure the rats were killed, and necropsy and comprehensive histological examinations were performed. Additional groups of 10 male rats were maintained on the 1,2-dichloroethane-containing drinking water for hematological and clinical chemistry determinations; these rats were not necropsied. None of the rats given 1,2-dichloroethane in drinking water died. Significantly ($p<0.05$) decreased mean body weights were seen in male F344/N rats at 4000 and 8000 ppm, in female F334/N rats at 8000 ppm and in male Sprague-Dawley and Osborne-Mendel rats at 8000 ppm. Dose-related decreased water consumption was seen at >1000 ppm in F344/N rats, and Sprague-Dawley and Osborne-Mendel rats exposed to >2000 ppm drank about half as much water as the controls. Absolute kidney weights were significantly ($p<0.05$ or <0.001) increased at ≥1000 ppm in male F344/N rats, at ≥500 ppm in female F344/N, Sprague-Dawley and Osborne-Mendel rats

and at 1000 ppm in male Osborne-Mendel rats. Relative kidney weights were significantly increased at ≥1000 ppm for both male and female F344/N and Sprague-Dawley rats, at ≥2000 ppm in male Osborne-Mendel rats and at >500 ppm in female Osborne-Mendel rats. Absolute liver weights were significantly increased at 2000 ppm in male F344/N rats, at 1000 and 4000 ppm in female F344/N rats and at 1000 ppm in male Osborne-Mendel rats. Relative liver weights were significantly increased at ≥2000 ppm in F344/N males, at ≥4000 ppm in F344/N females, at ≥500 ppm in Sprague-Dawley males, at 8000 ppm in Sprague-Dawley females, at 1000 and 2000 ppm in Osborne-Mendel males, but not in Osborne-Mendel females. The only histopathological finding was minimal to mild renal tubular regeneration, which was found in all groups of treated and control F344/N males, Sprague-Dawley males and females and Osborne-Mendel males and females at similar incidence and severity. However, female F344/N rats had a dose-related increased incidence of this lesion: 0/10 in controls, 0/10 at 500 ppm, 1/10 at 1000 ppm, 3/10 at 4000 ppm and 9/10 at 8000 ppm.

Thus 1,2-dichloroethane was minimally toxic to the rats when administered in the drinking water. The decreases in body weight were probably secondary to reduced water intake due to unpalatability of the treated water. Likewise the increases in relative liver and kidney weight could be secondary to decreased body weight, since no treatment-related histopathological lesions, with the possible exception of a significantly increased incidence of renal tubular regeneration in F344/N female rats at 8000 ppm, were observed in these organs. Although increased absolute liver and kidney weights were seen in some groups, the increases were sporadic, did not necessarily correlate with increases in relative organ weights and were not always dose-related. The authors concluded that because of the solubility and unpalatability of 1,2-dichloroethane, it was not possible to reach a dose high enough in drinking water to produce biologically significant toxicity.

In the same study, groups of 10 male and 10 female F344/N rats were given 1,2-dichloroethane in corn oil by gavage on 5 days/week for 90 days at doses that approximated the estimated doses in the drinking water study (Morgan et al., 1990; NTP, 1991). The doses were 0, 30, 60, 120, 240 and 480 mg/kg-day for males and 0, 18, 37, 75, 150 and 300 mg/kg-day for females. All males given 240 and 480 mg/kg-day and all females given 300 mg/kg-day died, but all other rats survived until the end of the experiment. Necropsy was performed on all rats, but comprehensive histological examination was performed on vehicle controls, males treated with ≥120 mg/kg-day and females treated with ≥150 mg/kg-day. There were no differences in body weight gains among the groups. Clinical signs were observed in males at 240 mg/kg-day and females at 300 mg/kg-day and included tremors, salivation, emaciation, abnormal postures, ruffled fur and dyspnea. Relative kidney weights were increased in males at ≥60 mg/kg-day and in females at ≥75 mg/kg-day. Relative liver weights were increased in males at 120 mg/kg-day and in females at ≥37 mg/kg-day. Histological examination revealed minimal to mild hyperplasia and inflammation of the forestomach epithelium and necrosis of the cerebellum and thymus in the rats that died (i.e., the high dose groups). The incidence and severity of renal tubular regeneration did not differ among the groups. Treatment-related histopathological lesions were not seen in the animals examined histologically (i.e., males at ≥120 mg/kg-day and females at ≥150 mg/kg-day); therefore, it is reasonable to assume that no treatment-related histopathological lesions would have occurred in the lower dose groups. Therefore, increases in liver and kidney weights observed at lower doses are probably not toxicologically significant. The

high mortality of the high dose rats indicates that F344/N rats were more sensitive to equivalent doses of 1,2-dichloroethane administered by gavage than in the drinking water. The authors suggested that administration of the bolus may cause saturation of elimination processes resulting in higher blood levels.

Groups of 10 male and 10 female B6C3F1 mice were administered drinking water containing 1,2-dichloroethane at concentrations of 0, 500, 1000, 2000, 4000 or 8000 ppm for 13 weeks (NTP, 1991). Based on water consumption and body weight data, the authors calculated the daily doses as follows:

DOSES IN MG/KG-DAY IN MICE

CONCENTRATION IN WATER (ppm)	Male Mice	Female Mice
500	249	244
1000	448	647
2000	781	1182
4000	2710	2478
8000	4207	4926

Necropsy was performed on all mice that died during the study or were killed at the end of the study. Comprehensive histological examination was limited to controls and high dose mice (for females, the 4000 ppm group was examined histologically because of high mortality in the 8000 ppm group). Apparently livers and kidneys were examined histologically for all groups. At 8000 ppm, 9/10 female mice died between weeks 1 and 13 of dosing. Mean body weights were lower than controls throughout the study in the male mice exposed to ≥500 ppm and in the female mice exposed to ≥1000 ppm, but were significantly ($p<0.01$) lower than controls only in the high dose males. There were no significant differences in water consumption between controls and exposed groups. Absolute and relative kidney weights were significantly ($p<0.05$ or 0.01) increased in males at >1000 ppm and in females at ≥500 ppm. Absolute liver weight was significantly increased in males and females at ≥4000 ppm, while relative liver weight was significantly increased in males and females at ≥500 ppm. Histopathological lesions were limited to kidneys and were most prevalent in high dose males. Tubular regeneration was seen in 0/10 control males, 1/10 males at 500 ppm, 2/10 males at 1000 ppm, 2/10 males at 2000 ppm, 8/10 males at 4000 ppm ($p<0.01$) and 9/10 8000 ppm ($p<0.01$). No other lesions were seen in male mice in the control, 500, 1000, 2000 or 4000 ppm groups. In the high dose males the incidence of other kidney lesions were: karyomegaly - 10/10, dilatation - 5/10, protein cases - 8/10 and mineralization - 5/10. A single female mouse in the 4000 ppm groups had tubular regeneration. NTP (1991) concluded that the NOAELs were 2000 ppm (781 mg/kg-day) in males based on kidney lesions and 4000 ppm (2478 mg/kg-day) for females based on mortality.

Developmental and Reproduction Studies

In a multigeneration reproduction study, male and female ICR Swiss mice were given drinking water containing 1,2-dichloroethane 0, 30, 90 or 290 ppm, giving nominal daily doses of 0, 5, 15 or 50 mg/kg-day (Lane et al., 1982). No significant increase in gross, visceral or skeletal anomalies or any fetotoxic effects were observed. Furthermore, there were no significant differences between treated and controls groups for number of pregnant females, implants/litter, resorptions, live fetuses and 4- and 21-day survival. There was also no evidence of dominant lethality in treated males mated to untreated females in this study. No parental treatment-related effects were observed in F0 and F1B generations as judged by mortality rates, fluid intake, body weight gain, and gross pathology. During the conduct of the two-year study by Alumot et al. (1976), in which rats were maintained on feed mash fumigated with 1,2-dichloroethane at 250 or 500 ppm, the effects of 1,2-dichloroethane on male fertility were also examined. No differences were found in the percentage of females bearing litters, litter size, mortality, and body weights of pups. No treatment-related effects were observed regarding parental body weights or feed consumption. The authors calculated that the 500 ppm level was equivalent to approximately 25 mg/kg-day. Additional details of the Lane et al. (1982) and Alumot et al. (1976) studies can be found in U.S. EPA (1985a).

Derivation of the Provisional Chronic Oral RfD

In the NCI (1978) bioassay of 1,2-dichloroethane in rats and mice, serious clinical signs of toxicity (hunched appearance, labored breathing) occurred at considerably higher incidence in the low and high dose groups of rats than in the controls. The low dose rats received 47 mg/kg-day, 5 days/week, (TWA = 34 mg/kg-day), the lowest dose level in the study. The severity of the clinical signs precludes that use of this dose in the derivation of the RfD. Furthermore, other parameters such as hematological and clinical chemistry determinations were not performed. A chronic feeding study in rats by Alumot et al. (1976) reported a NOAEL of 25 mg/kg-day based on a lack of effects for mortality, growth, food consumption or serum chemistry indices, but no histological examinations were performed. Furthermore, U.S. EPA (1985b) also considered this study inappropriate for the use in the RfD derivation because of reporting and protocol inadequacies. Since the dose of 47 mg/kg-day, 5 days/week (34 mg/kg-day) produced serious signs of toxicity in the chronic study by NCI (1978), a NOAEL lower than 34 mg/kg-day from subchronic studies would be more appropriate for the derivation of the RfD.

Several subchronic oral studies in rats and mice were available for consideration. Munson et al. (1982) found decreased growth in mice given drinking water containing 1,2-dichloroethane that provided 189 mg/kg-day for 90 days, but no effects were found on immune function at 3, 24 or 189 mg/kg-day. No histological examinations were performed in this study. A 90-day gavage study by Van Esch et al. (1977) found no effects on organ weights, clinical chemistry parameters or histology in rats given ≤30 mg/kg-day, 5 days/week (21 mg/kg-day), but increased relative kidney, liver and brain weights occurred at 90 mg/kg-day, 5 days/week (64 mg/kg-day). Drinking water studies in three strains of rats exposed for 13 weeks to up to 8000 ppm 1,2-dichloroethane reported decreased body weight gains, probably due to decreased drinking water consumption because of unpalatability, and increases in absolute and/or relative liver and kidney weights at various concentrations among

the groups of the three strains (Morgan et al., 1990; NTP, 1991). However, no treatment-related histopathological lesions were found, with the possible exception of mild kidney tubular regeneration in female F344/N rats at 8000 ppm, which was equivalent to 601 mg/kg-day. In the same study, 1,2-dichloroethane was more toxic to F344/N rats when administered for 5 days/week for 13 weeks in corn oil by gavage at doses that approximated the doses received in drinking water (Morgan et al., 1990; NTP, 1991). Tremors, salivation, emaciation, abnormal postures, ruffled fur, dyspnea and 100% mortality occurred at doses ≥240 mg/kg-day. Histological examination revealed hyperplasia and inflammation of the forestomach epithelium and necrosis of the cerebellum and thymus in rats that died. Organ weight changes in the absence of histological evidence of lesions in the respective organs occurred at doses ≥37 mg/kg-day 5 days/week. Because no treatment-related lesions could be associated with the increases in organ weights, 37 mg/kg-day, 5 days/week (26 mg/kg-day) is the highest NOAEL in subchronic studies below the FEL of 47 mg/kg-day, 5 days/week (34 mg/kg-day) in the chronic study. Developmental and reproductive studies have also been conducted by the oral route with no effects (Kavlock et al., 1979; Lane et al., 1982; Alumot et al., 1976).

Dividing the NOAEL of 26 mg/kg-day by an uncertainty factor of 1000 (10 for intraspecies extrapolation, 10 for sensitive humans and 10 for use of a subchronic NOAEL) results in the provisional RfD of 0.03 mg/kg-day.

$$RfD = NOAEL / UF \times MF$$

where:

NOAEL	=	26 mg/kg-day
UF	=	1000. Uncertainty factor includes 10 to account for intraspecies extrapolation, 10 for sensitive humans, and 10 for use of a subchronic NOAEL.
MF	=	1. Default value for modifying factor.
RfD	=	(26 mg/kg-day) / 1000 x 1
	=	0.026 mg/kg-day
	≈	0.03 mg/kg-day, rounded to 1 significant figure.

Confidence in the RfD is judged to be low because it is based on a subchronic study and the subchronic NOAEL of 26 mg/kg-day is close to the chronic Frank Effect Level (FEL) of 47 mg/kg-day. Furthermore, although 1,2-dichloroethane has been sufficiently studied for subchronic toxicity and developmental and reproductive toxicity, a suitable NOAEL could not be identified from a chronic study.

Summary

Several chronic, subchronic, developmental and reproduction toxicity studies conducted by the oral route were reviewed. Chronic studies were unsuitable for RfD derivation. A NOAEL of 26 mg/kg-day was identified in rats in the subchronic NTP (1991) study. The NOAEL was used to derive a provisional RfD of
0.03 mg/kg-day, in which confidence was judged to be low.

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Attachment 2

Risk Assessment Issue Paper for:
Provisional Oral RfD for Naphthalene (CASRN 91-20-3)

The FY 1992 Health Effects Assessment Summary Tables (HEAST) March 1992 Annual Update (U.S. EPA, 1992a) presented provisional chronic and subchronic oral [RfD]s for naphthalene, both equal to 4E-2 mg/kg/day. These provisional [RfD]s were based on a subchronic study by NTP (1980) in which rats were administered naphthalene by gavage 5 days/week for 13 weeks. A NOEL of 50 mg/kg/day was identified and a provisional [RfD] calculated as follows:

[RfD] = 50 mg/kg/day X (5days/7days) / 1000 (UF)

[RfD] = 4E-2 mg/kg/day

The uncertainty factor of 1000 included 10 for interspecies extrapolation, 10 to protect sensitive subpopulations and 10 for the use of a subchronic study. The chronic oral [RfD] was adopted as the subchronic oral [RfD]. Even though a subchronic to chronic UF was used for the chronic [RfD], concern over the health effects of naphthalene precluded adjusting the subchronic [RfD] upwards.

The HEAST only presents provisional toxicity values that are calculated in EPA documents or are the verified results of RfD/RfC or CRAVE Work Group deliberations that are pending input to the Integrated Risk Information System (IRIS) (U.S. EPA, 1995). The [RfD] of 4E-2 mg/kg/day for naphthalene meets neither of these requirements. The chronic RfD calculated in the Health Effects Assessment (HEA) document for Naphthalene (U.S. EPA, 1988) is based on a dietary cancer study by Schmahl (1955) with the NTP (1980) study presented as supporting information. In reviewing the literature on naphthalene, the RfD/RfC Work Group rejected the Schmahl (1955) study in favor of the NTP (1980) study and is currently reviewing, but has not verified, the provisional chronic [RfD] value of 4E-2 mg/kg/day.

Because of this uncertainty over the calculation of the provisional [RfD] for naphthalene, both the chronic and subchronic [RfD]s were removed from the HEAST in the November 1992 Supplement No. 2 to the March 1992 Annual Update (U.S. EPA, 1992b). However, the chronic and subchronic oral [RfD] values of 4E-2 mg/kg/day remain the most current values available for the risk assessment of naphthalene.

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Risk Assessment Issue Paper for: Chronic RfD for 1,1,1-Trichloroethane (CASRN 71-55-6)

INTRODUCTION

Toxicity values for 1,1,1-trichloroethane are not verified or on IRIS (U.S. EPA, 1996). An RfC was under review by the RfD/RfC Work Group as of September, 1995, and an RfD that was based on inhalation data was withdrawn in 1991 pending further review by the Work Group (U.S. EPA, 1995a). No toxicity assessments for 1,1,1-trichloroethane are available on the HEAST (U.S. EPA, 1995b). ATSDR (1995) did not derive any oral MRLs for 1,1,1-trichloroethane due to lack of adequate studies, although inhalation MRLs of 2 ppm (10.9 mg/m^3) and 0.7 ppm (3.8 mg/m^3) were derived for acute- and intermediate-duration exposure, respectively. A carcinogen classification of Group D for 1,1,1-trichloroethane is online in IRIS (U.S. EPA, 1996). Toxicity-based drinking water standards (MCLG and MCL of 0.2 mg/L) and health advisories (One-day, Ten-day, Longer-term values of 100, 40 and 40 mg/L, respectively, for children; One-day, Ten-day, Longer-term and Lifetime values of 100, 0.035, 1 and 0.2 mg/L, respectively, for adults) have been established by the Office of Water (U.S. EPA, 1995c). Short term toxicity feeding studies of 1,1,1-trichloroethane in rats and mice have been completed by the NTP and are scheduled for peer review (NTP, 1996a).

Reviews by ATSDR (1995) and U.S. EPA (1984, 1987a), and literature searches of TOXLINE (December 1993-December 1995), MEDLINE (1985-1995; for pharmacokinetic modeling studies) and TSCATS (health effects cites) were used to identify studies relevant to an RfD for 1,1,1-trichloroethane.

Information on the oral toxicity of 1,1,1-trichloroethane is limited in comparison to the inhalation data base on this chemical (see *Risk Assessment Issue Paper for: Chronic RfC for 1,1,1-Trichloroethane*). Because the majority of toxicity studies of 1,1,1-trichloroethane have been performed by inhalation and these studies provide data on sensitive effects and other information relevant to oral risk assessment, pertinent inhalation pharmacokinetic and toxicity data are included in this RfD Issue Paper.

PHARMACOKINETIC DATA

Studies of pharmacokinetics that have focused on issues relevant to the derivation of an

RfD include investigations in humans, rats, and mice of potential species, dose, and route differences in the absorption and disposition of 1,1,1-trichloroethane and comparisons of fate following single versus repeated (5 days/week) inhalation exposures. PBPK (physiologically based pharmacokinetic) modeling has been performed with the objective of assessing health risks of 1,1,1-trichloroethane in drinking water or derivation of a drinking water criterion for humans from inhalation or oral toxicity data in animals. PBPK modeling and its application to oral risk

assessment of 1,1,1-trichloroethane is discussed later in this Issue Paper (see section on Derivation of RfD).

Absorption, Distribution, and Elimination

Oral Exposure

Data regarding pharmacokinetics following oral exposure of humans to 1,1,1-trichloroethane were not located. In animals, virtually all the orally administered dose was absorbed, regardless of whether the 1,1,1-trichloro-^{14}C-ethane was administered by gavage in vegetable oil (to rats at 100-1000 and mice at 300-3000 mg/kg bw) (RTI, 1987), or *ad lib* in drinking water (to rats at 116 mg/kg bw) over a period of 8 hours (Reitz et al., 1987, 1988), or by gavage in corn oil (to rats at 3000 mg/kg bw and mice at 4000 mg/kg) following gavage administration at the same doses on 5 days/week for 4 weeks with unlabeled 1,1,1-trichloroethane (Mitoma et al., 1985). Thus, an absorption factor of 100% is appropriate for the oral route. Absorption from the gastrointestinal tract was more rapid when 1,1,1-trichloroethane was administered in water than when administered in vegetable oil because of the tendency for the chemical to remain in the oil in the gut until the oil is digested and absorbed (ATSDR, 1995).

Most of the orally administered radioactivity was eliminated in the exhaled air as unchanged 1,1,1-trichloroethane (Mitoma et al., 1985, Reitz et al., 1987, 1988; RTI et al., 1987). In the rat study of Reitz et al. (1987, 1988), ≈3% of the ingested 1,1,1-trichloroethane was recovered as metabolites in urine and as CO_2 in the expired air. Mitoma et al. (1985) found that, in rats, 5 and 4% of 750 and 3000 mg/kg doses, respectively, were metabolized. In mice, in the same study, 8 and 6% of 1000 and 4000 mg/kg doses, respectively, were metabolized. In both species, the amount metabolized increased about 3-fold with a 4-fold increase in dose. The data suggest that metabolism may not increase in proportion to dose level. The results also suggest that metabolism may be a quantitatively more significant elimination pathway for 1,1,1-trichloroethane in mice than in rats. In the only study that investigated tissue distribution (RTI, 1987), the tissues examined included blood, liver, kidney, and fat, but not brain, and the results were presented as % dose in tissue, rather than tissue concentration. Adipose tissue had the highest % dose. (Tissue concentration data could be extracted from the individual animal data if needed.)

Essentially all of the radioactivity from the oral dose of 1,1,1-trichloroethane was excreted

within 24 hours after dosing or exposure termination (Reitz et al., 1987, 1988; RTI, 1987). Pharmacokinetic analyses of the elimination data (including estimation of half times) were not presented.

Inhalation Exposure

In studies conducted at the Toxicology Research Laboratory of Dow Chemical Co., Nolan et al. (1984) exposed 6 healthy Caucasian men to 35 and 350 ppm of 1,1,1-trichloroethane (95% purity) in air for 6 hours (with 3 weeks separating the exposures), and Schumann et al. (1982a) exposed adult male F344 rats and B6C3F1 mice to 150 or 1500 ppm of 1,1,1-trichloro-2-^{14}C-ethane (in 94% pure, unlabeled 1,1,1-trichloroethane, for the balance and metabolism studies) or unlabeled 1,1,1-trichloroethane (94% pure, for blood analyses) in air for 6 hours. Regardless of species or exposure level, ≈25% of the inhaled 1,1,1-trichloroethane was absorbed and ≈90% of the absorbed 1,1,1-trichloroethane was excreted unchanged in the expired air. The principal metabolites in all three species were trichloroethanol and trichloroacetic acid.

Tissue concentration studies in the rats and mice indicated that the highest concentrations of radioactivity occurred in fat (as compared with liver and kidney), but that clearance from fat was rapid (Schumann et al., 1982a). Concentrations of 1,1,1-trichloroethane and metabolites in brain, a potential target organ, were not studied. Two other studies in mice exposed to 1000 ppm 1,1,1-trichloroethane by inhalation for 1 hour have indicated that concentrations of parent compound in brain are lower than in fat, liver, kidney, and blood at termination of exposure (Shimada, 1988; Takahara, 1987), but elimination was slower from brain than from blood (Takahara, 1987). An additional study in mice that encompassed exposures of 10-10,000 ppm 1,1,1-trichloroethane and exposure periods ranging from 0.5-24 hours for lower concentrations and 0.5-6 hours for higher concentrations reported end-exposure brain concentrations of parent compound that were similar to or slightly higher than blood concentrations at all exposure levels and times studied (Holmberg et al., 1977). Liver concentrations of parent compound were higher than either blood or brain. None of these distribution studies in mice analyzed for metabolites. A study in which rats were ventilated with a high (ataxic) concentration of 1,1,1-trichloroethane, 8000 ppm, in 3:1 nitrous oxide:oxygen for 2 hours found that, at the end of the exposure period, the concentration of parent compound in brain was 90% of that in blood (Westerberg and Larsson, 1982). Elimination from brain was slower than from blood, such that one hour after exposure was terminated, the concentration in brain was 2.5 times that in blood. No trichloroethanol or other metabolites were detected in the blood or brain. The relevance of these data, obtained at a high level of 1,1,1-trichloroethane exposure in rats that had previously been anesthetized with halothane and were coexposed to nitrous oxide, to long-term, low-level exposure is questionable.

In the studies of Nolan et al. (1984) and Schumann et al. (1982a), there were considerable differences among species in the amount of 1,1,1-trichloroethane absorbed per kg body weight per ppm exposure concentration (human 0.4, rat 1.0, mouse 1.2 μmole/kg/ppm), in end-exposure

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blood concentrations of 1,1,1-trichloroethane per ppm exposure concentration (human 0.004, rat 0.017, and mouse 0.084 µg/g blood/ppm), and in the amount metabolized per kg body weight per ppm exposure concentration (human 0.014, rat 0.06, and mouse 0.16 µmole/kg/ppm). These values were taken from the lowest exposure level tested in each species: 35 ppm in humans and 150 ppm in rats and mice. The authors proposed that these species differences indicate that if toxicity is expressed in terms of exposure concentration, rats and mice will appear more sensitive than humans to effects due to parent compound as well as to effects due to metabolites because of their greater absorption, higher blood levels of parent compound, and greater metabolism. Because the rat values for these parameters were intermediate between those for humans and for mice, the authors contend that the rat is a better model than the mouse for the assessment of human health effects.

Using the same reasoning, mice would be expected to appear more sensitive than rats to the toxicity of 1,1,1-trichloroethane expressed in terms of exposure concentration. Nevertheless, as reviewed in the *Risk Assessment Issue Paper for: Chronic RfC for 1,1,1-Trichloroethane*, subchronic and chronic toxicity studies in which rats and mice were exposed by inhalation to the same concentrations of 1,1,1-trichloroethane show that the rat is at least as sensitive and probably more sensitive than the mouse to 1,1,1-trichloroethane (Calhoun et al., 1981; Quast et al., 1988). Thus the predictions based on the pharmacokinetic data are not consistent with the toxicity data for these two species. Gerbils and guinea pigs appear to be sensitive to the toxicity of 1,1,1-trichloroethane based on inhalation studies (Rosengren et al., 1985; Torkelson et al., 1958), but no studies of pharmacokinetics in these species were found in the literature searched.

The studies by Nolan et al. (1984) and Schumann et al. (1982a) showed that, within each species, there were no differences in absorption or blood levels of 1,1,1-trichloroethane per ppm exposure level at the low and high exposure levels tested in humans, rats, and mice. The results did show a difference in percentage of absorbed 1,1,1-trichloroethane that was metabolized in rats and mice, with a larger percentage of the dose metabolized at the lower of the two levels tested. Only a 2- to 3-fold increase in the amount of 1,1,1-trichloroethane metabolized was seen with a 10-fold increase in exposure concentrations. This finding suggests that the metabolism may be saturable. For humans, little difference in metabolism was seen between the exposure levels, but the low and high exposure levels were lower than those used in the animal studies.

The study in humans by Nolan et al. (1984) measured not only the concentrations of 1,1,1-trichloroethane, but also of trichloroethanol and trichloroacetic acid in blood. Peak blood concentrations (µg/L) of trichloroethanol occurred during the interval from the end of exposure to 6 hours postexposure, were highly variable and somewhat lower than peak concentrations of parent compound, and declined with an average half time of 27 hours. Peak blood (µg/L) concentrations of trichloroacetic occurred 30-40 hours postexposure, were similar to peak levels of parent compound, and declined with an average half time of 76 hours.

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Additional pertinent details of the human study (Nolan et al., 1984) may be of interest in evaluating the relevance of single exposure studies and short exposure periods to the assessment of chronic exposure. The concentration of 1,1,1-trichloroethane in blood rose rapidly during the initial portion of the exposure period such that by 1.5 hours it was 90% of the mean concentration at 6 hours of exposure. [A similar pattern of initial rapid increase followed by an apparent leveling off in blood concentration was seen in 12 men exposed for 3 hours to 175 or 350 ppm 1,1,1-trichloroethane (Mackay et al., 1987).] Based on blood and expired air concentrations, elimination of 1,1,1-trichloroethane was described as triexponential, with estimated half times of 44 minutes, 5.7 hours and 53 hours for the initial, intermediate, and terminal phases (Nolan et al., 1984). Simulations of repeated 8-hour daily exposures based on a three compartment pharmacokinetic model and the data from this study indicated that at the end of the fifth daily exposure, the expired air and blood concentrations of 1,1,1-trichloroethane would be within 4 and 8%, respectively, of the concentrations after a single 8-hour exposure, and that the amount of 1,1,1-trichloroethane in the body would be 1.8 times that following a single exposure. This simulation is in agreement with the results of a repeated exposure study in humans (Stewart et al., 1969), in which the concentration of 1,1,1-trichloroethane in expired air increased very little over 5 consecutive days of exposure to 507 ppm of 1,1,1-trichloroethane. The simulation predicted that twelve daily exposures would be required to reach 95% of steady state concentrations of 1,1,1-trichloroethane in the body (Nolan et al., 1984). At steady state, the body would contain 3.6 times the amount of 1,1,1-trichloroethane as after a single 8-hour exposure; about 70% of this would be in the fat. Thus, although there may be some accumulation of 1,1,1-trichloroethane in fat with repeated exposure, the increase in blood concentration at steady state as compared with the concentration at the end of a single exposure is predicted to be modest.

The studies in rats and mice did not monitor blood levels during the early portion of exposure for rats or at all for mice (Schumann et al., 1982a,b). Elimination of 1,1,1-trichloroethane was rapid and diexponential in rats, with estimated half lives of 10.5-36 minutes for the initial and 139-258 for the terminal phase, and was triexponential in mice, with estimated half lives of 2, 13, and 169-193 minutes for the initial, intermediate, and terminal phases (Schumann et al., 1982a). The disposition and tissue concentrations of 1,1,1-trichloroethane and metabolites in rats and mice that received 6-hour exposures to 0 ppm 1,1,1-trichloroethane on 5 days/week for ≈16 months followed by a single 6-hour exposure to 1500 ppm of 1,1,1-trichloro-2-^{14}C-ethane (in 94% pure, unlabeled 1,1,1-trichloroethane) did not differ significantly from those seen in rats and mice that received 6-hour exposures to 1500 ppm 1,1,1-trichloroethane on 5 days/week for ≈16 months followed by exposure to the radiolabeled compound (Schumann et al., 1982b). Thus, in rats and mice, no tendency toward tissue accumulation or increasing blood concentrations was seen with repeated exposure for ≈16 months as compared with a single exposure. Comparison of the data from the single exposures to 1,1,1-trichloroethane in these older rats and mice with those from the single exposure study in younger rats and mice (Schumann et al., 1982a) revealed increased body burden and metabolism and decreased rate of pulmonary elimination of 1,1,1-trichloroethane in the older animals. For the rat, these differences were attributable primarily to the increased fat content of the older animals; for the mouse, only

part of the observed differences could be accounted for by this factor (Reitz et al., 1987, 1988; Schumann et al., 1982b).

Metabolic Pathways and Mechanism of Action

As reviewed by ATSDR (1995), the data from *in vivo* studies in humans and in animals, including oral and inhalation exposure, and from *in vitro* studies using tissue fractions from animals indicate that 1,1,1-trichloroethane is metabolized to trichloroethanol, probably by the microsomal cytochrome P-450 mixed-function oxidase system. Trichloroethanol can be conjugated with glucuronide, or further metabolized to trichloroacetic acid, presumably through the intermediate chloral hydrate, and then to carbon dioxide. Metabolism to trichloracetic acid may involve alcohol and aldehyde dehydrogenases or cytochrome P-450 mixed-function oxidases. Trichloroethanol, its glucuronide, and trichloroacetic acid are excreted primarily in the urine; carbon dioxide is excreted in the expired air. In general, regardless of route of exposure, <10% of the absorbed 1,1,1-trichloroethane is metabolized.

A single report of *in vivo* and *in vitro* experiments with rats provided suggestive evidence that 1,1,1-trichloroethane can be reductively dechlorinated *to a limited extent under conditions of low oxygen supply*, resulting in the formation of free radical intermediates and acetylene (<1% of the metabolized 1,1,1-trichloroethane was exhaled as acetylene). This process appeared to involve cytochrome P-450, and represented a very minor metabolic pathway (ATSDR, 1995).

Whether the mild hepatic effects of 1,1,1-trichloroethane are due to the parent compound or are mediated by a metabolite is not known. One type of evidence used in discerning the role of metabolites of chlorinated alkanes in hepatotoxicity is to administer an inducer of cytochrome P-450 mixed function oxidases prior to administration of the chlorinated alkane. Results of rat studies in which phenobarbital was administered prior to 1,1,1-trichloroethane, however, are conflicting, with one study reporting a modest increase in indices of hepatotoxicity relative to administration of 1,1,1-trichloroethane alone (Carlson, 1973) and the other reporting no differences (Cornish et al., 1973). Pretreatment with 3-methylcholanthrene did not appear to affect the hepatotoxicity of 1,1,1-trichloroethane (Carlson, 1973).

The acute CNS depressant effects of high exposures to 1,1,1-trichloroethane are thought to involve interactions of the parent compound with lipids and/or proteins in neural membranes (ATSDR, 1995). The mechanism of neurotoxicity during long-term, lower level exposures, which produced changes indicative of astrogliosis in gerbils (Rosengren et al., 1985), is unknown. Inhalation studies in mice and rats, discussed previously, have demonstrated that 1,1,1-trichloroethane enters the brain and may reach concentrations similar to those in blood, and is eliminated more slowly from brain than from blood. Only one study, in rats, analyzed specifically for metabolites in brain, and did not detect them (Westerberg and Larsson, 1982). Thus, there is limited support for considering the parent compound to be the neurotoxic agent.

Oral Exposure

One report of human oral exposure to 1,1,1-trichloroethane was located (Stewart and Andrews, 1966). This involves a case of a man who accidentally ingested one ounce (≈600 mg/kg) of 1,1,1-trichloroethane and experienced an immediate burning sensation in the mouth and throat, nausea after 30 minutes, severe vomiting and diarrhea after 1-6 hours, and slightly elevated serum bilirubin levels after 48 hours (serum transaminase, BUN and other clinical pathology indices were normal). The subject showed no signs of CNS depression (disorientation, incoordination or drowsiness), and thorough neurological examinations (details not reported) showed no abnormalities.

Limited information is available regarding effects of 1,1,1-trichloroethane in animals following oral exposure, but acute studies suggest that neurotoxicity of orally administered compound is similar to that following inhalation exposure and that the CNS may be a more sensitive target than liver following oral exposure (ATSDR, 1995). Rats that were treated with 705 mg/kg-day 1,1,1-trichloroethane by gavage for 2 days did not show any changes in behavior or appearance that could be detected by a functional observational battery, although neurophysiological testing performed after exposure for 4 days showed some alterations (Spencer et al., 1990). Neurophysiological effects included marked flash-evoked potential and EEG changes and smaller alterations in somatosensory-evoked potential, and were similar to effects observed after inhalation exposure to 2000 ppm for 4 days. Rats administered high oral doses of 1,1,1-trichloroethane showed gross neurobehavioral changes (initial hyperexcitability followed by prolonged narcosis) after daily dosing with ≥5000 mg/kg and ≥2500 mg/kg in 11- and 88-day exposure studies, respectively (Bruckner, 1983). There were no histopathological indications of liver damage in rats given a single gavage dose of 4000 mg/kg or ≤10,000 mg/kg-day by gavage for up to 11 days (Bruckner, 1983). Subchronic and chronic oral toxicity studies in animals, summarized below, are insufficient for characterizing relative sensitivity of CNS, liver and other effects of 1,1,1-trichloroethane.

NTP (1996b) conducted a subacute study in which groups of 5 male F344/N rats were administered 1,1,1-trichloroethane (purity 100%) by gavage in corn oil in dosages of 0, 0.62 or 1.24 mmol/kg-day (0, 83 or 165 mg/kg-day) for 21 days. Evaluations included survival, body weight gain, clinical signs, urinalysis (creatinine, glucose, total protein, aspartate aminotransferase, γ-glutamyl transpeptidase, *N*-acetyl-β-D-glucosaminidase, volume, specific gravity), a few organ weights (liver, right kidney, right testis) and limited histological assessment (liver, right kidney, gross lesions). The clinical and tissue pathology evaluations were limited in scope and centered on renal endpoints because this study was part of an investigation of structure-activity relationships involved in the induction of hyaline droplet nephropathy by halogenated ethanes. There were statistically significant ($p<0.05$) changes in some endpoints at 165 mg/kg-day, including increases in relative liver weight (≈11% higher than controls), urinary

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protein output (≈79% higher) and urinary aspartate aminotransferase activity (≈5700% higher). Increases in urinary γ-glutamyl transpeptidase (≈31% higher than controls) and *N*-acetyl-β-D-glucosaminidase (≈355% higher) also occurred at 165 mg/kg-day, but these changes were not statistically significant ($p>0.05$), apparently due to the relatively small number of rats examined ($n=4$). NTP (1996b) concluded that the urinalysis findings were highly suggestive of renal injury (even though renal histology was normal), indicating that 83 and 165 mg/kg-day are a subchronic NOAEL and minimal LOAEL, respectively.

An unpublished study was performed in which male Sprague-Dawley rats were gavaged with 0, 0.5, 2.5 or 5.0 g/kg (0, 500, 2500 or 5000 mg/kg) trichloroethane (purity 99%) in corn oil on 5 days/week for up to 88 days (Bruckner, 1983). Adjusting for partial weekly exposure yields estimated average daily dosages of 0, 357, 1786 and 3571 mg/kg-day. Group sizes were 15 rats/dosage at 0-1786 mg/kg-day and 20 rats at 3571 mg/kg-day. Endpoints included clinical signs, body weight, blood chemistry [OCT, SDH, GPT, BUN] and liver and kidney pathology (organ weight and histology). The histological examinations of the liver and kidneys were limited to rats in the 0 and 357 mg/kg-day groups (10 and 5 rats/group were sacrificed 4 and 10 days, respectively, following the last exposure) and showed no abnormalities. Approximately 35% of the rats treated with 1786 or 3571 mg/kg-day died within the first 50 days of the study; the lack of autopsies precluded establishing cause of death. Other effects at ≥1786 mg/kg-day included signs of CNS toxicity (initial hyperexcitability after each day's dosing followed by protracted necrosis) and decreased body weight gain (22-28% lower than controls). Serum levels of OCT and GPT at 3571 mg/kg-day were significantly ($p<0.05$) higher than control values (112-113% and 70-80%, respectively) during the first 4 weeks of the study; no other significant changes in serum chemistry were observed. Based on the lack of histopathological and other alterations, 357 mg/kg-day is a subchronic NOAEL; the next highest dosage, 1786 mg/kg-day, is a FEL due to mortality.

A chronic carcinogenesis bioassay was conducted in which technical grade 1,1,1-trichloroethane (≈95% pure containing 3% dioxane stabilizer and 2% minor impurities) was administered in corn oil by gavage to male and female Osborne-Mendel rats and B6C3F1 mice on 5 days/week for 78 weeks (NCI, 1977). Control and treated group sizes were 20/sex/species and 50/sex/species, respectively. Male and female rats were treated with dosages of 750 or 1500 mg/kg (536 or 1071 mg/kg-day) for 78 weeks and observed for the next 32 weeks; untreated control rats were observed for 110 weeks. Low dose male and female mice were sequentially treated with 2000 mg/kg for 10 weeks, 2500 mg/kg for 10 weeks and 3000 mg/kg for 58 weeks [TWA dosage 2807 mg/kg (2005 mg/kg-day)], and observed for the following 12 weeks. High dose male and female mice were sequentially treated with 4000 mg/kg for 10 weeks, 5000 mg/kg for 10 weeks and 6000 mg/kg for 58 weeks [TWA dosage 5615 mg/kg (4011 mg/kg-day)], and observed for the following 12 weeks. Untreated male and female control mice were observed for 90 weeks. Study endpoints included clinical observations, body weight, food consumption and histopathology; hematology, clinical chemistry and urine indices were not evaluated. Effects in male and female rats included reduced survival (≈30-40% increased mortality compared to

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controls during the first year of the study), decreased body weight gain and urine staining of abdominal fur at ≥536 mg/kg-day; no histopathological changes were observed. Effects occurred in mice at ≥2005 mg/kg-day, including reduced survival in females (13 and 35% increased low- and high-dose group mortality during the first year) and ≈15-20% decreased body weight gain in both sexes. The reduced survival in rats and mice was considered compound-related by NCI (1977), although chronic murine pneumonia was a prevalent spontaneous lesion in all control and treated groups of both sexes and was a probable contributing factor in the early deaths. Based on reduced survival, the lowest dosages tested, 536 mg/kg-day in rats and 2005 mg/kg-day in mice, are FELs for chronic exposure.

In another chronic carcinogenesis bioassay, groups of 50 and 40 Sprague-Dawley rats of each sex were gavaged with 0 or 500 mg/kg doses of 1,1,1-trichloroethane (technical grade containing 3.8% dioxane) in olive oil, respectively, on 4-5 days/week for 104 weeks (Maltoni et al., 1986). Adjusting for partial weekly exposure yields an estimated average daily dosage range of 286-357 mg/kg-day. The experiment lasted 141 weeks as animals that survived to the end of the treatment period were allowed to live until spontaneous death. Body weight and survival were assessed throughout the study, and complete necropsies including histopathological examinations were performed on each animal; hematology, clinical chemistry and urine indices were not evaluated. Comparison of survival curves indicates that survival was similar in control and treated groups. Average body weight gain was reduced in treated females after approximately 80 weeks of exposure; body weight in exposed females was ≈12% and ≈25% lower than controls at the end of the treatment and observation periods, respectively. An increased total incidence of leukemias (primarily immunoblastic lymphosarcomas in lungs of males) was the only reported histopathological finding. Based on reduction in body weight gain, this study identifies a chronic LOAEL of ≈286-357 mg/kg-day.

Results of a study designed to investigate effects of 1,1,1-trichloroethane on cardiovascular development in offspring of exposed rats have been reported as abstracts (Dapson et al., 1984; Hutcheon et al., 1985). Rats (strain not reported) were provided drinking water containing 0 or 10 ppm 1,1,1-trichloroethane (purity not reported) dispersed in 0.05% Tween 80 from before gestation through lactation (postnatal day 21). Using a rat daily water consumption factor of 0.14 L water/kg body weight based on default chronic reference values of 0.033 L/day and 0.229 kg for food consumption and body weight in female F344 rats (U.S. EPA, 1987b), respectively, the estimated dosages are 0 and 1.4 mg/kg-day. Examination of offspring from 6 control and 6 exposed litters showed no effects on mean body weight or mean wet heart weights. Cardiac abnormalities, consisting of persistent ductus arteriosus and right and/or left atrial hypoplasia or displacement, occurred in "more than 30%" of the exposed pups. These cardiac malformations were reported to be significantly more frequent and severe than in the control group, suggesting that 1.4 mg/kg-day was a LOAEL for developmental toxicity. Confidence in this LOAEL is low because additional salient information (e.g., incidences of malformations in controls and other quantitative data) was not reported in the abstract and the effect was not

corroborated in another study (George et al., 1989; NTP, 1987a).

In a postnatal developmental study designed to assess the repeatability of the cardiovascular effects reported by Dapson et al. (1984), Charles River CD rats were exposed to drinking water containing 0 (water-only control), 0 (water containing stabilizer and emulsifier), 3, 10 or 30 ppm 1,1,1-trichloroethane (97% pure stabilized with 3% dioxane) and 0.05%Tween 80 emulsifying agent (George et al., 1989; NTP, 1987a). Groups of more than 30 males and 30 females (exact numbers not reported) were exposed for 14 days prior to cohabitation for ≤13 days. Male breeders and sperm-negative females were killed after the cohabitation period was completed, and sperm-positive females (24-30 per group) continued to be exposed through lactation [postnatal day (PND) 21]. Reported average compound consumption during the premating period was 0.3, 0.9 and 2.6 mg/kg-day for exposed males and 0.3, 1.3 and 3.3 mg/kg-day for exposed females. Reported average maternal intake was 0.3, 1.2 and 3.5 mg/kg-day from gestational day 0 to parturition and 0.6, 2.0 and 5.9 mg/kg-day from PNDs 1-21. Evaluation of adult males and females included clinical signs, food and water consumption and body weight throughout the exposure period for each sex. Other endpoints included number of implantation sites, gestation length, litter size and pup weight and survival. Litters containing >10 pups on PND 4 were culled to litter size 10 and the remaining pups were evaluated until PND 21. The culled pups (PND 4) and surviving pups (PND 21) were sacrificed and examined for visceral malformations with special attention given to the heart and surrounding vasculature. No treatment-related parental effects or changes in postnatal growth or development of offspring were observed. Percentage mortality from implantation to PND 1 was significantly higher (224%, $p \leq 0.05$) in 30 ppm litters than in the vehicle control group, but this increase appeared to be primarily due to high mortality (61%) in one litter on PND 1 and was not accompanied by an effect on numbers of live pups/litter on PNDs 1 or 4. Patent ductus arteriosus occurred in 10/28 treated pups (6 from 4 litters at 3 ppm, 1 at 10 ppm, 3 from 2 litters at 30 ppm) that died on PND 1 (no occurrence in either control group) and in 1 pup (3 ppm) culled on PND 4. Statistical analysis of incidence by litter indicated no significant effect of treatment, and there was no evidence of cardiac or other malformations in any dose group on PND 21, which was the time at which Dapson et al. (1984) reported effects. The investigators discuss that closure of the ductus arteriosus in rat pups is not unexpected at earlier postnatal time points (PNDs 1 and 4) and do not attribute the delay in closure to 1,1,1-trichloroethane exposure. Due to the lack of evidence for compound-related changes, 3.5 mg/kg-day (highest tested dosage) is a NOAEL for developmental toxicity.

A teratogenicity study of 1,1,1-trichloroethane (NTP, 1987b) was conducted in conjunction with the postnatal developmental evaluation summarized above (NTP, 1987a). Exposure and other aspects of the experimental design are essentially the same as in the postnatal study except that dams were sacrificed on gestational day 20 and comprehensive teratological examinations of fetuses were performed. Reported average compound consumption corresponding to the 3, 10 and 30 ppm drinking water concentrations were 0.3, 0.6 and 2.0 mg/kg-day for males during the premating period and 0.3, 0.8 and 2.4 mg/kg-day for females

from premating to gestational day 20. No exposure-related maternal, embryotoxic, fetotoxic or developmental (external, visceral, skeletal or cardiovascular) abnormalities were found, indicating that 2.4 mg/kg-day (highest tested dosage) is a developmental toxicity NOAEL.

An oral multigeneration reproduction study modified to include screening for teratogenic and dominant lethal effects of 1,1,1-trichloroethane was conducted in mice (Lane et al., 1982). Groups of 30 female and 10 male ICR Swiss mice (F0 generation) were provided drinking water containing 1,1,1-trichloroethane (97% pure containing 3% *p*-dioxane inhibitor) in concentrations of 0 (water-only control), 0 (vehicle control), 0.58, 1.75 or 5.83 mg/mL (reported nominal calculated dosages 100, 300 or 1000 mg/kg-day) for 5 weeks prior to mating and throughout gestation and lactation of the F1a litters. At 2 weeks postweaning of the F1a litters, the F0 adults were remated to produce F1b litters. At 2 weeks postweaning of the F1b litters, the F0 adults were remated for teratology and dominant lethal screening of female and male F1c pups, respectively. The F1b litters were culled to 30 females and 10 males at weaning and placed on test solutions until age 14 weeks when they were mated to produce the F2a litters. At 2 weeks postweaning of the F2a pups, the F1b adults were remated for teratology and dominant lethal screening of male and female F2b pups, respectively. Adult observations included body weight and water consumption, reproductive performance (fertility and gestation indices), mortality and gross pathology (necropsies performed after week 24 or 25 of dosing). Offspring endpoints included litter size, body weight, viability and lactation indices, and gross pathology (necropsies performed on F1a and F1b pups at age 21 days). The teratology screenings involved sacrificing females on gestational day 18 for assessment of implantations, resorptions, fetal viability, gross malformations, visceral abnormalities (one-third of fetuses) and skeletal abnormalities (remaining fetuses). Dominant lethal reproductive indices were based on implantation, resorption and fetal viability data in untreated females that were mated with the exposed F1c and F2b males. No exposure-related effects on male or female reproductive function or offspring development were found in this study, indicating that 1000 mg/kg-day, the highest dosage tested, is a NOAEL for reproductive and developmental toxicity.

In an unpublished study summarized and peer-reviewed by ATSDR (1995), Dow Chemical (1993) assessed neurobehavioral effects of 1,1,1-trichoroethane in offspring of rats treated with dosages of 0, 75, 250 or 750 mg/kg-day by gavage on gestational day 6 through lactation day 10. Endpoints that were examined included body weight, physical maturation landmarks, motor activity, functional observational battery, brain measurements and neuropathology, and evaluation of learning capacity, task performance and short-term memory. No statistically significant or dose-related changes were observed (although there were some sporadic differences between treated and control animals in some tests), indicating that the highest dosage tested, 750 mg/kg-day, was a NOAEL for neurodevelopmental effects.

Inhalation Exposure

As discussed in the *Risk Assessment Issue Paper for: Chronic RfC for 1,1,1-*

Trichloroethane, CNS depressant effects are the predominant signs of acute inhalation exposure to 1,1,1-trichloroethane in humans (ATSDR, 1995), and there is some evidence that acute exposure to moderate (≥175 ppm) concentrations may cause psychomotor impairment (e.g., slowed reaction time) (Gamberale and Hultengren, 1973; Mackay et al., 1987). Inconclusive data are available on CNS effects of chronic inhalation exposure in humans (Maroni et al., 1977). Both the CNS and liver are sensitive targets of 1,1,1-trichloroethane in animals following subchronic/chronic inhalation exposure, although the lowest inhalation LOAEL is for a CNS effect (Rosengren et al., 1985).

Rosengren et al. (1985) exposed groups of 4 male and 4 female Mongolian gerbils to 0, 70, 210 or 1000 ppm (382, 1147 or 5460 mg/m^3) 1,1,1-trichloroethane continuously for 3 months. All animals were sacrificed 4 months post-exposure for assessment of brain weight [total and cerebral cortex frontal, middle (sensorimotor) and dorsal (occipital) regions] and regional biochemical alterations in the cerebral cortex. Brain histology and neurobehavioral endpoints were not evaluated. The brain biochemical analyses consisted of determinations of total protein and two astroglial protein [S-100 and glial fibrillary acidic (GFA) protein] concentrations. No deaths occurred during the study and no effects on body weight were found at the end of the exposure or post-exposure periods. Brain weight was significantly ($p \leq 0.01$) reduced in the 1000 ppm group, although the difference from controls was slight (2.5% reduction). Significantly increased concentrations of GFA protein (~33%, $p \leq 0.01$) were found in the sensorimotor cerebral cortex following exposure to ≥210 ppm. GFA protein levels were not increased in the frontal cerebral cortex or the occipital cerebral cortex, and brain S-100 protein and total protein concentrations were unaffected by exposure. GFA protein is the main protein subunit of astroglial filaments and is used by neurobiologists as a marker for demonstrating formation of astroglial fibrils in response to brain injury (ATSDR, 1995). Increase in GFA protein, therefore, is associated with astrogliosis and CNS damage, and the findings of this study indicate that the sensorimotor cerebral cortex was affected by 1,1,1-trichloroethane. Additionally, the fact that the effect was found 4 months after the end of exposure suggests it is irreversible. Based on increased GFA protein, indicating brain astrogliosis in guinea pigs following continuous exposure, the inhalation NOAEL and LOAEL for neurotoxicity are 70 ppm (382 mg/m^3) and 210 ppm (1147 mg/m^3), respectively (see *Risk Assessment Issue Paper for: Chronic RfC for 1,1,1-Trichloroethane)*.

DERIVATION OF RfD

The oral data base for 1,1,1-trichloroethane is insufficient for deriving a chronic RfD. Few longer-term oral studies have been performed and these do not provide adequate information on effects and species known to be sensitive to 1,1,1-trichloroethane in inhalation studies. In particular, as discussed in the *Risk Assessment Issue Paper for: Chronic RfC for 1,1,1-*

Trichloroethane, increased GFA protein (a biochemical marker for brain damage) in gerbils (Rosengren et al., 1985) is the critical effect used as the basis for the provisional RfC, but none of the oral studies adequately investigated sensitive CNS endpoints and or species other than rats (all but one oral study were in mice). For example, neither of the chronic oral studies of 1,1,1-trichloroethane investigated neurobehavioral performance or CNS biochemical endpoints (NCI, 1977; Maltoni et al., 1986). Also, the lowest dosages tested in the NCI (1977) study were FELs for decreased survival in rats (536 mg/kg-day) and mice (2005 mg/kg-day), and the LOAEL in the Maltoni et al. (1986) study (286-357 mg/kg-day, lowest dosage range) is based on reduced body weight gain, a relatively insensitive endpoint for 1,1,1-trichloroethane. The lowest dosage in the unpublished 88-day oral study of Bruckner (1983) was a subchronic NOAEL (357 mg/kg-day), but this study is primarily centered on liver and kidney histology and related blood chemistry indices. A minimal LOAEL of 165 mg/kg-day is identified on the basis of abnormal urinalysis findings unaccompanied by kidney or liver histopathology in rats treated for 21-days (NTP, 1996b), but the relevance of this subacute finding to chronic toxicity is unclear due to the small numbers of animals (4-5 per dose), lack of urinalysis data and lack of abnormal renal histology in the chronic studies. Developmental and reproductive toxicity is not an oral effect of concern based on lack of neurodevelopmental effects in rats at 750 mg/kg-day (Dow Chemical, 1993) and reproductive and developmental toxicity in rats at 1000 mg/kg-day (Lane et al., 1982).

Due to the lack of adequate oral toxicity data pertaining to sensitive effects and species of 1,1,1-trichloroethane, it is appropriate to consider deriving a provisional RfD using inhalation data. As discussed below, it is feasible to use traditional route-to-route extrapolation methods or PBPK-based modeling to estimate an RfD using the subchronic inhalation NOAEL for CNS effects in gerbils (Rosengren et al., 1985) on which the provisional RfC for 1,1,1-trichloroethane is based.

Extrapolation based on relative absorption efficiency

Using the traditional EPA approach for route-to-route extrapolation, the 382 mg/m^3 continuous subchronic exposure NOAEL for CNS effects from the Rosengren et al. (1985) study is converted to an inhaled dose of 287 mg/kg-day by multiplying by an inhalation rate of 0.03 m^3/day and dividing by a body weight of 0.04 kg (subchronic reference values for Mongolian gerbils; U.S. EPA, 1987b). Multiplying the inhaled dose of 287 mg/kg-day by an inhalation:oral absorption factors ratio of 0.25 (see section on Pharmacokinetic Data) yields an equivalent oral dose of 72 mg/kg-day. Using this dose and applying an uncertainty factor of 3000 (10 for subchronic study, 10 for interspecies extrapolation, 10 for intraspecies sensitivity and 3 for data base limitations), the provisional RfD is 2E-2 mg/kg-day. A higher factor for data base uncertainty was not applied because the main deficiency of the oral data, lack of studies investigating sensitive CNS effects, is partially addressed by inhalation studies. Confidence in the principal study (Rosengren et al., 1985) is medium because it is an adequately designed study that examined a sensitive neurological endpoint. Confidence in the data base is medium to low. Although CNS effects are generally well-characterized in various species by the inhalation route.

corroborating inhalation data are lacking for the critical CNS effect and non-neurologic effects in gerbils. Additionally, sufficient data are not available on sensitive CNS effects by the oral route. Reflecting medium confidence in the data base, confidence in the RfD is medium to low.

Extrapolation based on PBPK modeling

PBPK models have been used to investigate the health risks of typical levels of 1,1,1-trichloroethane contamination in drinking water by extrapolating from inhalation toxicity data in animals (Reitz et al., 1987, 1988) or to estimate non-adverse concentrations of 1,1,1-trichloroethane in drinking water from inhalation and oral toxicity data in animals (Bogen and Hall, 1989). The results of these modeling efforts are discussed in terms of their applicability to RfD derivation in the following paragraphs. One problem with PBPK modeling for 1,1,1-trichloroethane is that the mechanism of action for sensitive endpoints (i.e., neurological and hepatic effects) is not known. Thus, the appropriate dose surrogate for these endpoints is uncertain. As discussed in the section on Pharmacokinetic Data, the prediction of relative species sensitivity for rats and mice from the pharmacokinetic data (amount absorbed and metabolized, blood levels) does not correlate with the toxicity data. Hence, the uncertainties involved in route and species extrapolation may not be alleviated substantially by the use of PBPK modeling as compared with the more traditional method of RfD derivation. In addition, there are some problems with selected NOAELs and exposure scenarios for the PBPK modeling, as discussed below.

Reitz et al. (1987, 1988) based their assessment of the safety of low levels of 1,1,1-trichloroethane (0.001-0.300 ppm) in drinking water on chronic NOAELs for liver effects due to inhalation exposure 6 hours/day, 5 days/week of 875 ppm for rats (Quast et al., 1978; Rampy et al., 1978) and 1500 ppm for mice (Quast et al., 1988). Their four-compartment PBPK model, based on that of Ramsey and Andersen (1984), was developed and validated using data of Schumann et al. (1982a,b), Nolan et al. (1984), and i.v., gavage, and 8-hour drinking water exposure studies in rats (Reitz et al., 1987, 1988). The average concentration of 1,1,1-trichloroethane in the liver over the lifetime (ACL = 28 and 95 μmole/L for rats and mice, respectively) was selected as the dose surrogate. The rationale for using the concentration of parent compound as the dose surrogate was that the effects of 1,1,1-trichloroethane on the liver were mild and there was no necrosis; therefore, it could not be determined whether parent compound or more reactive metabolites were the cause. ACLs were then calculated for humans ingesting water containing the above concentrations of 1,1,1-trichloroethane, and the ratio of the animal to the human ACL constituted the safety factor. The estimated safety factor for humans ingesting 0.300 ppm 1,1,1-trichloroethane in their drinking water was 2.8×10^3 based on the rat ACL and 9.5×10^3 based on the mouse ACL.

The critical effect of 1,1,1-trichloroethane by inhalation exposure, however, is related to CNS toxicity. It is likely, given the low rate of metabolism in rodents and humans (i.e., little first-pass impact), that the critical effect of oral exposure also will be a CNS effect. In addition, the rat

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liver NOAEL chosen for use in this model is based on a less-than-lifetime study of questionable adequacy for assessing hepatic toxicity. In this study (Quast et al., 1978; Rampy et al., 1978), only 3 rats/sex/group were examined histopathologically at the end of the 12-months of exposure; the remaining animals were observed for 19 additional months before sacrifice and histopathological examination. A better choice would have been the 2-year study (Quast et al., 1988) from which the mouse ACL was estimated; rats were also tested in that study at the same exposure levels. The NOAEL (and LOAEL) for rats in this chronic exposure study was lower than in the 12-month exposure study used as the basis for the rat ACL. An additional problem is that the Reitz et al. (1987, 1988) model does not extrapolate from the animal ACLs to an equivalent oral dosage for humans.

Bogen and Hall (1989) used PBPK modeling based on NOAELs for a variety of effects in animal inhalation and oral studies to predict nontoxic concentrations of 1,1,1-trichloroethane in drinking water for human exposure via ingestion, inhalation, and dermal contact. Their model also was based on the Ramsey and Andersen (1984) model, modified for the human exposure scenario by splitting the muscle/skin compartment into separate compartments for muscle and skin so that dermal uptake could be modeled. The assumptions used for the human exposure scenario may be problematic because the 2 L/day ingestion component is assumed to occur as a single bolus immediately before showering. The dermal component also was assumed to occur entirely during showering, and showering provides an inhalation exposure. This approach will tend to underestimate the 24-hr TWA hepatic metabolism of 1,1,1-trichloroethane (because of the saturability of metabolism) and, as acknowledged by the authors, will overestimate peak arterial blood concentrations relative to a more realistic ingestion scenario.

The NOAELs chosen as the basis for the extrapolation were a NOAEL of 70 ppm for neurotoxicity in gerbils given continuous subchronic inhalation exposure (Rosengren et al., 1985), a NOAEL of 10 ppm for reproductive and developmental effects in rats given the chemical in drinking water (George et al., 1989; NTP 1987a), and a NOAEL of 250 ppm for liver effects in rats given continuous subchronic inhalation exposure to 1,1,1-trichloroethane (McNutt et al. (1975). The NOAEL for neurotoxicity in gerbils is an appropriate choice and was used as the basis for a provisional RfC (see *Risk Assessment Issue Paper for: Chronic RfC for 1,1,1,-Trichloroethane*). The dose surrogates for the neurotoxicity NOAEL were the peak and the 24-hr TWA arterial blood concentrations of parent compound (both estimated at 4.05 mg/L), selected because there were no data regarding neurotoxicity of metabolites, and because 1,1,1-trichloroethane has been detected in human and animal brain tissue after inhalation exposure (no references cited for this statement). The selected NOAEL of 10 ppm in drinking water for reproductive effects is too conservative; the next higher exposure level, 30 ppm, is considered to be a NOAEL in this issue paper. The dose surrogates were the peak and 24-hr TWA concentrations of parent compound in arterial blood, selected because there is no evidence to suggest that 1,1,1-trichloroethane would not enter fetal circulation and because the model did not include a fetal compartment. The NOAEL [=NOAEL(HEC)] for liver effects in the continuous exposure study of McNutt et al. (1975) is similar to the LOAEL(HEC) and is considerably higher

than the NOAEL(HEC) for liver effects in the chronic intermittent exposure study in rats (Quast et al., 1988). Thus, a better choice would be the NOAEL from the chronic rat study. The dose surrogate selected for the liver NOAEL was the 24-hr TWA of 1,1,1-trichloroethane metabolized per kg liver. The rationale for this selection was that the process of 1,1,1-trichloroethane metabolism was responsible for the hepatotoxicity, based on the potentiation of the acute hepatotoxicity of 1,1,1-trichloroethane by pretreatment with a cytochrome P-450 inducer (phenobarbital) (Carlson, 1973). As discussed in the section on metabolic pathways and mechanism of action, however, the evidence is inadequate and conflicting – another study reported that phenobarbital pretreatment did not potentiate the acute hepatotoxicity of 1,1,1-trichloroethane (Cornish et al., 1973).

Based on modeling of the relative contributions from inhalation, ingestion, and dermal exposure to 1,1,1,-trichloroethane from drinking water, Bogen and Hall (1989) calculated a factor of 3.4 to convert water concentrations estimated as nontoxic for ingestion to water concentrations that would be nontoxic for multiroute exposure to 1,1,1-trichloroethane. The ingestion concentration divided by 3.4 equals the multiroute concentration. Conversely, the drinking water concentrations estimated as nontoxic for multiroute exposure can be adjusted to concentrations for ingestion by multiplying by 3.4. The Bogen and Hall (1989) PBPK model estimates of nontoxic water concentrations for multiroute exposure based on the NOAEL for neurotoxicity in gerbils were 0.60 and 0.060 mg/L using "safety" (uncertainty) factors of 100 and 1000, respectively, when the effective dose was assumed to be the peak arterial blood concentration, and 22 and 2.2 mg/L, using the same uncertainty factors and assuming the effective dose was the TWA arterial blood concentration. Multiplying by 3.4 to convert from multiroute to oral exposure, the nontoxic water concentrations are 2.0 and 0.2 mg/L for the peak arterial blood scenario and 75 and 7.5 mg/L for the TWA arterial blood scenario. Using the reference water ingestion of 2 L/day and body weight of 70 kg, the corresponding nontoxic intakes are 0.06 and 0.006 mg/kg-day for the peak arterial blood scenario and uncertainty factors of 100 and 1000, and 2 and 0.2 mg/kg-day for the TWA arterial blood scenario and uncertainty factors of 100 and 1000, respectively. The use of the TWA arterial blood concentration as the dose surrogate appears to be a more reasonable approach, given that the NOAEL is from a study that involved continuous exposure and that the peak arterial blood concentration for humans involved an unrealistic exposure scenario [consumption of 2 L of water as a single bolus immediately before a high inhalation and dermal exposure (showering)]. An uncertainty factor of 1000 is appropriate for estimation of an RfD based on the TWA arterial blood scenario (10 for subchronic study, 3 for interspecies extrapolation uncertainties associated with PBPK modeling, 10 for intraspecies sensitivity and 3 for data base limitations), indicating that the provisional RfD is 2E-1 mg/kg-day. A higher factor for data base uncertainty is not applied because the main deficiency of the oral data, lack of studies investigating sensitive CNS effects, is partially addressed by inhalation studies.

Recommendation for an RfD

The RfDs derived using the traditional approach (2E-2 mg/kg-day) and PBPK approach (2E-1 mg/kg-day) for route-to-route extrapolation differ by an order of magnitude, partially due to the uncertainty factors (3000 and 1000, respectively) used in their derivation. The difference in these uncertainty factors is attributable to a difference in the interspecies extrapolation subfactor (10 for traditional approach, 3 for PBPK approach). Although it might be expected that the PBPK approach would obviate the need for an interspecies extrapolation uncertainty factor, insufficiencies of the available PBPK models for 1,1,1-trichloroethane (Reitz et al., 1987, 1988; Bogen and Hall, 1989) preclude eliminating this factor. In particular, although the PBPK models appear to accurately predict blood levels of parent compound, rates of metabolism and whole body burden of parent compound, there is suggestive evidence that they do not accurately predict the rank order of toxic potency for different species (i.e., the apparent greater sensitivity of rats than mice). Therefore, either the models do not accurately predict the internal dose surrogate that is most relevant to toxicity in these species, or the interspecies differences in sensitivity has a pharmacodynamic rather than pharmacokinetic basis. Until these issues are resolved, the PBPK models as described and implemented in the published reports do not appear to reduce uncertainty in either the interspecies or route-to-route extrapolation. Therefore, either the traditional or PBPK model-based route-to-route approaches to an RfD for 1,1,1-trichloroethane appear to be equally viable.

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Risk Assessment Issue Paper for: Provisional Oral RfD for Trichloroethylene (CASRN 79-01-6)

INTRODUCTION

An oral RfD is not available for trichloroethylene on IRIS (U.S. EPA, 1995a) or the HEAST (U.S. EPA, 1995c). The RfD/RfC status report (U.S. EPA, 1995b) states that the RfD is under review, but cites 6/23/92 as the last Work Group meeting concerning this RfD. OHEA documents listed on the CARA list (U.S. EPA, 1994b) include WQCD (U.S. EPA, 1980), HADs (U.S. EPA, 1985; 1987a), and HEAs (U.S. EPA, 1984; 1988). None of these documents derived an oral RfD for trichloroethylene.

The Drinking Water Regulations and Health Advisories (U.S. EPA, 1994a) provides a Drinking Water Equivalent Level (DWEL) of 0.3 mg/l; this toxicity value was derived in an ODW Health Advisory on trichloroethylene (U.S. EPA, 1987b). The basis was a free-standing LOAEL for elevated liver weights in rats exposed to inhaled trichloroethylene for 14 weeks (Kimmerle and Eben, 1973). The derivation involved a determination of an absorbed dose for humans using the rat LOAEL, human inhalation rates and body weights, an absorption efficiency ratio of 0.3, and adjustments for continuous exposure. The absorbed dose (7.35 mg/kg/day) was divided by an uncertainty factor of 1000 (10 for the use of a LOAEL, 10 for interspecies extrapolation, and 10 for intraspecies variation).

ATSDR has prepared two Toxicological Profiles on trichloroethylene (ATSDR, 1989; 1991). The 1989 document derived an intermediate oral MRL of 2.2 E+0 mg/kg/day based on a NOAEL (217 mg/kg/day) for renal effects (increased urinary ketone and protein levels) in mice exposed to trichloroethylene in drinking water for six months (Tucker et al., 1982). The 1991 document derived an intermediate oral MRL of 1E-1 mg/kg/day based on a LOAEL of 100 mg/kg/day for increased liver weight in mice exposed by gavage for 4 weeks (Buben and O'Flaherty, 1985). Neither document derived a chronic oral MRL for trichloroethylene.

To identify research reports pertinent to the derivation of a chronic RfD for trichloroethylene, EPA and ATSDR documents on trichloroethylene (as cited above) and the HSDB, RTECS and TSCATS databases were reviewed; in addition, a computer search of the literature was conducted (TOXLINE, 1989 - January, 1992).

As reviewed by U.S. EPA (1985) and ATSDR (1989; 1991), trichloroethylene has been used as a surgical anesthetic, and effects on neurobehavior and the central nervous system are

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well studied in humans and animals exposed acutely to the inhaled compound. The effects of repeated exposures of humans to trichloroethylene are less well studied. Occupational exposure to trichloroethylene in air has been associated with symptoms of effects on the central nervous system (e.g., nausea, headache, reduced cognitive performance, and sleep disturbances), but not on the kidney or liver (ATSDR, 1989, 1991; U.S. EPA, 1985; Nagaya et al., 1989; Ruijten et al., 1991). Data regarding effects in humans repeatedly exposed to trichloroethylene in drinking water are confounded by concurrent exposure to other chemicals (ATSDR, 1991; Goldberg et al., 1990). However, several studies are available in which animals have been repeatedly exposed to orally administered trichloroethylene. The data are reviewed herein, and a chronic RfD for trichloroethylene is derived.

CHRONIC ORAL TOXICITY

Nonneoplastic kidney lesions, in addition to carcinogenic responses, have been observed in studies designed to examine the carcinogenicity of chronic oral exposures to trichloroethylene in rodents.

NCI (1976) studied the carcinogenicity of trichloroethylene in corn oil in 78-week chronic gavage studies with rats and mice. The trichloroethylene sample used in these studies was ≥ 99.0% pure, but contained 0.09% epichlorohydrin, a demonstrated carcinogenic agent.

Groups of 50 male and 50 female rats were provided time-weighted average doses of 549 or 1,097 mg/kg/day (NCI, 1976). A matched vehicle control group contained 20 males and 20 females, and an unmatched vehicle control group contained an additional 79 male rats and 78 female rats. Rats were allowed to survive until 32 weeks after exposure. The exposed rat groups did not display statistically significant increases in incidences of tumors compared with control rats, but both exposed groups displayed decreased peak body weights and survival compared with controls. Nephropathy was common in both treated groups. The nephropathy was described as slight to moderate degenerative and regenerative changes in the tubular epithelium; the authors stated that these lesions were unlike those that frequently occur in aging Osborne-Mendel control rats.

Groups of 50 male and 50 female B6C3F1 mice were provided time-weighted average doses of 1,169 or 2,339 mg/kg/day for males and 869 or 1,739 mg/kg/day for females (NCI, 1976). A matched vehicle control group contained 20 males and 20 females, and an unmatched control group contained an additional 57 male and 60 female mice. Significantly reduced survival was observed in both exposed groups compared with matched vehicle controls. Significantly increased incidences of liver tumors were observed in both exposed groups of both sexes compared with the matched vehicle control groups. The occurrence of nonneoplastic lesions of the kidney were not mentioned in the report of this study.

In a second series of chronic gavage studies, NTP (1988, 1990) studied the carcinogenicity of epichlorohydrin-free trichloroethylene in rats and mice. The test chemical (designated as "Hi-Tri") used in these studies was tested to be > 99.9% pure and contained 8 ppm diisopropylamine as a stabilizer.

Trichloroethylene in corn oil was administered by gavage at doses of 0 or 1000 mg/kg to groups of 50 male and 50 female B6C3F1 mice for 5 days/week for up to 103 weeks (NTP, 1990). Adjustment for partial weekly exposures gives average daily doses of 0 and 714 mg/kg/day. Statistically significant differences between dosed and control mice included decreased survival in males, decreased body weights in male mice, increased hepatocellular carcinoma incidence in both sexes, increased adenoma incidence in male mice, and toxic nephrosis in both sexes. Toxic nephrosis, described as cytomegaly of the renal tubular cells, was observed in 45/50 male and 48/49 female dosed mice, but was absent in the vehicle controls.

Groups of 50 male and 50 female F344/N rats were administered gavage doses of 0, 500 or 1000 mg/kg trichloroethylene in corn oil for 5 days/week for up to 103 weeks (average daily doses of 0, 357, and 714 mg/kg/day) (NTP, 1990). Statistically significant differences between dosed and control rats included decreased survival of both low- and high-dose male rats, decreased body weights in both sexes of rats at both doses, increased incidence of renal tubular adenocarcinomas in male rats killed at the end of the study, and cytomegaly of the kidney. Renal cytomegaly was observed in 96/98 dosed male and 97/97 dosed female rats; no vehicle control rats displayed renal cytomegaly.

In another bioassay, groups of 50 male and 50 female rats of four strains (ACI, August, Marshall, and Osborne-Mendel) were administered 0, 500 and 1000 mg/kg trichloroethylene in corn oil by gavage 5 days/week for 103 weeks (average daily doses were 0, 357 and 714 mg/kg/day) (NTP, 1988). Depressions in final body weights ≥ 10%, compared with controls, were observed in ACI, August and Osborne-Mendel male rats and Marshall female rats exposed to 1000 mg/kg; final body weight depression > 10% were observed only in ACI males at the 500-mg/kg dose level. Survival was significantly reduced in 7 of the 16 dosed groups compared with respective control groups. Clinical signs of central nervous toxicity (sedation, loss of consciousness, tremors, convulsions, and hindlimb paralysis) were observed following dose administration in male and female rats of all strains. Significantly increased incidence of renal tubular cell adenomas or adenomacarcinomas were observed only in low-dose male Osborne-Mendel rats, and interstitial cell neoplasms of the testis were observed in dosed Marshall rats. Exposure to trichloroethylene caused renal tubular cell cytomegaly in 82-100% of all dosed rats. Toxic nephropathy, described as dilated tubules lined by elongated and flattened epithelial cells, was observed in 17%-80% of the animals in the dosed groups. Cytomegaly or toxic nephropathy were not observed in untreated or vehicle control groups. NTP (1988) concluded that these studies were inadequate tests of the carcinogenicity of trichloroethylene because of deficiencies in study-conduct and decreased survival, but clearly demonstrated the nephrotoxicity of trichloroethylene. NTP (1988) also concluded that the cause of early mortality in the dosed rats

was not known but could have been due to gavage-related trauma, anesthetic properties of the chemical, nephrotoxicity or a combination of these factors.

SUBCHRONIC AND NEAR SUBCHRONIC ORAL TOXICITY

NTP has published results from 13-week gavage studies with rats exposed to trichloroethylene (NTP, 1988, 1990) and mice (NTP, 1990). The test chemical in this series of experiments was the same as designated for the chronic NTP studies reviewed in the previous section.

Groups of 10 male F344/N rats were administered gavage doses of 0, 125, 250, 500, 1,000 or 2,000 mg/kg trichloroethylene in corn oil 5 days per week for 13 weeks (NTP, 1990). Adjusting for the partial weekly exposure protocol, average daily doses are 0, 89, 179, 357, 714, or 1429 mg/kg/day. Groups of 10 female rats received doses of 0, 62.5, 125, 250, 500 or 1,000 mg/kg by the same schedule. (Adjusted doses were 0, 45, 89, 179, 357, or 714 mg/kg/day.) All rats survived to the end of the exposure period and only male rats dosed with 2,000 mg/kg exhibited depressions of body weight gain > 10%. Organ weight data were not reported. Histopathological examinations of major organs and tissues from the high-dose and control groups revealed cytomegaly and karyomegaly of the renal tubular epithelial cells in 8/9 high-dose males and 5/10 high-dose females, but not in the controls. The lesions were graded as minimal or mild in males and equivocal to minimal in females; these minimal renal effects were diagnosed during a reevaluation of the tissues after observation of pronounced renal effects in the subsequent 2-year study. Pulmonary vasculitis was observed in 6/10 high-dose males and 6/10 high-dose females (compared with 1/10 male and 1/10 female control rats).

In a separate rat study (NTP, 1988), groups of 10 male ACI and 10 male August rats were administered gavage doses of 0, 125, 250, 500, 1,000 or 2,000 mg/kg trichloroethylene in corn oil 5 days per week for 13 weeks (adjusted doses of 0, 89, 179, 357, 714, or 1429 mg/kg/day); groups of 10 females of these strains received doses of 0, 62.5, 125, 250, 500 or 1,000 mg/kg (adjusted doses of 0, 45, 89, 179, 357, or 714 mg/kg/day). Groups of 10 male Marshall rats received doses of 268, 308, 495, 932, or 1834 mg/kg by the same schedule (0, 191, 220, 354, 666, or 1310 mg/kg/day, adjusted doses); groups of 10 female Marshall rats received 0, 134, 153, 248, 466 or 918 mg/kg (0, 96, 109, 177, 333, 656 mg/kg/day, adjusted doses). All rats survived to the end of the study with the exception of 3 high-dose male August rats. Average depressions in final body weight > 10% (relative to control values) were observed only in the high-dose male groups. Organ weight data were not reported. No clinical signs of central nervous system toxicity were recorded, and histological examination of major tissues and organs from high-dose rats did not reveal alterations compared with control tissues.

In the final NTP subchronic study (NTP, 1990), gavage doses of 0, 375, 750, 1500, 3000 or 6000 mg/kg were administered to groups of 10 male and 10 female B6C3F1 mice 5 days per

week for 13 weeks (0, 268, 536, 1071, 2143, or 4286 mg/kg/day, adjusted doses). Deaths occurred in 2/10 males and 1/10 females at 1500 mg/kg, 7/10 males and 1/10 females at 3000 mg/kg, and all male and 9/10 females at 6000 mg/kg. Depressions in mean body weights were > 10% relative to controls in male mice receiving doses ≥ 750 mg/kg; body weight alterations were not apparent in female mice. Liver weight elevations (both absolute and relative) > 10% relative to controls were observed in male mice at doses ≥ 750 mg/kg and in females at doses ≥ 1500 mg/kg. Centrilobular necrosis was observed in 6/10 males and 1/10 females exposed to 6000 mg/kg. At the 3000 mg/kg level centrilobular necrosis was not observed in either sex, but 2/10 males had multifocal areas of calcification in their livers. Histopathological examinations of tissues from mice treated with the 3 lowest doses were not conducted. Mild to moderate cytomegaly and karyomegaly of the renal tubular epithelial cells was observed in all of the mice that received the two highest doses and survived for more than 6 weeks.

Stott et al. (1982) administered gavage doses of trichloroethylene (> 99.9% pure, stabilized with diisopropylamine) in corn oil at levels of 0, 250, 500, 1200 or 2400 mg/kg, 5 days/week for 3 weeks to groups of 10-12 male B6C3F1 mice. Adjusting for the partial weekly exposures gives average daily doses of 0, 179, 357, 857, or 1714 mg/kg/day. No exposure-related effects were observed on body weight, kidney weight or kidney histopathology. Increased relative liver weights and decreased DNA content per gram of hepatic tissue were observed at doses ≥ 500 mg/kg. Histopathological changes in hepatic tissues were observed at all dose levels. The severity of the changes increased with increasing dosage level. Slight increases in cytoplasmic eosinophilic staining of the centrilobular hepatocytes were observed at 250 and 500 mg/kg. At 1200 mg/kg increased centrilobular hepatocellular swelling was observed, and at 2400 mg/kg, more severe hepatocellular swelling, giant cell inflammation and mineralized cells were observed. Under the conditions of this study, the lowest dosage level of 250 mg/kg (179 mg/kg/day) was the LOAEL for response of the liver to trichloroethylene.

Stott et al. (1982) also administered gavage doses of trichloroethylene in corn oil of 0 or 1100 mg/kg, 5 days per week for 3 weeks, to groups of 4 male Osborne-Mendel rats. No treatment-related alterations in body weight, kidney weight, histopathology of the kidney or liver, or DNA content per gram of renal or hepatic tissue were observed. Increased relative liver weight was the only significant treatment-related change observed in this study.

Tucker et al. (1982) provided trichloroethylene (reagent grade containing 0.004% diisopropylamine as stabilizer) in drinking water containing 1% emulphor at concentrations of 0, 0.1, 1.0, 2.5 and 5.0 mg/mL to groups of 30 male and 30 female CD-1 mice for 4 or 6 months. Average dosage levels estimated from water consumption data were reported to be 0, 18.4, 216.7, 393.0, and 660.2 mg/kg/day for males and 0, 17.9, 193.0, 437.1, and 793.3 mg/kg/day for females. No significant effects on weight gain were observed in the treated groups compared with the control group. The results of gross pathological examination of tissues at 4 and 6 months were reported to be unremarkable. Microscopic examinations of tissues and organs were not

performed. Terminal body weights of male and female mice treated with the highest concentration of trichloroethylene were significantly decreased compared with the vehicle control terminal body weights. Increased relative liver weights were observed in males at both exposure times at the three higher doses and in females at the highest dose. Significantly increased kidney weights were observed in high-dose males at 4 and 6 months and in high-dose females at 6 months; urinalysis at 6 months of exposure showed elevated protein and ketone levels in high-dose females and males treated with the two highest concentrations of trichloroethylene. The NOEL of 0.1 mg/mL (18.4 mg/kg/day) and LOAEL of 1.0 mg/mL (216.7 mg/kg/day) for increased relative liver weight in mice describes the most sensitive toxicity threshold identified in this study. The LOAEL for kidney effects was 2.5 mg/mL (393 mg/kg/day).

In a study restricted to the hepatotoxicity of trichloroethylene, male Swiss-Cox mice (age 3-5 months, body weight 34-45 g) were administered distilled trichloroethylene (% purity not reported) in corn oil by gavage in doses of 0, 100, 200, 400, 800, 1600, 2400 or 3200 mg/kg on five days a week for 6 weeks (Buben and O'Flaherty, 1985). Adjusting for the partial weekly exposure gives average daily dosages of 71.4, 142.9, 285.7, 571.4, 1142.9, 1714.3 and 2285.7 mg/kg/day. Twelve mice per dosage were tested except for 5 mice at 100 mg/kg/day, 4 mice at 3200 mg/kg/day and 24 mice in the control group. The following endpoints were assessed on the day following treatment at all dosages: relative liver weight, liver glucose-6-phosphatase (G6P) activity, concentrations of liver triglycerides, serum glutamate-pyruvate transaminase (SGPT) activity. Liver DNA concentration and histology were evaluated at 285.7 and 1142.9 mg/kg/day. Statistically significant ($p < 0.05$) increases in relative liver weight at ≥ 71.4 mg/kg/day, G6P at ≥ 571.4 mg/kg/day, and SGPT at ≥1714.3 mg/kg/day were observed. The changes in relative liver weight and G6P were clearly dose-related. Liver triglycerides were significantly increased only at 1714.3 mg/kg/day ($p<0.01$); a comparable increase occurred at 2285.7 mg/kg/day but was not statistically significant, apparently due to the small number of animals (4). The increases in liver size were attributed to hepatocellular hypertrophy based on histology and decreased hepatic DNA concentrations. Other hepatic histologic effects included degeneration, karyorrhexis (disintegration of the nucleus) and polyploidy at 285.7 and 1142.9 mg/kg/day, and necrosis at 1142.9 mg/kg/day. The degeneration was manifested by swollen hepatocytes that were not due simply to edema, as liver wet weight/dry weight ratios did not increase. Under the conditions of this experiment, the lowest dosage level (71.4 mg/kg/day) was a LOAEL for a dose-related response of the mouse liver to trichloroethylene which caused hepatocellular hypertrophy, and progressing to hepatocellular necrosis.

REPRODUCTIVE AND DEVELOPMENTAL TOXICITY

In a 2-generation fertility study (NTP, 1986), groups of 20 F_0 breeding pairs of F344 rats (11 weeks of age at the start) were provided diets containing nominal trichloroethylene concentrations of 0.15, 0.30 and 0.60% for a 7-day mating period, a 98-day cohabitation period, and a subsequent 28-day segregation period. A control group of 40 F_0 breeding pairs was

provided a normal diet for the same period of time. Trichloroethylene (designated as "Hi-Tri Purity grade") was microencapsulated in a gelatin/sorbitol shell. Estimated average dosage levels were calculated from initial and week 13 body weight data reported by the authors and the allometric equation recommended by the U.S. EPA (1987c) for calculating food consumption by laboratory mammals. The estimated doses for male F_0 rats were 0, 130.2, 261.1, and 523.9 mg/kg/day; for F_0 females the doses were 0, 147.8, 301.7, and 599.3 mg/kg/day.

Statistically significant ($p < 0.05$) differences between the dosed and control F_0 groups were not observed in the following parameters: the proportion of breeding pairs able to produce at least one litter, the number of live litters per pair, the number of live pups per litter, the proportion of pups born alive, the sex of pups born alive (NTP, 1986). Dam body weights on postnatal day 0 were significantly depressed in all of the exposed F_0 groups compared with the control. Statistically significant ($p < 0.05$) trends with increasing dose were observed for decreased numbers of live litters per pair and for decreased numbers of live pups per litter. A crossover mating trial was subsequently conducted using three combinations of F_0 breeding pairs (20 pairs per combination) as follows: control male x control female; 0.6% male x control female; and control male x 0.6% female. In this trial, the only significant differences between the mating pairs with exposed partners and the control pairs were decreased proportion of detected matings (observed when either the male or female partners were exposed), and decreased bodyweight of the 0.6% dams on postnatal day 0. Exposure of either the male or female partner had no significant effect on the other indices of fertility and reproductive performance listed above for the initial F_0 breeding trial.

Continuous exposure of F_1 rats (81 days ± 10) to the same dietary concentrations of trichloroethylene fed to their parents (14-20 breeding pairs were evaluated for each exposure level) had no effect on indices of mating, fertility or reproductive performance (NTP, 1986). As in the F_0 generation, treated F_1 dams displayed depressed body weight on postnatal day 0, indicating generalized maternal toxicity. Microscopic examination of major tissues and organs revealed no treatment-related pathological changes in either sex in the F_0 or the F_1 generations. At necropsy, body weights were depressed and liver weights (adjusted for body weight by an analysis of covariance) were increased in male and female F_0 rats treated with 0.6% trichloroethylene compared with control F_0 rats. F_1 male and female rats from all treatment groups displayed significantly decreased body weights at 21 and 81 (necropsy) days after birth. Significantly increased adjusted liver weights were observed for all treated F_1 male groups and for F_1 female rats treated with 0.3 or 0.6% trichloroethylene. Under the conditions of this experiment, the lowest exposure level (0.15% trichloroethylene) was a LOAEL for maternal toxicity demonstrated by decreased body weight (147.8 mg/kg/day), for decreased body weight and increased liver weight in F_1 males (130.2 mg/kg/day), and for decreased body weight in F_1 females (147.8 mg/kg/day).

In a similarly designed mouse study, NTP (1985) provided nominal concentrations of 0, 0.15, 0.30 and 0.60% trichloroethylene ("Hi-Tri Purity grade") in the diet of groups of breeding

pairs of CD-1 mice starting at 11 weeks of age and continuing as described for the rat fertility study (NTP, 1986). The groups contained 35, 17, 18, and 19 pairs of mice, respectively. Average doses, in units of mg/kg/day, were reported to be 0, 63.8, 247.5, for week 1, 0, 52.5, 266.5, and 615.0 for week 2, and 0, 187.5, 375.0, and 750.0 for the remainder of the 18-week exposure period. Time-weighted average doses are calculated to be 0, 173, 362, and 737 mg/kg/day. No clinical signs of toxicity were observed throughout the exposure period. Indices of fertility and reproductive performance for the F_0 generation were not affected by exposure, except for a slight (< 10%), but statistically significant ($p < 0.05$), depression of birth body weights of live male pups or combined male and female pups compared with controls. The depression was only significant when adjustments were made for the total number of live and dead pups per litter by an analysis of variance.

Litters from the control and high-dose mouse groups were raised to sexual maturity to assess fertility and reproductive performance. Perinatal mortality was pronounced in the 0.6% group, a 61.3% mortality rate was observed compared with a 28.3% mortality rate for the control group. Survival after weaning was the same for both control and exposed F_1 groups. Surviving F_1 mice were provided the same feed level of trichloroethylene as their parents for 74 ± 10 days; breeding pairs were then established and the F_1 females were allowed to deliver their litters. Indices of mating, fertility or reproductive performance for the 0.6% F_1 group were not significantly different from those for the control group.

Tissues from the control and high-dose F_0 and F_1 mice were weighed and examined microscopically (approximately 18 and 15 weeks of exposure for the F_0 and F_1 generations, respectively). Body weights at necropsy were not affected by high-dose exposure in either generation. Liver weights (absolute and adjusted) were increased by high-dose exposure in both sexes of both generations. Liver and kidney lesions (hypertrophy of the centrilobular liver cells and tubular degeneration and karyomegaly of the renal tubular epithelium) were also observed in high-dose F_0 and F_1 mice of both sexes. Significantly decreased proportions of sperm that were motile were observed in high-dose F_0 and F_1 males (45 and 18% decreases compared with controls). In summary, although trichloroethylene treatment at dietary concentrations as high as 0.6% did not alter several indices of fertility or reproductive performance, organ-specific effects on the F_0 and F_1 male reproductive tract and increased perinatal mortality of F_1 pups were observed. The authors concluded that trichloroethylene may present a selective risk to the neonatal mouse (NTP, 1985). The study identified 0.6% (737 mg/kg/day) as a FEL for the effects on the male mouse reproductive tract and neonatal survival, but did not identify a NOEL or NOAEL for these effects (neither endpoints were assessed at the lower exposure levels).

Manson et al. (1984) administered gavage doses of 0, 10, 100 or 1000 mg/kg trichloroethylene in corn oil to groups of 23 female Long-Evans hooded rats. Exposure commenced 2 weeks before mating, continued throughout mating (1 week), and was stopped on day 21 of pregnancy. Doses were administered 5 days/week for the first 3 weeks and 7 days/weeks for the last 3 weeks. Adjusting for the partial weekly exposure during the first part of

the study, average daily doses were 0, 8.6, 85.7, or 857.1 mg/kg/day. Females were bred to untreated males. Indices of fertility (i.e., the average number of mating trials required for insemination and the number of rats which became pregnant) were not affected by exposure to any level of trichloroethylene. Maternal body weight gain during pregnancy, litter size at birth, and neonatal survival (up to 31 days after birth) were not altered in the groups exposed to 10 or 100 mg/kg. Body weight gains during the premating period and during pregnancy were significantly depressed only in the high-dose dams, as was decreased neonatal survival up to 18 days after birth (16.9% of 1000-mg/kg pups died compared with 7.7% in the control). Four deaths occurred among the 23 dams exposed to 1000 mg/kg. No major malformations were revealed by gross examinations of the pups. The authors speculated that the decreased neonatal survival was related to maternal toxicity rather than to specific developmental toxicity. Under the conditions of this study, 100 mg/kg (85.7 mg/kg/day) was the NOAEL, and 1000 mg/kg/day (857.1 mg/kg/day) was the LOAEL for maternal toxicity and FEL for decreased neonatal survival.

DERIVATION OF A PROVISIONAL RfD

The chronic and subchronic mouse and rat gavage bioassays conducted by NCI (1976) and NTP (1988, 1990) identify the kidney (in mice and rats) and the liver (in mice) as target organs for trichloroethylene-induced nonneoplastic effects, however the data are not suitable bases for an RfD. The lowest doses in the chronic studies produced reduced survival, and, as FELs, cannot be used to derive an RfD. Deficiencies in the design of the subchronic NTP (1988, 1990) studies compromise their usefulness; histological examinations were conducted only on high-dose animals and controls, and organ weight data was reported for only one of the studies. In general, the NTP studies provide insufficient information for exposure to doses less than 500 mg/kg, a level identified as producing frank effects; the only exception is the mouse subchronic study (NTP) which identified 375 mg/kg (268 mg/kg/day adjusted for partial weekly exposure) as a NOAEL and 675 mg/kg as the LOAEL for increased liver weight in male mice. Other subchronic studies are available that identified LOAELs lower than 268 mg/kg/day (NTP, 1986; Tucker et al., 1982; Buben and O'Flaherty, 1985).

The 2-generation fertility study of B6C3F1 mice (NTP, 1985) indicated that reduced neonatal survival during lactation is a significant effect produced by exposure to trichloroethylene. However, the study did not identify a NOAEL for this frank effect, and thus the data cannot be used to derive an RfD.

The 2-generation fertility study of F344 rats exposed to trichloroethylene in the diet (NTP, 1986) identified a free-standing LOAEL of 130.2 mg/kg/day for decreased body weight and increased liver weight in F_1 male rats exposed for 18 weeks to trichloroethylene; indices of fertility

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and reproductive performance and histological features of major organs and tissues in rats exposed to this dose or higher doses were not significantly different from comparable endpoints in controls

While the 1986 NTP study is suitable for consideration as a basis for the RfD, the 6-month drinking water study of mice by Tucker et al. (1982) provides a better basis because it identified both NOAELs and LOAELs for the responses of the liver and kidney to orally administered trichloroethylene. The threshold for liver toxicity (NOAEL of 18.4 and LOAEL of 216.7 mg/kg/day for increased relative liver weight) was lower than that for renal effects (NOAEL of 216.7 and LOAEL of 393.0 mg/kg/day for elevated levels of protein and ketones; increased kidney weight was observed at the highest dose, 660.2 mg/kg/day). Although the Tucker et al. (1982) study did not include histological examinations of the liver and kidney, a more comprehensive examination of hepatotoxicity in mice orally exposed to trichloroethylene for 6 weeks showed that liver weight increases were attributable to hypertrophy of the liver cells and that the hepatic response progressed to degenerative changes at higher doses (Buben and O'Flaherty, 1985). The study by Tucker et al. (1982) is a better basis for derivation of the RfD than the study by Buben and O'Flaherty (1985) because a NOAEL was identified and the duration of exposure was closer to a life-time.

A provisional chronic RfD of 6E-3 mg/kg/day is derived by dividing the mouse NOAEL of 18.4 mg/kg/day from the study by Tucker et al. (1982) by an uncertainty factor of 3000 (10 for interspecies extrapolation, 10 for intraspecies variation, 10 for extrapolation to chronic duration and 3 for weakness of the data base).

Confidence in the principal study is low. Adequate numbers of animals were exposed by a relevant route and were evaluated for several endpoints. However, histological examinations were not conducted on the tissues, and the duration of exposure was only one-quarter of a life-time. Confidence in the data base is low. Several subchronic toxicity studies in rats and mice are available, as are studies of reproductive performance in rats and mice. However, chronic oral bioassays do not adequately describe dose-response relationships for chronic oral exposure to low doses of trichloroethylene and comprehensive developmental toxicity studies are not available. Reflecting low confidence in the principal study and the data base, confidence in the provisional RfD for trichloroethylene is low.

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