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Remedial Investigation Report for the Lee Acres Landfill Response to EPA Region VI Comments

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REMEDIAL INVESTIGATION REPORT
FOR THE
LEE ACRES LANDFILL
RESPONSE TO EPA REGION VI COMMENTS

Prepared for

United States Department of the Interior
Bureau of Land Management
1235 N. La Plata Highway
Farmington, New Mexico 87401

Prepared by
Roy F. Weston, Inc.
6501 Americas Parkway NE, Suite 800
Albuquerque, New Mexico 87110
(505) 884-5050

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INTRODUCTION

In October 1989, the Bureau of Land Management (BLM) began a comprehensive remedial investigation (RI) at the former Lee Acres Landfill to characterize environmental conditions and contaminant migration pathways. This investigation was completed in July 1991. The BLM conducted this RI according to the Comprehensive Environmental Response, Compensation, and Liability Act/Superfund Amendments and Reauthorization Act (CERCLA/SARA). The scope of RI data collection activities is presented in the Sampling and Analysis Project Plan for the Lee Acres Landfill RI/FS/EIS (WESTON 1990d).

An RI Report was submitted to Region VI of the U.S. Environmental Protection Agency (EPA) on 25 February 1992; EPA provided formal general and specific comments on 18 September 1992. Additional comments regarding the baseline risk assessment were received 2 October and 13 October 1992. This document contains the EPA comments numbered consecutively to facilitate referencing of specific comments. The additional comments received on the baseline risk assessment are included after the original comments received on Section 10, the Baseline Risk Assessment. BLM responses and requested information for each EPA comment are italicized. To illustrate conclusions or present technical information, references are made to specific subsections, figures, tables or appendixes of the RI Report. Appendix A presents the original EPA comments. Appendixes B and C are the additional EPA comments on the risk assessment.

GENERAL COMMENTS

EPA has reviewed the draft Remedial Investigation (RI) report on the Lee Acres Landfill site. This report was prepared by Roy F. Weston - contractor to the U.S. Department of Interior (DOI), Bureau of Land Management (BLM) and submitted to the Environmental Protection Agency (EPA) on February 25, 1992.

Based on the information contained in the draft RI report, EPA has determined that extensive technical problems requiring explanation and, in some cases, extensive revision by BLM are present. The revisions are necessary to bring the draft RI report into conformance with RI guidance documents. These problems are addressed in general and specific comments, as appropriate. Specific comments are referenced by section, page, and in some cases, paragraph. Specific comments concerning tables and figures are referenced as such.

> *This document presents the formal BLM responses to EPA comments on the draft RI Report. As stated in the introduction, all specific EPA comments have been numbered consecutively to facilitate referencing. Where appropriate, revised text and examples of tables and figures have been included in the response.*

Because the comments on the RI report are extensive, EPA is currently reviewing the Standard Operating Procedures and Work Plans generated by the DOI and its contractor against EPA guidance and policy. EPA will make this review available to DOI as soon as it is ready. EPA is also conducting further review of the draft RI Risk Assessment and will make that available as well.

The BLM is currently awaiting the EPA review of Standard Operating Procedures and workplans. Two additional sets of comments on the draft RI Risk Assessment have been received (Appendixes B and C). Responses to the additional risk assessment comments have been included after the formal comments/responses on the risk assessment (comment numbers 121 through 147) as comment numbers 148 through 170.

Since the major conclusion of the RI was based on the results from the groundwater model, EPA conducted two independent reviews of the model. Two groundwater experts conducted a review in Dallas while a copy of the RI report was forwarded to the EPA Kerr Environmental Research Laboratory in Ada, Oklahoma.

The conclusions drawn from those reviews state that assumptions, discretization, and calibration used by the model have significant problems. In short, the modeling effort is "extremely questionable" and "the conclusions derived from the modeling effort should not be considered valid." Another reviewer commented that "all of the available data has not been evaluated by this model." This is discussed further in the comments on Section 7.

Based on the level of concern that EPA has expressed through the comments on the groundwater modeling (Section 7 of the RI Report), the BLM has reevaluated the modeling approach and results. BLM proposes that the modeling results be removed from the RI report and an analytical approach used. A position paper entitled "The Evaluation of Goundwater Contaminant Fate and Transport - Proposed Approach" is provided as Appendix F to this document. The position paper proposes a simple modeling approach and proposes removing the existing Section 7 of the RI Report based on the EPA comments. The intent of this paper is to provide clarification of the contaminant fate and transport at the Lee Acres Landfill and study area. Additionally, specific comments have been addressed in responses numbered 94 through 113.

Each section of the draft RI report must be comprehensive, because the RI report is to be used for public information. Several sections and subsections of the RI, specifically Sections 5 and 6 - Source Characterization and Groundwater Characterization - are difficult to understand because of the way in which the information is organized. Within these sections, other sections of the report are referenced to support interpretations and conclusions. It would be helpful if each section and subsection includes the referenced information in a summary format. Furthermore, several subsections are referenced in other sections but are not available for review. Specific examples of this occurrence are noted within the specific comments.

The format of the draft RI Report is modeled after the suggested RI Report format presented in the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final (EPA 1988). To allow comparison, Table 1 cross-references RI/FS guidance with the draft RI Report subsections. A general description of each section is presented in Subsection 1.9, page 1-24 of the draft RI Report.

A section completely discussing the analytical quality assurance and quality control (QA/QC) information should be included. This section is needed to adequately review the RI for support of the conclusions and interpretations that have been proposed. It is important that the validity of the analytical data be discussed in relation to the QA/QC procedures. The section should include information discussing the validation procedures and QA elements.

This comment is addressed for specific comment number 18.

All structural features should be discussed in Section 4 of the RI report - Geologic and Hydrogeologic Characterization - because the site is located within an area that was once structurally active, geologically. This comment is specifically associated with the bedrock units and its potential to have lineaments that are structurally related to faulting and fracturing. The relationship between these

Table 1. Summary of RI/FS Report Guidance

RI/FS Guidance Section	RI/FS Guidance Section Description	Cross Reference to RI Report
1. Introduction	Includes purpose of report, site background (site description, site history, previous investigations) and report organization.	Section 1 of the draft RI Report presents information concerning the Lee Acres Landfill RI/FS Program. Subsections 1.1.5, 1.2 (1.2.1, 1.2.2, Appendix C), and 1.9 of the draft RI Report address the guidance requirements.
2. Study Area Investigation	Includes field activities associated with site characterization.	Section 2 of the draft RI Report presents the technical rationale and strategy used for the design and implementation of the 11 RI field activities. Locations, methods, protocols, and schedules are included with a complete technical description of each activity.
3. Physical Characteristics of the Study Area	Includes results of field activities to determine physical characteristics (surface features, meteorology, surface water hydrology, geology, soils, hydrogeology, demography and land use and ecology).	Sections 3 and 4 of the draft RI Report present air quality and meteorology (3.1), land use and demographics (3.2), ecology (3.3), geology (4.1), hydrogeology (4.2), and floodplain analysis (4.3) integrating RI and previous data sets.
4. Nature and Extent of Contamination	Presents the results of site characterization, both natural chemical components and contaminants in some, but not necessarily all, of the following media: sources (lagoons), soils and vadose zone, groundwater, surface water and sediments, and air.	Section 5 of the draft RI Report presents the source (5.1 and 5.2), soils, and vadose zone (5.3 and 5.7) physical and chemical characterizations of the Lee Acres Landfill. Section 6 of the draft RI Report presents the groundwater characterization for the Lee Acres Landfill Study Area. RI and previous data sets are integrated, compared, and interpreted.

Table 1. (continued)

RI/FS Guidance Section	RI/FS Guidance Section Description	Cross Reference to RI Report
5. Contaminant Fate and Transport	Includes potential routes of migration, contaminant persistence, and contaminant migration (factors affecting migration and if applicable, modeling).	Section 7 of the draft RI Report presents the contaminant fate and transport for groundwater. An evaluation of all potential contaminant migration pathways and their combinations is presented in Section 8, Pathway Analysis. Sources, transport mechanisms, receptors, and operating processes are described. A site conceptual model is presented in Section 9 that integrates site characteristics, source characteristics, the nature and extent of contamination, and pathway analysis to present the current situation at the former landfill.
6. Baseline Risk Assessment	Includes human health evaluation (exposure and toxicity assessments, risk characterization) and environmental evaluation.	Section 10 of the draft RI Report presents the baseline risk assessment. The exposure and toxicity assessments are presented in Subsections 10.2 and 10.3, respectively. The risk characterization is presented in Subsection 10.4 and the environmental evaluation is presented in Subsection 10.5.
7. Summary and Conclusions	Includes summaries of nature and extent of contamination, fate and transport, and risk assessment. Conclusions include recommendations for future work and recommended remedial action objectives.	Section 11 of the draft RI Report presents the summary and conclusions. The RI program summary is presented in Subsection 11.1. Nature and extent of contamination (Subsection 11.2), potential contaminant migration (Subsection 11.3), and baseline risk (Subsection 11.4) are also summarized. Preliminary remedial action objectives are identified in Subsection 11.5.

features and the effects that they may have on the hydrological interaction between the alluvial bedrock aquifers should be addressed. In addition, a discussion of how these features relate to potential pathways of migration for contaminants should be included.

The bedrock units that outcrop in the study area were deposited simultaneously with the last major period of structural activity in the area. Tectonic activity that has affected these units (or temporally equivalent strata) in other parts of the San Juan Basin and Colorado Plateau Region has not been documented in the immediate vicinity of the study area, either in published geologic maps or in the detailed geologic mapping conducted for this RI. As discussed in Subsection 4.1.5.2, there are no faults or folds of tertiary bedrock units in the study area.

Joints (fractures with no displacement) were noted both in bedrock outcrop and in bedrock core samples. No analysis of joint orientation, density, or width was conducted for this RI. Joint analysis was not considered crucial to understanding the hydrogeologic regime for the following reasons: 1) the fractures encountered in the subsurface were filled with secondary minerals (such as gypsum and limonite), which inhibit groundwater flow; 2) no groundwater contamination has been found in the bedrock aquifer adjacent to contaminated groundwater in the alluvial aquifer, suggesting that fracture flow is negligible; 3) the bedrock aquifer is not a source of drinking water; and 4) the primary sedimentary structures of the bedrock (such as interbedded sandstone and claystone) far outweigh jointing as a major control of groundwater flow in the bedrock.

The hydraulic relationship between the alluvial and bedrock aquifers is not adequately addressed in the draft RI report. It is concluded, based on the well data, that the vertical hydraulic gradient is downward on the west side of the arroyo but upward on the east side of the arroyo. It is true that the well data indicate this occurrence; however, the report does not discuss the cause, effect, and relevance of it. This occurrence should be discussed in relation to stratigraphic controls. Furthermore, this information should be included on a map for review.

Responses to specific comment numbers 22, 46, and 77 and the discussion provided in Subsection 4.2 of the RI Report adequately address this comment.

Analytical results of the February 6, 1989, sampling event are used to support several conclusions of the RI. In particular, this information is used to support the conclusion that chromium in groundwater is from an off-site source. Although there is the potential for chromium to be from another source, the interpretation is not substantiated by the information provided in the draft RI report. A review of the historical analytical data indicated that the high chromium concentration is limited to this one-time sampling event, which appears to have provided anomalous results. All of the QA/QC criteria from the laboratory should be provided to support and justify the conclusions that are based on this sampling event.

This comment is addressed for specific comment numbers 64 and 83.

Finally, it would be helpful if the figures/tables referenced in the text were located on the subsequent pages and not at the ends of each chapter.

Due to the scope of the RI Report, a large number of figures and tables are required. Placing the figures and tables after each page where they are referenced was determined to be disruptive to the continuity of the text.

SPECIFIC COMMENTS

1. Executive Summary, Page 1, Paragraph 3

Text states, "This mass, referred to as the southern area of contamination at Site 1, is identified as a contaminant slug because there is currently no continuous upgradient contaminant mass to indicate an available constant contaminant source." The text should state that no continuous upgradient contaminant mass has yet been identified.

The text will be revised to state "The BLM feels that the available data indicate that there is not a continuous upgradient source".

2. Executive Summary, Page 1, Paragraph 3

The text states that an elevated concentration level of chromium was observed in the background alluvial aquifer groundwater. This elevated concentration may be skewed because of the disproportionate weight given to the sampling conducted on February 6, 1989. Review of other chromium data - both dissolved and total - indicates that the concentration values recorded from this particular sampling and analysis event may be anomalous. BLM should provide further reasoning, such as additional data, for using data from this sampling to justify the established background.

The data collected during the RI currently indicate that an elevated concentration of chromium was observed in the background alluvial aquifer groundwater. The soluble and total analyses will be discussed in the revised RI Report separately. The BLM is committed to developing an ongoing groundwater monitoring program that includes the background monitoring wells. The details of the proposed groundwater monitoring program will be submitted for approval.

In general, chromium concentrations in the upgradient wells are at detectable concentrations. Review of groundwater data for other wells within the study area, including those located in and south of the landfill, generally show nondetections, whereas, chromium is detected in wells located in the unnamed arroyo (BLM-17 and BLM-18), downgradient of wells BLM-14 and BLM-15. The BLM feels the analytical data support the conclusion that an upgradient chromium source may exist. Additional information is provided in the response to comment number 64.

3. Executive Summary, Page 2, Paragraph 1

Identifying the lagoon as the primary source of contamination appears to have been the focus of the RI. Although the lagoon may be the primary source of contamination, the report should recognize and investigate other potential sources, such as contaminants from municipal wastes and the disposal area identified around BH-13 in the southwestern portion of the landfill. These other potential sources should be further characterized and detailed in the RI report.

The RI Report provides all the data collected during the investigation and discusses other potential sources based on the data collection activities. Additionally, the RI Report states that:

- The former landfill is considered as a source of contamination.

- Two primary subsources, the former northern and southern liquid waste lagoons, were identified during characterization.

- Other potential sources were identified and characterized as shown on Figure 6-4. This figure will be revised to include borehole and CPT locations.

- Groundwater samples collected from downgradient monitoring wells do not exhibit similiar contaminants as detected in BH-13 soil samples.

4. Executive Summary, Page 2, Last Paragraph

Text states, "Groundwater modeling results show that approximately 22 years would be required for the leading plume edge of the organic plume to migrate from the former landfill liquid waste lagoons to the area just south of U.S. 64." There is a degree of concern as to the accuracy of the model as indicated above.

The BLM is very concerned regarding this and other comments associated with Section 7, Contaminant Fate and Transport. In response to EPA's concerns with the groundwater modeling presented in the draft RI Report, BLM has reevaluated the modeling approach and results. As stated in the responses to the general comments, BLM proposes that the modeling results be replaced with an analytical approach. A separate technical memorandum entitled "The Revised Contaminant Fate and Transport for the Lee Acres Landfill" has been prepared and issued concurrently with this document. The BLM would like to discuss this issue with the EPA.

5. Executive Summary, Page 3, 2nd paragraph

Text states, "For this reason, any risk or hazard associated with Site 2 contamination is not estimated or considered further as part of the risk assessment of FS process."

This is a major issue. As stated above, too much emphasis is being placed on a model that has not addressed the complete area of interest. "Site 2" shall not be eliminated from further study based on the model as it is currently being presented.

As stated in response to comment 4, the BLM would like to discuss the rationale and objectives of the groundwater modeling with the EPA. Within this discussion, the two-site approach will be presented and discussed. The basis for this approach is the groundwater analytical data, not the model. The BLM is not responsible for evaluating contaminant migration released from the Giant-Bloomfield Refinery. However, the BLM is responsible for delineating contamination eminating from the former Lee Acres Landfill.

6. Executive Summary, Page 3, Paragraph 3

Text states, "the air pathway is rejected as an active pathway because results of the RI air monitoring program show no contaminant vapors being released from the former landfill." The air pathway may need to be studied at least in respect to the potential for contaminated vapors to be released during the implementation of remedial action alternatives. This study would need to at least include the potential for worker exposure.

The qualitative pathway analysis evaluates the potential threat to human health and the environment in the absence of any remedial action. Therefore, the BLM feels the rejection of the air pathway as an active pathway is correct. The Phase III feasibility study, which will present the detailed analysis of alternatives and final design, will address the potential for contaminated vapors to be released during implementation of remedial action alternatives.

7. Executive Summary, Page 3, Paragraph 3

The two pathways identified in the conceptual model do not address all potential future uses. Other pathways that should be considered include exposure to contaminated soils, as discussed in Section 8, and impacts on surface water during catastrophic flooding. These are discussed in comments for Sections 4, 8, 9, and 10.

This comment is addressed as part of the specific comments for Sections 4, 8, 9, and 10.

8. Section 1.1.1, Page 1, Paragraph 4

The RI and feasibility study (FS) process also includes a risk assessment that addresses all present and future potential risks to human health and the environment. The appropriate sections of the report should be expanded to address all potential risks, not only current ones.

The BLM has included a baseline risk assessment as Section 10 of this report. Specific comments and responses numbered 121 through 170 regarding the baseline risk assessment address the need for expanding sections of the report.

9. Section 1.1.1, Page 2, Last paragraph:

Text states, "A Record of Decision (ROD) will be prepared to certify that the remedy selection process ..." EPA must concur on this document.

The BLM agrees. Text will be revised to read "A Record of Decision (ROD) will be prepared to certify that the remedy selection process was carried out in accordance with CERCLA and to provide the public with a consolidated source containing information about the site, technical details about the chosen remedy, and the rationale for selection of the chosen remedy. The ROD will be submitted to EPA. Prior to the ROD being issued, the BLM will implement a program to satisfy public participation requirements specified in Section 117 of CERCLA."

10. Section 1.1.4, Page 6, first bullet

Text states, "...significantly reduce the toxicity, mobility, or volume of waste." This statement needs to be modified in accordance with CERCLA § 121 (b)(1), which states, "Remedial actions in which treatment which permanently and significantly reduces volume, toxicity or mobility of hazardous substances, pollutants, and contaminants is a principal element, are to be preferred over remedial actions not involving such treatment."

BLM agrees and the text will be modified to read "Remedial actions in which treatment which permanently and significantly reduces volume, toxicity or mobility of hazardous substances, pollutants, and contaminants is a principal element, are to be preferred over remedial actions not involving such treatment."

11. Section 1.1.5, Page 6, Paragraph 1, Bullet 6,

As noted above, the risk assessment should include all potential risk scenarios.

The BLM agrees that all potential risk scenarios will be addressed. Comments specific to the risk assessment have been addressed (comment numbers 118 through 167).

12. Section 1.2.2.1, Page 10, Paragraph 3,

The presence of bermed areas is used to determine the locations used for liquid waste disposal; however, there are other possible liquid waste disposal areas. There is a potential for liquid waste disposal to have occurred in other areas of the landfill, such as the (1) pits and trenches, adjacent to the two lagoon areas in the southern part of the landfill which were used extensively between 1975 and 1980 (Figure 1-4), or (2) pits and trenches with stained soils (Figure 6-4). The pits and trenches identified in Figure 6-4 are located outside the current southern fenced boundary but, according to Figure 6-4, were within the fenced boundary during the early 1980s. Explain why other areas of the landfill are not considered as possible areas that may have received liquid wastes.

The potential source areas identified on Figure 6-4 were characterized with boreholes, monitoring wells, hydrocones, and CPTs. Figure 6-4 will be revised to identify all sampling locations. Boreholes BH-31, BH-32, and BH-33 were drilled in the location south of the landfill fenceline in the vicinity of the stained soils identified in 1977 aerial photographs (Figure 6-4). All borehole locations will be added to Figure 6-4.

13. Section 1.3.2, Page 12, Paragraph 2

Text states, "After a comment period and the receipt of comments, a public meeting will be held if sufficient interest is demonstrated." This statement needs to be modified to meet the requirements of CERCLA § 117 (a)(2) which states, "Provide a reasonable opportunity for submission of written and oral comments and an opportunity for a public meeting at or near the facility at issue regarding the proposed plan and regarding any proposed findings under section 9621(d)(4) of this title (relating to cleanup standards). The President or the State shall keep a transcript of the meeting and make such transcript available to the public."

The BLM agrees and the quotation from CERCLA § 117 (a)(2) will be added to the paragraph. The text paraphrases the Council on Environmental Quality (CEQ) and presents the intent without direct quotations for ease of understanding.

14. Section 1.6.2.2, Page 19, Paragraph 3

Text states, "Generally one-time detections are eliminated as COCs. The number of sampling events per well ranges from 3 to 21. In most cases when a contaminant was detected once, it was in an early sampling event and the nondetects in later groundwater samples provide confirmation of the absence of the contaminant." One time detections should not be eliminated when the frequency of sampling is low (i.e. 3). Other discussion on this topic follows.

One-time detections are not eliminated when the frequency of sampling is low (3). The text continues "Where frequency is not a strict elimination criterion, a qualitative analysis of trends in a well, subarea, site, or region is also discussed in Section 6." Additionally, the low sampling frequency applies only to the 13 monitoring wells (BLM-67 through BLM-79, located in the southern area of OU 2) that were installed in April and May 1991. All other monitoring wells have been sampled four or more times. The 13 monitoring wells were sampled in May, June, July 1991, and August 1992. Table 6-14 presents the organic compounds detected in the Site 1, Southern Area of the Operable Unit 2 Alluvial Aquifer. The screening criteria columns were reviewed with the analytical results presented in Appendix N for the 13 monitoring wells. All compounds eliminated based on frequency were detected in wells that were sampled more than three times.

EPA and BLM need to discuss this and an appropriate freqency must be approved by the EPA RPM.

Additional groundwater sampling was performed in August 1992. A preliminary data summary is being provided to EPA during the first technical working group meeting, to present these data.

15. Section 2.1.1.2.2, Page 6, Paragraph 1

The text indicates that the depth of penetration during the EM survey was limited to 5 to 8 feet below the instrument and to 3 to 6 feet below the ground surface if the instrument was held waist high. Since the permitted requirements for operating the landfill included the application of 2 to 10 feet of fill, the limitation of shallow penetration depth with the EM 31 may be compounded. A discussion of the potential effects of the cover is needed to provide for accurate interpretations of the electromagnetic (EM) data.

The objectives of the EM survey were to first, as a reconnaissance measure, delineate areas of high conductivity and to define the presence of wastes with high conductivities in the covered lagoons and in the buried trenches. Additionally, the EM survey supplemented the metal detection values obtained from the magnetometer survey. Subsequently, the geophysical survey results were used to guide the placement of boreholes and monitoring wells. The geophysical surveys were performed in the initial phase of the landfill investigation and little information was known regarding the depth of the cover. The resulting data from the EM survey were evaluated and the conclusion regarding the depth of cover on the landfill was made. The subsection will be revised to include this explanation.

16. Section 2.4.2, Page 18, Paragraph 1

During future sampling events, discretionary samples based on visual or instrument observations should be collected to improve the delineation of the contamination. This is particularly important at locations where borehole clusters are drilled. The text states that geochemical samples were collected at 5-to-10- foot intervals, with certain exceptions. A review of the chemical results in Appendix I indicated that on-site visual or instrument - especially HNu - observations were seldom used to deviate from the 5-or-10-foot standard interval. For example, discretionary sampling would have been useful in the southwest area of the landfill near monitoring wells BLM-33 and BLM-34. The borehole logs in Appendix L indicate that the highest HNu readings in the core samples were observed near the alluvium-bedrock contact in both well boreholes, not at the selected interval location.

The BLM performed discretionary sampling when appropriate. For the example presented above, both logs for boreholes BLM-33 and BLM-34 must be reviewed together. These two boreholes are approximately 5 ft apart, and BLM-33 is the shallower of the two holes. Due to their proximity, the lithology and any potential subsurface contamination was assumed to be similar. Therefore, samples from BLM-34 were collected after the ending depth of BLM-33. Samples from BLM-33 were collected from 0 to 60 ft and samples from BLM-34 were collected from 60 to 80 ft. In reviewing the log for BLM-33, a sample was collected at 30 ft, within the area of high HNu readings of 17 and 72 units above background. This information will be provided in the revised RI Report.

17. Section 2.4.2, Page 18, Paragraph 2

A rationale should be included in the report to support the selected method for analyzing metals. The text states that soil samples were analyzed for metals by using the Extraction Procedure (EP) Toxicity method rather than analyzing for total metals. Results of analysis from using this method indicate the possible impact of soil leachate on groundwater; however, this data is not useful for evaluating direct exposure to contaminated soils. Total metals analysis was performed only for soil samples from well boreholes BLM-33, BLM-34, and BLM-35. No soil samples collected from the lagoon areas were analyzed for total metals. In addition, background values for total metals are not presented in the report. EPA guidance (EPA, 1989) discusses background sampling needs. Without representative background and landfill soil analytical results for metals, a complete risk assessment for soil exposure pathways cannot be performed. Provide an explanation as to why the EP analytical methodology was used in lieu of total metals analysis. Total metals analysis of representative background locations as well as the landfill will be required so that a risk assessment for each exposure pathway may be performed.

The EP Toxicity samples were collected to

- *determine the potential for leaching, and*
- *determine whether the soil could be characterized as a hazardous waste to assist in the development of remedial alternatives. This explanation will be provided in the revised report.*

18. Section 2.4.3, Page 20

This section should include information discussing the validation procedures and QA elements. Criteria that should be available for review include the following:

- Holding times
- Surrogate recoveries
- Spike duplicate results
- QA objectives for measurement data in terms of precision, accuracy, representativeness, completeness, and comparability (PARCC)
- Sampling procedures
- Sample custody
- Calibration procedures and frequency
- Analytical procedures
- Data reduction, validation, and reporting
- Internal quality control checks and frequency
- Performance maintenance procedures and schedules

If this information is included in another document, it should be summarized in this section and referenced.

All analytical data were analyzed according to CLP protocol. Data evaluation was performed by both the BLM prime contractor and the technical support contractor. Approximately 30% of the RI analytical data through June 1990 were evaluated.

BLM is in the process of developing a data validation effort to support this RI. BLM pursues discussion with EPA on the proposed approach. Currently, as a start, the August 1992 groundwater data are being validated.

19. Section 2.4.3, Page 20, Paragraph 1, Bullet 3

The volatile organic compound (VOC) results and the supporting validation documentation should be included in this report for review. The text states that "One trip blank per shipment of VOCs" will be used. EPA guidance (1987) states that one trip blank should be shipped with each shipping container.

All positive analytical results for soil samples are presented in Volume II, Appendix I and for groundwater in Appendix N. Data evaluation reports will be provided in an additional appendix to the RI Report, as discussed in the response to comment 18.

One trip blank was shipped with each shipping container containing samples for volatile organic analyses. The text will be corrected to read as follows: "One trip blank per shipping container of VOCs."

20. Section 2.8.1, Page 30

When using the terms "uppermost" and "lower" for the alluvial and bedrock aquifers respectively, the text indicates that each aquifer has associated "lowermost" and "upper" units. Clarify this issue.

The term "uppermost" was used to identify the alluvial aquifer as the water table aquifer and the first occurrence of saturation. It does not indicate that there is more than one alluvial aquifer or more than one zone or unit within the alluvial aquifer. The term "lower" bedrock aquifer was used to indicate that it is below the alluvial aquifer and does not indicate that there is more than one unit within the bedrock aquifer. Therefore, the report will be revised and the terms "uppermost" and "lower" will be removed from the text.

21. Section 2.8.1, Page 30, Paragraph 2

The text states that "Cone Penetrometer (CPT) activities performed during December 1989 and January 1990 allowed the delineation of areas where alluvial groundwater does and does not occur." The distribution of precipitation, which is discussed in Section 3.1.2.3, indicates that the maximum extent of the alluvial aquifer would occur after local storms in August or September, or during snowmelt in the early spring. In view of these potential seasonal occurrences, the aquifer will fluctuate in horizontal and vertical extent. Explain how the cone penetrometer (CPT) data were used to estimate the areal extent of the alluvial aquifer.

The CPT used during the RI has the capability of recording conductivity in micromhos per meter versus depth. The conductivity recorded on the CPT profile showed a background increase to consistently over 30 micromhos/m when the cone encountered the saturated zone. Direct field testing was performed by using the CPT adjacent to an existing well. The CPT was not used to define the water table, but rather to detect the saturated zone. The sentence will be revised to read "CPT activities performed during December 1989 and January 1990 delineated the areas where alluvial groundwater does and does not occur." Additionally, 19 groundwater monitoring wells (BLM-14 through BLM-32) were installed prior to the RI and CPTs. Hydrographs for thses monitoring wells reveal no significant evidence of periodic seasonal trends or yearly cycles of the alluvial aquifer (Volume III, Apppendix S). all other RI well clsuter hydrographs presented in Appendix S reveal the same general trend.

22. Section 2.8.2, Page 31, Paragraph 1

The discussions of upward and downward hydraulic gradients in the text of the report should be consistent with the findings that are presented in the referenced tables. These findings and associated discussions should be consistent between the various sections of the report. It is stated that "the lower bedrock unit is hydraulically connected to the alluvial system, and no upward or downward hydraulic gradient is apparent. In other locations along the arroyo, an upward gradient is observed, suggesting that the bedrock aquifer recharges the alluvial system." The data listed in Table 4-3 indicate that some well clusters, such as BLM-20 and BLM-22, show a downward hydraulic gradient. Also, as stated in other sections of the report, a downward hydraulic gradient is observed on the west side of the arroyo, and an upward hydraulic gradient on the east side of the arroyo. Discuss these occurrences.

The discussion in Subsection 4.2.5 will be expanded to include and describe specific locations of the various hydraulic head relationships.

23. Section 2.9, Page 32

The first sentence in this section indicates that the topic discussed will be the technical rationale for geographical placement of monitoring wells. However, the major topic discussed is the placement of well screens. If the placement of the well screen is associated with the groundwater monitoring program, more information is needed. Also, it would be beneficial for this placement of the well screen to be presented in Section 2.7.2. which discusses well completion details.

The paragraph will be rewritten to clarify the intent of this subsection.

24. Section 2.9.1, Page 34, Paragraph 2

A table indicating the sampling method for all previous groundwater sampling events should be included in the report. The difference between the sampling methods may have a particularly important effect on the frequency of detection in groundwater samples collected from monitoring wells located along the edges of the contaminated areas. The text states that a test was conducted to compare sampling results between a submersible pump and a bailer. The results indicate that sample collection with the submersible pump minimized the volatilization of VOCs from the groundwater samples. This observation is consistent with tests performed at other Superfund sites. Although the conclusion that the pump sampling method did not cause volatilization of VOCs from the samples may be true, it not necessarily true that all of the data are comparable.

Prior to May 1991, all groundwater samples were collected using a peristaltic pump for purging and a bailer to collect the samples. An additional table indicating the sampling method for all sampling events is unnecessary. Table 6-8 will be revised to identify the samples collected by bailer and by submersible pump. In addition, a sentence will be added in Subsection 2.9.1 stating that prior to the 1991 sampling events, samples were collected by bailer.

25. Section 3.1.1

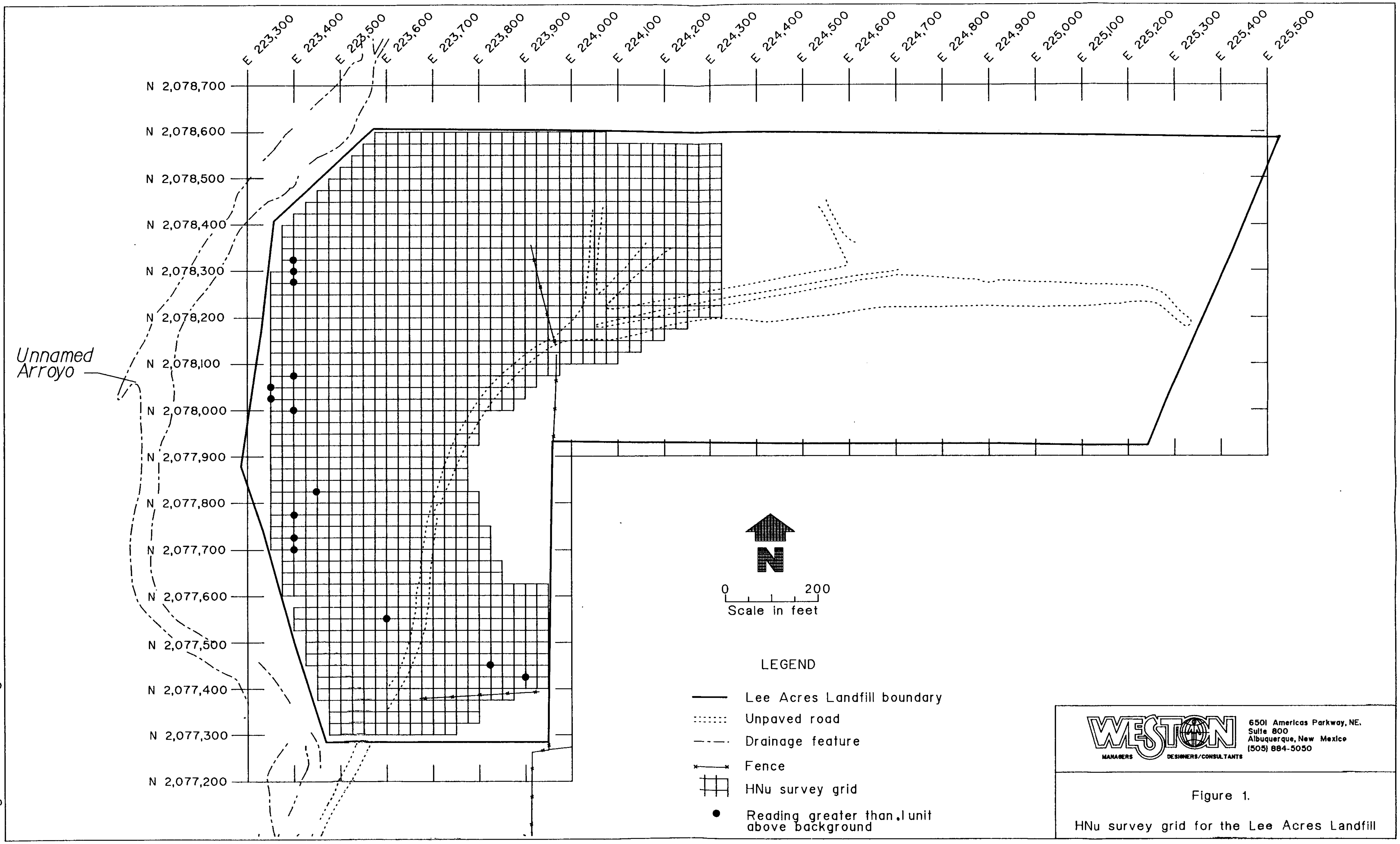
This section discusses the soil gas investigation activities that were conducted at the site. However, a discussion of the Tracer soil gas survey, conducted on July 7, 1986, is not presented. A discussion of the Tracer soil gas survey, its findings, and its conclusions should be included in the draft RI report for review. It is important that all investigations conducted - both by the PRPs and other parties - be discussed in detail to support the conclusions.

The Tracer soil gas survey report is provided as Appendix D to this document.

26. Section 3.1.1.1, Page 2, Paragraph 2

It is stated that only one HNu reading, out of about 1,300 readings, was above background concentrations. However, no discussion of the background concentrations, locations of the readings, or HNu QA/QC information was provided for review. If the results were used to refine or scope further investigation activities, provide that information. Discuss the significance of the HNu survey investigation and its purpose and results.

Figure 1 shows the area of the landfill where the survey was performed. The HNu readings obtained during the investigation are presented in Table 1 in Appendix E. Table 1 includes location (northing and easting), background reading, and reading just above the soil (if different than background). Background refers to the "zero" setting of the instrument, which is normally set between 0.5 and 1.0 units in order to ensure the instrument is responsive. Thirteen readings ranged from 0.2 to 0.8 units above background. The one reading referred to in the text was 5.8 units, with a background reading of 0.6 units. The QA/QC information for the HNu investigation is summarized in Table 2 of Appendix E and provides all calibration information. The results of the HNu survey were used to determine locations for the air canister sampling program. A complete discussion of the purpose and results of the HNu survey will be provided in the revised RI Report. Additionally, Appendix E will be included in the revised report.



WESTON
MANAGERS DESIGNERS/CONSULTANTS
6501 Americas Parkway, NE.
Suite 800
Albuquerque, New Mexico
(505) 884-5050

Figure 1.

HNu survey grid for the Lee Acres Landfill

27. Section 3.1.1.2, Page 2

The air canister analytical results presented in Appendix P do not include the locations for each sample. To adequately review the air data, either indicate the locations on the data sheets, or summarize analytical results in a table or figure to compare the locations to the results. In addition, to provide for a comprehensive report and review, information on the laboratory and validation QA/QC requirements should be discussed.

The analytical results are now presented in Tables 2 and 3 and include location information. In addition, the analytical QA/QC procedures such as spiked samples, surrogate analysis, and CLP data documentation will be provided in the revised report.

28. Section 3.1.1.3, Page 2, Paragraph 1

Explain the rationale for choosing the middle of the landfill (mid-site) as a location for air particulates and metals. According to Figure 1-5, this location appears to be centered in the northeastern portion of an excavated (and clean) area. Clarify the rationale for using this location to represent the landfill.

The middle of the landfill was selected for an air particulates and metals sampling location to provide air quality data resulting from boring and trenching activities occurring near the center of the landfill.

29. Section 3.1.1.4, Page 6, Paragraph 2

This paragraph includes a brief description of the soil gas emissions monitoring. Information about monitoring conditions should include, but not be limited to, the ambient temperature inside and outside the chamber at each site, the time for equilibration after purging, and duration of sampling. This information should be presented and discussed to support the analytical results and the sampling methodology, and to provide a comprehensive review of the report. If sampling occurred immediately after purging with an inert gas, it appears that surface gas emission concentration would be diluted by a minimum of one order of magnitude. If the upper few centimeters of the surface were also affected when the flux chamber was purged, an air sample collected immediately after purging would have little relation to actual site conditions.

The sampling procedures for the air quality data will be provided in the revised RI Report.

30. Section 3.1.1.4, Page 6, Paragraph 3

During the October and November 1989 air sampling event, four on-site locations were chosen for soil gas emission monitoring. The results for the sample collected from location 6 are not easily identified in Appendix P. A table summarizing the individual location results in the text or in Appendix P would enhance the review. According to Figure 3-1, location 6 appears to be where a roadway across the landfill was once located. The use of an area where repeated compaction has occurred is not appropriate for soil gas monitoring. Provide these results and clarify the location of soil gas emission monitoring station number 6.

A table presenting the analytical results from Appendix P has been provided for the response for comment 27.

Location 6 was not located on the roadway itself, but to one side. Figure 3-1 will be revised to show the appropriate location for this sample.

Table 2. Summary of Isolation Flux Chamber Analysis Results

PARAMETER NAME	PARAMETER VALUE (ppb)	SAMPLE #	DATE SAMPLED	CANISTER #	LOCATION	NORTHING	EASTING
1,2-Dichloro-1,1,2,2-tetrafluoroethane, Freon 114	0.87	FLUX001	10/20/89	(95)23936	MET TOWER	N77550	E23600
1,2,4-Trichlorobenzene	2.0						
Dichlorodifluoromethane, Freon 12	3.5	FLUX002F	11/02/89	LC0034	FIRE STATION	OFF SITE	
1,1,2-Trichloro-1,2,2-trifluoroethane, freon 113	3.4						
Benzene	2.0						
Toluene	8.5						
Ethylbenzene	1.8						
m-Xylene	8.5						
o-Xylene	2.7						
Dichlorodifluoromethane, Freon 12	1.3	FLUX002FD	11/02/89	LC0069	FIRE STATION	OFF SITE	
1,1,2-Trichloro-1,2,2-trifluoroethane, freon 113	4.2						
Benzene	2.4						
Toluene	8.8						
Chlorobenzene	2.5						
Ethylbenzene	3.5						
m-Xylene	10						
o-Xylene	3.3						
Dichlorodifluoromethane, Freon 12	3.8	FLUX003F	11/02/89	LC0012	MET TOWER	N77550	E23600
1,1,2-Trichloro-1,2,2-trifluoroethane, freon 113	14						
Toluene	15						
Chlorobenzene	3.0						
Ethylbenzene	2.5						
o-Xylene	3.2						
1,2,4-Trimethylbenzene	1.8						

Table 2. Summary of Isolation Flux Chamber Analysis Results

PARAMETER NAME	PARAMETER VALUE (ppb)	SAMPLE #	DATE SAMPLED	CANISTER #	LOCATION	NORTHING	EASTING
Trichlorofluoromethane, Freon 11	1.5	FLUX004F	11/02/89	LC0026	SITE # 1	N77475	E23775
1,1,2-Trichloro-1,2,2-trifluoroethane, freon 113	20						
1,1,1-Trichloroethane	6.4						
Benzene	5.1						
Toluene	32						
Chlorobenzene	7.7						
Ethylbenzene	7.4						
o-Xylene	10						
1,3,5-Trimethylbenzene	1.7						
1,2,4-Trimethylbenzene	6.5						
1,2,4-Trichlorobenzene	1.6						
1,1,2-Trichloro-1,2,2-trifluoroethane, freon 113	6.8	FLUX005F	11/02/89	(30)23976	SITE # 6	N78175	E24000
Toluene	5.8						
Ethylbenzene	2.3						
m-Xylene	11						
o-Xylene	3.8						
1,1,2-Trichloro-1,2,2-trifluoroethane, freon 113	5.6	FLUX005FD	11/02/89	(34)23980	SITE # 6	N78175	E24000
Toluene	4.4						
Ethylbenzene	1.6						
m-Xylene	8.2						
o-Xylene	2.9						
1,1,2-Trichloro-1,2,2-trifluoroethane, freon 113	2.6	FLUX006F	11/02/89	(32)23978	SITE # 2	N78025	E23350
Toluene	3.6						
Ethylbenzene	1.5						
m-Xylene	6.0						
o-Xylene	2.4						

Table 2. Summary of Isolation Flux Chamber Analysis Results

PARAMETER NAME	PARAMETER VALUE (ppb)	SAMPLE #	DATE SAMPLED	CANISTER #	LOCATION	NORTHING	EASTING
None detected		MET-SITE (140)	07/27/90	140(2937)	MET TOWER	N77550	E23600
None detected		MET-DUP (138)	07/27/90	138(2935)	MET TOWER	N77550	E23600
None detected		BLMNLK4 (69)	07/28/90	69(2555)	SITE #7		
None detected		WELL#37 (124)	07/27/90	124(2834)	SITE #8	SOUTH OF US 64 NEAR BLM-37	
None detected		BLM242526(68)	07/28/90	68(2551)	SITE #9	SOUTH OF US 64 NEAR BLM-24, -25, -26	
Benzene	2.3	TRIP BLANK(125	07/27/90	125(2835)	TRIP BLANK	N/A	

NOTE: TRIP BLANK FLUX001B HAD NO DETECTED COMPOUNDS (QA/QC DATA PRESENTED IN APPENDIX P)

Table 3. Summary of Ambient Air Canister Analytical Results

PARAMETER NAME	PARAMETER VALUE (ppb)	SAMPLE #	DATE SAMPLED	CANISTER #	LOCATION	NORTHING	EASTING
Benzene	6.9	BLM0001A	10/20-21/89	(93)23934	MET SITE	N77550	E23600
Toluene	8.2						
Tetrachloroethylene	1.4						
Ethylbenzene	1.1						
p-Xylene	4.3						
Styrene	3.2						
o-Xylene	1.4						
Benzene	1.1	BLM0002A	10/20-21/89	(92)23933	SITE # 2	N78025	E23350
Toluene	1.7						
Tetrachloroethylene	1.5						
p-Xylene	0.81						
Styrene	1.2						
Trichlorofluoromethane, Freon 11	1.8	BLM0002AD	10/20-21/89	(90)23931	SITE # 2	N78025	E23350
Benzene	1.2						
Toluene	2.0						
Tetrachloroethylene	1.0						
Ethylbenzene	0.99						
p-Xylene	1.2						
Styrene	4.1						
1,2,4-Trimethylbenzene	0.73						
Benzene	9.4	BLM0003A	10/22-23/89	(91)23932	SITE # 1	N77475	E23775
Toluene	8.0						
Ethylbenzene	1.2						
p-Xylene	4.0						
Styrene	1.4						
o-Xylene	1.5						
1,2,4-Trimethylbenzene	1.5						

Table 3. Summary of Ambient Air Canister Analytical Results

PARAMETER NAME	PARAMETER VALUE (ppb)	SAMPLE #	DATE SAMPLED	CANISTER #	LOCATION	NORTHING	EASTING
Dichlorodifluoromethane, Freon 12	0.96	BLM0003AD	10/22-23/89	LC0025	SITE # 1	N77475	E23775
Benzene	4.0						
Toluene	4.7						
Tetrachloroethylene	0.98						
Ethylbenzene	0.55						
p-Xylene	2.0						
Styrene	1.2						
o-Xylene	0.71						
1,2,4-Trimethylbenzene	0.53						
Trichlorofluoromethane, Freon 11	2.1	BLM0004A	10/23-24/89	(3)21734	FIRE STATION	OFF SITE	
Styrene	2.4						
1,2,4-Trichlorobenzene	1.2						
Dichlorodifluoromethane, Freon 12	1.1	BLM0005A	10/23-24/89	LC0063	SITE # 3	N78275	E23400
Benzene	3.5						
Toluene	4.5						
Tetrachloroethylene	1.1						
Chlorobenzene	2.7						
p-Xylene	1.8						
Styrene	1.3						
Methyl Chloride	3.5	BLM0006A	10/24-25/89	LC0047	SITE # 5	N78325	E23825
Benzene	6.7						
Toluene	8.8						
Tetrachloroethylene	0.52						
Chlorobenzene	3.3						
Ethylbenzene	1.6						
p-Xylene	4.5						
Styrene	1.8						
o-Xylene	1.8						
1,3,5-Trimethylbenzene	0.44						
1,2,4-Trimethylbenzene	1.7						

Table 3. Summary of Ambient Air Canister Analytical Results

PARAMETER NAME	PARAMETER VALUE (ppb)	SAMPLE #	DATE SAMPLED	CANISTER #	LOCATION	NORTHING	EASTING
Benzene	1.8	BLM0007A	10/24–25/89	LC0007	SITE # 4	N78275	E23700
Toluene	2.7						
Tetrachloroethylene	0.80						
Chlorobenzene	3.3						
p–Xylene	1.0						
Styrene	0.90						
None detected		BLM0001AD	10/20–21/89	(94)23935	MET SITE	N77550	E23600
Methyl Chloride	2.2	BLM0008A	10/22/89	LC0052	TRIP BLANK	N/A	
Trichlorofluoromethane, Freon 11	3.0	BLM0009A	10/23/89	LC0080	TRIP BLANK	N/A	

31. Section 3.1.1.4, Page 6, Paragraph 3, additional

According to this paragraph, six air sampling locations were on-site. The distribution of sampling does not appear to be consistent with the contention that the lagoon areas are the most likely sources of hazardous waste disposal. For example one location appears to be in a compacted area, and three [two from the meteorological (met) station] were collected in the southern portion of the landfill. All of these locations are far from the former lagoon areas. The rationale for the distribution of sample locations, in relation to the lagoons and other potential sources, should be discussed in the report.

The sampling location rationale will be provided in the revised RI report.

32. Section 3.1.1.4, Page 7, Paragraph 3

The text states that no unusually high levels of volatile toxics are associated with the Lee Acres Landfill. The results of air monitoring shown in Table 3-5 are not consistent with this conclusion. Even if the sampling methodology and locations prove to be acceptable, benzene is present in concentrations comparable to suburban and urban settings, not remote locations. Weather conditions at the time of ambient air sampling are not included in the report, so the effect of the former refinery to the south cannot be evaluated. The values for 1,1,1-trichloroethane, trichloroethene (TCE), and toluene are also well above values for rural areas. The conclusions in this and the following paragraph should be re-evaluated. A rationale to substantiate these conclusions should be included in the report.

The area in which the Lee Acres Landfill is located is not considered either rural or remote. Directly south of the former landfill is the Giant-Bloomfield Refinery. Crouch Mesa Road, located west of the landfill, is heavily traveled. U.S. 64 is approximately a half mile south of the landfill and is the main thoroughfare for San Juan County. Light industry is located along U.S. 64 directly south of the landfill. Additionally, the fairgrounds and a residential subdivision are located south of U.S. 64. Therefore, the comparison of ambient VOC concentrations with remote and rural studies is inappropriate and will be removed from the report.

33. Section 4.1.5.2, Page 11, Paragraph 2

The relationship of BLM-61, BLM-63, and BLM-64 to the steep gradient is not fully explained. Provide more detailed information, including referencing of other borehole logs, that show the relationship between bedrock, saturated alluvium, and groundwater gradient.

"Steep gradient" refers to the steep slope of the bedrock channel and not the groundwater gradient. The text will be corrected to read "The contours show that the saturated alluvium is controlled by the shape of the top of the bedrock channel (compare to Plate 5) and reflects the same steep slope of this channel (as seen in the area of BLM-61, BLM-63, and BLM-64)."

34. Section 4.1.5.2, Page 11, Paragraph 3

The reference to Plate 3 appears to be incorrect. Plate 4 is the geologic map of the study area.

The text will be corrected to refer to Plate 4, the surficial geology map of the study area.

35. Section 4.1.6, Page 12, Paragraph 1

The text refers to a top-of-bedrock topographic map that was generated. A map with this identification was not found in the report. If there is a reference number to this figure, provide it. Also, by using the term paleotopographic, it is implied that this was once a topographic surface feature. Clarification of this term and how it is used is needed, as well as a top-of--bedrock topographical map.

The text incorrectly refers to Plate 5 as the top-of-bedrock map. The correct reference is to Plate 2 and the text will be corrected.

Paleotopographic refers to the topographic surface at a given time in the geologic past and is synonymous with top-of-bedrock topographical map, as it is used in this report. The paleotopographic surface is the surface between the Nacimiento formation and recent unconsolidated deposits. The term "paleotopographic" will be replaced in the text by the term "top-of-bedrock".

36. Section 4.1.6, Page 12, Paragraph 3

The text refers to cross-section H-H'. An H-H' cross-section is shown in Figure 5-3, but the bedrock is not detailed in the subsequent cross sections. Provide the figure with the H-H' cross section that is referenced in this section.

The reference to cross-section H-H' will be corrected to refer to cross-section A-A'.

37. Section 4.1.6, Page 13, Paragraph 4

To provide a thorough report for a site that is stratigraphically and hydrologically complicated, it is recommended that all borehole logs within the line of a cross section be used to support all interpretations and conclusions. The text refers to wells BLM-37 and BLM-32 in cross section C-C'. These wells are situated in the south half of the area and are in the line of the cross section C'-C". However, information from these wells was not used in the construction of the cross section. Explain this omission and include the information available from the C'-C" cross section in the report.

The text incorrectly refers the reader to cross section C-C'. The text will be corrected to refer the reader to borehole logs in Appendix L. As stated above, the site is "stratigraphically and hydrologically complicated" and the distance from monitoring wells BLM-37 and BLM-32 to cross-section C'-C" is too great to accurately project the stratigraphy. All available information from the C'-C" cross-section was presented. The intent of cross-section C'-C" was to present the stratigraphy as close to the unnamed arroyo as possible, based on available information.

38. Section 4.1.7, Page 13, Paragraph 1

This section states that geotechnical tests were conducted on representative samples of alluvium. The logs in Appendix H for soil boreholes BH-28 and BH-29 indicate that 27 geotechnical samples were collected from these two boreholes. A table indicating the total number of geotechnical samples collected and their locations should be added to the report. The discussion should also include results from the other geotechnical tests, besides grain size analysis, that were conducted.

Table 2-9, page 2-85, presents the RI Sampling and Analytical Program for Geotechnical Samples (1990-1991).

A discussion of all other geotechnical tests will be included.

39. Section 4.2.1, Page 14, Paragraph 2

Since the regional ground-water quality parameters for the Nacimiento aquifer are presented in ranges, it would be helpful to know the range for the regional sulfate concentrations.

The sulfate concentrations in the Nacimiento sandstones range from 21 to 6,700 mg/L (Stone et al. 1983). The range will be added to the text.

40. Section 4.2.1, Page 15, Paragraph 2

The Zuni, Chuska, and Cebolleta Mountains are not north of the San Juan Basin as suggested in this sentence. The text should be corrected.

The text will be corrected to read "In the New Mexico portion of the San Juan Basin, recharge occurs on the flanks of the Chuska Mountains to the west, the Zuni Mountains to the south, the Cebolleta Mountains to the southeast and the San Juan Mountains to the north."

41. Section 4.2.2, Page 15, Paragraph 1

This section notes that the alluvial and bedrock (Nacimiento) aquifers are hydraulically connected and that the vertical gradient is upward on the east side of the arroyo but downward on the west side. This section should address the causes of the gradients and the impact that this will have on contaminant transport, particularly relating to contamination of the bedrock aquifer and how this information affected planning of the site investigation. In addition, potential bedrock contamination should be discussed in the report.

The response to comment number 22 addresses hydraulic gradients. The information regarding the hydraulic gradients resulted from the investigation and was unknown at the time of planning.

Potential bedrock contamination is presented in Section 6 of the RI Report.

42. Section 4.2.2, Page 15, Paragraph 1

Additional evidence and further discussion are needed to support the statement relating the saturated thickness of the alluvial aquifer to the approximate center of the active unnamed arroyo channel. In reviewing Plate 5, the varying thickness of the alluvial sediments makes it apparent that the saturated thickness of the alluvial sediments varies. However, according to Plate 5, it does not appear that the thickest portion of the saturated alluvium is associated with the approximate center of the arroyo channel. There are apparently other factors associated with the saturated thickness, such as the presence of buried paleochannels.

The text will be corrected to state the saturated thickness beneath the arroyo channel ranges from approximately 10 to 15 ft. The saturated alluvium is thickest (20 ft) beneath the active unnamed arroyo channel near upgradient wells and thins to the east and west. It was not intended to relate the saturated thickness of the alluvial aquifer to the approximate center of the existing surface feature of the active unnamed arroyo channel. The paragraph will be clarified.

43. Section 4.2.3, Page 16, Paragraph 1

The statement that cross-sections A-A' through G-G' "show the stratigraphic relationships between the aquifer, the landfill, the groundwater monitoring screens, and the lithology" is inadequate to explain or interpret the relationships. Because this report is written as public information, it is recommended that a discussion of each cross-section be included. Also, any interpretation of these relationships should be fully supported in the RI, FS, and the risk assessment (RA) reports.

The BLM disagrees with the recommendation that a discussion of each cross-section be included. Subsection 4.1.6 presents a discussion of the regional stratigraphy and refers to the cross-sections. The cross-sections are presented as supportive information to the appropriate topics within Section 4 and to bring out salient points, such as the large-scale heterogeneities. The *depositional process of this arroyo is too complex to allow the mapping of small-scale discontinuous heterogeneities.*

44. Section 4.2.4, Page 17, Paragraph 1

This paragraph states that Appendix S contains hydrographs for 18 well clusters and pairs. In fact, Appendix S contains hydrographs for 17 additional single wells and Giant Bloomfield Refinery (GBR) wells. In addition, all wells should be used in a hydrograph. However, if not all of the information is used, explain why some is being omitted.

Hydrograph data have not been omitted. The text will be corrected to read "Eighteen hydrographs were generated for all BLM well clusters and pairs and are presented in Appendix S. Individual well hydrographs were also generated for BLM monitoring wells and selected Giant-Bloomfield Refinery wells." Sixty-four monitoring wells were installed by the BLM within the Lee Acres Landfill Study Area. A hydrograph containing all wells would be very difficult to read and would be confusing to the reader. Five piezometric surface maps have been generated for the alluvial aquifer (Figures 4-6 through 4-10).

45. Section 4.2.4, Page 18, Paragraph 4

The text should state that the decrease in groundwater elevation over time is apparent in most of the well hydrographs in Appendix S, not only those for BLM wells no. 17, 18, 19, 27, 28, and 29.

The text reads "A subtle decrease in groundwater elevation was observed at the study area from late 1987 to mid 1991." The reference to wells BLM-17, 18, 19, 27, 28, and 29 provides documentation for this statement. A sentence will be added to the text to indicate that the decrease in groundwater elevation over time is apparent in all wells.

46. Section 4.2.5, Page 19, Paragraph 2

Vertical gradients in Table 4.3 show "both" upward and downward hydraulic gradients, but not "alternating," as indicated here. The term "alternating" implies that the vertical gradients change between well cluster locations in an orderly or directional fashion. It is recommended that the term "alternating" be deleted.

The text will be corrected to read "Vertical hydraulic gradients shown on Table 4-3 reveal both upward and downward hydraulic gradients."

47. Section 4.2.6, Page 20, Paragraph 3

Table 4-4 gives K values ranging from 0.7 to 17.9 gallons per day per foot squared (gpd/ft^2) for those well boreholes screened in the bedrock aquifer. The text states that the values ranged from 0.7 to 14.2 gpd/ft^2. Clarify this discrepancy, and provide the reference.

The text will be corrected to read "0.7 to 17.9 gpd/ft^2". The reference for these values are the slug tests performed during the RI.

48. Section 4.2.6, Page 20, Paragraph 3

Table 4-4 indicates that the range of K values for the alluvial aquifer is 6.0 to 85.3 gpd/ft^2. However, it is stated in the previous paragraph that the K values ranged from 0.7 to 245.3 gpd/ft^2. The text and the table should be reconciled, or an explanation should be provided, to prevent any misunderstandings or misinterpretations.

The text will be corrected to read "6.0 to 85.3 gpd/ft^2".

49. Section 4.2.6, Page 21, Paragraph 1

The text refers to contaminant transport simulations in Subsection 4.8. There was no such subsection in the RI report. This reference should be corrected.

The correct reference is Section 7. The text will be corrected.

50. Section 4.3, Page 22, Paragraph 2

This section describes the computer modeling of flood data and indicates that a 500-year event occurred in 1989. To enhance the review, visual observations of the effects of the flood and a map showing the areas affected should be included for review.

A more detailed presentation of the visual observations of the effects of the flood will be included, as well as a map.

51. Section 4.3.2, Page 26, Paragraph 3

This paragraph contains a brief summary of the model results for a 500-year storm flood along the reach of the unnamed arroyo that passes the landfill. Missing from this summary are the model predictions for Section 2, which encompasses most of the northern gabion depicted in Figure 4-14. According to Table 4-8, the water velocity will be over 20 feet per second against the gabion wall. This information should be included in the text, along with a discussion of how such velocities may affect gabion walls that are entrenched 2 feet below the ground surface.

The 500-year flood elevation predictions are as follows:

> *Section 1, 5439.1 ft; Section 2, 5433.1 ft; Section 3, 5425.1 ft; Section 4, 5420.6 ft; Section 5, 5415.6 ft (Figure 4-14).*

This information is presented on Figure 4-14 and will be incorporated into the text.

Designing for a 500-year flood is considered a conservative design method. Standard design methods used by the Corps of Engineers is for 50- to 100-year floods. Additionally, RCRA Land Disposal Restrictions (40 CFR 241.204-2) indicate that "if a land disposal site is located in a floodplain, it should be protected against at least the 50-year design flood ... by appropriate measures." The gabion walls protect the Lee Acres Landfill from a 500-year design flood, and therefore, are adequately designed.

52. Section 4.3.2, Page 27, Paragraph 2

The text states that gabion walls will sag into eroded areas and still provide protection for the former landfill. Explain how this protective, sagging mechanism will function in the event of a flood and provide the construction specifications of the gabions to support this claim.

As the erosion occurs, the weight of the gabions will cause the walls to sag into the eroded area. The walls are effected by the PMF for less than 30 minutes and the peak flow decreases rapidly within the following two hours.

53. Section 5, Page 1, Paragraphs 1 and 2

The introductory remarks in this section are confusing and difficult to follow. The division of the discussion in this section into separate, but adjacent, areas is unnecessary. As noted previously, division of the landfill waste into solid liquid disposal areas is not appropriate from a regulatory standpoint.

The BLM agrees that the division of the landfill waste into different disposal areas is not appropriate from a regulatory standpoint. However, the primary goal of the RI program is to determine the extent and magnitude of contamination at the former Lee Acres Landfill (subsection 1.1.4). Additionally, specific technical data requirements were established for the RI by the BLM. Two of these requirements were to determine the horizontal and vertical extent of contamination within the former landfill and to estimate the volume and boundaries of waste contained in the former landfill. Therefore, to present the data in a clear, logical manner, the landfill waste was divided into separate, adjacent areas. An extensive drilling and sampling program was performed at the former landfill. All activities and analytical results from this program are presented in Section 5. The intent of the introductory paragraphs to this section was to provide the reader with information about the section and where summary subsections could be found.

54. Section 5.1.2, Page 3, Paragraph 2

This section implies that an FS is dependent on the identification of contaminants of concern. According to the National Contingency Plan (NCP), sites that have been placed on the National Priorities List (NPL) are required to have an FS conducted. Clarify this statement to avoid detracting from the purpose of conducting an FS.

The sentence will be corrected to read "Currently under CERCLA, soil standards do not exist; therefore, RI soil data are compared with the proposed RCRA Corrective Action Rule action levels (55 FR 30865)."

55. Section 5.1.2, Page 3, Paragraph 2

Other standards for identifying contaminants of concern in soil are needed, because the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) has not set standards for soil. However, alternate standards, in addition to the Resource Conservation and Recovery Act (RCRA) Corrective Action Rule (CAR) action levels should be considered. For example, background concentrations may also be used for comparison to identify the contaminants of concern.

Background concentrations will be used for comparison of metals and inorganics to identify COCs. Organics (VOCs, BNAs, PCBs and pesticides) are assumed not to be naturally occurring. Therefore, positive results of these compounds are compared with standards (proposed CAR action levels) as shown in Tables 5-1 through 5-5.

56. Section 5.1.2.1, Page 4

Table 5-1 summarizes the soil data for VOCs and the decision criteria for determining which chemicals are to be contaminants of concern. To provide a more comprehensive picture of the distribution of contaminants across the site, frequency of detection should be included for each borehole in the table. Also, as discussed in the previous comment, background levels for soil should also be considered for determining the contaminants of concern.

Figures 5-4 through 5-9 provide a visual picture of contaminant distribution and frequency of detection for each borehole. As indicated by these five figures, contaminants were often only *detected one time in each borehole. Therefore, frequency of detection per borehole does not provide additional information.*

57. Section 5.1.2.1.1, Page 5, Paragraph 5

The text states that "potential source areas are the former liquid waste lagoons, and the area of soil contamination located in the center of the eastern portion of the former landfill." However, according to the analytical results presented in the RI report, the southern portion of the landfill, especially around BH-13, is also a possible source area. The report should address this area or provide a rationale as to why it is not included.

A discussion of BH-13 as potential source area has been provided as part of the response to comment number 3.

58. Section 5.1.2.1.2, Page 7, Paragraph 1

The text states that nonchlorinated VOCs were found only in well boreholes no. 33 and 35 in the southwest corner of the landfill. It is also stated that "it is not known why non-chlorinated VOCs were detected at only two locations in the former landfill." It appears that additional characterization in this area of the landfill is warranted, because (1) why the non-chlorinated VOCs were detected in these two well boreholes is not explained, (2) high HNu readings were recorded on soil material from the alluvium-bedrock interface in well boreholes 33 and 35, and (3) observations of the lagoonal sediments from BH-13 have shown this to be a potential source area.

1) The BLM disagrees that additional characterization is warranted. The text presents the data and does not speculate. The sentence "It is not known why non-chlorinated VOCs were detected at only two locations in the former landfill" will be removed from the paragraph. Based on the data, non-chlorinated VOCs were detected in only two wellbores (BLM-33 and BLM-35). In addition, the former Lee Acres Landfill was an uncontrolled landfill with a random distribution of household wastes. The random disposal is a possible explanation for the detection of non-chlorinated VOCs.

Further characterization of the former landfill will not impact the selection of the final remedy.

2) High HNu readings were recorded only for BLM-33. Samples were collected from BLM-33 at areas of high HNu readings (20 ft and 30 ft). Additionally, no alluvial groundwater was encountered in either BLM-33 or BLM-35. There is no contamination present in the bedrock aquifer.

3) This comment was previous addressed as comment 3.

59. Section 5.4.3.1, Page 35, Paragraph 6

The assumption that the excavated area is free of contamination has not been adequately justified. It is stated that "assumption 2 is justified because geochemical samples from BH-17 and -28 did not show positive results . . . " However, a review of the supporting data - borehole logs and HNu data - shows that (1) the deepest sample collected from BH-17 was only 14 feet, and (2) the HNu readings recorded indicated the possible presence of contamination (see Appendix U). Additional evidence must be provided to justify using this conclusion as an assumption.

The BLM agrees. However, the additional volume resulting from the inclusion of this area will not cause a significant increase in the total volume of contamination. Expanding the area of contamination for potential excavation for treatment supports the conclusion that removal and treatment technologies are technically impractical due to the large volume (>600,000 cy).

60. Section 5.5.2, Page 40, Paragraph 1

It is stated that "three gases, methane, solvent vapor, and hydrogen sulfide, were identified in subsurface soils within the landfill boundaries during intrusive activities under the RI." According to the information provided in Section 5.5.1, these gases were identified by using (1) an organic vapor analyzer (OVA), (2) a combustible gas indicator (CGI), (3) an HNu meter, and (4) a hydrogen sulfide meter. Section 5.5.1 also includes a discussion of the limitations of each of these instruments and also indicates that the results used to determine the types of gases that are actually present are subject to interpretation. Hydrogen sulfide has been positively identified, because the instrument used is specifically designed for the compound. The presence of methane is also highly probable, because it is a common gas formed from the decomposition of organic materials normally disposed of in a municipal landfill; however, it has not been positively identified. The identification of methane and solvent vapors as the other gases present within the landfill boundaries is not justified by the information provided in the RI report, because liquid wastes and other undocumented types of wastes were disposed of in the landfill. Discuss the potential for other types of gases to be present. Also, because solvent vapors consist of a wide range of gas compounds, a discussion of the potential types of solvent gases and their relationship as to where they could be present within the subsurface needs to be provided.

The nature of the site as a former landfill implies that solvent vapors are potentially present. Subsurface soil samples were collected and analyzed to identify and quantify sources of contamination. The identification of vapors is very problematic and does not provide additional information on the sources of contamination. The monitoring of soil gases was performed for health and safety reasons.

61. Section 5.5.2, Page 40, Paragraph 1

The occurrence of subsurface gas below, or in the absence of, waste should be discussed. The text states that methane was detected at depths of 53 feet. As stated in the previous comment, the absolute presence of methane is not supported, but some form of subsurface gas is present. Because subsurface gas is present in measurable concentrations at this depth, the source must be identified and characterized.

The source of subsurface gas is the landfill. Subsurface soil samples were collected and analyzed as part of the RI to identify and characterize source areas. The text will be modified to reflect the uncertainty of (but high probability of) the vapor identification, as stated in Section 5.5.1. Methane and solvent vapors are suspected and therefore, tentatively identified, in the subsurface because of the common occurrence of methane in landfills and because solvents have been identified in soil samples at the site.

62. Section 5.5.2, Page 41, Paragraph 4

The text states that solvent vapors were generally limited to areas within the former lagoons or adjacent to the former lagoons. This conclusion should be reevaluated and either adequately justified or deleted. Significant gas readings were detected at the bedrock in BH-13, and the alluvium and bedrock contact in BLM-33 and BLM-34. These readings occur at the southern end of the landfill, close to and upgradient from the VOC contaminant plume/slug in the alluvial aquifer located southwest of the landfill.

Re-evaluation of the data indicates the contaminants detected in soil samples collected from boreholes located in the southern part of the landfill have not been detected in the contaminant plume to the south. In addition, the random disposal of wastes, as described in response to comment number 58, may provide an explanation for the vapors detected in the southern portion of the landfill.

63. Section 6.1.1.1, Page 3, Paragraph 3

The text states that "of the soluble metals detected in the upgradient alluvial groundwater samples, only chromium exceeds the Safe Drinking Water Act (SDWA) maximum contaminant level (MCL) concentration of 50 µg/L." However, in reviewing Table 6-1, it is reported that aluminum also exceeds the SDWA MCL and the upper limit of the regional background range. The text should be revised to reflect the information in Table 6-1.

The maximum concentration of 1280 µg/L is an outlier value. It was a one-time detection in five samples from this well. Fifteen samples collected from the upgradient alluvial wells are below the detection limit of 200 µg/L.

64. Section 6.1.2.1, Page 5, Paragraph 2

The text states that there may be an upgradient source of chromium. Additional justification (analytical or otherwise) for this statement should be provided, because (1) the high chromium values were detected for some BLM wells only one time, and (2) sampling of other BLM wells on February 6, 1989, was only a onetime sampling for the presence of chromium. The conclusion of an upgradient chromium source is based mainly on analytical results from a sampling round that was conducted in February 1989. Although high chromium concentrations were detected in several monitoring wells sampled during that sampling round, it seems to be an anomalous condition when comparing these results with the results collected from these wells over the historical sampling activities. For example, the chromium values listed in Appendix N for 2-6-89 (wells BLM-14, 15, 17, 18, 20, and 21), are nearly twice the average chromium values of all other samples collected from those wells. For BLM-14, the average chromium concentration drops from 54.7 to 46.3 micrograms per liter (µg/L) if the 113 µg/L value detected on February 6, 1989 is not included in the average calculation. BLM-15 averages 18.4 µg/L without the 82.4 µg/L value detected on February 6, 1989. Also, Appendix N indicates that detection of chromium in several of the wells occurred only on February 6, 1989. Because that was a one-time occurrence, it seems to represent an anomaly.

The analytical data for background alluvial wells support the statement that an upgradient source of chromium may exist. As stated in the comment, for BLM-14, the average chromium concentration drops from 54.7 to 46.3 micrograms per liter (µg/L) if the 113 µg/L value detected on February 6, 1989 is not included in the average calculation. These two average values are within the same order of magnitude. Total (unfiltered) metals analyses were performed for the February 1989 event, resulting in anomalously high metals results.

Chromium concentrations in the upgradient wells are at detectable concentrations. Review of groundwater data for other wells within the study area, including those located in and south of the landfill, generally show nondetections, whereas chromium is detected in wells located in the unnamed arroyo (BLM-17 and BLM-18), downgradient of wells BLM-14 and BLM-15. The BLM feels the analytical data support the conclusion that an upgradient chromium source may exist.

65. Section 6.1.3, Page 6, Paragraph 1

The text notes that elevated chromium values were consistently measured in several sampling events in all five upgradient wells. However, a review of the analytical data for BLM-40 in Appendix N (page 118), shows that chromium was not detected in groundwater samples. The results should be reevaluated and this statement altered to reflect the data available, because BLM-40 is one of two upgradient bedrock aquifer background wells.

The BLM has re-evaluated the chromium results for the five upgradient wells and agrees that chromium contamination is present in only the three alluvial upgradient wells. The introductory paragraph of subsection 6.1.3 will be revised to state "The groundwater analytical results for the *background alluvial wells indicate that there may be a source of chromium in the upgradient alluvial aquifer. Consistently elevated values of dissolved chromium were measured during several sampling events in the three alluvial upgradient wells." Additionally, the last paragraph of Subsection 6.1.2.1 will be revised to reflect the fact that the chromium detected in February 1989 in a sample from well BLM-16 is an anomalous value because it is a total (unfiltered) analysis versus filtered analyses for all other sampling events.*

66. Section 6.1.3, Page 7, Paragraph 2

Chloride, sodium, total dissolved solids (TDS), and sulfate concentrations were used as indicator parameters of downgradient groundwater contamination. In Paragraph 1 of this page, it is also noted that the lagoons contained high concentrations of BTEX and chlorinated hydrocarbons. Since the contents of the lagoons were sampled and characterized, BTEX could have and most probably should have been used as indicator parameters as well. Explain why benzene, toluene, ethylbenzene, and xylene (BTEX) were not used as an indicator parameters. Give attention to the proximity of Giant Refining in this explanation.

Benzene, toluene, ethylbenzene, and xylene were used to identify contamination but were not applicable to identifying a plume from the landfill. The intent of Subsection 6.2 is to present an additional technique commonly used to identify contamination: the study of general chemistry parameters. The general chemistry parameters used as indicators are chloride, total dissolved solids (TDS), sodium, and sulfate. Both inorganic and organic compounds were used to identify groundwater contamination. The introductory paragraph of Subsection 6.2, Distribution of Primary Groundwater Constituents, will be revised to clarify the intent of this subsection.

The issue of the proximity of Giant Refining with respect to BTEX contamination is addressed in Subsection 6.5.1.1 of the RI Report. BTEX is found in the groundwater on Giant-Bloomfield Refinery property. Floating product (gasoline and diesel fuel) have been detected on Giant-Bloomfield Refinery property, but not in Site 1, north of well GBR-24.

67. Section 6.2.1.2, Page 9, Paragraph 3

Sulfate is being used as an indicator parameter for contamination in the aquifer. Discuss the relationship of high sulfate concentrations to the potential for the presence of contamination in the alluvial groundwater. It is stated that "only two alluvial monitoring wells (BLM-17 and BLM-21) at the southwest corner of the landfill exceed the maximum background (upgradient) sulfate concentration." It is also noted that the upgradient maximum sulfate concentration is 2,120 mg/L. In reviewing the data for BLM-17 and -21, it is found that the maximum sulfate concentrations identified were 4,370 and 2,800 mg/L, respectively, and that all other sulfate values from these wells ranged from 1,000 to 1,300 mg/L. Provide an explanation as to how the maximum background value was derived.

The introduction to Subsection 6.2 states that sulfate was used as an indicator because relatively low levels of sulfate were detected in some of the lagoon samples. Groundwater contamination originating from the former landfill lagoons should, therefore, have low sulfate concentrations. The following sentences will be added to the revised report: "The maximum background concentration of sulfate in the alluvial aquifer was determined from the analytical results for the three background alluvial monitoring wells BLM-14, BLM-15 and BLM-39. Alluvial background concentrations for sulfate range from 420 to 2,120 mg/L."

The statement that sulfate concentrations in subarea 2 alluvial groundwater fall within background concentration ranges is true, with the exception of two outlier values detected in wells BLM-17 and BLM-21. Therefore, the text will be revised to read "Sulfate concentrations range from 195 to 4,370 mg/L in subarea 2 alluvial groundwater and with the exception of two outlier values, fall within the background concentration range (Table 6-5). Sulfate concentrations during two different sampling *events for wells BLM-17 (4,370 mg/L) and BLM-21 (2,870 mg/L) exceed the maximum background concentration of 2,120 mg/L. However, these concentrations were one-time anomalies with all subsequent sulfate concentrations in these wells detected below the maximum background concentration. Because sulfate concentrations in the subarea 2 alluvial groundwater are within background concentrations and are not significantly lower, sulfate does not seem to be an indicator of groundwater contamination from the former lagoons."*

68. Section 6.2.1.3, Page 9, Paragraph 1

The text states that the variation in groundwater quality between these GBR wells and BLM wells may be a result of several factors discussed in Subsection 6.4. The factors to be discussed were not found in Subsection 6.4. Subsection 6.4 refers to the discussion in Subsection 6.2.1.3. A discussion should be included in the report.

There are differences that cannot be explained. It is speculation to state what caused the differences in groundwater quality without evidence. Wells were installed near (within 25 ft) Giant wells and the differences were noted through the groundwater analytical results. The sentence will be removed from the text.

69. Section 6.2.1.3, Page 9, Paragraph 4

The text states that the highest sodium concentration was 1,060 mg/L. However, a review of Appendix N, Page 237, shows that the highest sodium concentration reported for well GBR-48 was 1,176 on June 13, 1989. The text should be corrected to indicate this.

The BLM agrees the concentration should be changed. However, upon reevaluation of the sodium data for the wells GBR-32, GBR-48, and GBR-49, the highest sodium concentration was detected at 1,199 mg/L in GBR-49 on March 14, 1989 (Appendix N, p. 242). Therefore, the text will be corrected from 1,060 mg/L to 1,199 mg/L.

70. Section 6.2.1.3, Page 10

The text states that BLM wells adjacent to wells GBR-32, GBR-48, and GBR-49 had sodium concentrations near background values (173 to 452 mg/L). Although some of the adjacent BLM wells did have concentrations near background levels, some of the concentrations were above the background levels. Explain the high sodium concentration in adjacent well BLM-62, which had an average value, for six samples, of 593 mg/L.

Sodium concentrations for BLM-62 are as follows: 562, 619, 697, 578, 617, and 486 mg/L (Appendix N, RI Report). These high sodium concentrations in BLM-62 cannot be explained. However, the sodium concentrations detected in the GBR wells range from 386 to 1,199 mg/L and averages 775.2 mg/L, indicating that concentrations from BLM-62 are between background and the high concentrations detected in the GBR wells.

71. Section 6.2.1.3, Page 10, Paragraph 1

The text states that "sulfate concentrations in wells GBR-32, GBR-48, and GBR-49 are slightly lower than the sulfate concentrations in adjacent wells." The text should be revised to indicate that, in Appendix N, only the sulfate concentrations in BLM-62 were higher, with a value of 2,330 mg/L. Also, the sulfate concentrations in the adjacent wells were in the same range as those in the GBR wells, and several were slightly lower.

The BLM agrees and the text will be revised.

72. Section 6.2.1.3, Page 10, Paragraph 1

The text states that low sulfate values may indicate that microbial reduction of sulfate is an ongoing process in Subarea 3. This hypothesis was to be the topic of additional discussion in Subsection 6.4, where contamination in the southern area of OU 2 is described, and in Subsection 6.6.1, where stable sulfur isotope results are analyzed. However, the hypothesis of microbial reduction or biological degradation is discussed in Subsection 6.4.1.2.2 only as it relates to chlorinated aliphatic hydrocarbons, not sulfate isotopes. The report should be revised to discuss this hypothesis in the sections referenced.

The sentences regarding sulfate microbial reduction will be removed from the text.

73. Section 6.2.1.4, Page 10

The individual figures showing the distribution of each contaminant plume in relation to the wells used to construct the plumes should be included for review to (1) support the conclusion that the contamination in this area is not related to the activities at the landfill, and (2) provide a clear picture of the relationship of the distribution of contaminants identified in the alluvial groundwater in Site 2.

The BLM has made the decision not to define contaminant plumes or specific areas of contamination for the Giant-Bloomfield Refinery. Therefore, individual figures showing contaminant plumes on Giant property will not be provided. However, Figures 6-5 through 6-9 indicate wells with floating product and concentrations of BTEX and total chlorinated hydrocarbons for various sampling events. Plumes are not identified, but concentrations for each well are presented for the reader to interpret. The intent of subsection 6.2 is to discuss the distribution of primary groundwater constituents (chloride, TDS, sodium and sulfate) within the various study subareas. Discussions of contaminants such as BTEX, chlorinated solvents, and manganese are provided in subsections within Section 6. As stated in subsection 6.2.1.4, there is an area of contamination in Site 2 located at the former Giant-Bloomfield Refinery facility that is defined by chloride concentrations.

74. Section 6.2.1.4, Page 10, Paragraph 1

If the GBR wells are to be used to determine the distribution of contamination at a particular horizon, the placement of the well screen is crucial. It is not clear whether the screened sections of the GBR wells discussed in this paragraph are limited to the alluvial aquifer or span both the bedrock and alluvial aquifer. The screened horizon is not given for several of the GBR wells listed in Appendix N. To provide an adequate review of the well information and its relevance to the aquifers, all well information should be included in the report.

A large volume of data has been collected by Giant during their investigations. The BLM decided early in the data presentation process not to provide all the data collected by Giant because completeness and accuracy of the datasets could not be guaranteed. The data collected by Giant were for purposes other than a remedial investigation and were collected under different standard operating procedures and quality assurance/quality control protocols. Additionally, the conclusions regarding groundwater contamination within the Lee Acres Landfill Study Area are not drawn solely from Giant wells or data. Data collected by Giant within Site 1 are used to substantiate the conclusions resulting from the BLM's performance of the Lee Acres Landfill remedial investigation.

The well screen intervals for Giant wells are provided where they are known based on the data available to the BLM. All known information relating to Giant wells is provided in the RI Report appendixes.

75. Section 6.2.1.4, Page 10, Paragraph 1

Monitoring well GBR-47 is referenced as being in Site 2. However, the survey coordinates for GBR-47 in Appendix N, on Page 231, place it in Site 1, Subarea 3. Plate 1 should be revised to reflect the proper location.

The survey coordinates for monitoring well GBR-47 will be corrected in the revised RI Report.

76. Section 6.2.2, Page 11, Paragraph 1

It is stated that "chloride concentrations in the bedrock aquifer are quite consistent and are generally less than 40 mg/L (Table 6-5). It does not appear that any sources of chloride have affected the chemical composition of bedrock alluvial aquifer waters." This statement must be justified or deleted. All information from the tables and appendices should be included for discussion to support all conclusions and assumptions made in the text. For example, Table 6-5 shows chloride values in the bedrock aquifer ranging from 15.1 to 448 mg/L, and Table 6-3 gives the background chloride concentrations ranging from 10.8 to 26.1 mg/L. Data in Appendix N show that a sample from BLM-26 contained 448 mg/L chloride on June 1988, but that 11 other samples, including seven subsequent samples, averaged 33.4 mg/L. Although the concentrations have been shown to be consistently less than 40 mg/L, there are apparent outlying concentrations. To provide for a comprehensive report, a discussion of the outlying concentrations is needed.

Paragraph 1 of Subsection 6.2.2 will be revised to read "Chloride concentrations in the Site 1, OU 2 bedrock aquifer are generally consistent at concentrations less than 40 mg/L (Table 6-5). Generally, it does not appear that any sources of chloride have affected the chemical composition of bedrock aquifer waters within the study area, with one exception. South of U.S. 64, in Site 2, well BLM-26 has a high chloride concentration, possibly indicating that alluvial contamination in the vicinity of this well has moved into the bedrock aquifer. In addition, south of U.S. 64, the bedrock and alluvial aquifers are connected. An analysis of other constituents and contaminant distribution is necessary to form any firm conclusions."

77. Section 6.2.3, Page 12, Paragraph 3

The discussion of the hydraulic relationship between the bedrock and alluvial aquifers in this paragraph is deficient. It has been stated in other sections that the vertical hydraulic gradient on the west side of the arroyo is downward and that the vertical gradient on the east side of the arroyo is upward. The significance and possible impact of variations in the vertical gradient should be discussed more thoroughly.

The hydraulic relationship between the bedrock and alluvial aquifers has been addressed in comment number 22. The text will be revised to read "potential horizontal and vertical gradients". The paragraph in subsection 6.2.3 will be revised to clarify the relationship. Additionally, vertical gradients have no influence on the plume or flow regime because the plume exists in a confined system.

78. Section 6.3.1.1, Page 13, Paragraph 4

The generalization is made that it is common for metals to form oxyanions under oxidizing conditions. This is an oversimplification of metal oxidation and is generally not true under ambient environmental conditions. Further justification should be provided to support this statement, or it should be deleted from the text.

The oversimplification of metal oxidation was made in the attempt to explain this process to the layperson. Additional discussion of metal oxidation will be provided in the revised RI Report.

79. Section 6.3.1.1, Page 14, Paragraph 2

The text indicates the average chromium concentration for BLM-51 is 54.3 μg/L. However, the highest value listed in Appendix N is 20.0 μg/L. The text and the appendix should reconciled.

The text should refer to well BLM-52 and not BLM-51. The text will be revised.

80. Section 6.3.1.1, Page 14, Paragraph 3

Chromium concentration in GBR-32 is 0.27 mg/L or 270 μg/L, and not 70 μg/L as presented here. The text should be corrected.

The text will be corrected to read "In the OU 2 southern area of contamination, all the BLM wells had chromium concentrations less than the SDWA MCL. However, one GBR well in OU 2, GBR-49, had a concentration of 60 μg/L, which exceeds the SDWA MCL of 50 μg/L."

81. Section 6.3.1.2, Page 16, Paragraph 2

It is stated that trichloromethane data for BLM-56 are listed in Table 6-8. However, a review of Appendix N indicates that reported concentrations of trichloromethane above detection limits were not presented. Clarify and correct this deficiency.

Trichloromethane is the International Union of Pure and Applied Chemistry (IUPAC) name for chloroform. The trichloromethane data for well BLM-56 appears in Table 6-8 and Appendix N as chloroform. The text and Table 6-8 will be revised.

82. Section 6.3.1.2, Page 16, Paragraph 3

The TCE data for BLM-43, BLM-60, and BLM-21 are not given in Appendix N. Clarify and correct this deficiency.

TCE (trichloroethene) was not detected in wells BLM-43, BLM-60, or BLM-21. The text states that trichloromethane was detected once in these wells. As stated in the response to comment number 81, trichloromethane is the IUPAC name for chloroform. The text and tables will be clarified.

83. Section 6.3.2.1, Page 17, Paragraph 1

The second sentence of this paragraph states that chromium is identified as a contaminant of concern (COC), and sentence 6 of this paragraph concludes that chromium is not a COC because it is considered to be from an upgradient source. These two sentences contradict each other. If chromium is not going to be considered a COC, this decision must be justified and explained. The justification must include the technical reasoning, because background chromium values for the bedrock aquifer are based on one sample in February 1989 for well BLM-16 and no chromium values for BLM-40.

The statement "Chromium is the only COC identified" will be revised to read "Chromium is the only metal in the bedrock aquifer that exceeds regulatory standards." As identified in previous comments, chromium was detected only in one sample, which was from the February 1989 sampling event. The chromium data will be re-evaluated to determine if this value is significant, or if the monitoring program needs to be modified.

84. Section 6.3.2.1, Page 17, Paragraph 1

The text notes that chromium is identified as a background contaminant in the bedrock aquifer. This statement must either be deleted from the text, or the higher background chromium value must be fully supported. Background chromium values for the bedrock aquifer are based on one sample in February 1989 for well BLM-16 and no chromium values for BLM-40. Page 14, Paragraph 1 indicates that chromium values for February 1989 are anomalously high. Therefore, it appears that the conclusion that background chromium concentrations in the bedrock aquifer are elevated is not substantiated.

Chromium is not a contaminant in the bedrock aquifer and all references in the text will be corrected. See response to comment number 83.

85. Section 6.4.1, Page 19, Paragraph 1

The text states that BLM-62 was installed adjacent to GBR-32. Plate 1 indicates that the wells are over 30 feet apart. The text should be revised to reflect the lateral differences between the two boreholes because of the possible lateral variations in lithology at the site.

The phrase "adjacent to" will be revised to "approximately 25 ft east of".

86. Section 6.4.1.1, Page 19, Paragraph 2

The text in Section 6.2.1.3, Page 9, indicates that the elevated chloride values in GBR, compared with those in BLM wells, will be explained in this section. No explanation is apparent. The text should be corrected.

As stated in the response to comment number 68, an explanation of the differences cannot be made. The text will be revised to remove this reference in the revised document.

87. Section 6.4.1.2.1, Page 20, Paragraph 1

Figure 6-2 shows the extent of chlorinated hydrocarbon contamination in the southern area alluvial aquifer. The clarity of this figure needs to be improved; therefore, the scale should be increased, similar to that used for Figure 6-4. Also, the concentration values should be contoured by using an algorithm to indicate the distribution of contaminants within the plume/slug. If data are available, a time sequence of the contaminant distribution should be presented.

The figure will be revised to the same scale used for Figure 6-4. Contour maps using an algorithm were attempted during data analysis. Contouring misrepresented the data because the eastern extent of the alluvial aquifer is within approximately 25 ft of some wells and contaminant contours extended eastward where alluvial groundwater does not exist. Additionally, the wide variation in concentrations (from 1 to 200 μg/L) within an area approximately 200 ft wide by 600 ft long, resulted in "bulls eyes". Therefore, contour maps were not provided.

88. Section 6.4.1.2.2, Page 22, Paragraph 1

Sources for the information presented in this section on chlorinated VOC degradation should be cited in the text.

The references for the information concerning chlorinated VOC degradation are given below and will be incorporated into the revised document:

Olsen, R.L., and A. Davis. 1990. "Predicting the Fate and Transport of Organic Compounds in Groundwater, Part 1." Hazardous Materials Control. May/June 1990.

Davis, A., and R.L. Olsen. 1990. "Predicting the Fate and Transport of Organic Compounds in Groundwater, Part 2." Hazardous Materials Control. July/August 1990.

89. Section 6.4.1.2.4, Page 24, Paragraph 2

The text states that the distribution of dichloromethane is shown on Figure 6-2. However, only the area of chlorinated hydrocarbon contamination is shown in the figure. The text and the figure should be reconciled.

The distribution of dichloromethane is shown on Figure 6-2 with "" next to the appropriate wells. The figure will be revised for clarity.*

90. Section 6.5.3, Page 32, Paragraph 1

Potential sources of contamination at the Giant Bloomfield Refinery listed in this section and their relationship to the landfill should be shown on a figure.

Locations of these potential sources cannot be verified. To locate the potential sources on a figure implies knowledge and exactness that the BLM does not have. In addition, the topic of potential contamination at Giant-Bloomfield Refinery relates to the issue of Site 2 contamination and requires further discussion.

91. Section 6.6.1, Page 36, Paragraph 3

Figure 6-10 contains a summary of the stable sulfur isotope data. All of the isotope data should be included in this table, and the table should be expanded to include the data on which the summary statistics are based.

The stable sulfur isotope data are provided in Appendix N. However, Table 4 is a summary table presenting the sulfur isotope data and will be included in the revised document. Table 6-26 will be revised to include footnotes identifying the data used for each statistic calculation.

92. Section 6.7, Page 43, Paragraph 1

The text states that chromium contamination is present in the groundwater upgradient of the landfill. As noted previously, this finding should be reevaluated. Additional groundwater samples should be collected and analyzed for chromium to support the conclusions of the report.

The BLM feels that an upgradient alluvial source of chromium may exist. The response to comment number 64 states that the analytical data for background alluvial wells support the statement that an upgradient source of chromium may exist. Chromium concentrations in the upgradient wells are at detectable concentration. Review of groundwater data for other wells within the study area generally show nondetections. Chromium is not detected in the alluvial wells located in the landfill. However, it is detected in BLM-17 and BLM-18, located within the unnamed arroyo, and downgradient from BLM-14 and BLM-15. Additionally, the groundwater samples collected in August 1992 confirm the presence of chromium in the upgradient wells as discussed in the Data Report (separate attachment). The BLM is developing an ongoing groundwater monitoring program that will include the upgradient wells.

Table 4. Stable Sulfur Isotope Analytical Results

SITE: BLM01 BLM (Lee Acres)
02/26/90 TO 03/22/90
REPORT DATE: 01/09/93

PARAMETER NAME	LOCATION ID	LOG DATE	SAMPLE ID	FORM COMP	FLOW REL.	UNITS OF MEASURE	PVI	PARAMETER VALUE	DETECTION LIMIT	LAB CODE	DILUTION FACTOR
ISOTOPIC SULFER RATIO	B051	03/20/90	0001	DA	2	%		0.8	-	KRU	-
	B052	03/20/90	0001	SA	2	%		-2.5	-	KRU	-
	B053	03/21/90	0001	BR	2	%		4.3	-	KRU	-
	B054	03/04/90	0001	BR	2	%		8.7	-	KRU	-
	B055	03/04/90	0001	SA	2	%		-6.1	-	KRU	-
	B056	03/05/90	0001	DA	2	%		-1.6	-	KRU	-
	B057	03/21/90	0001	SA	2	%		2.8	-	KRU	-
	B058	03/05/90	0001	SA	2	%		-6.7	-	KRU	-
	B059	03/02/90	0001	BR	2	%		-8.1	-	KRU	-
	B060	03/02/90	0001	SA	2	%		-4.3	-	KRU	-
	B061	03/21/90	0001	BR	3	%		-2.4	-	KRU	-
	B062	03/21/90	0001	SA	3	%		2.9	-	KRU	-
	B063	03/21/90	0001	BR	3	%		4.5	-	KRU	-
	B064	03/21/90	0001	BR	3	%		2.0	-	KRU	-
	B065	03/20/90	0001	SA	4	%		1.8	-	KRU	-
	B066	03/20/90	0001	SA	4	%		0.0	-	KRU	-
	G018	03/22/90	0001	BR	3	%		2.0	-	KRU	-
	G032	03/22/90	0001	SA	3	%		0.1	-	KRU	-
	G048	03/22/90	0001	SA	3	%		0.1	-	KRU	-
	G049	03/22/90	0001	SA	3	%		-0.5	-	KRU	-
	G050	03/22/90	0001	SA	3	%		1.8	-	KRU	-

FORMATION OF COMPLETION CODE:
DA - DEEP ALLUVIAL AQUIFER
SA - SHALLOW ALLUVIAL AQUIFER
BR - BEDROCK AQUIFER

FLOW RELATIONSHIP CODE:
2 - SUBAREA 2
3 - SUBAREA 3
4 - SUBAREA 4

PARAMETER VALUE INDICATOR (PVI): U - LESS THAN DETECTION LIMIT

DATA FILE NAME: K:\DART\BLMX\BLM01\GWQ10004.DAT

Regarding chromium contamination in the bedrock aquifer, the BLM agrees that the data do not substantiate this conclusion. Responses to comment numbers 65, 83, and 84 address the corrections to the RI Report.

93. Section 6.7, Page 44, Paragraphs 2 and 3

The text states that chromium is not a contaminant of concern. As previously noted, this conclusion should be reevaluated.

Chromium concentrations in groundwater within the landfill range from not detected to 22.4 μg/L. Concentrations in the upgradient well BLM-14 range from 31.8 to 50.4 μg/L. The concentrations upgradient of the landfill are higher than chromium concentrations detected in wells located in the landfill. Therefore, chromium is not from the landfill and may be from an upgradient source that is not the responsibility of the BLM to identify.

94. Section 7

The current model calibrations do not appear to produce an acceptable match between field data and simulated values. Therefore, these models should not be used to characterize the concentration distribution of contaminants within the plume boundaries. The conclusion that Site 2 groundwater contamination is unrelated to former landfill activities is overstated. The model results suggest that, based on the assumptions used, groundwater contaminated by 1,2 DCE may not have originated from the former liquid waste lagoons. The text should draw conclusions that can be supported by the data and analyses.

It is proposed that this model be removed and an analytical approach used. A separate position paper is provided as Appendix F to these responses that addresses this proposal. The identification of Site 1 and Site 2 has been based on the analytical data and the proposed approach will be used to further delineate the location of the BLM plume.

95. Section 7

Throughout this report, there is the assumption that the contaminant sources in the area designated as Site 2 are not in any way related to the landfill. This assumption is stated as fact. Examples of the RI assumption are:

> Section 8, page 1, 2nd paragraph, last sentence: "A pathway analysis for Site 2 is not performed because contaminant sources are unrelated to the landfill."
>
> Section 8, page 4, 1st paragraph, last sentence: "Human exposure pathways to the San Juan River were not included in the analysis as the river is located in Site 2."
>
> Section 9, page 1, 1st paragraph, 3rd sentence: "A conceptual site model has not been developed for Site 2 because contaminant sources are unrelated to the former landfill."

A two-site interpretation is presented in subsection 1.1 of the RI Report. It is BLM's belief that further evaluation of Giant-Bloomfield Refinery data and the results of the revised groundwater modeling, the approach to which is described in the Groundwater Fate and Transport position paper (Appendix F), will support the interpretation that landfill contaminants have not entered Site 2. In addition, the landfill history, groundwater quality, groundwater level and hydraulic data, and modeling strongly suggest that contaminant sources are unrelated to the landfill.

96. Section 7

EPA has determined the model to be incomplete and not representative of the actual conditions at the Lee Acres Landfill. The most significant flaw in the model is in its setup. The East boundary condition chosen is a poor selection. Specifically the model does not attempt to address the data available from the Giant Refining Wells because the East boundary or "no-flow" condition is West of these wells. The RI report then in turn makes the determination that the plumes from the landfill and the refinery are separate and distinct and discontinues discussion about possible contamination in and around Giant Refining. Simple hand plotting of Chlorides, Chlorinated Solvents, Total Dissolved Solids, and Petroleum Hydrocarbons quickly indicate that more consideration and effort should have been spent on determining the model boundary conditions and contaminants selected to illustrate extent of the groundwater contamination. The RI, and therefore the model, should address all the data available, including the data available from the Giant Refinery Wells.

BLM has made the decision to evaluate contaminants that may have originated at its site, the former Lee Acres Landfill. BLM is not responsible for evaluating the migration of contaminants origining from its downgradient neighbor, the Giant Refinery.

BLM agrees that the RI should incorporate groundwater data from Giant's remediation project, which is under the jurisdiction of the New Mexico Oil Conservation Division. The appropriate data and its usability should be discussed in future technical meetings.

97. Section 7

There are four general classifications of problems with the model: (1) assumptions, (2) discretization, (3) calibration, and (4) the HELP simulation.

The first three classifications are addressed in Appendix F. The fourth classification is discussed specifically in other comments and responses to comments.

98. Section 7

The modeling effort ignored coupling between the bedrock and the alluvial aquifer yet the field piezometric data suggests that interaction exists. In particular, throughout most or the area of concern flow occurs from the bedrock aquifer to the alluvial aquifer. Hence, the assumption that infiltration equals leakage to the bedrock aquifer does not appear valid. In addition, it is not clear what role well BLM-37 has in potentially effecting the flow conditions in the aquifer.

As stated in the response to comment number 22, some well clusters indicate differences in the vertical hydraulic gradient. Appendix F proposes an analytical approach that should be discussed with EPA.

Clarification is requested regarding the comment on well BLM-37.

99. Section 7

Although no fundamental problems are apparent in the grid design, it is recommended that the discretization scheme be tested to ensure that it does not influence the accuracy of the solution. This can be accomplished by decreasing (preferably halving) the grid spacing and comparing the solutions.

It is proposed that the modeling presented in Section 7 of the RI Report be removed. Appendix F proposes an analytical approach.

Comments 100 through 108, and comments 110 through 113, will be addressed in direct conversations with EPA regarding the new modeling approach presented in the position paper (Appendix F).

100. Section 7

The weakest part of the modeling effort was in the calibration process. Specifically, the calibrated retardation values for manganese and DCE are approximately the same, 2.4 and 2.5 respectively. This correlation is contrary to general geochemical principles as the partition coefficient of organic compounds are typically different than inorganic compounds. Furthermore, the retardation value used in the Random Walk modeling effort does not agree with that utilized in the HELP modeling effort (EPA used both a Random Walk Solute Transport code and the Hydrologic Evaluation of Landfill Performance (HELP) model). It is recommended that retardation should be estimated from laboratory breakthrough curve analyses using aquifer materials from the site. In addition, it is uncertain why dispersivity was not calibrated.

Please see Appendix F.

101. Section 7

The process of calibration could be improved by randomly selecting the parameter values for dispersivity and retardation rather than assigning various retardation values to a fixed dispersivity value. Most importantly, the simulated contaminant plumes derived from the results of the calibration did not agree with the measured concentrations. In particular, the inaccuracy of the simulated values for DCE exceeded 100 ppm at some sell [sic] locations. As a result this and the poorly defined no-flow boundaries, the stated conclusions derived from the modeling effort are extremely questionable and unsupported.

Please see Appendix F.

102. Section 7

The leachate concentrations predicted by HELP simulations are not conservative. In order to arrive at conservative values, chemical equilibrium between soil and leachate should be assumed.

For example, based on a linear partitioning, the leachate concentration of DCE (Table 7.8) should be:

$$C = S/K_d = 14\ \mu g/kg\ /\ 0.1\ L/kg = 140\ \mu g/L$$

where
C = concentration in water
S = soil concentration
K_d = partitioning coefficient

The predicted HELP value is only 12.68 μg/L, which is an order of magnitude smaller than the conservative value. In addition, the use of material gradation to determine the capillary pressure data is a questionable assumption. It is recommended that actual moisture retention analyses be conducted to determine this important model parameter value.

Please see Appendix F.

103. Section 7

However, modeling objectives are clearly stated, model assumptions and the rationale for selection of model input parameters are addressed, and there is a discussion regarding model limitations. The models for manganese and 1,2 DCE should not be used to predict the concentration of contaminants in groundwater within the plume boundaries because the models do not appear to be fully calibrated based on regression analyses.

Please see Appendix F.

104. Section 7

The quality of several figures presented in Section 7.0 of the report should be improved. For example, the contours and labels for chemical isoconcentration lines in Figures 7-1, 7-2, 7-3, 74, 7-7, and 7-8 are illegible. In some figures, isoconcentration lines appear to overlap.

BLM agrees and the quality of these or similar figures will be improved in the revised report.

105. Section 7.1, page 3, Paragraph 2

It is unclear whether the version of Random-Walk used in this modeling exercise is numerical or analytical. The text states that the Random-Walk solute transport model (Prickett, 1981) was used to simulate the migration of manganese and 1,2 DCE. In the numerical version of Random Walk, particles are moved by advection based on velocity vectors derived through finite difference methods. However, the text states that groundwater flow is modeled by a single velocity vector with an x and y component, and that groundwater flow and boundaries are not considered explicitly. If an analytical function driven version of Random-Walk was used, the text should state this and provide an appropriate reference for the source of the model code. The text should also point out that the boundary conditions described in Section 7.1, page 3 only apply to the conceptual model of the site, and that the model assumes that the aquifer is infinite in areal extent.

Please see Appendix F.

106. Section 7.1, page 4, Paragraph 2

The text states that the version of Random-Walk used in the modeling investigation assumes one-dimensional advection. The analytical version of the computer code is not but should be documented and referenced.

Please see Appendix F.

107. Section 7.1, page 4, Paragraph 2

The text states that a portion of the modeling grid was bent at a 10-degree angle. It is unclear how the model grid was bent since it is not discussed in the Random-Walk model documentation (Prickett, 1981). In fact, groundwater model grids cannot be bent and two-dimensional groundwater flow cannot be modeled with a unidirectional flow field. The presentation of results related to model grid development and plume migration appears to be either misleading or hypothetical. The text should be corrected to reflect the fact that (1) computer model grids cannot be bent, (2) the no-flow boundary conditions representing the eastern and western margins of the alluvium cannot be described using the assumption that the aquifer is infinite in areal extent, and (3) that the unidirectional steady-state flow field assumed in the transport model can only provide an estimate of the distance a contaminant plume may migrate downgradient.

Please see Appendix F.

108. Section 7.3, page 7, Paragraph 4

A nonstandard method of calibration is used. In addition, the calibration method does not appear to result in an acceptable match between observed and simulated ground-water concentrations. For example, independently generated regression analysis for the manganese and 1,2 DCE calibration data sets were determined. Computer output from these regression analyses appear in attached Figures 1 and 2. These figures indicate the correlation coefficient squared (R2) value for the manganese model calibration was equal to 0.69. The R2 value for 1,2 DCE model calibration was only 0.40. R2 values for calibrated groundwater models should be closer to 0.90. The regression analysis suggests that 31 percent of the variation between field data and simulated values cannot be explained by the contaminant transport model. Sixty percent of the variation between field data and simulated values for 1,2 DCE cannot be explained. The report should identify an acceptable R2 value, and support the use of this value prior to using model results to draw conclusions.

Please see Appendix F.

109. Section 7.4, Page 10, Paragraph 3

As per the above, the conclusion that Site 2 ground-water contamination is unrelated to former landfill activities is overstated. Based on the assumptions used, the model results suggest that groundwater contaminated by 1,2 DCE may not have originated from the former liquid waste lagoons. The text should draw conclusions that can be supported by the data and analyses.

The language can be changed to imply suggestion rather than fact in the conclusions.

110. Section 7.5, Page 10, Paragraph 4

Text refers to groundwater modeling and states, "This observation reveals that Site 2 groundwater contamination is unrelated to former landfill activities." It would be more accurate to state, "This observation suggests that Site 2 groundwater contamination is unrelated to former landfill activities." Again, a disproportionate amount of weight has been given to an inadequate model.

Please see Appendix F.

111. Figures 7-1 and 7-2, Pages 13 and 14

Results of simulation presented in Figure 7-2 indicate the 1,2 DCE plume is located along the eastern edge of the model grid. However, in Figure 7-1 the plume is located closer to the western boundary of the model grid. The inconsistency in the location of the 1,2 DCE plume should be corrected, or an explanation should be provided.

Please see Appendix F.

112. Figures 7-3 and 7-4, Pages 15 and 16

Results of simulation presented in Figure 7-4 indicate the manganese plume is located along the eastern edge of the model grid. However, in Figure 7-3, the plume is located closer to the western boundary of the model grid. The inconsistency in the location of the manganese plume should be corrected, or an explanation should be provided.

Please see Appendix F.

113. Figure 7-5, Page 17

Bending a model grid is not a standard modeling approach, and is not discussed in the Random-Walk model documentation (Prickett, 1981). A discussion of how this was accomplished should be provided.

Please see Appendix F.

114. Section 8, Page 2, Paragraph 1

The text states that decision networks were used to identify active pathways. EPA guidance (EPA, 1989) suggests that not only active, but also potentially active, pathways must be considered in the risk assessment.

The BLM requires clarification of this comment.

115. Section 8.1, Page 2, Paragraph 1

The results of the RI air sampling program indicate that there are not any current air emissions of concern occurring at the landfill. However, as noted previously, the sampling methodology used for gas emissions should be reevaluated. In addition, QA/QC data for the ambient air and soil gas analysis should be reviewed and included in the report.

This comment has been addressed as part of comments 26 and 27 (Section 3 comments).

116. Section 8.1, Page 2, Paragraph 2

This paragraph indicates that future remedial activity at the landfill may result in the release of potentially hazardous gases. EPA recommends that the risk assessment also consider other excavation activities, such as construction, which may occur if the property ownership changes.

The property will never change ownership. BLM will ensure that this property will be administratively withdrawn from any future uses.

117. Section 8.2, Page 2, Paragraph 1

The claim is made that surface water should not be considered a pathway, partly, because the gabion walls will provide permanent protection for the landfill contents. However, in Section 4.3, it is acknowledged that the gabion walls may sag because of undercutting by relatively high velocity floodwater during extreme events. While the conclusion that the surface water pathway does not need to be considered further appears to be justified, exaggerated claims about the permanence of the gabion walls should not be included in the report.

The text will be corrected to read "...the gabion walls provide a measure of protection against a 500-year flood."

118. Section 8.3, Page 3, Paragraph 2

The text states that landfill constituents may have leached into the alluvial aquifer. The text should be corrected to indicate that landfill constituents have leached into the alluvial aquifer. The statement in the text is not supported by the investigation results such as the analytical results, for (1) surface soil samples, (2) soil from well boreholes, (3) groundwater samples from alluvial aquifer wells, and (4) lagoon samples from previous investigations.

The text will be corrected.

119. Section 9, Page 1, Paragraph 2

The text states that disposal activity was minimal until 1970 and that 390,000 cubic yards of solid waste were disposed of from 1962 to 1970. In Section 5.4.4, the landfill is estimated to contain approximately 600,000 to 800,000 cubic yards of waste and contaminated soil. If the figures are correct, the characterization of waste disposal activities prior to 1970 as minimal is not appropriate. These figures should be checked and, if necessary, the text should be changed accordingly.

The text will be corrected.

120. Section 9, Page 2, Paragraph 1

As previously noted, the gabion walls should not be considered permanent, based on BLM's own modeling results.

See response to comment number 117.

In addition to the following responses for Section 10 comments, a position paper is presented in Appendix G which also addresses the following comments.

121. Section 10

The RA section of the RI report is not in conformance with RA guidance documents. Based on the information contained in the RA section of the RI report, EPA will require explanations by BLM and, in some cases, extensive revision. Such correction is necessary to bring the RA section into conformance with RA guidance documents and to be protective of human health and the environment.

In general, BLM believes that the RI Report is in substantial compliance with EPA's risk assessment guidance documents. In certain cases, such as the ecological risk assessment, BLM has agreed to revise the document to better conform to available guidance. Refer to the specific comments. Subsection 1.4 identifies the data quality objectives for the risk assessment; only Level IV or higher data collected during the RI were used for the RA. All elements of the data evaluation conformed to EPA's Assessment Guidance for Superfund (RAGS). Subsection 1.6 identifies the selection of contaminants of concern (COCs). BLM chose to select preliminary COCs in order to focus the RI discussions on nature and extent of contamination. This is why portions of the risk assessment are contained in other sections. Figures 1-6 and 1-7 present the process decision trees for identifying COCs in soil and groundwater, respectively. The analysis of the results from RI data collection activities, including the identification of soil and groundwater COCs, are presented in Subsections 5.1.3, 5.2.3, 5.3.3, 5.7.5, 6.1.1.1, 6.1.1.2, 6.1.2.1, 6.1.2.2, 6.3.1.1, 6.3.1.2, 6.3.2.1, 6.3.2.2, 6.4.1.1, 6.4.1.2, 6.5.1.3, 6.5.2.1, and 6.5.2.2. Additional detailed explanation of the data precedes these sections, and a thorough selection of COCs cannot be made without studying Sections 5 and 6 in whole. The initial list of COCs was then refined in the RA section based on comparisons to MCLs and toxicity screening. Comparisons to MCLs did not affect the results in screening for COCs and will be removed from Section 10. The RA section cross references these elements when they do not directly appear there; additional explanation and revision will be made wherever it is appropriate.

122. Section 10

One of the specific components associated with the RA is an exposure assessment. Much of the information required to support the exposure assessment was referenced as being in Section 8 Pathway Analysis - and Section 9 - Conceptual Site Model - of the RI report. However, in Section 8, the exposure pathways identified were not evaluated against the criteria outlined in the RA guidance for exposure assessment. If the proper guidance is followed, potential pathways of concern are evaluated in the exposure assessment of the RA. Therefore, a separate section evaluating the potential pathways is not necessary. Section 9 of the RI is also unnecessary, because a conceptual site model is used in the initial planning for the RI. At this point in the RI and RA, the conceptual site model does not provide any additional information. However after the RA is completed in accordance with the guidance documents, the conceptual site model can be refined to show the pathways supported by the RA.

The BLM disagrees with this comment. The exposure assessment and the evaluation of potential pathways are rigorously evaluated in the RI Report. In order to provide an integrated RI report and risk assessment, groundwater modeling, pathway analysis, and the conceptual site model were presented in the RI Report, and cross referenced when necessary. The criteria outlined in RAGS for evaluating exposure pathways were addressed and tailored for this document in order to provide continuity between development and implementation of the field program, the results of the Remedial Investigation, and the identification of risk associated with the Lee Acres Landfill. BLM disagrees that the site conceptual model (Section 9) does not belong in the document. The site conceptual model is the bridge between the RI and the RA. Note the elements in RAGS Sections 6.2 and 6.3 are equivalent to the site conceptual model. The changes in the format are identified below.

First, a detailed identification and characterization of sources and receiving media were presented in Sections 5 and 6. Next, evaluation of fate and transport in release media were presented in the groundwater modeling section (Section 7), and additional explanation (including the physical and chemical properties of chemicals) was given in Subsection 10.2. Fate and transport was also provided in Appendix X, Fate and Toxicity Profiles of the Contaminants of Concern. The identification of exposure points and exposure routes were presented in detail in the Pathway Analysis in Section 8, the Conceptual Site Model in Section 9, and in Subsection 10.2.2. Integrating the information on sources, releases, fate and transport, exposure points, and exposure routes into exposure pathways was performed in the Pathway Analysis in Section 8, where complete pathways were chosen having a source, an exposure point where contact can occur, and an exposure route by which contact can occur. The reasoning and justification for each of the decisions in the decision tree (Figures 8-1 to 8-5) will be expanded. A summary of the pathway analysis was provided in Subsection 8.6. Additional explanation, revision, and format changes will be included, references to RAGS will be made in Sections 8 and 9, and a new summary of the pathway analysis itself will be included in Subsection 10.2.

123. Section 10

In reviewing the section discussing the procedures for selecting the contaminants of concern, several problems were identified with the procedures that were followed. First, the information on selecting the contaminants of concern is scattered throughout Sections 1, 5, 6, and 10 of the RI report. Because this information is useful in reviewing the selection procedures, it would be beneficial for all of the information to be consolidated in the RA to provide for a comprehensive review. Second, it appears that the risk assessment guidance (EPA, 1989) was not followed in selecting the contaminants of concern. Based on the RA, it appears that elimination of contaminants was based on (1) laboratory contamination, (2) applicable or relevant and appropriate requirements (ARAR), and (3) frequency of detection.

The RA is part of the RI Report. In BLM's view, a comprehensive review of the RA requires reading of the RI document.

The selection of contaminants of concern was a phased process which is presented in the RI Report in the most organized manner possible. To repeat all this information again in the RA section would be redundant and make for an unwieldy document, however additional cross referencing may be appropriate. In addition, references to RAGS will be made in Sections 1, 5, 6, 8, and whenever appropriate.

BLM recognizes that selection criteria above and beyond RAGS procedures were used in the selection of COCs. The text accompanying the criteria used to compile the chemicals of concern will be expanded including: positive detection in at least one CLP sample in a given medium, detection at levels significantly above blank values, detection at levels significantly above naturally occurring levels, evaluating tentatively identified compounds, and evaluating transformation products of chemicals. However, all of the RAGS-specified selection procedures were observed, and this will be clarified in the revised text. In particular, EPA comments later that the comparison with ARARs was inappropriate. BLM agrees and this comparison has been de-emphasized. As a general rule, screening on the basis of detection will be made a consistent 5%, except for carcinogens which will be included.

124. Section 10

The decision trees (Figures 10-2 and 10-3) for identifying contaminants of concern indicate that chemicals may have been deleted from consideration in the risk assessment for reasons that are inconsistent with guidance. On Figure 10-2, one of the decision criteria - "Is concentration attributed to laboratory contamination? (Less than 5 or 10 times concentration in lab blank?)" - is unclear. It is recommended that clarification be added in the form of a statement that, when eliminating chemicals based on whether they were considered to be laboratory contaminants, the concentrations must be 10 times the blank concentration for chemicals considered to be common laboratory contaminants and five times the blank concentration for chemicals that are not considered to be common laboratory contaminants.

Figures 10-2 and 10-3 are simplified, and more easily followed representations of Exhibit 5-1 in RAGS. The text accompanying selection of contaminants on the basis of the 5X and 10X rules will be clarified.

125. Section 10

According to Figure 10-3, elimination of contaminants was based on regulatory standards, meaning ARARs. The risk assessment guidance (EPA 1989b) indicates that chemicals with ARARs are usually not appropriate for exclusion from the quantitative risk assessment. This is due partly because many ARARs are not solely health-based but may include adjustments for technical and/or economic feasibility.

The BLM disagrees with this comment. Elimination of a groundwater contaminant was never made wholly on the basis of regulatory standards. However, comparisons and references to groundwater ARARs will be de-emphasized from the RA, however, BLM believes that RCRA corrective action levels for soils should be kept as a screening criteria because they are health-based. Elimination of air data were made by comparing suitable background monitoring data with onsite data. All data for metals was statistically higher at the background location than on site. Data supporting elimination of organics will be tabulated and explained.

126. Section 10

In accordance with guidance (EPA, 1989b), known human carcinogens, such as benzene, should be retained for consideration regardless of whether frequency of detection and concentrations were low. Also, the criteria used to determine whether a chemical would be retained, based on frequency of detection, are not consistent. For example, 1,1,1-trichloroethane and total xylene, which were detected at 10 and 11 percent frequency of detection, respectively, were not retained (Table 10-6). However, 1,1-dichloroethane, which was detected at 7 percent frequency of detection, was retained (Table 10-7). A detection frequency limit should be stated in the text and observed consistently. According to guidance (EPA, 1989b), any detection frequency limit to be used, such as 5 percent, should be approved by the remedial project manager (RPM) for use in the risk assessment. Also according to guidance, when trying to reduce the number of chemicals of concern in the risk assessment "... the time required to implement and defend the selection procedures discussed in this section may exceed the time needed to simply carry all the chemicals of potential concern through the risk assessment" (EPA, 1989b).

The evaluation of contaminants of concern was never made wholly on the basis of frequency of detections; one-time "hits" of carcinogenic chemicals were not the sole criteria for eliminating that chemical. For example, a concentration-toxicity screen was used to identify relative risks of that chemical with other chemicals present. Screening on the basis of frequency of detection will be made a consistent 5%, unless otherwise indicated. In addition, carcinogenic chemicals were not generally screened out on the basis of frequency at all, unless that chemical was a common laboratory contaminant found in the laboratory blanks. The text will be clarified to emphasize the protocols used in the selection process.

127. Section 10

To determine a background location for collecting air samples to compare with air samples collected from the site, the guidance (EPA, 1989b) recommends that regional data be obtained from the U.S. Geological Survey or the Soil Conservation Service. Also according to guidance, it is appropriate to possibly eliminate inorganic chemicals from contaminants of concern if the inorganic concentrations are not higher than the background sample concentrations collected from the vicinity of the site. Section 3 of the RI states that a fire station was selected as a background location because it was representative of the air quality at the community nearest to the landfill. It is not appropriate to compare a remote location, such as the landfill, to an urban area, such as the fire station where other anthropogenic activities may have affected contaminant concentrations. This appears to hold true, since the concentrations for metals - Section 3, page 5 - and particulates -Section 3, page 25 - are consistently higher at the background than at the site. It is recommended that a background location be chosen, because it is unaffected by the site but represents an area similar to the site.

The BLM disagrees with this comment. The commenter refers to Section 5.7 of RAGS. This section discusses background samples in general, and does not refer to air sampling. The U.S. Geological Survey and Soil Conservation Service do not maintain ambient hazardous chemical databases for air contaminants, nor does any other agency. The Lee Acres Landfill is not situated in a "remote" (meaning pristine or rural) location. The location of a background air sampling station at the fire station provides a conservative representation of the air quality in the nearby industrial community. Both locations are in industrialized areas within the same airshed. Meteorological data from the fire station and the onsite station indicate that the fire station air monitoring station is laterally removed from the site and Giant-Bloomfield Refinery, indicating its suitability for background comparisons. This location provides adequate and sufficient air data for the Lee Acres Landfill area, which itself is located adjacent to a refinery, gas wells, and a major highway. No other background air monitoring station data collection is necessary.

128. Section 10

To complete an adequate review of the RA, it is imperative that all information including, but not limited to, calculations, formulas, and other relevant mathematical information, be included to reproduce the final calculated risks. Also, it is recommended that the report discuss in detail the (1) methodologies used to determine the concentrations used in calculating risks, and (2) assumptions used in calculating risks. For example, state whether the quantitation limit (QL) or one half of the QL was used as a proxy concentration if the QL is unusually high; or whether a chemical was not detected in a sample but was detected in other samples in the same medium. Also, it is not known whether the areas exhibiting higher metal concentrations were treated as hot spots or whether the concentrations were averaged over the entire site. Another example is the second assumption stated on Table 10-12. It states that both subchronic and chronic dose indices have been adjusted for adsorption, yet this is not discussed in the text.

Agree. An appendix with all calculations will be provided.

The methodologies used to determine the concentrations used in calculating risks and all assumptions will be clarified. For nondetects, one-half the QL was used in the calculations.

For all contaminants, including metals, a comparison between geometric average concentration (for the whole subarea) as well as the maximum concentration in the subarea was used in risk calculations. An explanation was provided that the "real" risks are conservatively bracketed between these extremes. Use of maximum concentrations is approved in RAGS and is more conservative than the 95% CI on the arithmetic average. Additional explanation regarding this approach can be added to the text.

More text explanation for the models will be added.

129. Section 10

A geometric average was used to calculate the exposure concentrations. Risk assessment guidance (EPA, 1989b) specifies that the arithmetic average of the concentration that is contacted over the exposure period be used for this concentration. Using the geometric average rather than the arithmetic average for the exposure concentration may result in lower risk levels being calculated. An explanation should be provided for not following the guidance on this issue. Also, to reproduce the data in the risk calculation, justify using a geometric average for the exposure concentration.

The BLM disagrees with this comment. As explained in the previous response, BLM used RAGS-approved maximum concentration as the reasonable maximum exposure (RME) exposure point concentration. EPA has recognized the need to provide a "full and complete estimate of risk" and that "information on the range of exposures derived from exposure scenarios and on the use of multiple risk descriptors." This guidance, contained in a May 26, 1992 memorandum from Henry L. Longest, II to regional waste management directors (Implementing the Deputy Administrators risk Characterization Memorandum) goes on to stress the need for estimates of central tendency exposure and risk.

Data were tested for normality and were determined to be non-normally distributed. Therefore, assumptions of normality were not made. Since environmental data are often distributed lognormally (Gilbert 1987), geometric averages were calculated in place of arithmetic averages.

RAGS states that a determination of "reasonable" [in the case of reasonable maximum exposure, pg 6-19] cannot be made solely on quantitative information, but also requires the use of professional judgement. Instead of calculating a complex upper 95% confidence limit for non-

normal data, a comparison between geometric average concentration and the maximum concentration was provided, along with the explanation that the "real" risks are conservatively bracketed between these extremes. Using the maximum concentrations this way is a very conservative approach, approved by RAGS, and is an estimate which is designed to be a measure of "high-end" exposure, implementing the Deputy Administrator's risk characterization memorandum (EPA 1992). In order to further comply with this memorandum, BLM will present the geometric mean risks in the uncertainty section.

130. Section 10

It is not clear whether all of the exposure pathways - including current, potential future, and residential scenarios - for the site were considered and discussed in the RA. For the current scenarios, drinking water sources for the residents south of the landfill must be identified and discussed. Also, it is not clear whether the existing ground-water wells south of the landfill are used for drinking water, irrigation of crops, or livestock. If wells are being used for irrigation of crops or for livestock, food ingestion pathways should be addressed in the RA. Also, for the current scenarios, Section 10.1.2.1, page 10-3 states that the contaminated soils and waste trenches are covered with 2 to 10 feet of soil. Since erosion was known to occur in a past flooding event, it should be stated how it is known that this soil cover is still at the site and what the probability is that contaminated soils have been exposed. If these soils may now be accessible, adding a trespasser scenario should be considered. A trespasser scenario should include, but not be limited to, (1) ingestion of contaminated soils, (2) dermal contact with contaminated soils, and (3) inhalation of contaminated soil particulates. Potential future scenarios, ignored the prerequisite of construction activity for residences to exist in the northern and southern areas of operable unit 1. A construction scenario would include, but not be limited to, worker exposure to subsurface soils. Construction could result in the moving of contaminated subsurface soils to the surface, making them available for exposure contact during the residential scenarios. For the residential scenarios, food ingestion pathways for home-grown vegetables and livestock should be addressed in the RA.

No current exposure to the landfill contamination is occurring, hence this scenario was not evaluated. BLM assumed future residential exposure in Site 1, Subareas 2 and 3 and assumed current groundwater concentrations equal to future concentrations, a routine assumption. These assumptions are clearly overconservative and worst-case possible, and fail the test specified in the NCP preamble:

> *"An assumption of future residential land use may not be justifiable if the probability that the site will not support residential land use in the future is small."*

The likelihood of future residential land use in this parcel is small because it is owned by BLM, because BLM policy does not permit release of contaminated land for residential or any other use, because the site has historically been used for industrial purposes, and because adjacent land use is industrial. Nor would Subtitle D regulations permit disturbance of the final cap for the purpose of development. In addition, RAGS page 6-27 states, " In a few situations, however, it may not be reasonable to assume that water will be drawn from directly beneath a specified source (e. g., a waste management unit such as a landfill) in the future.

Arguably, BLM could have assumed recreational or industrial land use instead of residential land use, thus causing an overall reduction in the magnitude of site risks. Exposure pathways must be consistent with the selected land use. Whichever predominant land use is selected, the other hypothetical land uses and associated exposure pathways are less pertinent and may not need to be quantified.

A two-site interpretation is presented in Subsection 1.1 of the RI Report. It is BLM's belief that further evaluation of Giant-Bloomfield Refinery data and the results of the revised groundwater *modeling, the approach to which is described in the Groundwater Fate and Transport Position Paper, will support the interpretation that landfill contaminants have not entered Site 2. If the revised groundwater modeling indicates that landfill contaminants have entered Site 2, the risk assessment will include Site 2.*

The landfill will be capped according to 40 CFR 257 standards, and a soil cap precludes exposure. Subsection 8.3 of the RI Report indicates that ingestion, inhalation, or contact with contaminated soils within the landfill boundary is not considered to be a potential exposure pathway. Workers participating in RI data collection activities are protected and excluded as potential receptors as a result of procedures required by their health and safety plan. In addition, there is low likelihood of residential development of the Lee Acres Landfill site, because it is a landfill with restricted access for 30 years, and the adjacent property has been a refinery for 25 years. Finally, future ingestion, inhalation, or contact with contaminated landfill soil is prevented by restricting access to the site with a chain-link and barbed wire fence, locked gate, and warning signs in three languages. BLM believes that since the landfill is capped and since BLM policy and surrounding land use preclude residential land use, that evaluation of soil exposure pathways is not warranted.

The residential scenario is considered to be a hypothetical worst case scenario and uses the conservative assumption that future concentrations of contaminants are identical to concentrations presently found. A construction worker scenario would not be worst case. Workers participating in RI data collection activities, and/or future remedial workers, are protected according to procedures required by their health and safety plan (29 CFR 1910.120). Future remedial workers' exposure to contaminated soils is low, since the landfill cap will be upgraded per 40 CFR 257 standards and no intrusive activities are planned; therefore, workers are excluded as potential receptors.

A food ingestion pathway is most appropriately associated with an agricultural land use. BLM has selected a residential land use for the Lee Acres Landfill. While the residential land use does not exclude food ingestion a priori, the concessions made on assuming residential ingestion of groundwater and the fact that the landfill must be capped under Subtitle D regulations, make this pathway much less important. In addition, experience has shown that only bioaccumulative chemicals (lacking at this site), contribute significant risk via ingestion of vegetables. An appendix can be added to show the very small risk posed by ingestion of vegetables using Risk Assistant™.

131. Section 10

It is unlikely that the adverse ecological effects addressed in Section 10.5, caused by the contamination at the site, could be fully understood and assessed simply through a site walk-over. This is especially true, since a decrease in population may not be the only toxicological end point to exposure. It would be more appropriate to follow ecological RA guidance (EPA, 1989a and EPA, 1989c) and assess the impacts on a selected number of indicator species by known contaminant concentrations at the site.

An ecological risk assessment will be provided to determine relative risk to selected groups of indicator organisms identified in RAGS (these may include plants, mice, prairie dogs, fish, and raptors), although the use of other species may be investigated.

The ecological risk assessment would include site description, data evaluation, selection of contaminants of concern, selection of indicator species, exposure assessment, toxicity assessment, and risk characterization to species selected. Geometric mean and maximum detected site-wide chemical concentrations in soils would be used, up to 10 ft in depth. A more detailed approach is described in the Risk Assessment Position Paper.

132. Section 10

The baseline risk assessment did not address the contamination in Site 2. For example: Section 10, page 5, subsection 10.1.4.: Text states, "Site 2 groundwater may be considered to be an important exposure pathway but is beyond the scope of this document. Therefore, no quantitative risk assessment will be performed.

The text will be revised to say that no current resident exposure scenarios are presented because no landfill contamination has been demonstrated in residential areas. The existing groundwater contamination will be used to conservatively evaluate future hypothetical residential exposure. The groundwater pathway Subsection 8.4 will be revised to clarify the future hypothetical resident scenario, as well as the rationale for eliminating the current resident scenario.

133. Section 10

One critical item missing from the RI and RA is the lack of any surface soil analytical data. It is apparent that due to the reported "two to ten feet of soil" reported to be covering the contaminated soil, it was assumed that no possibility that contaminated soils would be exposed. This is of concern due to the fact that it is not possible to know how quickly the cover soil might erode and reveal a potential pathway and that this cover soil did not appear to be taken into consideration during the EM Survey. If this assumption is true, not only did the EM fail to take into account the fact that the instrument may have been held waist high, but also that there may have been more fill material than the instrument could penetrate (see Page 6, Section 2.1.1.2.2). Surface soil sampling of the landfill should occur and special attention given to the characterization of what currently appears to be stained soils.

The landfill will be capped according to 40 CFR 257 standards, and a soil cap precludes exposure. Subsection 8.3 of the RI Report indicates that ingestion, inhalation, or contact with contaminated soils within the landfill boundary is not considered to be a potential exposure pathway.

As described in response to comment 130, there is low likelihood of residential development of the Lee Acres Landfill site, because it is a landfill with restricted access for 30 years, and the adjacent property has been a refinery for 25 years. Finally, future ingestion, inhalation, or contact with contaminated landfill soil is prevented by restricting access to the site with a chain-link and barbed wire fence, locked gate, and warning signs in three languages.

BLM believes that since the landfill is capped and since BLM policy and surrounding land use preclude residential land use, that quantitative evaluation of soil exposure pathways is not warranted.

134. Section 10, Page 10-1, Paragraph 2

It is stated that "The baseline risk assessment for the former Lee Acres Landfill site addresses future public health risks ..." However, both future and current public health risks are discussed in the RA. Clarify this statement.

Agree. See response to comments 130 and 132. The text will be revised to say that no current resident exposure scenarios are presented because no landfill contamination has been demonstrated in residential areas. The existing groundwater contamination will be used to conservatively evaluate future hypothetical residential exposure. The groundwater pathway Subsection 8.4 will be revised to clarify the future resident scenario, as well as the rationale for eliminating the current resident scenario.

135. Section 10.1.2.1, Page 10-3, Paragraph 2

The statement that concentrations of barium and strontium are within regional background levels should be substantiated with a reference. Also, explain why no quantitative baseline RA was performed for landfill soils. The paragraph implies that dieldrin is above the proposed Resource Conservation and Recovery Act (RCRA) action levels. Note the general comment on Section 10 addresses the appropriateness of using ARARs for eliminating chemicals from consideration in the risk assessment.

Quantitative surface soil samples were not collected from the landfill because the contaminants identified from previous investigations were volatile organic compounds. Volatile organic compounds would not be detected in samples collected from the first few inches of topsoil as they would volatilize into the atmosphere, thus making this data collection activity uninformative and inconclusive. In addition, the landfill has been capped.

This referenced paragraph, as well as Pathway Analysis Section 8, will be rewritten and clarified. Since the landfill contents are capped, exposure scenarios involving soil pathways were considered to be nonexistent (see previous comment responses).

BLM believes that since the landfill is capped and since BLM policy and surrounding land use preclude residential land use, that evaluation of soil exposure pathways is not warranted. See response to comment 133.

136. Section 10.2.4, Page 9

It is stated that the amount of volatile organic compounds (VOC) absorbed through inhalation during showering has been estimated to be equal to the amount of VOCs absorbed through the ingestion of drinking water. Explain why the RA assumes that the inhalation and dermal absorption of VOCs during showering was equal to ingestion of VOCs in drinking water.

Agree. Cothern et al. (1986) functionally equates the inhalation and ingestion pathways; this estimate was used to simplify the computations. More explanation on this approach will be provided in the text and calculations will be provided in an appendix.

137. Section 10.3, Page 10, Paragraph 3

This paragraph states that nine of the 11 contaminants of concern are carcinogens. However, Section 10.4 on page 10-11 states that seven of the chemicals are evaluated for carcinogenic risk. This discrepancy should be resolved.

Agree. There is insufficient data, and/or no slope factors for carcinogenicity via the oral route for several metals, therefore these metals were not included in calculations of carcinogenic risk.

138. Section 10.3, Page 11, Paragraph 1

Risk assessment guidance (EPA, 1989b) states that, "If EPA-derived toxicity values are unavailable but adequate toxicity studies are available, one may derive toxicity values using Agency methodology. Any such derivation should be done in conjunction with the regional risk assessment contact, who will submit the derivation to Environmental Criteria and Assessment Office (ECAO) for approval. Contact with ECAO should be established early in the process to eliminate any duplication of effort because the ECAO may have information on the chemical being evaluated." Provide documentation showing that the regional RA contact and ECAO have verified the appropriateness of the reference doses (RfD) calculated here.

RfDs for these compounds will not be derived, but these chemical effects will be discussed in the uncertainty analysis.

139. Section 10.4.1, Page 11

Assumptions made for children who are residents at the site are not detailed in the text. Present and support the assumptions made for the children.

Agree. Tables 10-12 and 10-15 identify assumptions (i.e., the average body weight for the child 1-6 years old is 10 kilograms, and the child drinks 1 liter water per day). These tables will be clarified, and the assumptions will be included/clarified in the text.

140. Section 10.5, Page 12, Paragraph 4

Discuss in detail, and reference the methodologies used to derive, concentrations of contaminants in the San Juan River.

Agree. The computation of contaminants in the San Juan River will be described and recomputed using the approach presented in the Contaminant Fate and Transport Position Paper, and aquifer and river parameters presented in the RI Report.

141. Section 10.6, Page 13

It is unclear to whom "future nonresidents located downgradient from the northern groundwater plume" refers, since future nonresidents have not been discussed earlier in the text.

Agree. The reference to future nonresidents will be stricken from the text.

142. Section 10.6.1.1, Page 13, Paragraph 2

It is unclear how the contribution of risk could be different for inhalation of and direct contact with contaminants while showering, since it was stated earlier that the combination of these two was equal to the intake of contaminants through ingestion of drinking water.

The RfD and slope factors vary depending on routes of exposure, which accounts for the difference in risk. Calculations will be provided in a new appendix. See response to comment number 136.

143. Section 10.6.3, Page 15, Paragraph 2

The rationale for concluding that contamination from subarea 3 poses no threat to aquatic organisms in the San Juan River is questionable. The paragraph states that there is no threat to aquatic organisms, because mass transport modeling has shown that contaminant concentrations will be below Safe Drinking Water Act (SDWA) maximum contaminant levels (MCL) in the river. The SDWA MCLs were derived for human consumption of drinking water (and may not be solely health-based) and were not designed for the protection of aquatic life. Again, it is suggested that RA guidance be consulted for appropriate methodologies (see General Comment 7 for Section 10).

Calculated concentrations of contaminants in the San Juan River (see response to comment 140) will be compared to ambient water quality criteria instead of SDWA MCLs.

144. Section 10.7.3, Page 17, Paragraph 2

Although it is true that VOCs tend to volatilize, other contaminants of concern, such as metals, may not volatilize and may be taken up by the vegetables via their root systems. It is recommended that a vegetable ingestion scenario be addressed in the RA.

As indicated in response to comment 130, this pathway will be screened in an appendix using Risk Assistant™.

145. Table 10-12, Page 39

It is recommended that any adjustments for frequency and/or duration of exposure be added to the generic calculation for dose. Also, on Assumption 2, any adjustments made for absorption should be clearly detailed in the text.

See response to comment 131.

146. Table 10-13, Page 40

The split for the different isotopes of chromium should be described in the text. Also, it appears that the concentrations for inhalation and direct contact were derived by taking one-half of the concentration for ingestion. This does not seem appropriate, since these concentrations are not actually known.

Agree. The 90:10 split for chromium VI:chromium III is a very conservative scenario which will be better described in Section 10.2.4. Calculations will be provided in a new appendix.

147. Table 10-15, Page 42

Any adjustments for frequency and/or duration of exposure should be added to the generic calculation for dose.

Agree. See response to comment number 145.

148. Additional Comments - 10/02/92

An ecological risk assessment based on visual estimates of no known reductions/changes in populations, communities, or ecosystems is unacceptable. We will provide examples of acceptable ecological risk assessments done for other Region 6 Superfund Sites should you require them.

See response to comment number 131.

149. Additional Comments - 10/02/92

More documentation of whether exposure pathways for ecological receptors are complete is required. For instance:

a) If soil staining is due to contamination, stained soil areas could serve as a source of contamination for ecological receptors and would need to be evaluated for toxicity or bioaccumulation/food chain effects. What is the source of the stained soil, and what contaminants are in the stained soils? It is mentioned on page 1-8 that surficial waters from the study area drain toward and through an unnamed arroyo system that joins the San Juan River. It should be clarified whether the stained areas erode into the arroyo and get transported to the San Juan River. If so, evaluation of ecological risks to aquatic ecological receptors, as well as terrestrial ecological receptors, would need to be conducted.

The BLM disagrees with this comment. Surface soil staining was not identified during the investigation. No erosion of the landfill cap into the arroyo is known to exist. Subsection 2.5 and Figures 2-18 through 2-21 identify the trench study that was performed within the former landfill to help define the location, nature, and extent of the waste contained within the northwest portion of the landfill, and to verify the existence of the former liquid waste lagoons suspected to contain hydrocarbon contamination; this study identifies 0.5 to 10 ft of soil cover (average 2 ft) in place at the landfill trenches and waste cells. This cover is adequate and has not eroded, and Subsection 2.5 will reiterate the adequacy and integrity of the cover. The proposed remedy at the site is additional cover.

Release of landfill groundwater contaminants to the San Juan River will be assessed. See response to comment 140.

150. Additional Comments - 10/02/92

More documentation of whether exposure pathways for ecological receptors are complete is required. For instance:

b) Contaminants were detected in the borehole and surface soil sampling of the arroyo and should be discussed/evaluated for availability to ecological receptors through such exposure routes as soil ingestion and bioaccumulation or through temporary use (i.e., for breeding habitat) of intermittent arroyo water containing contaminants from the sediments. Further evaluation of these sediments, such as further sampling of surface arroyo sediments, may be necessary to assess risks from site-related contaminants transported to the arroyo by erosion/runoff or leachate in groundwater.

Subsection 5.7 identifies boreholes and wellbores drilled in the arroyo to determine if the arroyo had acted as a transport mechanism for contaminants migrating from the southern boundary of the Lee Acres Landfill or from the area east of the arroyo with surface runoff or with infiltrated surface water. Geometric mean and maximum detected site-wide chemical concentrations in soils up to 10 ft in depth will be used for an ecological risk assessment.

151. Additional Comments - 10/02/92

More documentation of whether exposure pathways for ecological receptors are complete is required. For instance:

c) The landfill contaminants under 2-10 feet of soil could serve as a source of contaminants for burrowing animals in arid areas such as prairie dogs or badgers. These animals can burrow to deep cool soil levels. The soil pathway could be a complete ecological pathway. Burrowing activity needs to be evaluated, and if a complete exposure pathway is present, potential adverse toxicity or food chain effects from exposure of burrowing animals and their predators to the landfill soil contaminants would need to be evaluated. On page 8-3, first paragraph, it is mentioned that access is restricted by a fence. A fence is not a hindrance to access by wildlife such as small mammals and avian predators, and thus, should not be used as a rationale to eliminate a pathway from evaluation.

See response to comment number 131.

152. Additional Comment - 10/02/92

Ecological evaluations for the stained soil, arroyo, and landfill contaminant sources could be either done by a literature review of ecotoxicity and exposure parameter information for each indicator species (ecological receptor) and ecological contaminant of concern, or by a combination of literature values and site-specific measured tissue residue values.

Agree. See response to comment number 131.

153. Additional Comments - 10/02/92

The ecological risk assessment should be distinct from the human health risk assessment. The identification of ecological contaminants of concern, toxicological assessment, exposure assessment, and risk characterization need to be done separately for the ecological risk assessment.

Agree. See response to comment number 131.

154. Additional Comments - 10/02/92

Specific details need to be provided, on a chemical by chemical basis, describing the rationale (and providing the concentration and toxicity) used for elimination as a contaminant of concern.

The BLM disagrees with this comment. See response to comment number 123.

155. Additional Comments - 10/02/92

It is against Region 6 policy to eliminate from the risk assessment (organic) contaminants detected in concentrations at or below naturally-occurring concentrations. These contaminants should be included in the risk assessment. It is also unacceptable to eliminate contaminants that were detected but do not exceed regulatory standards such as RCRA soil action levels or TCLP metals standards. These contaminants should also be included in the risk assessment. In the risk characterization, the regulatory standard may, in some cases, be used as the toxicity criterion in the denominator of the hazard quotient. The baseline risk assessment should be revised to address both of these deficiencies.

The comment appears to be directed at soil chemicals of concern. Soil COCs will also be selected using a concentration-toxicity score (see the Risk Assessment Position Paper).

Additionally, inorganic contaminants detected will be compared to true natural background values such as Shacklette and Boerngen (1984).

Contaminants that are detected will be compared to true natural background values wherever possible. See also response to comment number 131.

156. Additional Comments - 10/02/92

Page 1-19: One-time detections were eliminated as COCs. There is no justification adequate for eliminating contaminants based on infrequent detection.

The BLM disagrees with this comment. The rationale for elimination of contaminants of concern based on frequency of detection is identified in RAGS (Subsection 5.9.3). Contaminants were never eliminated solely on the basis of frequency of detection. Additional clarification will be added to the text.

157. Additional Comments - 10/02/92

Page 10-13: SDWA MCLs were used to evaluate future ecological risk. It is inappropriate to use MCLs, which are human health values, for evaluating ecological risk. Comparison to MCLs should be eliminated from the ecological risk assessment.

Agree. Comparisons to Maximum Contaminant Limits (MCLs) will be eliminated from the ecological risk assessment, and replaced with a comparison to ambient water quality criteria.

158. Additional Comments - 10/02/92

Documentation that suspected laboratory contaminants were only eliminated as contaminants of concern is required. One such example might be a table illustrating that if sample concentrations were below 10 times the concentration found in any blank, the contaminant was eliminated. If sample concentrations exceeded 10 times the concentration of any blank, these contaminants should be retained as contaminants of concern and be included in the risk assessment.

Suspected laboratory contaminants were evaluated against the 5X and 10X rules, although this was not the sole criteria for screening COCs. Additional clarification will be added to the text, and documentation of when chemicals were eliminated based on blank contamination will be provided.

159. Additional Comments - 10/02/92

A site conceptual model should be developed for Site 2.

A two-site interpretation is presented in Subsection 1.1 of the RI Report. It is BLM's belief that further evaluation of Giant-Bloomfield Refinery data and the results of the revised groundwater modeling, the approach to which is described in the Groundwater Fate and Transport Position Paper, will support the interpretation that landfill contaminants have not entered Site 2. If the revised groundwater modeling indicates that landfill contaminants have entered Site 2, the risk assessment will include Site 2.

160. Additional Comments - 10/13/92

Section 8: The decision networks provide an unacceptable and inappropriate screening of potential exposure pathways. The entire pathway screening process as it presently stands is unacceptable for risk assessment purposes.

The BLM disagrees with this comment. The exposure assessment and the evaluation of potential pathways are rigorously evaluated in the RI Report. In order to provide what was thought to be the clearest presentation of the data, groundwater modeling, pathway analysis, and the conceptual site model were presented in the RI Report, and cross referenced when necessary. The criteria outlined in RAGS for evaluating exposure pathways were addressed and tailored for this document in order to provide continuity between development and implementation of the field program, the results of the RI, and the identification of risk associated with the Lee Acres Landfill.

First, a detailed identification and characterization of sources and receiving media were presented in Sections 5 and 6. Next, evaluation of fate and transport in release media were presented in the groundwater modeling section (Section 7), and additional explanation (including the physical and chemical properties of chemicals) was given in Subsection 10.2. Fate and transport was also provided in Appendix X, Fate and Toxicity Profiles of the Contaminants of Concern. The identification of exposure points and exposure routes were presented in detail in the Pathway Analysis in Section 8, the Conceptual Site Model in Section 9, and in Subsection 10.2.2. Integrating the information on sources, releases, fate and transport, exposure points, and exposure routes into exposure pathways was performed in the Pathway Analysis in Section 8, where complete pathways were chosen having a source, an exposure point where contact can occur, and an exposure route by which contact can occur. A summary of the pathway analysis was provided in Subsection 8.6. Additional explanation and revision will be made wherever it is appropriate, references to RAGS will be made in Sections 8 and 9, and a new summary of the pathway analysis itself will be included in Subsection 10.2.

161. Additional Comments - 10/13/92

Section 9: The Conceptual Site Model lists several pathways as "dormant" without presenting adequate justification.

"Dormant" was intended to mean incomplete. The revised text will clarify this term and provide further justification.

162. Additional Comments - 10/13/92

Section 10, Contaminants of Concern: The process of screening contaminants of concern (COCs) is not in accordance with Chapter 5 of the Risk Assessment Guidance for Superfund (RAGS).

Since this is a general comment, BLM's response is that, in general the selection of chemicals of concern is in compliance with RAGS. As described in response to comment 120, BLM selected COCs not only for the RA, but to focus the RI presentation on nature and extent of contamination. Therefore, the elements of COC selection are found in Sections 1, 5, and 6, as well as Section 10. The selection of contaminants of concern was a phased process which is presented in the RI Report in the most organized manner possible. To summarize all this information again in the RA section would be redundant and make for an unwieldy document, however additional cross referencing may be appropriate. In addition, references to RAGS will be made in Sections 1, 5, 6, 8, and whenever appropriate. See response to comment 123.

According to RAGS, the elements of data evaluation and the selection of contaminants of concern begin with the identification of data quality objectives (Section 1). The evaluation of analytical methods and the evaluation of quantitation limits and qualified data conforms to RAGS. In addition, an evaluation of the frequency of detection, a comparison with ARARs, and a concentration-toxicity screen were performed and provided in the RA section itself. The only additional elements of data evaluation and selection according to RAGS include comparisons with blank data, comparisons with tentatively identified compounds, and comparisons with background data; these will be described. In addition, the comparisons and references to ARARs will be de-emphasized in the RA since the BLM recognizes that it is supplemental information and does not contribute to the selection of COCs.

163. Additional Comments - 10/13/92

Section 10, Exposure Assessment: The exposure parameters which are used in the baseline risk assessment are not in accordance with the "Standard Default Exposure Factors" (OSWER Directive 9285.6-03). Deviation from these parameters requires site-specific data and explanation.

Agree. The models will identify adjustments for frequency and duration.

164. Additional Comments - 10/13/92

Section 10, Concentration Term: The baseline risk assessment should use the 95th percent of the upper confidence limit on the arithmetic mean (Supplemental Guidance to RAGS: Calculating the Concentration Term).

See response to comment 129.

165. Additional Comments - 10/13/92

Section 10, Central Tendency and Reasonable Maximum Exposure: Superfund risk assessments require the calculation of a central tendency and a reasonable maximum exposure (RME) (Guidance on Risk Characterization for Risk Managers and Risk Assessors). The Risk Characterization should discuss only RME. The central tendency should be discussed only in the uncertainty section.

Agree. See response to comment 129.

166. Additional Comments - 10/13/92

Page 8-1, 1st Paragraph: The Endangerment Assessment Handbook has been superseded by the RAGS.

Agree. Reference to the Endangerment Assessment Handbook will be deleted.

167. Additional Comments - 10/13/92

Page 8-2, 2nd Paragraph: What regulatory air standard are used to screen the air pathway? The air pathway should not be screen due to regulatory air standard. The regulatory standards may be used as Applicable or Relevant and Appropriate Requirements (ARARs), but not to screen out risk analysis of the pathway.

The BLM agrees that comparison to "standards" (TWA-TWAS are not regulatory standards) was not performed and the text will be corrected. The air pathway was screened out based on the comparison to background concentrations, comparisons to RCRA Corrective Action Levels, and literature concentrations for urban, suburban, and rural environments.

168. Additional Comments - 10/13/92

Page 10-1, 2nd Paragraph: The baseline risk assessment should address both current and future risk to human health and the environment. In addition, the baseline risk assessment is used as a basis for action at the site.

The text will be revised to say that no current resident exposure scenario is presented because landfill contamination has not been demonstrated in any residential areas. The risk assessment uses existing groundwater contamination to conservatively assess future exposure and risk. The groundwater pathway Subsection 8.4 will be revised to clarify the future resident scenario, as well as the rationale for eliminating the current resident scenario.

Agree. It is understood that the baseline risk assessment is used as a basis for action at the site.

169. Additional Comments - 10/13/92

Page 10-2, 1st Paragraph: The risk assessment eliminates several chemicals from the risk assessment due to laboratory contamination. Eliminating toluene as COC on this basis may be questionable.

The text does not state that toluene was eliminated as a COC. It was not eliminated.

170. Additional Comments - 10/13/92

Page 10-4, 3rd Paragraph: The screening process described in this paragraph is an optional procedure and can be implemented only after consultation with the EPA RPM. The argument of carrying only a small number of chemicals through the risk assessment is not justified considering the availability of computer spreadsheets.

The selection of COCs was a phased process and was never made wholly on the basis of relative concentration-toxicity. RAGS provides for the option to perform the concentration-toxicity screen, nevertheless. Professional judgement was applied in order that chemicals contributing to greater than 1% risks are included.

171. Plate 1

Many areas on Plate 1 are difficult to read because the multitude of activities that occurred during the RI. Although it is necessary to provide the visual aids that show the areas of investigation, it would be helpful if the information on this plate were divided into two or more groups. With all of the information provided on one map, it is difficult to follow in the discussion of the report. Additional plates showing separate investigation activities should be provided.

The RI Report provides numerous figures specific to the discussions provided in each section. Furthermore, these figures highlight only the activities of concern for specific geographic locations within the site. The BLM feels this comment is subjective and all report figures provide the detail necessary to understand the RI.

172. Plate 4

The bedrock channel should be clearly defined on Plate 4, because the plate is referenced several times in Section 4.0 of the draft RI report; also, this bedrock channel has been identified as a controlling factor for the occurrence of saturated alluvium. Furthermore, it is recommended that query symbols (- - ? - -) be included on the east side of the arroyo where the map symbols suggest that the contact is more of an approximation than the contact on the west side of the arroyo.

Plate 4 presents the surface geology within the study area. To add the subsurface bedrock channel to this plate is inappropriate. References to this plate in Section 4 will be double-checked for correctness. Query symbols will be added to Plate 4 to identify the contact between the Quaternary alluvium and the other surficial deposits.

173. Appendix U

Some of the figures in this appendix are not consistent with the operating capabilities of the HNu. The HNu does not detect methane. However, the sections where HNu readings were recorded in the figures for BH-03, BH-12, and BH-13 include the interpretations, that no solvent vapors are present. An introductory paragraph should be included in this appendix to explain the manner in which the interpretations were made.

The BLM agrees that the HNu does not detect methane and the interpretation for BH-03 will be reevaluated. The organic vapor analyzer (OVA) is calibrated to methane and a response indicates methane may be present. Reviewing figures for BH-12 and BH-13 indicate readings above background on the OVA were recorded. Therefore, methane may have been present during the drilling of these boreholes. A explanatory paragraph regarding the interpretation procedures will be added to this appendix.

APPENDIX A

COMMENTS ON THE LEE ACRES DRAFT REMEDIAL INVESTIGATION REPORT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

SEP 18 1992

Mr. Bruce Davis
United States Department of Interior
Bureau of Land Management
PO Box 1449
Santa Fe, New Mexico 87504

RE: Comments on the Lee Acres Draft
Remedial Investigation (RI) Report

Dear Mr. Davis,

Enclosed you will find the Environmental Protection Agency's (EPA) comments on the draft Remedial Investigation (RI) report. To best assure efficient development of quality work products, it will be necessary for EPA and BLM to improve coordination and communication between the technical staffs of both agencies.

As stated in the comments, EPA conducted two independent reviews of the ground water model upon which major conclusions were drawn. Each of these reviews concluded that the model is inadequate. Therefore, the conclusion that the plumes from the landfill and refinery are separate and distinct is not justified.

EPA has also initiated a review of the workplans and standard operating procedures (SOPs) used by the BLM and its contractor, Roy F. Weston, Inc. and will review the risk assessment in more detail as well. These reviews will be made available to BLM when they are complete. As you know, the SOPs and workplans were not made available to EPA prior to the conduct of the RI. Due to this and the fact that the comments were so comprehensive, EPA is concerned that the objectives set may not have been aligned with EPA guidance documents. Therefore, we will now investigate the workplans and SOPs in regard to how well they follow EPA guidance.

Although extensive sampling has been performed at Lee Acres, there are instances where the reviewing team has called for additional analytical justification of points made, conclusions drawn, or procedures used. Specifically, the reviewing team noted that: the substitution of the extraction procedure for metals analysis rather than analysis of total metals concentration (needed for risk assessment exposure pathways) was not productive, there were no surface soil samples analyzed, the RI lacked considerable QA/QC information, explanation of locations chosen for air sampling was required, the gases found in subsurface soils have not been accurately identified nor have their sources been accurately characterized, benzene, toluene, ethylbenzene and xylene (BTEX) were not used as indicator parameters, and in some instances data available to BLM has either been overlooked or discarded (lack of incorporation of the Giant Refining Well data in the ground water model and discussion on the Tracer soil gas survey).

Written justifications may answer many of the questions that EPA has concerning the RI. However, it does not appear that the analytical data available to BLM at present will allow BLM to bring the RI into conformance with EPA guidance documents for conducting RIs, nor will the data allow BLM to make the conclusions currently being presented. Perhaps, most of the required work has been done and much of what is mentioned above, and in the body of the text that is enclosed, may be corrected without field operations.

Hopefully we can solve these technical issues and be ready to move towards remedial design and remedial action soon after the negotiation of the Federal Facilities Agreement (FFA) between the BLM and EPA. As you may be aware, EPA has responded to letters from both the Secretary of the New Mexico Environment Department and the Director of the New Mexico Oil Conservation Division in which both state agencies request expedited elevation of the FFA and an immediate Interim Remedial Action. EPA has elevated certain portions of the FFA to Washington for negotiations at the headquarters level and is in concurrence with the state that some type of action be taken directly.

Please feel free to contact me at any time during your review of these comments as I would be glad to answer any questions you have or discuss any issues you feel relevant. I may be reached in the Region 6 office at (214) 655-6730.

Sincerely,

Ky D. Nichols

Ky D. Nichols
Remedial Project Manager
Oklahoma/New Mexico Section

Attachment

EPA has reviewed the draft Remedial Investigation (RI) report on the Lee Acres Landfill site. This report was prepared by Roy F. Weston - contractor to the U.S. Department of Interior (DOI), Bureau of Land Management (BLM) and submitted to the Environmental Protection Agency (EPA) on February 25, 1992.

Based on the information contained in the draft RI report, EPA has determined that extensive technical problems requiring explanation and, in some cases, extensive revision by BLM are present. The revisions are necessary to bring the draft RI report into conformance with RI guidance documents. These problems are addressed in general and specific comments, as appropriate. Specific comments are referenced by section, page, and in some cases, paragraph. Specific comments concerning tables and figures are referenced as such.

Because the comments on the RI report are extensive, EPA is currently reviewing the Standard Operating Procedures and Workplans generated by the DOI and its contractor against EPA guidance and policy. EPA will make this review available to DOI as soon as it is ready. EPA is also conducting further review of the draft RI Risk Assessment and will make that available as well.

Since the major conclusion of the RI was based on the results from the ground water model, EPA conducted two independent reviews of the model. Two ground water experts conducted a review in Dallas while a copy of the RI report was forwarded to the EPA Kerr Environmental Research Laboratory in Ada, Oklahoma.

The conclusions drawn from those reviews state that assumptions, discretization, and calibration used by the model have significant problems. In short, the modeling effort is "extremely questionable" and "the conclusions derived from the modeling effort should not be considered valid." Another reviewer commented that "all of the available data has not been evaluated by this model." This is discussed further in the comments on Section 7.

Each section of the draft RI report must be comprehensive, because the RI report is to be used for public information. Several sections and subsections of the RI, specifically Sections 5 and 6 - Source Characterization and Ground Water Characterization - are difficult to understand because of the way in which the information is organized. Within these sections, other sections of the report are referenced to support interpretations and conclusions. It would be helpful if each section and subsection includes the referenced information in a summary format. Furthermore, several subsections are referenced in other sections but are not available for review. Specific examples of this occurrence are noted within the specific comments.

A section completely discussing the analytical quality assurance and quality control (QA/QC) information should be included. This section is needed to adequately review the RI for support of the conclusions and interpretations that have been proposed. It is important that the validity of the analytical data be discussed in relation to the QA/QC procedures. The section should include information discussing the validation procedures and QA elements.

All structural features should be discussed in Section 4 of the RI report - Geologic and Hydrogeologic Characterization - because the site is located within an area that was once structurally active, geologically. This comment is specifically associated with the bedrock units and its potential to have lineaments that are structurally related to faulting and fracturing. The relationship between these features and the effects that they may have on the hydrological interaction between the alluvial and bedrock aquifers should be addressed. In addition, a discussion of how these features relate to potential pathways of migration for contaminants should be included.

The hydraulic relationship between the alluvial and bedrock aquifers is not adequately addressed in the draft RI report. It is concluded, based on the well data, that the vertical hydraulic gradient is downward on the west side of the arroyo but upward on the east side of the arroyo. It is true that the well data indicate this occurrence; however, the report does not discuss the cause, effect, and relevance of it. This occurrence should be discussed in relation to stratigraphic controls. Furthermore, this information should be included on a map for review.

Analytical results of the February 6, 1989, sampling event are used to support several conclusions of the RI. In particular, this information is used to support the conclusion that chromium in ground water is from an off-site source. Although there is the potential for chromium to be from another source, the interpretation is not substantiated by the information provided in the draft RI report. A review of the historical analytical data indicated that the high chromium concentration is limited to this one-time sampling event, which appears to have provided anomalous results. All of the QA/QC criteria from the laboratory should be provided to support and justify the conclusions that are based on this sampling event.

Finally, it would be helpful if the figures/tables referenced in the text were located on the subsequent pages and not at the ends of each chapter.

Specific Comments:

Executive Summary, Page 1, Paragraph 3

Text states, "This mass, referred to as the southern area of contamination at Site 1, is identified as a contaminant slug because there is currently no continuous upgradient contaminant mass to indicate an available constant contaminant source." The text should state that no continuous upgradient contaminant mass has yet been identified.

Executive Summary, Page 1, Paragraph 3

The text states that an elevated concentration level of chromium was observed in the background alluvial aquifer ground water. This elevated concentration may be skewed because of the disproportionate weight given to the sampling conducted on February 6, 1989. Review of other chromium data - both dissolved and total - indicates that the concentration values recorded from this particular sampling and analysis event may be anomalous. BLM should provide further reasoning, such as additional data, for using data from this sampling to justify the established background.

Executive Summary, Page 2, Paragraph 1

Identifying the lagoon as the primary source of contamination appears to have been the focus of the RI. Although the lagoon may be the primary source of contamination, the report should recognize and investigate other potential sources, such as contaminants from municipal wastes and the disposal area identified around BH-13 in the southwestern portion of the landfill. These other potential sources should be further characterized and detailed in the RI report.

Executive Summary, Page 2, Last Paragraph

Text states, "Ground water modeling results show that approximately 22 years would be required for the leading plume edge of the organic plume to migrate from the former landfill liquid waste lagoons to the area just south of U.S. 64." There is a degree of concern as to the accuracy of the model as indicated above.

Executive Summary, Page 3, 2nd paragraph

Text states, "For this reason, any risk or hazard associated with Site 2 contamination is not estimated or considered further as part of the risk assessment of FS process."

This is a major issue. As stated above, too much emphasis is being placed on a model that has not addressed the complete area of interest. "Site 2" shall not be eliminated from further study based on the model as it is currently being presented.

Executive Summary, Page 3, Paragraph 3

Text states, "the air pathway is rejected as an active pathway because results of the RI air monitoring program show no contaminant vapors being released from the former landfill." The air pathway may need to be studied at least in respect to the potential for contaminated vapors to be released during the implementation of remedial action alternatives. This study would need to at least include the potential for worker exposure.

Executive Summary, Page 3, Paragraph 3

The two pathways identified in the conceptual model do not address all potential future uses. Other pathways that should be considered include exposure to contaminated soils, as discussed in Section 8, and impacts on surface water during catastrophic flooding. These are discussed in comments for Sections 4, 8, 9, and 10.

Section 1.1.1, Page 1, Paragraph 4

The RI and feasibility study (FS) process also includes a risk assessment that addresses all present and future potential risks to human health and the environment. The appropriate sections of the report should be expanded to address all potential risks, not only current ones.

Section 1.1.1, Page 2, Last paragraph:

Text states, "A Record of Decision (ROD) will be prepared to certify that the remedy selection process ..." EPA must concur on this document.

Section 1.1.4, Page 6, first bullet

Text states, "...significantly reduce the toxicity, mobility, or volume of waste." This statement needs to be modified in accordance with CERCLA § 121 (b)(1), which states, "Remedial actions in which treatment which permanently and significantly reduces volume, toxicity or mobility of hazardous substances, pollutants, and contaminants is a principal element, are to be preferred over remedial actions not involving such treatment."

Section 1.1.5, Page 6, Paragraph 1, Bullet 6,

As noted above, the risk assessment should include all potential risk scenarios.

Section 1.2.2.1, Page 10, Paragraph 3,

The presence of bermed areas is used to determine the locations used for liquid waste disposal; however, there are other possible liquid waste disposal areas. There is a potential for liquid waste disposal to have occurred in other areas of the landfill, such as the (1) pits and trenches, adjacent to the two lagoon areas in the southern part of the landfill which were used extensively between 1975 and 1980 (Figure 1-4), or (2) pits and trenches with stained soils (Figure 6-4). The pits and trenches identified in Figure 6-4 are located outside the current southern fenced boundary but, according to Figure 6-4, were within the fenced boundary during the early 1980s. Explain why other areas of the landfill are not considered as possible areas that may have received liquid wastes.

Section 1.3.2, Page 12, Paragraph 2

Text states, "After a comment period and the receipt of comments, a public meeting will be held if sufficient interest is demonstrated." This statement needs to be modified to meet the requirements of CERCLA § 117 (a)(2) which states, "Provide a reasonable opportunity for submission of written and oral comments and an opportunity for a public meeting at or near the facility at issue regarding the proposed plan and regarding any proposed findings under section 9621(d)(4) of this title (relating to cleanup standards). The President or the State shall keep a transcript of the meeting and make such transcript available to the public."

Section 1.6.2.2, Page 19, Paragraph 3

Text states, "Generally one-time detections are eliminated as COCs. The number of sampling events per well ranges from 3 to 21. In most cases when a contaminant was detected once, it was in an early sampling event and the nondetects in later groundwater samples provide confirmation of the absence of the contaminant." One time detections should not be eliminated when the frequency of sampling is low (ie 3). Other discussion on this topic follows.

Section 2.1.1.2.2, Page 6, Paragraph 1

The text indicates that the depth of penetration during the EM survey was limited to 5 to 8 feet below the instrument and to 3 to 6 feet below the ground surface if the instrument was held waist high. Since the permitted requirements for operating the landfill included the application of 2 to 10 feet of fill, the limitation of shallow penetration depth with the EM 31 may be compounded. A discussion of the potential effects of the cover is needed to provide for accurate interpretations of the electromagnetic (EM) data.

Section 2.4.2, Page 18, Paragraph 1

During future sampling events, discretionary samples based on visual or instrument observations should be collected to improve the delineation of the contamination. This is particularly important at locations where borehole clusters are drilled. The text states that geochemical samples were collected at 5-to-10-foot intervals, with certain exceptions. A review of the chemical results in Appendix I indicated that on-site visual or instrument - especially HNu - observations were seldom used to deviate from the 5-or-10-foot standard interval. For example, discretionary sampling would have been useful in the southwest area of the landfill near monitoring wells BLM-33 and BLM-34. The borehole logs in Appendix L indicate that the highest HNu readings in the core samples were observed near the alluvium-bedrock contact in both well boreholes, not at the selected interval location.

Section 2.4.2, Page 18, Paragraph 2

A rationale should be included in the report to support the selected method for analyzing metals. The text states that soil samples were analyzed for metals by using the Extraction Procedure (EP) Toxicity method rather than analyzing for total metals. Results of analysis from using this method indicate the

Section 2.4.2, Page 18, Paragraph 2, cont.

possible impact of soil leachate on ground water; however, this data is not useful for evaluating direct exposure to contaminated soils. Total metals analysis was performed only for soil samples from well boreholes BLM-33, BLM-34, and BLM-35. No soil samples collected from the lagoon areas were analyzed for total metals. In addition, background values for total metals are not presented in the report. EPA guidance (EPA, 1989) discusses background sampling needs. Without representative background and landfill soil analytical results for metals, a complete risk assessment for soil exposure pathways cannot be performed. Provide an explanation as to why the EP analytical methodology was used in lieu of total metals analysis. Total metals analysis of representative background locations as well as the landfill will be required so that a risk assessment for each exposure pathway may be performed.

Section 2.4.3, Page 20

This section should include information discussing the validation procedures and QA elements. Criteria that should be available for review include the following:

- Holding times
- Surrogate recoveries
- Spike duplicate results
- QA objectives for measurement data in terms of precision, accuracy, representativeness, completeness, and comparability (PARCC)
- Sampling procedures
- Sample custody
- Calibration procedures and frequency
- Analytical procedures
- Data reduction, validation, and reporting
- Internal quality control checks and frequency
- Performance maintenance procedures and schedules

If this information is included in another document, it should be summarized in this section and referenced.

Section 2.4.3, Page 20, Paragraph 1, Bullet 3

The volatile organic compound (VOC) results and the supporting validation documentation should be included in this report for review. The text states that "One trip blank per shipment of VOCs" will be used. EPA guidance (1987) states that one trip blank should be shipped with each shipping container.

Section 2.8.1, Page 30

When using the terms "uppermost" and "lower" for the alluvial and bedrock aquifers respectively, the text indicates that each aquifer has associated "lowermost" and "upper" units. Clarify this issue.

Section 2.8.1, Page 30, Paragraph 2

The text states that "Cone Penetrometer (CPT) activities performed during December 1989 and January 1990 allowed the delineation of areas where alluvial ground water does and does not occur." The distribution of precipitation, which is discussed in Section 3.1.2.3, indicates that the maximum extent of the alluvial aquifer would occur after local storms in August or September, or during snowmelt in the early spring. In view of these potential seasonal occurrences, the aquifer will fluctuate in horizontal and vertical extent. Explain how the cone penetrometer (CPT) data were used to estimate the areal extent of the alluvial aquifer.

Section 2.8.2, Page 31, Paragraph 1

The discussions of upward and downward hydraulic gradients in the text of the report should be consistent with the findings that are presented in the referenced tables. These findings and associated discussions should be consistent between the various sections of the report. It is stated that "the lower bedrock unit is hydraulically connected to the alluvial system, and no upward or downward hydraulic gradient is apparent. In other locations along the arroyo, an upward gradient is observed, suggesting that the bedrock aquifer recharges the alluvial system." The data listed in Table 4-3 indicate that some well clusters, such as BLM-20 and BLM-22, show a downward hydraulic gradient. Also, as stated in other sections of the report, a downward hydraulic gradient is observed on the west side of the arroyo, and an upward hydraulic gradient on the east side of the arroyo. Discuss these occurrences.

Section 2.9, Page 32

The first sentence in this section indicates that the topic to be discussed will be the technical rationale for geographical placement of monitoring wells. However, the major topic discussed is the placement of well screens. If the placement of the well screen is associated with the ground water monitoring program, more information is needed. Also, it would be beneficial for this placement of the well screen to be presented in Section 2.7.2. which discusses well completion details.

Section 2.9.1, Page 34, Paragraph 2

A table indicating the sampling method for all previous ground water sampling events should be included in the report. The difference between the sampling methods may have a particularly important effect on the frequency of detection in ground water samples collected from monitoring wells located along the edges of the contaminated areas. The text states that a test was conducted to compare sampling results between a submersible pump and a bailer. The results indicate that sample collection with the submersible pump minimized the volatilization of VOCs from the ground water samples. This observation is consistent with tests performed at other Superfund sites. Although the conclusion that the pump sampling method did not cause volatilization of VOCs from the samples may be true, it is not necessarily true that all of the data are comparable.

Section 3.1.1

This section discusses the soil gas investigation activities that were conducted at the site. However, a discussion of the Tracer soil gas survey, conducted on July 7, 1986, is not presented. A discussion of the Tracer soil gas survey, its findings, and its conclusions should be included in the draft RI report for review. It is important that all investigations conducted - both by the PRPs and other parties - be discussed in detail to support the conclusions.

Section 3.1.1.1, Page 2, Paragraph 2

It is stated that only one HNu reading, out of about 1,300 readings, was above background concentrations. However, no discussion of the background concentrations, locations of the readings, or HNu QA/QC information was provided for review. If the results were used to refine or scope further investigation activities, provide that information. Discuss the significance of the HNu survey investigation and its purpose and results.

Section 3.1.1.2, Page 2

The air canister analytical results presented in Appendix P do not include the locations for each sample. To adequately review the air data, either indicate the locations on the data sheets, or summarize analytical results in a table or figure to compare the locations to the results. In addition, to provide for a comprehensive report and review, information on the laboratory and validation QA/QC requirements should be discussed.

Section 3.1.1.3, Page 2, Paragraph 1

Explain the rationale for choosing the middle of the landfill (mid-site) as a location for air particulates and metals. According to Figure 1-5, this location appears to be centered in the northeastern portion of an excavated (and clean) area. Clarify the rationale for using this location to represent the landfill.

Section 3.1.1.4, Page 6, Paragraph 2

This paragraph includes a brief description of the soil gas emissions monitoring. Information about monitoring conditions should include, but not be limited to, the ambient temperature inside and outside the chamber at each site, the time for equilibration after purging, and duration of sampling. This information should be presented and discussed to support the analytical results and the sampling methodology, and to provide a comprehensive review of the report. If sampling occurred immediately after purging with an inert gas, it appears that surface gas emission concentration would be diluted by a minimum of one order of magnitude. If the upper few centimeters of the surface were also affected when the flux chamber was purged, an air sample collected immediately after purging would have little relation to actual site conditions.

Section 3.1.1.4, Page 6, Paragraph 3

During the October and November 1989 air sampling event, four on-site locations were chosen for soil gas emission monitoring. The results for the sample collected from location 6 are not easily identified in Appendix P. A table summarizing the individual location results in the text or in Appendix P would enhance the review. According to Figure 3-1, location 6 appears to be where a roadway across the landfill was once located. The use of an area where repeated compaction has occurred is not appropriate for soil gas monitoring. Provide these results and

Section 3.1.1.4, Page 6, Paragraph 3, cont.

clarify the location of soil gas emission monitoring station number 6.

Section 3.1.1.4, Page 6, Paragraph 3, additional

According to this paragraph, six air sampling locations were on-site. The distribution of sampling does not appear to be consistent with the contention that the lagoon areas are the most likely sources of hazardous waste disposal. For example one location appears to be in a compacted area, and three [two from the meteorological (met) station] were collected in the southern portion of the landfill. All of these locations are far from the former lagoon areas. The rationale for the distribution of sample locations, in relation to the lagoons and other potential sources, should be discussed in the report.

Section 3.1.1.4, Page 7, Paragraph 3

The text states that no unusually high levels of volatile toxics are associated with the Lee Acres Landfill. The results of air monitoring shown in Table 3-5 are not consistent with this conclusion. Even if the sampling methodology and locations prove to be acceptable, benzene is present in concentrations comparable to suburban and urban settings, not remote locations. Weather conditions at the time of ambient air sampling are not included in the report, so the effect of the former refinery to the south cannot be evaluated. The values for 1,1,1-trichloroethane, trichloroethene (TCE), and toluene are also well above values for rural areas. The conclusions in this and the following paragraph should be re-evaluated. A rationale to substantiate these conclusions should be included in the report.

Section 4.1.5.2, Page 11, Paragraph 2

The relationship of BLM-61, BLM-63, and BLM-64 to the steep gradient is not fully explained. Provide more detailed information, including referencing of other borehole logs, that show the relationship between bedrock, saturated alluvium, and ground water gradient.

Section 4.1.5.2, Page 11, Paragraph 3

The reference to Plate 3 appears to be incorrect. Plate 4 is the geologic map of the study area.

Section 4.1.6, Page 12, Paragraph 1

The text refers to a top-of-bedrock topographic map that was generated. A map with this identification was not found in the report. If there is a reference number to this figure, provide it. Also, by using the term paleotopographic, it is implied that this was once a topographic surface feature. Clarification of this term and how it is used is needed, as well as a top-of-bedrock topographical map.

Section 4.1.6, Page 12, Paragraph 3

The text refers to cross-section H-H′. An H-H′ cross-section is shown in Figure 5-3, but the bedrock is not detailed in the subsequent cross sections. Provide the figure with the H-H′ cross section that is referenced in this section.

Section 4.1.6, Page 13, Paragraph 4

To provide a thorough report for a site that is stratigraphically and hydrologically complicated, it is recommended that all borehole logs within the line of a cross section be used to support all interpretations and conclusions. The text refers to wells BLM-37 and BLM-32 in cross section C-C′. These wells are situated in the south half of the area and are in the line of the cross section C′-C". However, information from these wells was not used in the construction of the cross section. Explain this omission and include the information available from the C′-C" cross section in the report.

Section 4.1.7, Page 13, Paragraph 1

This section states that geotechnical tests were conducted on representative samples of alluvium. The logs in Appendix H for soil boreholes BH-28 and BH-29 indicate that 27 geotechnical samples were collected from these two boreholes. A table indicating the total number of geotechnical samples collected and their locations should be added to the report. The discussion should also include results from the other geotechnical tests, besides grain size analysis, that were conducted.

Section 4.2.1, Page 14, Paragraph 2

Since the regional ground-water quality parameters for the Nacimiento aquifer are presented in ranges, it would be helpful to know the range for the regional sulfate concentrations.

Section 4.2.1, Page 15, Paragraph 2

The Zuni, Chuska, and Cebolleta Mountains are not north of the San Juan Basin as suggested in this sentence. The text should be corrected.

Section 4.2.2, Page 15, Paragraph 1

This section notes that the alluvial and bedrock (Nacimiento) aquifers are hydraulically connected and that the vertical gradient is upward on the east side of the arroyo but downward on the west side. This section should address the causes of the gradients and the impact that this will have on contaminant transport, particularly relating to contamination of the bedrock aquifer and how this information affected planning of the site investigation. In addition, potential bedrock contamination should be discussed in the report.

Section 4.2.2, Page 15, Paragraph 1

Additional evidence and further discussion are needed to support the statement relating the saturated thickness of the alluvial aquifer to the approximate center of the active unnamed arroyo channel. In reviewing Plate 5, the varying thickness of the alluvial sediments makes it apparent that the saturated thickness of the alluvial sediments varies. However, according to Plate 5, it does not appear that the thickest portion of the saturated alluvium is associated with the approximate center of the arroyo channel. There are apparently other factors associated with the saturated thickness, such as the presence of buried paleochannels.

Section 4.2.3, Page 16, Paragraph 1

The statement that cross-sections A-A′ through G-G′ "show the stratigraphic relationships between the aquifer, the landfill, the groundwater monitoring screens, and the lithology" is inadequate to explain or interpret the relationships. Because this report is written as public information, it is recommended that a discussion of each cross-section be included. Also, any interpretation of these relationships should be fully supported in the RI, FS, and the risk assessment (RA) reports.

Section 4.2.4, Page 17, Paragraph 1

This paragraph states that Appendix S contains hydrographs for 18 well clusters and pairs. In fact, Appendix S contains hydrographs for 17 additional single wells and Giant Bloomfield Refinery (GBR) wells. In addition, all wells should be used in a hydrograph. However, if not all of the information is used, explain why some is being omitted.

Section 4.2.4, Page 18, Paragraph 4

The text should state that the decrease in ground water elevation over time is apparent in most of the well hydrographs in Appendix S, not only those for BLM wells no. 17, 18, 19, 27, 28, and 29.

Section 4.2.5, Page 19, Paragraph 2

Vertical gradients in Table 4.3 show "both" upward and downward hydraulic gradients, but not "alternating," as indicated here. The term "alternating" implies that the vertical gradients change between well cluster locations in an orderly or directional fashion. It is recommended that the term "alternating" be deleted.

Section 4.2.6, Page 20, Paragraph 3

Table 4-4 gives K values ranging from 0.7 to 17.9 gallons per day per foot squared (gpd/ft^2) for those well boreholes screened in the bedrock aquifer. The text states that the values ranged from 0.7 to 14.2 gpd/ft^2. Clarify this discrepancy, and provide the reference.

Section 4.2.6, Page 20, Paragraph 3

Table 4-4 indicates that the range of K values for the alluvial aquifer is 6.0 to 85.3 gpd/ft^2. However, it is stated in the previous paragraph that the K values ranged from 0.7 to 245.3 gpd/ft^2. The text and the table should be reconciled, or an explanation should be provided, to prevent any misunderstandings or misinterpretations.

Section 4.2.6, Page 21, Paragraph 1

The text refers to contaminant transport simulations in Subsection 4.8. There was no such subsection in the RI report. This reference should be corrected.

Section 4.3, Page 22, Paragraph 2

This section describes the computer modeling of flood data and indicates that a 500-year event occurred in 1989. To enhance the review, visual observations of the effects of the flood and a map showing the areas affected should be included for review.

Section 4.3.2, Page 26, Paragraph 3

This paragraph contains a brief summary of the model results for a 500-year storm flood along the reach of the unnamed arroyo that passes the landfill. Missing from this summary are the model predictions for Section 2, which encompasses most of the northern gabion depicted in Figure 4-14. According to Table 4-8, the water velocity will be over 20 feet per second against the gabion wall. This information should be included in the text, along with a discussion of how such velocities may affect gabion walls that are entrenched 2 feet below the ground surface.

Section 4.3.2, Page 27, Paragraph 2

The text states that gabion walls will sag into eroded areas and still provide protection for the former landfill. Explain how this protective, sagging mechanism will function in the event of a flood and provide the construction specifications of the gabions to support this claim.

Section 5, Page 1, Paragraphs 1 and 2

The introductory remarks in this section are confusing and difficult to follow. The division of the discussion in this section into separate, but adjacent, areas is unnecessary. As noted previously, division of the landfill waste into solid and liquid disposal areas is not appropriate from a regulatory standpoint.

Section 5.1.2, Page 3, Paragraph 2

This section implies that an FS is dependent on the identification of contaminants of concern. According to the National Contingency Plan (NCP), sites that have been placed on the National Priorities List (NPL) are required to have an FS conducted. Clarify this statement to avoid detracting from the purpose of conducting an FS.

Section 5.1.2, Page 3, Paragraph 2

Other standards for identifying contaminants of concern in soil are needed, because the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) has not set standards for soil. However, alternate standards, in addition to the Resource Conservation and Recovery Act (RCRA) Corrective Action Rule (CAR) action levels should be considered. For example, background concentrations may also be used for comparison to identify the contaminants of concern.

Section 5.1.2.1, Page 4

Table 5-1 summarizes the soil data for VOCs and the decision criteria for determining which chemicals are to be contaminants of concern. To provide a more comprehensive picture of the distribution of contaminants across the site, frequency of detection should be included for each borehole in the table. Also, as discussed in the previous comment, background levels for soil should also be considered for determining the contaminants of concern.

Section 5.1.2.1.1, Page 5, Paragraph 5

The text states that "potential source areas are the former liquid waste lagoons, and the area of soil contamination located in the center of the eastern portion of the former landfill." However, according to the analytical results presented in the RI report, the southern portion of the landfill, especially around BH-13, is also a possible source area. The report should address this area or provide a rationale as to why it is not included.

Section 5.1.2.1.2, Page 7, Paragraph 1

The text states that nonchlorinated VOCs were found only in well boreholes no. 33 and 35 in the southwest corner of the landfill. It is also stated that "it is not known why non-chlorinated VOCs were detected at only two locations in the former landfill." It appears that additional characterization in this area of the landfill is warranted, because (1) why the non-chlorinated VOCs were detected in these two well boreholes is not explained, (2) high HNu readings were recorded on soil material from the alluvium-bedrock interface in well boreholes 33 and 35, and (3) observations of the lagoonal sediments from BH-13 have shown this to be a potential source area.

Section 5.4.3.1, Page 35, Paragraph 6

The assumption that the excavated area is free of contamination has not been adequately justified. It is stated that "assumption 2 is justified because geochemical samples from BH-17 and -28 did not show positive results . . . " However, a review of the supporting data - borehole logs and HNu data - shows that (1) the deepest sample collected from BH-17 was only 14 feet, and (2) the HNu readings recorded indicated the possible presence of contamination (see Appendix U). Additional evidence must be provided to justify using this conclusion as an assumption.

Section 5.5.2, Page 40, Paragraph 1

It is stated that "three gases, methane, solvent vapor, and hydrogen sulfide, were identified in subsurface soils within the landfill boundaries during intrusive activities under the RI." According to the information provided in Section 5.5.1, these gases were identified by using (1) an organic vapor analyzer (OVA), (2) a combustible gas indicator (CGI), (3) an HNu meter, and (4) a hydrogen sulfide meter. Section 5.5.1 also includes a discussion of the limitations of each of these instruments and also indicates that the results used to determine the types of gases that are actually present are subject to interpretation. Hydrogen sulfide has been positively identified, because the instrument used is specifically designed for the compound. The presence of methane is also highly probable, because it is a common gas formed from the decomposition of organic materials normally disposed of in a municipal landfill; however, it has not been positively identified. The identification of methane and solvent vapors as the other gases present within the landfill boundaries is not justified by the information provided in the RI report, because liquid wastes and other undocumented types of wastes were disposed of in the landfill. Discuss the potential for other types of gases to be present. Also, because solvent vapors consist of a wide range of gas compounds, a discussion of the potential types of solvent gases and their relationship as to where they could be present within the subsurface needs to be provided.

Section 5.5.2, Page 40, Paragraph 1

The occurrence of subsurface gas below, or in the absence of, waste should be discussed. The text states that methane was detected at depths of 53 feet. As stated in the previous comment, the absolute presence of methane is not supported, but some form of subsurface gas is present. Because subsurface gas is present in measurable concentrations at this depth, the source must be identified and characterized.

Section 5.5.2, Page 41, Paragraph 4

The text states that solvent vapors were generally limited to areas within the former lagoons or adjacent to the former lagoons. This conclusion should be reevaluated and either adequately justified or deleted. Significant gas readings were detected at the bedrock in BH-13, and the alluvium and bedrock contact in BLM-33 and BLM-34. These readings occur at the southern end of the landfill, close to and upgradient from the VOC contaminant plume/slug in the alluvial aquifer located southwest of the landfill.

Section 6.1.1.1, Page 3, Paragraph 3

The text states that "of the soluble metals detected in the upgradient alluvial groundwater samples, only chromium exceeds the Safe Drinking Water Act (SDWA) maximum contaminant level (MCL) concentration of 50 μg/L." However, in reviewing Table 6-1, it is reported that aluminum also exceeds the SDWA MCL and the upper limit of the regional background range. The text should be revised to reflect the information in Table 6-1.

Section 6.1.2.1, Page 5, Paragraph 2

The text states that there may be an upgradient source of chromium. Additional justification (analytical or otherwise) for this statement should be provided, because (1) the high chromium values were detected for some BLM wells only one time, and (2) sampling of other BLM wells on February 6, 1989, was only a one-time sampling for the presence of chromium. The conclusion of an upgradient chromium source is based mainly on analytical results from a sampling round that was conducted in February 1989. Although high chromium concentrations were detected in several monitoring wells sampled during that sampling round, it seems to be an anomalous condition when comparing these results with the results collected from these wells over the historical sampling activities. For example, the chromium values listed in Appendix N for 2-6-89 (wells BLM-14, 15, 17, 18, 20, and 21), are nearly twice the average chromium values of all other samples collected from those wells. For BLM-14, the average chromium concentration drops from 54.7 to 46.3 micrograms per liter (μg/L) if the 113 μg/L value detected on February 6, 1989 is not included in the average calculation. BLM-15 averages 18.4 μg/L without the 82.4 μg/L value detected on February 6, 1989. Also, Appendix N indicates that detection of chromium in several of the wells occurred only on February 6, 1989. Because that was a one-time occurrence, it seems to represent an anomaly.

Section 6.1.3, Page 6, Paragraph 1

The text notes that elevated chromium values were consistently measured in several sampling events in all five upgradient wells. However, a review of the analytical data for BLM-40 in Appendix N (page 118), shows that chromium was not detected in ground water samples. The results should be reevaluated and this statement altered to reflect the data available, because BLM-40 is one of two upgradient bedrock aquifer background wells.

Section 6.1.3, Page 7, Paragraph 2

Chloride, sodium, total dissolved solids (TDS), and sulfate concentrations were used as indicator parameters of downgradient ground water contamination. In Paragraph 1 of this page, it is also noted that the lagoons contained high concentrations of BTEX and chlorinated hydrocarbons. Since the contents of the lagoons were sampled and characterized, BTEX could have and most probably should have been used as indicator parameters as well. Explain why benzene, toluene, ethylbenzene, and xylene (BTEX) were not used as an indicator parameters. Give attention to the proximity of Giant Refining in this explanation.

Section 6.2.1.2, Page 9, Paragraph 3

Sulfate is being used as an indicator parameter for contamination in the aquifer. Discuss the relationship of high sulfate concentrations to the potential for the presence of contamination in the alluvial ground water. It is stated that "only two alluvial monitoring wells (BLM-17 and BLM-21) at the southwest corner of the landfill exceed the maximum background (upgradient) sulfate concentration." It is also noted that the upgradient maximum sulfate concentration is 2,120 mg/L. In reviewing the data for BLM-17 and -21, it is found that the maximum sulfate concentrations identified were 4,370 and 2,800 mg/L, respectively, and that all other sulfate values from these wells ranged from 1,000 to 1,300 mg/L. Provide an explanation as to how the maximum background value was derived.

Section 6.2.1.3, Page 9, Paragraph 1

The text states that the variation in ground water quality between these GBR wells and BLM wells may be a result of several factors discussed in Subsection 6.4. The factors to be discussed were not found in Subsection 6.4. Subsection 6.4 refers to the discussion in Subsection 6.2.1.3. A discussion should be included in the report.

Section 6.2.1.3, Page 9, Paragraph 4

The text states that the highest sodium concentration was 1,060 mg/L. However, a review of Appendix N, Page 237, shows that the highest sodium concentration reported for well GBR-48 was 1,176 on June 13, 1989. The text should be corrected to indicate this.

Section 6.2.1.3, Page 10

The text states that BLM wells adjacent to wells GBR-32, GBR-48, and GBR-49 had sodium concentrations near background values (173 to 452 mg/L). Although some of the adjacent BLM wells did have concentrations near background levels, some of the concentrations were above the background levels. Explain the high sodium concentration in adjacent well BLM-62, which had an average value, for six samples, of 593 mg/L.

Section 6.2.1.3, Page 10, Paragraph 1

The text states that "sulfate concentrations in wells GBR-32, GBR-48, and GBR-49 are slightly lower than the sulfate concentrations in adjacent wells." The text should be revised to indicate that, in Appendix N, only the sulfate concentrations in BLM-62 were higher, with a value of 2,330 mg/L. Also, the sulfate concentrations in the adjacent wells were in the same range as those in the GBR wells, and several were slightly lower.

Section 6.2.1.3, Page 10, Paragraph 1

The text states that low sulfate values may indicate that microbial reduction of sulfate is an ongoing process in Subarea 3. This hypothesis was to be the topic of additional discussion in Subsection 6.4, where contamination in the southern area of OU2 is described, and in Subsection 6.6.1, where stable sulfur isotope results are analyzed. However, the hypothesis of microbial reduction or biological degradation is discussed in Subsection 6.4.1.2.2 only as it relates to chlorinated aliphatic hydrocarbons, not sulfate isotopes. The report should be revised to discuss this hypothesis in the sections referenced.

Section 6.2.1.4, Page 10

The individual figures showing the distribution of each contaminant plume in relation to the wells used to construct the plumes should be included for review to (1) support the conclusion that the contamination in this area is not related to the activities at the landfill, and (2) provide a clear picture

Section 6.2.1.4, Page 10, cont.

of the relationship of the distribution of contaminants identified in the alluvial ground water in Site 2.

Section 6.2.1.4, Page 10, Paragraph 1

If the GBR wells are to be used to determine the distribution of contamination at a particular horizon, the placement of the well screen is crucial. It is not clear whether the screened sections of the GBR wells discussed in this paragraph are limited to the alluvial aquifer or span both the bedrock and alluvial aquifer. The screened horizon is not given for several of the GBR wells listed in Appendix N. To provide an adequate review of the well information and its relevance to the aquifers, all well information should be included in the report.

Section 6.2.1.4, Page 10, Paragraph 1

Monitoring well GBR-47 is referenced as being in Site 2. However, the survey coordinates for GBR-47 in Appendix N, on Page 231, place it in Site 1, Subarea 3. Plate 1 should be revised to reflect the proper location.

Section 6.2.2, Page 11, Paragraph 1

It is stated that "chloride concentrations in the bedrock aquifer are quite consistent and are generally less than 40 mg/L (Table 6-5). It does not appear that any sources of chloride have affected the chemical composition of bedrock alluvial aquifer waters." This statement must be justified or deleted. All information from the tables and appendices should be included for discussion to support all conclusions and assumptions made in the text. For example, Table 6-5 shows chloride values in the bedrock aquifer ranging from 15.1 to 448 mg/L, and Table 6-3 gives the background chloride concentrations ranging from 10.8 to 26.1 mg/L. Data in Appendix N show that a sample from BLM-26 contained 448 mg/L chloride on June 1988, but that 11 other samples, including seven subsequent samples, averaged 33.4 mg/L. Although the concentrations have been shown to be consistently less than 40 mg/L, there are apparent outlying concentrations. To provide for a comprehensive report, a discussion of the outlying concentrations is needed.

Section 6.2.3, Page 12, Paragraph 3

The discussion of the hydraulic relationship between the bedrock and alluvial aquifers in this paragraph is deficient. It has been stated in other sections that the vertical hydraulic gradient on the west side of the arroyo is downward and that the vertical gradient on the east side of the arroyo is upward. The significance and possible impact of variations in the vertical gradient should be discussed more thoroughly.

Section 6.3.1.1, Page 13, Paragraph 4

The generalization is made that it is common for metals to form oxyanions under oxidizing conditions. This is an oversimplification of metal oxidation and is generally not true under ambient environmental conditions. Further justification should be provided to support this statement, or it should be deleted from the text.

Section 6.3.1.1, Page 14, Paragraph 2

The text indicates the average chromium concentration for BLM-51 is 54.3 μg/L. However, the highest value listed in Appendix N is 20.0 μg/L. The text and the appendix should be reconciled.

Section 6.3.1.1, Page 14, Paragraph 3

Chromium concentration in GBR-32 is 0.27mg/L or 270 μg/L, and not 70 μg/L as presented here. The text should be corrected.

Section 6.3.1.2, Page 16, Paragraph 2

It is stated that trichloromethane data for BLM-56 are listed in Table 6-8. However, a review of Appendix N indicates that reported concentrations of trichloromethane above detection limits were not presented. Clarify and correct this deficiency.

Section 6.3.1.2, Page 16, Paragraph 3

The TCE data for BLM-43, BLM-60, and BLM-21 are not given in Appendix N. Clarify and correct this deficiency.

Section 6.3.2.1, Page 17, Paragraph 1

The second sentence of this paragraph states that chromium is identified as a contaminant of concern (COC), and sentence 6 of this paragraph concludes that chromium is not a COC because it is considered to be from an upgradient source. These two sentences contradict each other. If chromium is not going to be considered a COC, this decision must be justified and explained. The justification must include the technical reasoning, because background chromium values for the bedrock aquifer are based on one sample in February 1989 for well BLM-16 and no chromium values for BLM-40.

Section 6.3.2.1, Page 17, Paragraph 1

The text notes that chromium is identified as a background contaminant in the bedrock aquifer. This statement must either be deleted from the text, or the higher background chromium value must be fully supported. Background chromium values for the bedrock aquifer are based on one sample in February 1989 for well BLM-16 and no chromium values for BLM-40. Page 14, Paragraph 1 indicates that chromium values for February 1989 are anomalously high. Therefore, it appears that the conclusion that background chromium concentrations in the bedrock aquifer are elevated is not substantiated.

Section 6.4.1, Page 19, Paragraph 1

The text states that BLM-62 was installed adjacent to GBR-32. Plate 1 indicates that the wells are over 30 feet apart. The text should be revised to reflect the lateral differences between the two boreholes because of the possible lateral variations in lithology at the site.

Section 6.4.1.1, Page 19, Paragraph 2

The text in Section 6.2.1.3, Page 9, indicates that the elevated chloride values in GBR, compared with those in BLM wells, will be explained in this section. No explanation is apparent. The text should be corrected.

Section 6.4.1.2.1, Page 20, Paragraph 1

Figure 6-2 shows the extent of chlorinated hydrocarbon contamination in the southern area alluvial aquifer. The clarity of this figure needs to be improved; therefore, the scale should be increased, similar to that used for Figure 6-4. Also, the

Section 6.4.1.2.1, Page 20, Paragraph 1, cont.

concentration values should be contoured by using an algorithm to indicate the distribution of contaminants within the plume/slug. If data are available, a time sequence of the contaminant distribution should be presented.

Section 6.4.1.2.2, Page 22, Paragraph 1

Sources for the information presented in this section on chlorinated VOC degradation should be cited in the text.

Section 6.4.1.2.4, Page 24, Paragraph 2

The text states that the distribution of dichloromethane is shown on Figure 6-2. However, only the area of chlorinated hydrocarbon contamination is shown in the figure. The text and the figure should be reconciled.

Section 6.5.3, Page 32, Paragraph 1

Potential sources of contamination at the Giant Bloomfield Refinery listed in this section and their relationship to the landfill should be shown on a figure.

Section 6.6.1, Page 36, Paragraph 3

Figure 6-10 contains a summary of the stable sulfur isotope data. All of the isotope data should be included in this table, and the table should be expanded to include the data on which the summary statistics are based.

Section 6.7, Page 43, Paragraph 1

The text states that chromium contamination is present in the ground water upgradient of the landfill. As noted previously, this finding should be reevaluated. Additional ground water samples should be collected and analyzed for chromium to support the conclusions of the report.

Section 6.7, Page 44, Paragraphs 2 and 3

The text states that chromium is not a contaminant of concern. As previously noted, this conclusion should be reevaluated.

Section 7

The current model calibrations do not appear to produce an acceptable match between field data and simulated values. Therefore, these models should not be used to characterize the concentration distribution of contaminants within the plume boundaries. The conclusion that Site 2 ground water contamination is unrelated to former landfill activities is overstated. The model results suggest that, based on the assumptions used, ground water contaminated by 1,2 DCE may not have originated from the former liquid waste lagoons. The text should draw conclusions that can be supported by the data and analyses.

Throughout this report, there is the assumption that the contaminant sources in the area designated as Site 2 are not in any way related to the landfill. This assumption is stated as fact. Examples of the RI assumption are:

> Section 8, page 1, 2nd paragraph, last sentence: "A pathway analysis for Site 2 is not performed because contaminant sources are unrelated to the landfill."
>
> Section 8, page 4, 1st paragraph, last sentence: "Human exposure pathways to the San Juan River was not included in the analysis as the river is located in Site 2."
>
> Section 9, page 1, 1st paragraph, 3rd sentence: "A conceptual site model has not been developed for Site 2 because contaminant sources are unrelated to the former landfill."

EPA has determined the model to be incomplete and not representative of the actual conditions at the Lee Acres Landfill. The most significant flaw in the model is in its setup. The East boundary condition chosen is a poor selection. Specifically the model does not attempt to address the data available from the Giant Refining Wells because the East boundary or "no-flow" condition is West of these wells. The RI report then in turn makes the determination that the plumes from the landfill and the refinery are separate and distinct and discontinues discussion about possible contamination in and around Giant Refining. Simple hand plotting of Chlorides, Chlorinated Solvents, Total Dissolved Solids, and Petroleum Hydrocarbons quickly indicate that more consideration and effort should have been spent on determining the model boundary conditions and contaminants selected to illustrate extent of the ground water contamination. The RI, and therefore the model, should address all the data available, including the data available from the Giant Refinery Wells.

There are four general classifications of problems with the model: (1) assumptions, (2) discretization, (3) calibration, and (4) the HELP simulation.

The modeling effort ignored coupling between the bedrock and the alluvial aquifer yet the field piezometric data suggests that interaction exists. In particular, throughout most or the area of concern flow occurs from the bedrock aquifer to the alluvial aquifer. Hence, the assumption that infiltration equals leakage to the bedrock aquifer does not appear valid. In addition, it is not clear what role well BLM-37 has in potentially effecting the flow conditions in the aquifer.

Although no fundamental problems are apparent in the grid design, it is recommended that the discretization scheme be tested to ensure that it does not influence the accuracy of the solution. This can be accomplished by decreasing (preferably halving) the grid spacing and comparing the solutions.

The weakest part of the modeling effort was in the calibration process. Specifically, the calibrated retardation values for manganese and DCE are approximately the same, 2.4 and 2.5 respectively. This correlation is contrary to general geochemical principles as the partition coefficient of organic compounds are typically different than inorganic compounds. Furthermore, the retardation value used in the Random Walk modeling effort does not agree with that utilized in the HELP modeling effort (EPA used both a Random Walk Solute Transport code and the hydrologic Evaluation of Landfill Performance (HELP) model). It is recommended that retardation should be estimated from laboratory breakthrough curve analyses using aquifer materials from the site. In addition, it is uncertain why dispersivity was not calibrated.

The process of calibration could be improved by randomly selecting the parameter values for dispersivity and retardation rather than assigning various retardation values to a fixed dispersivity value. Most importantly, the simulated contaminant plumes derived from the results of the calibration did not agree with the measured concentrations. In particular, the inaccuracy of the simulated values for DCE exceeded 100 ppm at some sell locations. As a result this and the poorly defined no-flow boundaries, the stated conclusions derived from the modeling effort are extremely questionable and unsupported.

The leachate concentrations predicted by HELP simulations are not conservative. In order to arrive at conservative values, chemical equilibrium between soil and leachate should be assumed.

For example, based on a linear partitioning, the leachate concentration of DCE (Table 7.8) should be:

$$C = S/K_d = 14 \text{ ug/kg} / 0.1 \text{ L/kg} = 140 \text{ ug/L}$$

where C = concentration in water
S = soil concentration
K_d = partitioning coefficient

The predicted HELP value is only 12.68 ug/L, which is an order of magnitude smaller than the conservative value. In addition, the use of material gradation to determine the capillary pressure data is a questionable assumption. It is recommended that actual moisture retention analyses be conducted to determine this important model parameter value.

However, modeling objectives are clearly stated, model assumptions and the rationale for selection of model input parameters are addressed, and there is a discussion regarding model limitations. The models for manganese and 1,2 DCE should not be used to predict the concentration of contaminants in ground water within the plume boundaries because the models do not appear to be fully calibrated based on regression analyses.

The quality of several figures presented in Section 7.0 of the report should be improved. For example, the contours and labels for chemical isoconcentration lines in Figures 7-1, 7-2, 7-3, 7-4, 7-7, and 7-8 are illegible. In some figures, isoconcentration lines appear to overlap.

Section 7.1, page 3, Paragraph 2

It is unclear whether the version of Random-Walk used in this modeling exercise is numerical or analytical. The text states that the Random-Walk solute transport model (Prickett, 1981) was used to simulate the migration of manganese and 1,2 DCE. In the numerical version of Random Walk, particles are moved by advection based on velocity vectors derived through finite difference methods. However, the text states that ground water flow is modeled by a single velocity vector with an x and y component, and that ground water flow and boundaries are not considered explicitly. If an analytical function driven version of Random-Walk was used, the text should state this and provide an appropriate reference for the source of the model code. The text should also point out that the boundary conditions described in Section 7.1, page 3 only apply to the conceptual model of the site, and that the model assumes that the aquifer is infinite in areal extent.

Section 7.1, page 4, Paragraph 2

The text states that the version of Random-Walk used in the modeling investigation assumes one-dimensional advection. The analytical version of the computer code is not but should be documented and referenced.

Section 7.1, page 4, Paragraph 2

The text states that a portion of the modeling grid was bent at a 10-degree angle. It is unclear how the model grid was bent since it is not discussed in the Random-Walk model documentation (Prickett, 1981). In fact, ground water model grids cannot be bent and two-dimensional ground water flow cannot be modeled with a unidirectional flow field. The presentation of results related to model grid development and plume migration appears to be either misleading or hypothetical. The text should be corrected to reflect the fact that (1) computer model grids cannot be bent, (2) the no-flow boundary conditions representing the eastern and western margins of the alluvium cannot be described using the assumption that the aquifer is infinite in areal extent, and (3) that the unidirectional steady-state flow field assumed in the transport model can only provide an estimate of the distance a contaminant plume may migrate downgradient.

Section 7.3, page 7, Paragraph 4

A nonstandard method of calibration is used. In addition, the calibration method does not appear to result in an acceptable match between observed and simulated ground-water concentrations. For example, independently generated regression analysis for the manganese and 1,2 DCE calibration data sets were determined. Computer output from these regression analyses appear in attached Figures 1 and 2. These figures indicate the correlation coefficient squared (R^2) value for the manganese model calibration was equal to 0.69. The R^2 value for 1,2 DCE model calibration was only 0.40. R^2 values for calibrated ground water models should be closer to 0.90. The regression analysis suggests that 31 percent of the variation between field data and simulated values cannot be explained by the contaminant transport model. Sixty percent of the variation between field data and simulated values for 1,2 DCE cannot be explained. The report should identify an acceptable R^2 value, and support the use of this value prior to using model results to draw conclusions.

Section 7.4, page 10, Paragraph 3

As per the above, the conclusion that Site 2 ground-water contamination is unrelated to former landfill activities is overstated. Based on the assumptions used, the model results suggest that ground water contaminated by 1,2 DCE may not have originated from the former liquid waste lagoons. The text should draw conclusions that can be supported by the data and analyses.

Section 7.5, Page 10, Paragraph 4

Text refers to ground water modeling and states, "This observation reveals that Site 2 ground water contamination is unrelated to former landfill activities." It would be more accurate to state, "This observation suggests that Site 2 groundwater contamination is unrelated to former landfill activities." Again, a disproportionate amount of weight has been given to an inadequate model.

Figures 7-1 and 7-2, Pages 13 and 14

Results of simulation presented in Figure 7-2 indicate the 1,2 DCE plume is located along the eastern edge of the model grid. However, in Figure 7-1 the plume is located closer to the western boundary of the model grid. The inconsistency in the location of the 1,2 DCE plume should be corrected, or an explanation should be provided.

Figures 7-3 and 7-4, Pages 15 and 16

Results of simulation presented in Figure 7-4 indicate the manganese plume is located along the eastern edge of the model grid. However, in Figure 7-3 the plume is located closer to the western boundary of the model grid. The inconsistency in the location of the manganese plume should corrected, or an explanation should be provided.

Figure 7-5, Page 17

Bending a model grid is not a standard modeling approach, and is not discussed in the Random-Walk model documentation (Prickett, 1981). A discussion of how this was accomplished should be provided.

Section 8, Page 2, Paragraph 1

The text states that decision networks were used to identify active pathways. EPA guidance (EPA, 1989) suggests that not only active, but also potentially active, pathways must be considered in the risk assessment.

Section 8.1, Page 2, Paragraph 1

The results of the RI air sampling program indicate that there are not any current air emissions of concern occurring at the landfill. However, as noted previously, the sampling methodology used for gas emissions should be reevaluated. In addition, QA/QC data for the ambient air and soil gas analysis should be reviewed and included in the report.

Section 8.1, Page 2, Paragraph 2

This paragraph indicates that future remedial activity at the landfill may result in the release of potentially hazardous gases. EPA recommends that the risk assessment also consider other excavation activities, such as construction, which may occur if the property ownership changes.

Section 8.2, Page 2, Paragraph 1

The claim is made that surface water should not be considered a pathway, partly, because the gabion walls will provide permanent protection for the landfill contents. However, in Section 4.3, it is acknowledged that the gabion walls may sag because of undercutting by relatively high velocity floodwater during extreme events. While the conclusion that the surface water pathway does not need to be considered further appears to be justified, exaggerated claims about the permanence of the gabion walls should not be included in the report.

Section 8.3, Page 3, Paragraph 2

The text states that landfill constituents may have leached into the alluvial aquifer. The text should be corrected to indicate that landfill constituents have leached into the alluvial aquifer. The statement in the text is not supported by the investigation results such as the analytical results, for (1) surface soil samples, (2) soil from well boreholes, (3) groundwater samples from alluvial aquifer wells, and (4) lagoon samples from previous investigations.

Section 9, Page 1, Paragraph 2

The text states that disposal activity was minimal until 1970 and that 390,000 cubic yards of solid waste were disposed of from 1962 to 1970. In Section 5.4.4, the landfill is estimated to contain approximately 600,000 to 800,000 cubic yards of waste and contaminated soil. If the figures are correct, the characterization of waste disposal activities prior to 1970 as minimal is not appropriate. These figures should be checked and, if necessary, the text should be changed accordingly.

Section 9, Page 2, Paragraph 1

As previously noted, the gabion walls should not be considered permanent, based on BLM's own modeling results.

Section 10

The RA section of the RI report is not in conformance with RA guidance documents. Based on the information contained in the RA section of the RI report, EPA will require explanations by BLM and, in some cases, extensive revision. Such correction is necessary to bring the RA section into conformance with RA guidance documents and to be protective of human health and the environment.

One of the specific components associated with the RA is an exposure assessment. Much of the information required to support the exposure assessment was referenced as being in Section 8 - Pathway Analysis - and Section 9 - Conceptual Site Model - of the RI report. However, in Section 8, the exposure pathways identified were not evaluated against the criteria outlined in the RA guidance for exposure assessment. If the proper guidance is followed, potential pathways of concern are evaluated in the exposure assessment of the RA. Therefore, a separate section evaluating the potential pathways is not necessary. Section 9 of the RI is also unnecessary, because a conceptual site model is used in the initial planning for the RI. At this point in the RI and RA, the conceptual site model does not provide any additional information. However after the RA is completed in accordance with the guidance documents, the conceptual site model can be refined to show the pathways supported by the RA.

In reviewing the section discussing the procedures for selecting the contaminants of concern, several problems were identified with the procedures that were followed. First, the information on selecting the contaminants of concern is scattered throughout Sections 1, 5, 6, and 10 of the RI report. Because this information is useful in reviewing the selection procedures, it would be beneficial for all of the information to be consolidated in the RA to provide for a comprehensive review. Second, it appears that the risk assessment guidance (EPA, 1989) was not followed in selecting the contaminants of concern. Based on the RA, it appears that elimination of contaminants was based on (1) laboratory contamination, (2) applicable or relevant and appropriate requirements (ARAR), and (3) frequency of detection.

The decision trees (Figures 10-2 and 10-3) for identifying contaminants of concern indicate that chemicals may have been deleted from consideration in the risk assessment for reasons that are inconsistent with guidance. On Figure 10-2, one of the decision criteria - " Is concentration attributed to laboratory contamination? (Less than 5 or 10 times concentration in lab blank?)" - is unclear. It is recommended that clarification be added in the form of a statement that, when eliminating chemicals based on whether they were considered to be laboratory contaminants, the concentrations must be 10 times the blank concentration for chemicals considered to be common laboratory contaminants and five times the blank concentration for chemicals that are not considered to be common laboratory contaminants.

According to Figure 10-3, elimination of contaminants was based on regulatory standards, meaning ARARs. The risk assessment guidance (EPA, 1989b) indicates that chemicals with ARARs are usually not appropriate for exclusion from the quantitative risk assessment. This is due partly because many ARARs are not solely health-based but may include adjustments for technical and/or economic feasibility.

In accordance with guidance (EPA, 1989b), known human carcinogens, such as benzene, should be retained for consideration regardless of whether frequency of detection and concentrations were low. Also, the criteria used to determine whether a chemical would be retained, based on frequency of detection, are not consistent. For example, 1,1,1-trichloroethane and total xylene, which were detected at 10 and 11 percent frequency of detection, respectively, were not retained (Table 10-6). However, 1,1-dichloroethane, which was detected at 7 percent frequency of detection, was retained (Table 10-7). A detection frequency limit should be stated in the text and observed consistently. According to guidance (EPA, 1989b), any detection frequency limit to be used, such as 5 percent, should be approved by the remedial project manager (RPM) for use in the risk assessment. Also according to guidance, when trying to reduce the number of chemicals of concern in the risk assessment "... the time required to implement and defend the selection procedures discussed in this section may exceed the time needed to simply carry all the chemicals of potential concern through the risk assessment" (EPA, 1989b).

To determine a background location for collecting air samples to compare with air samples collected from the site, the guidance (EPA, 1989b) recommends that regional data be obtained from the U.S. Geological Survey or the Soil Conservation Service. Also according to guidance, it is appropriate to possibly eliminate inorganic chemicals from contaminants of concern if the inorganic concentrations are not higher than the background sample concentrations collected from the vicinity of the site. Section 3 of the RI states that a fire station was selected as a background location because it was representative of the air quality at the community nearest to the landfill. It is not appropriate to compare a remote location, such as the landfill, to an urban area, such as the fire station where other anthropogenic activities may have affected contaminant concentrations. This appears to hold true, since the concentrations for metals - Section 3, page 5 - and particulates -Section 3, page 25 - are consistently higher at the background than at the site. It is recommended that a background location be chosen, because it is unaffected by the site but represents an area similar to the site.

To complete an adequate review of the RA, it is imperative that all information including, but not limited to, calculations, formulas, and other relevant mathematical information, be included to reproduce the final calculated risks. Also, it is recommended that the report discuss in detail the (1) methodologies used to determine the concentrations used in calculating risks, and (2) assumptions used in calculating risks. For example, state whether the quantitation limit (QL) or one-half of the QL was used as a proxy concentration if the QL is unusually high; or whether a chemical was not detected in a sample but was detected in other samples in the same medium. Also, it is not known whether the areas exhibiting higher metal concentrations were treated as hot spots or whether the concentrations were averaged over the entire site. Another example is the second assumption stated on Table 10-12. It states that both subchronic and chronic dose indices have been adjusted for adsorption, yet this is not discussed in the text.

A geometric average was used to calculate the exposure concentrations. Risk assessment guidance (EPA, 1989b) specifies that the arithmetic average of the concentration that is contacted over the exposure period be used for this concentration. Using the geometric average rather than the arithmetic average for the exposure concentration may result in lower risk levels being calculated. An explanation should be provided for not following the guidance on this issue. Also, to reproduce the data in the risk calculation, justify using a geometric average for the exposure concentration.

It is not clear whether all of the exposure pathways - including current, potential future, and residential scenarios - for the site were considered and discussed in the RA. For the current scenarios, drinking water sources for the residents south of the landfill must be identified and discussed. Also, it is not clear whether the existing ground-water wells south of the landfill are used for drinking water, irrigation of crops, or livestock. If wells are being used for irrigation of crops or for livestock, food ingestion pathways should be addressed in the RA. Also, for the current scenarios, Section 10.1.2.1, page 10-3 states that the contaminated soils and waste trenches are covered with 2 to 10 feet of soil. Since erosion was known to occur in a past flooding event, it should be stated how it is known that this soil cover is still at the site and what the probability is that contaminated soils have been exposed. If these soils may now be accessible, adding a trespasser scenario should be considered. A trespasser scenario should include, but not be limited to, (1) ingestion of contaminated soils, (2) dermal contact with contaminated soils, and (3) inhalation of contaminated soil particulates. Potential future scenarios, ignored the prerequisite of construction activity for residences to exist in the northern and southern areas of operable unit 1. A construction scenario would include, but not be limited to, worker exposure to subsurface soils. Construction could result in the moving of contaminated subsurface soils to the surface, making them available for exposure contact during the residential scenarios. For the residential scenarios, food ingestion pathways for home-grown vegetables and livestock should be addressed in the RA.

It is unlikely that the adverse ecological effects addressed in Section 10.5, caused by the contamination at the site, could be fully understood and assessed simply through a site walk-over. This is especially true, since a decrease in population may not be the only toxological end point to exposure. It would be more appropriate to follow ecological RA guidance (EPA, 1989a and EPA, 1989c) and assess the impacts on a selected number of indicator species by known contaminant concentrations at the site.

The baseline risk assessment did not address the contamination in Site 2. For example: Section 10, page 5, subsection 10.1.4.: Text states, "Site 2 groundwater may be considered to be an important exposure pathway but is beyond the scope of this document. Therefore, no quantitative risk assessment will be performed.

One critical item missing from the RI and RA is the lack of any surface soil analytical data. It is apparent that due to the reported "two to ten feet of soil" reported to be covering the contaminated soil, it was assumed that no possibility that contaminated soils would be exposed. This is of concern due to the fact that it is not possible to know how quickly the cover soil might erode and reveal a potential pathway and that this cover soil did not appear to be taken into consideration during the EM Survey. If this assumption is true, not only did the EM fail to take into account the fact that the instrument may have been held waist high, but also that there may have been more fill material than the instrument could penetrate (see Page 6, Section 2.1.1.2.2). Surface soil sampling of the landfill should occur and special attention given to the characterization of what currently appears to be stained soils.

Section 10, Page 10-1, Paragraph 2

It is stated that "The baseline risk assessment for the former Lee Acres Landfill site addresses future public health risks ..." However, both future and current public health risks are discussed in the RA. Clarify this statement.

Section 10.1.2.1, Page 10-3, Paragraph 2

The statement that concentrations of barium and strontium are within regional background levels should be substantiated with a reference. Also, explain why no quantitative baseline RA was performed for landfill soils. The paragraph implies that dieldrin is above the proposed Resource Conservation and Recovery Act (RCRA) action levels. Note the general comment on Section 10 addresses the appropriateness of using ARARs for eliminating chemicals from consideration in the risk assessment.

Section 10.2.4, Page 9

It is stated that the amount of volatile organic compounds (VOC) absorbed through inhalation during showering has been estimated to be equal to the amount of VOCs absorbed through the ingestion of drinking water. Explain why the RA assumes that the inhalation and dermal absorption of VOCs during showering was equal to ingestion of VOCs in drinking water.

Section 10.3, Page 10, Paragraph 3

This paragraph states that nine of the 11 contaminants of concern are carcinogens. However, Section 10.4 on page 10-11 states that seven of the chemicals are evaluated for carcinogenic risk. This discrepancy should be resolved.

Section 10.3, Page 11, Paragraph 1

Risk assessment guidance (EPA, 1989b) states that, "If EPA-derived toxicity values are unavailable but adequate toxicity studies are available, one may derive toxicity values using Agency methodology. Any such derivation should be done in conjunction with the regional risk assessment contact, who will submit the derivation to Environmental Criteria and Assessment Office (ECAO) for approval. Contact with ECAO should be established early in the process to eliminate any duplication of effort because the ECAO may have information on the chemical being evaluated." Provide documentation showing that the

Section 10.3, Page 11, Paragraph 1, cont.

regional RA contact and ECAO have verified the appropriateness of the reference doses (RfD) calculated here.

Section 10.4.1, Page 11

Assumptions made for children who are residents at the site are not detailed in the text. Present and support the assumptions made for the children.

Section 10.5, Page 12, Paragraph 4

Discuss in detail, and reference the methodologies used to derive, concentrations of contaminants in the San Juan River.

Section 10.6, Page 13

It is unclear to whom "future nonresidents located downgradient from the northern groundwater plume" refers, since future nonresidents have not been discussed earlier in the text.

Section 10.6.1.1, Page 13, Paragraph 2

It is unclear how the contribution of risk could be different for inhalation of and direct contact with contaminants while showering, since it was stated earlier that the combination of these two was equal to the intake of contaminants through ingestion of drinking water.

Section 10.6.3, Page 15, Paragraph 2

The rationale for concluding that contamination from subarea 3 poses no threat to aquatic organisms in the San Juan River is questionable. The paragraph states that there is no threat to aquatic organisms, because mass transport modeling has shown that contaminant concentrations will be below Safe Drinking Water Act (SDWA) maximum contaminant levels (MCL) in the river. The SDWA MCLs were derived for human consumption of drinking water (and may not be solely health-based) and were not designed for the protection of aquatic life. Again, it is suggested that RA guidance be consulted for appropriate methodologies (see General Comment 7 for Section 10).

Section 10.7.3, Page 17, Paragraph 2

Although it is true that VOCs tend to volatilize, other contaminants of concern, such as metals, may not volatilize and

Section 10.7.3, Page 17, Paragraph 2

may be taken up by the vegetables via their root systems. It is recommended that a vegetable ingestion scenario be addressed in the RA.

Table 10-12, Page 39

It is recommended that any adjustments for frequency and/or duration of exposure be added to the generic calculation for dose. Also, on Assumption 2, any adjustments made for absorption should be clearly detailed in the text.

Table 10-13, Page 40

The split for the different isotopes of chromium should be described in the text. Also, it appears that the concentrations for inhalation and direct contact were derived by taking one-half of the concentration for ingestion. This does not seem appropriate, since these concentrations are not actually known.

Table 10-15, Page 42

Any adjustments for frequency and/or duration of exposure should be added to the generic calculation for dose.

Plate 1

Many areas on Plate 1 are difficult to read because the multitude of activities that occurred during the RI. Although it is necessary to provide the visual aids that show the areas of investigation, it would be helpful if the information on this plate were divided into two or more groups. With all of the information provided on one map, it is difficult to follow in the discussion of the report. Additional plates showing separate investigation activities should be provided.

Plate 4

The bedrock channel should be clearly defined on Plate 4, because the plate is referenced several times in Section 4.0 of the draft RI report; also, this bedrock channel has been identified as a controlling factor for the occurrence of saturated alluvium. Furthermore, it is recommended that query symbols (- - ? - -) be included on the east side of the arroyo where the map symbols suggest that the contact is more of an approximation than the contact on the west side of the arroyo.

Appendix U

Some of the figures in this appendix are not consistent with the operating capabilities of the HNu. The HNu does not detect methane. However, the sections where HNu readings were recorded in the figures for BH-03, BH-12, and BH-13 include the interpretations, that no solvent vapors are present. An introductory paragraph should be included in this appendix to explain the manner in which the interpretations were made.

APPENDIX B

COMMENTS ON ENVIRONMENTAL RISK ASSESSMENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

RECEIVED
BLM
92 OCT -5 AM 11:57
019 FARMINGTON, N.M.

OCT 02 1992

Mr. Bruce Davis
Bureau of Land Management
1235 La Plata Highway
Farmington, New Mexico 87401

RE: Comments on Environmental Risk Assessment

Dear Mr. Davis,

Included in this letter are comments on the draft Remedial Investigation Environmental Risk Assessment. Please review and provide the appropriate information/justification as necessary.

An ecological risk assessment based on visual estimates of no known reductions/changes in populations, communities, or ecosystems is unacceptable. We will provide examples of acceptable ecological risk assessments done for other Region 6 Superfund Sites should you require them.

More documentation of whether exposure pathways for ecological receptors are complete is required. For instance:

a) If soil staining is due to contamination, stained soil areas could serve as a source of contamination for ecological receptors and would need to be evaluated for toxicity or bioaccumulation/food chain effects. What is the source of the stained soil, and what contaminants are in the stained soils? It is mentioned on page 1-8 that surficial waters from the study area drain toward and through an unnamed arroyo system that joins the San Juan River. It should be clarified whether the stained areas erode into the arroyo and get transported to the San Juan River. If so, evaluation of ecological risk to aquatic ecological receptors, as well as terrestrial ecological receptors, would need to be conducted.

b) Contaminants were detected in the borehole and surface soil sampling of the arroyo and should be discussed/evaluated for availability to ecological receptors through such exposure routes as soil ingestion and bioaccumulation or through temporary use (i.e. for breeding habitat) of intermittent arroyo waters containing contaminants from the sediments. Further evaluation of these sediments, such as further sampling of surface arroyo sediments, may be necessary to assess risks from site-related contaminants transported to the arroyo by erosion/runoff or leachate in ground water.

c) The landfill contaminants under 2-10 feet of soil could serve as a source of contaminants for burrowing animals in arid areas such as prairie dogs or badgers. These animals can burrow to deep cool soil levels. The soil pathway could be a complete ecological pathway. Burrowing activity needs to be evaluated, and if a complete exposure pathway is present, potential adverse toxicity or food chain effects from exposure of burrowing animals and their predators to the landfill soil contaminants would need to be evaluated. On page 8-3, first paragraph, it is mentioned that access is restricted by a fence. A fence is not a hindrance to access by wildlife such as small mammals and avian predators, and thus, should not be used as a rationale to eliminate a pathway from evaluation.

Ecological evaluations for the stained soil, arroyo, and landfill contaminant sources could be either done by a literature review of ecotoxicity and exposure parameter information for each indicator species (ecological receptor) and ecological contaminant of concern, or by a combination of literature values and site-specific measured tissue residue values.

The ecological risk assessment should be distinct from the human health risk assessment. The identification of ecological contaminants of concern, toxicological assessment, exposure assessment, and risk characterization need to be done separately for the ecological risk assessment.

Specific details need to be provided, on a chemical by chemical basis, describing the rationale (and providing the concentration and toxicity) used for elimination as a contaminant of concern.

It is against Region 6 policy to eliminate from the risk assessment (organic) contaminants detected in concentrations at or below naturally-occurring concentrations. These contaminants should be included in the risk assessment. It is also unacceptable to eliminate contaminants that were detected but do not exceed regulatory standards such as RCRA soil action levels or TCLP metals standards. These contaminants should also be included in the risk assessment. In the risk characterization, the regulatory standard may, in some cases, be used as the toxicity criterion in the denominator of the hazard quotient. The baseline risk assessment should be revised to address both of these deficiencies.

Additionally, inorganic contaminants detected should be compared to true natural background values.

Page 1-19: One-time detections were eliminated as COCs. There is no justification adequate for eliminating contaminants based on infrequent detection.

On page 10-13, SDWA MCLs were used to evaluate future ecological risk. It is inappropriate to use MCLs, which are human health values, for evaluating ecological risk. Comparisons to MCLs should be eliminated from the ecological risk assessment.

Documentation that suspected laboratory contaminants were only eliminated as contaminants of concern is required. One such example might be a table illustrating that if sample concentrations were below 10 times the concentration found in any blank, the contaminant was eliminated. If sample concentrations exceeded 10 times the concentration of any blank, these contaminants should be retained as contaminants of concern and be included in the risk assessment.

A site conceptual model should be developed for Site 2.

Please call if you have questions concerning these comments on the Environmental Risk Assessment or the draft Remedial Investigation.

Sincerely,

Ky D. Nichols
Remedial Project Manager
Oklahoma/New Mexico Section

APPENDIX C

REMEDIAL INVESTIGATION RISK ASSESSMENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

RECEIVED
BLM
92 OCT 16 AM 11:17
019 FARMINGTON, N.M.

OCT 13 1992

Mr. Bruce Davis
Project Manager
Bureau of Land Management
1235 La Plata Highway
Farmington, New Mexico 87401

RE: Remedial Investigation Risk Assessment

Dear Mr. Davis,

This letter provides the comments on the Remedial Investigation Report Risk Assessment on the Lee Acres Landfill Superfund Site. The baseline risk assessment portions of the Remedial Investigation Report are not in accordance with EPA risk assessment policies and requires substantial revisions to be in accordance with these policies.

General Comments:

Section 8: The decision networks provide an unacceptable and inappropriate screening of potential exposure pathways. The entire pathway screening process as its presently stands is unacceptable for risk assessment purposes.

Section 9: The Conceptual Site Model lists several pathways as "dormant" without presenting adequate justification.

Section 10, Contaminants of Concern: The process of screening contaminants of concern (COCs) is not in accordance with Chapter 5 of the Risk Assessment Guidance for Superfund (RAGS).

Section 10, Exposure Assessment: The exposure parameters which are used in the baseline risk assessment are not in accordance with the "Standard Default Exposure Factors" (OSWER Directive 9285.6-03). Deviation from these parameters requires site-specific data and explanation.

Section 10, Concentration Term: The baseline risk assessment should use the 95th percent of the upper confidence limit on the arithmetic mean (Supplemental Guidance to RAGS: Calculating the Concentration Term).

Section 10, Central Tendency and Reasonable Maximum Exposure: Superfund risk assessments require the calculation of a central tendency and a reasonable maximum exposure (RME) (Guidance on Risk Characterization for Risk Managers and Risk Assessors). The Risk Characterization should discuss only the RME. The central tendency should be discussed only in the Uncertainty Section.

Specific Comments:

Page 8-1, 1st Paragraph: The Endangerment Assessment Handbook has been superseded by the RAGS.

Page 8-2, 2nd Paragraph: What regulatory air standard are used to screen the air pathway? The air pathway should not be screened due to regulatory air standard. The regulatory standards may be used as Applicable or Relevant and Appropriate Requirements (ARARs), but not to screen out risk analysis of the pathway.

Page 10-1, 2nd Paragraph: The baseline risk assessment should address both current and future risk to human health and the environment. In addition, the baseline risk assessment is used as basis for action at the site.

Page 10-2, 1st Paragraph: The risk assessment eliminates several chemicals from the risk assessment due to laboratory contamination. Eliminating toluene as COC on this basis may be questionable.

Page 10-4, 3rd Paragraph: The screening process described in this paragraph is an optional procedure and can be implemented only after consultation with the EPA RPM. The argument of carrying only a small number of chemicals through the risk assessment is not justified considering the availability of computer spreadsheets.

If you have any questions concerning these or any other comments on the draft Remedial Investigation report, please call and I will help as much as I can.

Sincerely,

Ky D. Nichols

Ky D. Nichols
Remedial Project Manager
Oklahoma/New Mexico Section

APPENDIX D

TRACER RESEARCH CORPORATION SOIL GAS SURVEY

SOIL GAS SURVEY
OF
LEE ACRES SITE
FARMINGTON, NEW MEXICO
Contract AA 852-RP6-7

JULY 1986

Prepared For:

United States Department of The Interior
Bureau of Land Management
Washington, D.C. 20240

Submitted By:

Tracer Research Corporation

EXECUTIVE SUMMARY

- A total of 46 soil gas samples were analyzed during an investigation of the Lee Acres site near Farmington, New Mexico.

- The Lee Acres landfill was found to be a source of both halocarbon and hydrocarbon contamination.

- Results indicate that the El Paso Natural Gas facility and the Giant Refinery are other potential sources of hydrocarbon contamination.

BACKGROUND ON THE METHODOLOGY

The presence of volatile organic chemicals (VOCs) in shallow soil gas indicates the observed compounds may either be in the vadose zone near the probe or in groundwater below the probe. The soil gas technology is most effective in mapping low molecular weight halogenated solvent chemicals and petroleum hydrocarbons possessing high vapor pressures and low aqueous solubilities. These compounds readily partition out of the groundwater and into the soil gas as a result of their high gas/liquid partitioning coefficients. Once in the soil gas, VOCs diffuse vertically and horizontally through the soil to the ground surface where they dissipate into the atmosphere. The groundwater acts as a source and the above ground atmosphere acts as a sink, and typically a concentration gradient develops between the two. The concentration gradient in soil gas between the water table and ground surface may be locally distorted by hydrologic and geologic anomalies (e.g. clays, perched water); however, soil gas mapping generally remains effective because surface distribution features of the observed compound are usually much larger in scale than the local anomalies and are defined using a large data base. The presence of geologic obstructions on a small scale tends to create anomalies in the soil gas-groundwater correlation, but generally does not obscure the broader areal picture of the contaminant distribution.

aromatic hydrocarbons are reported. The response factor for benzene (typically within 25% of other hydrocarbons) was used to calculate total hydrocarbons. Nitrogen was used as the carrier gas.

Detection limits are a function of the injection volume as well as the detector sensitivity for individual compounds. Thus, the detection limit varies with the sample size. Generally, the larger the sample, the greater the sensitivity. However, chromatographic peaks for compounds of interest must be kept within the linear range of the detector. If any compound has a high concentration, it is necessary to use small injections, and in some cases to dilute the sample to keep it within linear range. This may cause decreased detection limits for other compounds in the analyses. The detection limits range down to .00005 ug/l for compounds such as TCA and PCE depending on the conditions of the measurement, in particular, the sample size. If any component being analyzed is not detected, the detection limit for that compound in that analysis is given as a "less than" value (e.g. <.0001 ug/l). This number is calculated from the current response factor, the sample size and the estimated minimum peak size (area) that would have been visible under the conditions of the measurement.

Another factor which determines the sensitivity of the technique are the background concentrations which may be present at a given site. This background level is normally linked to the concentrations which are detected in ambient air. The end effect is that the background limits what can be identified as "significant" in the soil gas. For example at the Lee Acres Site, ambient air concentrations for TCA approached 0.001 ug/L. This figure only allowed TRC to identify concentrations greater than 0.01 ug/L as significant. This effect is true only for those compounds which have measureable air concentrations, in most cases only TCA and PCE.

U.S. Route 64 have shown detectable amounts of TCA.

CH_2Cl_2, TCE and PCE

Maps showing soil gas sampling locations, concentrations and isoconcentration contour lines for CH_2Cl_2, TCE and PCE are attached as Figures 2 through 4. The distribution of these halogenated solvents and chloroform is not as widespread as that for TCA. These compounds give further evidence that the landfill is a source of subsurface halocarbon contamination. Concentrations as high as 3,400 ug/l (CH_2Cl_2 at SG-9) are consistent with soil gas concentrations from samples taken in contaminated soil, that is soil which physically contains the contaminant in question, and not just vapors. The highest concentrations were found in both the north and west sections of the landfill.

Hydrocarbon Distribution

Total Hydrocarbons

A map showing soil gas sampling locations including concentrations and isoconcentration contour lines for total hydrocarbons is attached as Figure 5. Contour lines again indicate that the northern section of the landfill is the major source of contamination. Landfills commonly have high concentrations of hydrocarbons in the soil gas from the natural biodegradation of wastes. High concentrations of petroleum specific hydrocarbons (benzene, toluene, ethyl benzene and xylenes) indicate that the amount of total hydrocarbons measured had a petroleum source. All locations which had petroleum specific hydrocarbon concentrations greater than .1 ug/l are contained within the 1000 ug/l total hydrocarbon contour.

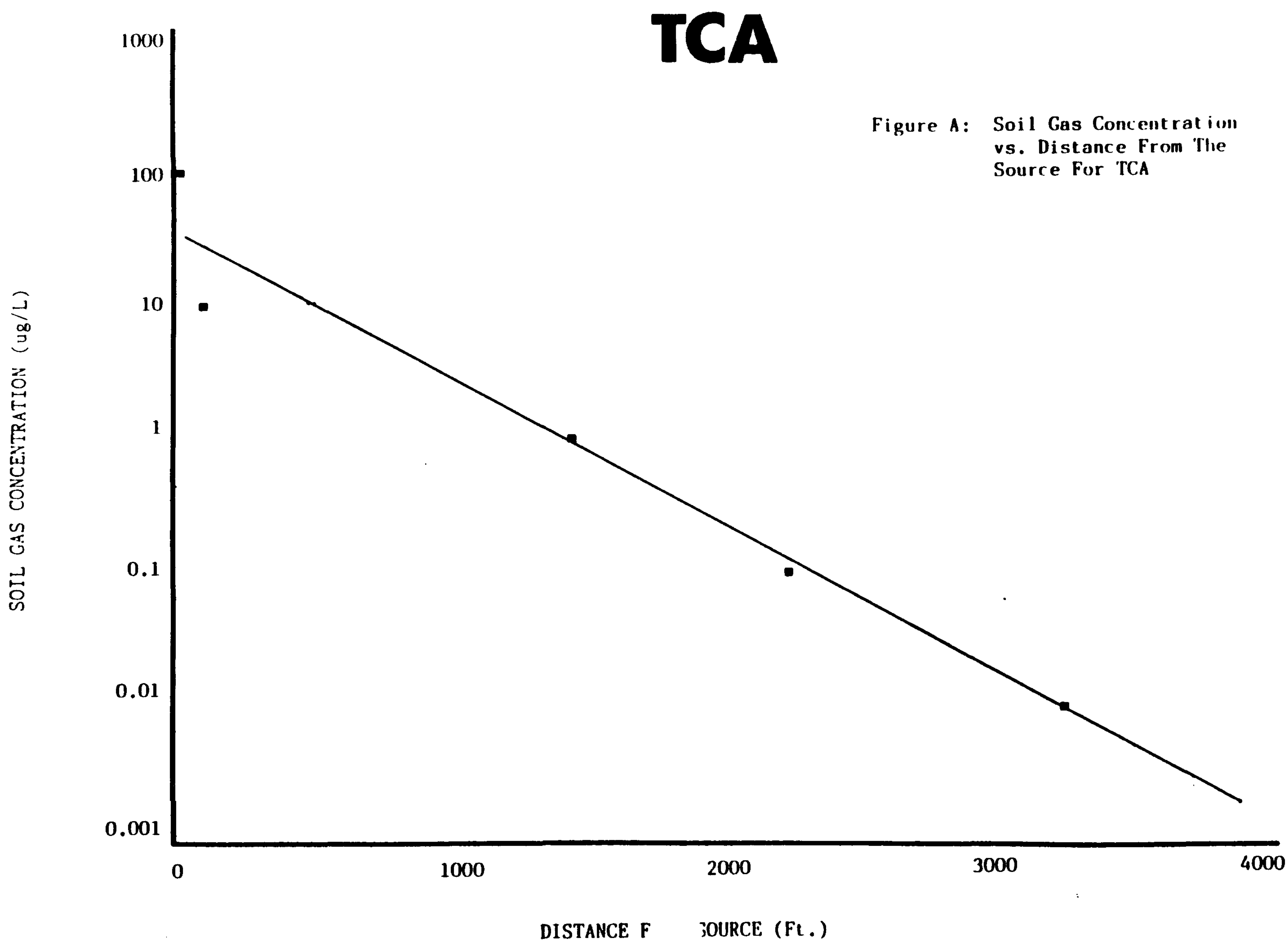


Figure A: Soil Gas Concentration vs. Distance From The Source For TCA

CONCLUSIONS

Results of this investigation indicate that the Lee Acres landfill is a source of both halocarbon and hydrocarbon contamination. Isoconcentration contour maps show VOCs migrating in a southerly direction towards wells which have been shown to be contaminated. Other potential sources of hydrocarbon contamination indicated by the soil gas survey include the El Paso Natural Gas facility and the Giant Refinery.

High concentrations found in the source areas indicate that the soil underlying the landfill is contaminated. That is, the soil actually contains the contaminant, not just its vapors. Knowing this fact, it is possible that the contamination is still diffusing downward in those areas, actively contaminating the groundwater.

Job Lee Acres Site, Farmington, New Mexico

TRACER RESEARCH CORPORATION

Date__________ Page________

CONDENSED DATA

CONTAMINANT			CH_2Cl_2	$CHCl_3$	TCA	TCE
sample	depth	date	mean ug/l concentration	mean ug/l concentration	mean ug/l concentration	mean ug/l concentration
SG1	6'	7/8	260	<0.07	8	2
SG2	6'	7/8	<2	<0.07	0.6	2
SG3	6'	7/8	<2	<0.07	24	<0.06
SG4	5.5'	7/8	<0.2	<0.007	0.5	<0.06
SG5	5.5'	7/8	<0.2	<0.007	30	6
SG6	6'	7/8	<2	<0.07	7	0.3
SG7	5.5'	7/8	<2	<0.07	4	<0.06
SG8	6'	7/8	2,000	<0.07	1	<0.06
SG9	6'	7/8	3,400	<0.07	180	60
SG10	6'	7/9	<4	<0.1	3	0.7
SG11	6'	7/9	5	<0.07	0.1	11
SG12	6'	7/9	1	<0.01	0.02	0.4
SG13	6'	7/9	<0.04	0.02	0.4	0.02
SG14	6'	7/9	<0.1	0.04	8	<0.003
SG15	6'	7/9	<0.1	0.5	0.08	<0.003
SG16	6'	7/9	<0.04	<0.001	0.008	<0.001
SG17	6'	7/9	0.4	<0.001	0.2	<0.001
SG17	13'	7/9	0.4	<0.004	0.2	<0.003
SG18	6'	7/9	12	0.3	5	11
SG19	6'	7/9	<10	3	1	80
SG20	6'	7/9	300	<0.004	0.1	<0.003

Notations:
RF response factor
I interference with adjacent peaks
NA not analyzed
E estinmated peak area

Summarized by: L. Lawlor

Checked by: J. Olexa

Proofed by: L. Laplander

ib Lee Acres Site, Farmington, New Mexico

TRACER RESEARCH CORPO... ON

Date________ Page______

CONDENSED DATA

CONTAMINANT			CH_2Cl_2	$CHCl_3$	TCA	TCE
sample	depth	date	mean ug/l concentration	mean ug/l concentration	mean ug/l concentration	mean ug/l concentration
SG39	6'	7/11	<0.01	<0.0004	0.0005	<0.0003
SG40	6'	7/11	<0.01	<0.0004	0.002	<0.0003
SG41	6'	7/10	<0.01	0.003	0.0006	<0.0002
SG42	6'	7/10	<0.01	<0.0004	0.0006	<0.0002

Notations:
- RF response factor
- I interference with adjacent peaks
- NA not analyzed
- E estinmated peak area

Summarized by: L. Lawlor

Checked by: J. Olexa

Proofed by: L. Laplander

ob Lee Acres Site, Farmington, New Mexico

TRACER RESEARCH CORP.

Date__________ Page________

CONDENSED DATA

CONTAMINANT			PCE			
sample	depth	date	mean ug/l concentration	mean ug/l concentration	mean ug/l concentration	mean ug/l concentration
SG20D	6'	7/9	0.3			
SG21	6'	7/9	0.003			
SG22	6'	7/9	0.2			
SG23	6'	7/9	0.8			
SG24	6'	7/10	NA			
SG24D	6'	7/10	0.003			
SG25	6'	7/10	<0.0002			
SG26	6'	7/10	<0.00007			
SG27	6'	7/11	0.0002			
SG28	6'	7/11	<0.00009			
SG29	6'	7/10	<0.00007			
SG30	5.5'	7/10	<0.00007			
SG31	6'	7/10	<0.00007			
SG32	6'	7/10	0.001			
SG33	6'	7/10	<0.00007			
SG34	6'	7/10	0.03			
SG35	6'	7/10	<0.00007			
SG36	6'	7/11	0.002			
SG37	6'	7/11	0.0007			
SG37D	6'	7/11	0.0008			
SG38	5.5'	7/11	0.0006			

Notations:
- RF response factor
- I interference with adjacent peaks
- NA not analyzed
- E estinmated peak area

Summarized by: L. Lawlor

Checked by: J. Olexa

Proofed by: L. Laplander

b Lee Acres Site, Farmington, New Mexico

TRACER RESEARCH CORPO[illegible]N

Date__________ Page________

CONDENSED DATA

CONTAMINANT			Benzene	Toluene	Ethyl Benzene	Ortho Xylene
sample	depth	date	mean ug/l concentration	mean ug/l concentration	mean ug/l concentration	mean ug/l concentration
SG1	6'	7/8	<0.3	33	<0.5	<0.5
SG2	6'	7/8	<0.1	3	<0.09	0.1
SG3	6'	7/8	<0.1	<0.1	<0.2	<0.2
SG4	5.5'	7/8	<0.06	<0.07	<0.09	<0.1
SG5	5.5'	7/8	<0.1	<0.1	<0.2	<0.2
SG6	6'	7/8	<0.3	8	<0.5	<0.5
SG7	5.5'	7/8	<0.06	<0.07	<0.09	<0.1
SG8	6'	7/8	<0.1	<0.2	<0.2	<0.3
SG9	6'	7/8	<0.1	<4	320	<5
SG10	6'	7/9	<7	60	<7	<7
SG11	6'	7/9	<7	80	<7	<7
SG12	6'	7/9	<1	<1	<1	<1
SG13	6'	7/9	<0.03	<0.04	<0.04	<0.03
SG14	6'	7/9	<0.03	<0.04	<0.04	<0.03
SG15	6'	7/9	<0.03	<0.04	<0.04	<0.03
SG16	6'	7/9	<0.03	<0.04	<0.04	<0.03
SG17	6'	7/9	<0.03	<0.04	<0.04	<0.03
SG17	13'	7/9	<0.03	<0.04	<0.04	<0.03
SG18	6'	7/9	<0.03	<0.04	<0.04	<0.03
SG19	6'	7/9	<0.03	<0.04	<0.04	<0.03
SG20	6'	7/9	<0.03	<0.04	<0.04	<0.03

Notations:
RF response factor
I interference with adjacent peaks
NA not analyzed
E estinmated peak area

Summarized by: L. Lawlor

Checked by: J. Olexa

Proofed by: L. Laplander

Job Lee Acres Site, Farmington, New Mexico

TRACER RESEARCH CORP. JN

Date__________ Page________

CONDENSED DATA

CONTAMINANT			Benzene	Toluene	Ethyl Benzene	Ortho Xylene
sample	depth	date	mean ug/l concentration	mean ug/l concentration	mean ug/l concentration	mean ug/l concentration
SG39	6'	7/11	<0.03	<0.03	<0.03	<0.03
SG40	6'	7/11	<0.03	<0.03	<0.03	<0.03
SG41	6'	7/10	<0.03	<0.03	<0.03	<0.03
SG42	6'	7/10	<0.03	<0.03	<0.03	<0.03

Notations:
- RF response factor
- I interference with adjacent peaks
- NA not analyzed
- E estinmated peak area

Summarized by: L. Lawlor

Checked by: J. Olexa

Proofed by: L. Laplander

Lee Acres Site, Farmington, New Mexico

TRACER RESEARCH CORPOR... .N

Date________ Page______

CONDENSED DATA

CONTAMINANT			Total Hydrocarbons			
sample	depth	date	mean ug/l concentration	mean ug/l concentration	mean ug/l concentration	mean ug/l concentration
SG20D	6'	7/9	31			
SG21	6'	7/9	0.1			
SG22	6'	7/9	0.6			
SG23	6'	7/9	0.9			
SG24	6'	7/10	0.1			
SG24D	6'	7/10	0.04			
SG25	6'	7/10	0.02			
SG26	6'	7/10	0.8			
SG27	6'	7/11	0.4			
SG28	6'	7/11	0.3			
SG29	6'	7/10	0.06			
SG30	5.5'	7/10	0.08			
SG31	6'	7/10	0.09			
SG32	6'	7/10	0.3			
SG33	6'	7/10	0.02			
SG34	6'	7/10	0.02			
SG35	6'	7/11	0.3			
SG36	6'	7/11	0.3			
SG37	6'	7/11	0.5			
SG37D	6'	7/11	0.2			
SG38	5.5'	7/11	0.3			

Notations:
RF response factor
I interference with adjacent peaks
NA not analyzed
E estinmated peak area

Summarized by: L. Lawlor

Checked by: D. Evans

Proofed by: D. Evans

Figure 1. Trichloroethane (TCA) in Soil Gas.
BUREAU OF LAND MANAGEMENT
Contract AA852-RP6-7
LEE ACRES SITE, NEW MEXICO

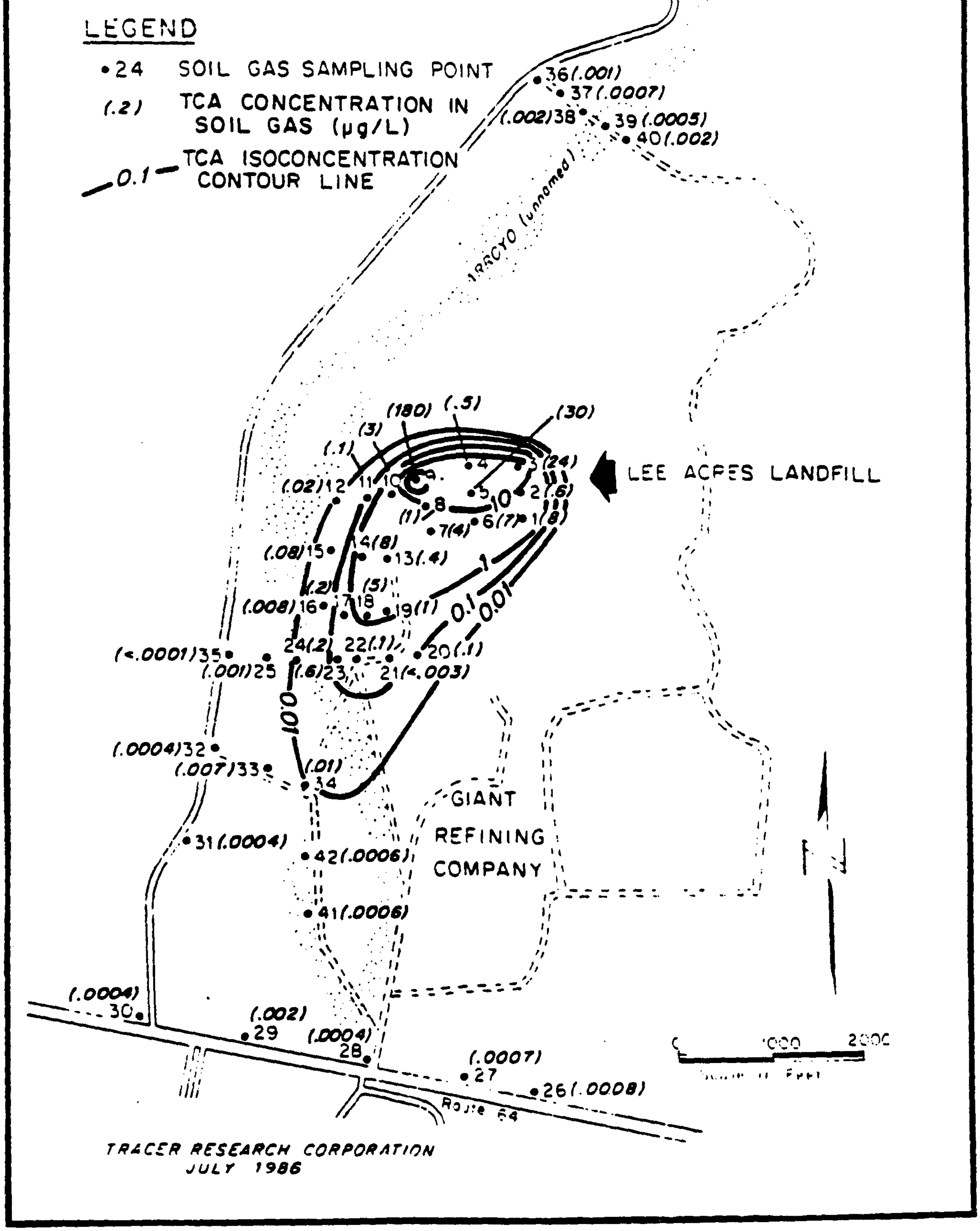


Figure 3. Trichloroethylene (TCE) in Soil Gas.
BUREAU OF LAND MANAGEMENT
Contract AA852-RP6-7
LEE ACRES SITE, NEW MEXICO

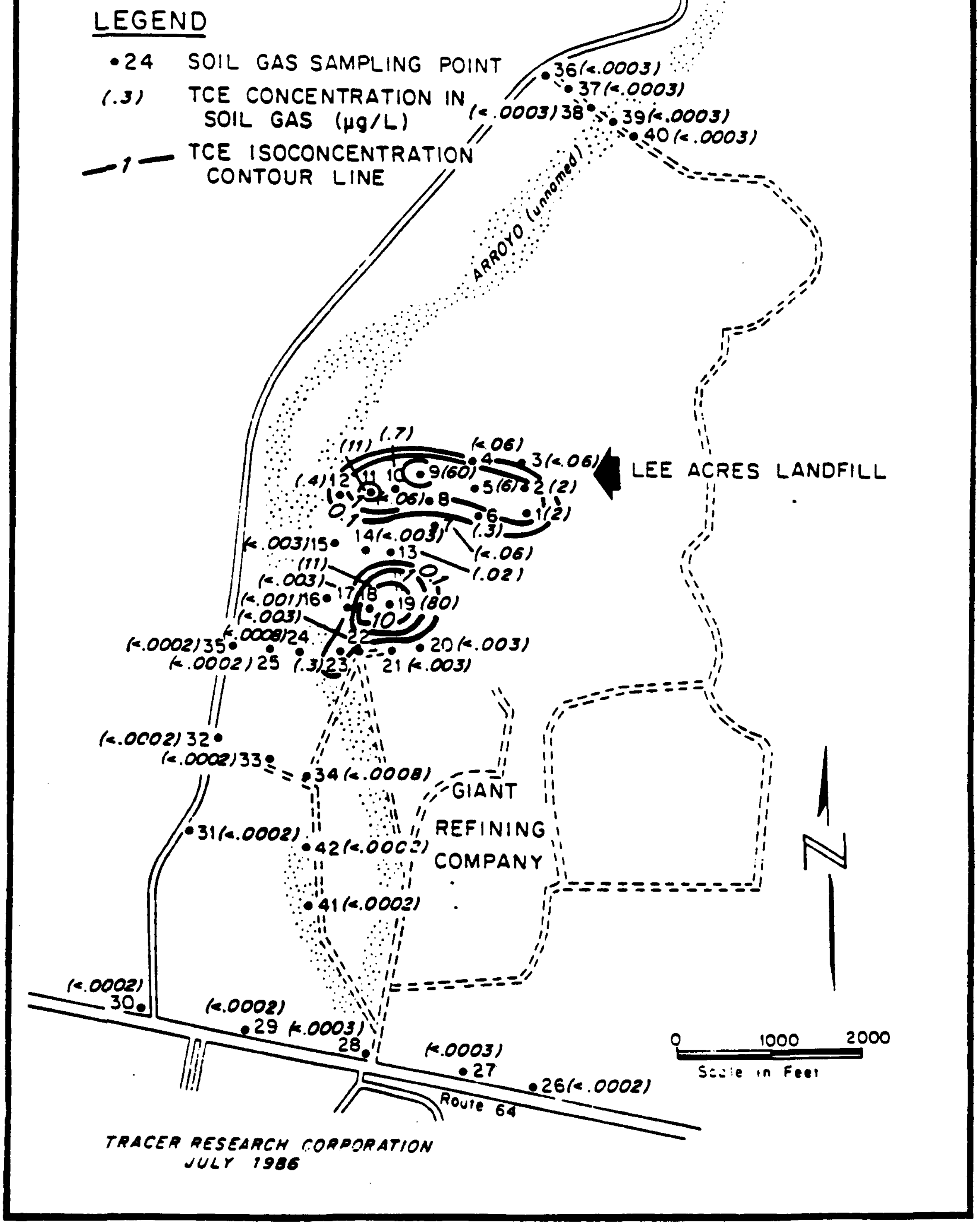
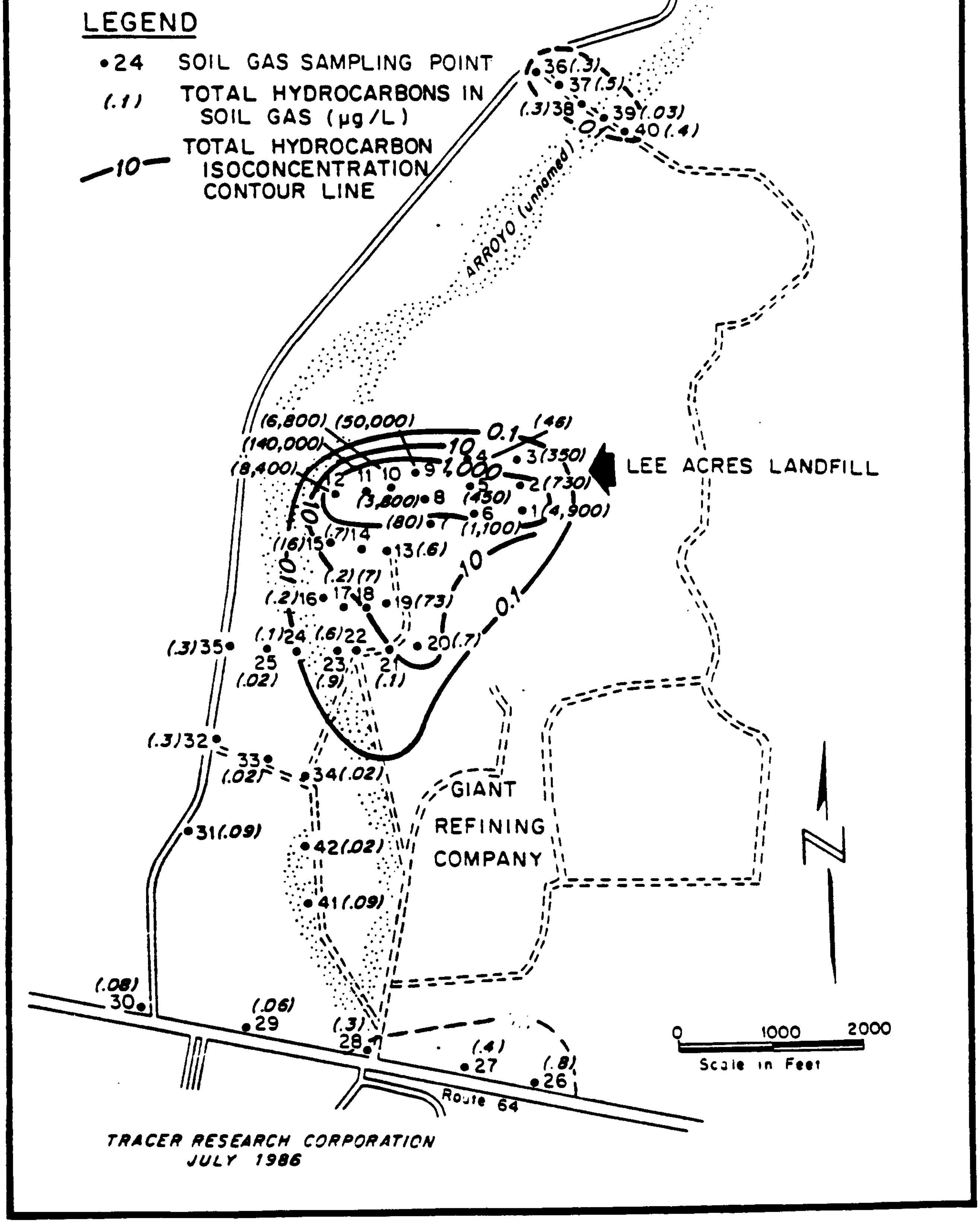


Figure 5. Total Hydrocarbons in Soil Gas.
BUREAU OF LAND MANAGEMENT
Contract AA852-RP6-7
LEE ACRES SITE, NEW MEXICO



APPENDIX E

HNu READINGS FOR THE LEE ACRES LANDFILL

Table 1. HNu Readings for the Lee Acres Landfill

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2077300	423475	10/17/89	0.6		
2077300	423500	10/17/89	0.8		
2077300	423525	10/17/89	--		No measurement
2077300	423550	10/17/89	0.6		
2077300	423575	10/17/89	0.8		
2077300	423600	10/17/89	0.8		
2077300	423625	10/17/89	0.8		
2077300	423650	10/17/89	0.6		
2077300	423675	10/17/89	0.8		
2077300	423700	10/17/89	0.8		
2077300	423725	10/17/89	0.6	0.7	
2077300	423750	10/17/89	0.8		
2077325	423475	10/17/89	0.5	0.6	
2077325	423500	10/17/89	0.7		
2077325	423525	10/17/89	0.7		
2077325	423550	10/17/89	0.7		
2077325	423575	10/17/89	0.8		
2077325	423600	10/17/89	--		Station obscured by drums
2077325	423625	10/17/89	0.8		
2077325	423650	10/17/89	0.7		
2077325	423675	10/17/89	0.7		
2077325	423700	10/17/89	0.8		
2077325	423725	10/17/89	0.8	0.7	
2077325	423750	10/17/89	0.7		
2077325	423775	10/17/89	0.8		
2077325	423800	10/17/89	0.6		
2077350	423450	10/17/89	0.5		
2077350	423475	10/17/89	0.6		
2077350	423500	10/17/89	0.4		
2077350	423525	10/17/89	0.4		
2077350	423550	10/17/89	0.4	0.5	
2077350	423575	10/17/89	0.5		
2077350	423600	10/17/89	0.6		
2077350	423625	10/17/89	--		Station obscured by drums
2077350	423650	10/17/89	--		Station obscured by drums
2077350	423675	10/17/89	0.5		
2077350	423700	10/17/89	0.8		
2077350	423725	10/17/89	0.6		
2077350	423750	10/17/89	0.7		
2077350	423775	10/17/89	0.7		

[a]*Only readings different from background levels are provided.*

Table 1. HNu Readings for the Lee Acres Landfill (page 2 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2077350	423800	10/17/89	0.7		
2077375	423450	10/17/89	0.5		
2077375	423475	10/17/89	0.6		
2077375	423500	10/17/89	0.4		
2077375	423525	10/17/89	0.5		
2077375	423550	10/17/89	0.7	0.6	
2077375	423575	10/17/89	0.5	0.4	
2077375	423600	10/17/89	0.6		
2077375	423625	10/17/89	--		Station obscured by drums
2077375	423650	10/17/89	--		Station obscured by drums
2077375	423675	10/17/89	0.7		
2077375	423700	10/17/89	0.7		
2077375	423725	10/17/89	0.7		
2077375	423750	10/17/89	0.5		
2077375	423775	10/17/89	0.6		
2077375	423800	10/17/89	0.5		
2077375	423825	10/17/89	0.7		
2077375	423850	10/17/89	0.6		
2077375	423875	10/17/89	0.6		
2077400	423450	10/17/89	0.4		
2077400	423475	10/17/89	0.5		
2077400	423500	10/17/89	0.5		
2077400	423525	10/17/89	0.4		
2077400	423550	10/17/89	0.6	0.5	
2077400	423575	10/17/89	0.6		
2077400	423600	10/17/89	0.5		
2077400	423625	10/17/89	0.7		
2077400	423650	10/17/89	0.6		
2077400	423675	10/17/89	0.5		
2077400	423700	10/17/89	0.5		
2077400	423725	10/17/89	0.5		
2077400	423750	10/17/89	0.5		
2077400	423775	10/17/89	0.6	0.7	
2077400	423800	10/17/89	0.7		
2077400	423825	10/17/89	0.6	0.7	
2077400	423850	10/17/89	0.7		
2077400	423875	10/17/89	0.6	0.7	
2077400	423900	10/17/89	0.6		
2077400	423925	10/17/89	0.7		
2077400	423950	10/17/89	0.6		
2077425	423450	10/17/89	0.5		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 3 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2077425	423475	10/17/89	0.6	0.5	
2077425	423500	10/17/89	0.6		
2077425	423525	10/17/89	0.5	0.4	
2077425	423550	10/17/89	0.3	0.4	
2077425	423575	10/17/89	0.5		
2077425	423600	10/17/89	0.4	0.5	
2077425	423625	10/17/89	0.6		
2077425	423650	10/17/89	0.6		
2077425	423675	10/17/89	0.5		
2077425	423700	10/17/89	0.6		
2077425	423725	10/17/89	0.5		
2077425	423750	10/17/89	0.4		
2077425	423775	10/17/89	0.5		
2077425	423800	10/17/89	0.3		
2077425	423825	10/17/89	0.4		
2077425	423850	10/17/89	0.3		
2077425	423875	10/17/89	0.5		
2077425	423900	10/17/89	0.4	0.6	
2077425	423925	10/17/89	0.5		
2077425	423950	10/17/89	0.5	0.6	
2077450	423425	10/17/89	0.4		
2077450	423450	10/17/89	0.3		
2077450	423475	10/17/89	0.4		
2077450	423500	10/17/89	0.3		
2077450	423525	10/17/89	0.3	0.4	
2077450	423550	10/17/89	0.3	0.4	
2077450	423575	10/17/89	0.3		
2077450	423600	10/17/89	0.3		
2077450	423625	10/17/89	0.3		
2077450	423650	10/17/89	0.3		
2077450	423675	10/17/89	0.3		
2077450	423700	10/17/89	0.3		
2077450	423725	10/17/89	0.4		
2077450	423750	10/17/89	0.3		
2077450	423775	10/17/89	0.4		
2077450	423800	10/17/89	0.4		
2077450	423825	10/17/89	0.4	0.6	
2077450	423850	10/17/89	0.4		
2077450	423875	10/17/89	0.5		
2077450	423900	10/17/89	0.5	0.6	
2077450	423925	10/17/89	0.4		

[a]Only readings different from background levels are provided.

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2077450	423950	10/17/89	0.5		
2077475	423425	10/17/89	0.4		
2077475	423450	10/17/89	0.3		
2077475	423475	10/17/89	0.3		
2077475	423500	10/17/89	0.3		
2077475	423525	10/17/89	0.3		
2077475	423550	10/17/89	0.3		
2077475	423575	10/17/89	0.3		
2077475	423600	10/17/89	0.3		
2077475	423625	10/17/89	0.3		
2077475	423650	10/17/89	0.3		
2077475	423675	10/17/89	0.3		
2077475	423700	10/17/89	0.3		
2077475	423725	10/17/89	0.3		
2077475	423750	10/17/89	0.2	0.3	
2077475	423775	10/17/89	0.4		
2077475	423800	10/17/89	0.3		
2077475	423825	10/17/89	0.3		
2077475	423850	10/17/89	0.2	0.3	
2077475	423875	10/17/89	0.2	0.3	
2077475	423900	10/17/89	0.3	0.4	
2077475	423925	10/17/89	0.3		
2077475	423950	10/17/89	0.2		
2077500	423425	10/17/89	0.3		
2077500	423450	10/17/89	0.3	0.4	
2077500	423475	10/17/89	0.4		
2077500	423500	10/17/89	0.4		
2077500	423525	10/17/89	0.3	0.4	
2077500	423550	10/17/89	0.4		
2077500	423575	10/17/89	0.4		
2077500	423600	10/17/89	0.4		
2077500	423625	10/17/89	0.4		
2077500	423650	10/17/89	0.4	0.5	
2077500	423675	10/17/89	0.3		
2077500	423700	10/17/89	0.4		
2077500	423725	10/17/89	0.4		
2077500	423750	10/17/89	0.3	0.4	
2077500	423775	10/17/89	0.3	0.4	
2077500	423800	10/17/89	0.3	0.4	
2077500	423825	10/17/89	0.3		
2077500	423850	10/17/89	0.3		

[a]Only readings different from background levels are provided.

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2077500	423875	10/17/89	0.3		
2077500	423900	10/17/89	0.3		
2077500	423925	10/17/89	0.3	0.4	
2077500	423950	10/17/89	0.2		
2077525	423400	10/17/89	0.4		
2077525	423425	10/17/89	0.3		
2077525	423450	10/17/89	0.3		
2077525	423475	10/17/89	0.3		
2077525	423500	10/17/89	0.4		
2077525	423525	10/17/89	0.5		
2077525	423550	10/17/89	0.3		
2077525	423575	10/17/89	0.4		
2077525	423600	10/17/89	0.3		
2077525	423625	10/17/89	0.4		
2077525	423650	10/17/89	0.3		
2077525	423675	10/17/89	0.3		
2077525	423700	10/17/89	0.3		
2077525	423725	10/17/89	0.3		
2077525	423750	10/17/89	0.3	0.4	
2077525	423775	10/17/89	0.3		
2077525	423800	10/17/89	0.3		
2077525	423825	10/17/89	0.3	0.4	
2077525	423850	10/17/89	0.3	0.4	
2077525	423875	10/17/89	0.3		
2077525	423900	10/17/89	0.3		
2077525	423925	10/17/89	0.3	0.4	
2077525	423950	10/17/89	0.4		
2077550	423400	10/17/89	0.3		
2077550	423425	10/17/89	0.3		
2077550	423450	10/17/89	0.3		
2077550	423475	10/17/89	0.3		
2077550	423500	10/17/89	0.3		
2077550	423525	10/17/89	0.3		
2077550	423550	10/17/89	0.3		
2077550	423575	10/17/89	0.3		
2077550	423600	10/17/89	0.3	1.0	Hit verified three times in field
2077550	423625	10/17/89	0.3		
2077550	423650	10/17/89	0.3		
2077550	423675	10/17/89	0.3		
2077550	423700	10/17/89	0.3		
2077550	423725	10/17/89	0.3		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 6 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2077550	423750	10/17/89	0.3		
2077550	423775	10/17/89	0.3		
2077550	423800	10/17/89	0.3		
2077550	423825	10/17/89	0.3	0.4	
2077550	423850	10/17/89	0.4		
2077550	423875	10/17/89	0.4		
2077550	423900	10/17/89	0.3		
2077550	423925	10/17/89	0.4		
2077550	423950	10/17/89	0.3	0.4	
2077575	423400	10/20/89	0.7		
2077575	423425	10/20/89	0.3		
2077575	423450	10/20/89	0.4		
2077575	423475	10/20/89	0.4		
2077575	423500	10/23/89	0.8		
2077575	423525	10/23/89	0.8		
2077575	423550	10/23/89	0.8		
2077575	423575	10/23/89	0.7		
2077575	423600	10/23/89	0.7		
2077575	423625	10/23/89	0.7		
2077575	423650	10/23/89	0.6		
2077575	423675	10/23/89	0.6		
2077575	423700	10/23/89	0.7		
2077575	423725	10/23/89	0.6		
2077575	423750	10/24/89	1.0		
2077575	423775	10/24/89	0.8		
2077575	423800	10/24/89	0.8		
2077575	423825	10/24/89	0.7		
2077575	423850	10/24/89	0.7		
2077575	423875	10/24/89	0.6		
2077575	423900	10/24/89	0.6		
2077575	423925	10/24/89	0.7		
2077575	423950	10/24/89	0.6		
2077600	423375	10/20/89	0.4		
2077600	423400	10/20/89	0.7		
2077600	423425	10/20/89	0.5		
2077600	423450	10/20/89	0.6		
2077600	423475	10/20/89	0.4		
2077600	423500	10/23/89	0.9		
2077600	423525	10/23/89	0.7		
2077600	423550	10/23/89	0.7		
2077600	423575	10/23/89	0.8		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 7 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2077600	423600	10/23/89	0.8		
2077600	423625	10/23/89	0.7		
2077600	423650	10/23/89	0.5		
2077600	423675	10/23/89	0.6		
2077600	423700	10/23/89	0.7		
2077600	423725	10/23/89	0.5		
2077600	423750	10/24/89	0.9		
2077600	423775	10/24/89	0.8		
2077600	423800	10/24/89	0.8		
2077600	423825	10/24/89	0.8		
2077600	423850	10/24/89	0.6		
2077600	423875	10/24/89	0.7		
2077600	423900	10/24/89	0.8		
2077600	423925	10/24/89	0.8		
2077600	423950	10/24/89	0.4		
2077625	423375	10/20/89	0.7		
2077625	423400	10/20/89	0.8		
2077625	423425	10/20/89	0.5		
2077625	423450	10/20/89	0.4		
2077625	423475	10/20/89	0.4		
2077625	423500	10/23/89	0.8		
2077625	423525	10/23/89	0.7		
2077625	423550	10/23/89	0.8		
2077625	423575	10/23/89	0.7	0.8	
2077625	423600	10/23/89	0.8		
2077625	423625	10/23/89	1.0		
2077625	423650	10/23/89	0.6		
2077625	423675	10/23/89	0.7		
2077625	423700	10/23/89	0.8		
2077625	423725	10/23/89	0.5		
2077625	423750	10/24/89	1.1		
2077625	423775	10/24/89	0.9		
2077625	423800	10/24/89	0.6		Meter fluctuating
2077625	423825	10/24/89	0.8		
2077625	423850	10/24/89	0.5		
2077625	423875	10/24/89	0.3		
2077625	423900	10/24/89	0.3		
2077625	423925	10/24/89	0.5		
2077625	423950	10/24/89	0.5		
2077650	423375	10/20/89	0.6		
2077650	423400	10/20/89	0.6		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 8 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2077650	423425	10/20/89	0.3		
2077650	423450	10/20/89	0.3		
2077650	423475	10/20/89	0.4		
2077650	423500	10/23/89	0.8		
2077650	423525	10/23/89	0.8		
2077650	423550	10/23/89	0.7		
2077650	423575	10/23/89	0.8		
2077650	423600	10/23/89	0.8		
2077650	423625	10/23/89	0.7		
2077650	423650	10/23/89	0.5		
2077650	423675	10/23/89	0.8		
2077650	423700	10/23/89	0.4		
2077650	423725	10/23/89	0.8		
2077650	423750	10/24/89	0.9		
2077650	423775	10/24/89	0.8		
2077650	423800	10/24/89	0.6		Meter fluctuating
2077650	423825	10/24/89	0.6		
2077650	423850	10/24/89	0.5		
2077675	423375	10/20/89	0.5		
2077675	423400	10/20/89	0.6		
2077675	423425	10/20/89	0.4		
2077675	423450	10/20/89	0.3		
2077675	423475	10/20/89	0.5		
2077675	423500	10/23/89	0.8		
2077675	423525	10/23/89	0.7		
2077675	423550	10/23/89	0.7		
2077675	423575	10/23/89	0.8		
2077675	423600	10/23/89	0.7		
2077675	423625	10/23/89	0.8		
2077675	423650	10/23/89	0.6		
2077675	423675	10/23/89	0.7		
2077675	423700	10/23/89	0.6		
2077675	423725	10/23/89	0.6		
2077675	423750	10/24/89	1.0		
2077675	423775	10/24/89	0.9		
2077675	423800	10/24/89	0.8		
2077675	423825	10/24/89	1.0		
2077675	423850	10/24/89	0.5		
2077700	423350	10/20/89	0.4		
2077700	423375	10/20/89	0.6		
2077700	423400	10/20/89	0.6	1.4	

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 9 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2077700	423425	10/20/89	0.4		
2077700	423450	10/20/89	0.5		
2077700	423475	10/20/89	0.4		
2077700	423500	10/23/89	1.0		
2077700	423525	10/23/89	0.8		
2077700	423550	10/23/89	0.7		
2077700	423575	10/23/89	0.7		
2077700	423600	10/23/89	0.7		
2077700	423625	10/23/89	0.7		
2077700	423650	10/23/89	0.6		
2077700	423675	10/23/89	0.6		
2077700	423700	10/23/89	0.6		
2077700	423725	10/23/89	0.7		
2077700	423750	10/24/89	1.1		
2077700	423775	10/24/89	0.8		
2077700	423800	10/24/89	1.0		
2077700	423825	10/24/89	0.9		
2077725	423350	10/20/89	0.6		
2077725	423375	10/20/89	0.5		
2077725	423400	10/20/89	0.6	0.8	
2077725	423425	10/20/89	0.4		
2077725	423450	10/20/89	0.4		
2077725	423475	10/20/89	0.3		
2077725	423500	10/23/89	0.9		
2077725	423525	10/23/89	0.8		
2077725	423550	10/23/89	0.8		
2077725	423575	10/23/89	0.8		
2077725	423600	10/23/89	0.8		
2077725	423625	10/23/89	0.9		
2077725	423650	10/23/89	0.6		
2077725	423675	10/23/89	0.6		
2077725	423700	10/23/89	0.6		
2077725	423725	10/23/89	0.4		
2077725	423750	10/24/89	1.1		
2077725	423775	10/24/89	0.7		
2077725	423800	10/24/89	0.8		
2077725	423825	10/24/89	0.7		
2077750	423350	10/20/89	0.5		
2077750	423375	10/20/89	0.5		
2077750	423400	10/20/89	0.7		
2077750	423425	10/20/89	0.4		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 10 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading*	Comments
2077750	423450	10/20/89	0.5		
2077750	423475	10/20/89	0.4		
2077750	423500	10/23/89	0.8		
2077750	423525	10/23/89	0.8		
2077750	423550	10/23/89	0.6		
2077750	423575	10/23/89	0.8		
2077750	423600	10/23/89	0.8		
2077750	423625	10/23/89	0.7		
2077750	423650	10/23/89	0.6		
2077750	423675	10/23/89	0.6		
2077750	423700	10/23/89	0.6		
2077750	423725	10/23/89	0.6		
2077750	423750	10/24/89	1.0		Meter fluctuating
2077750	423775	10/24/89	0.8		
2077750	423800	10/24/89	0.6		
2077750	423825	10/24/89	0.7		
2077775	423350	10/20/89	0.5		
2077775	423375	10/20/89	0.5		
2077775	423400	10/20/89	0.7	1.0	
2077775	423425	10/20/89	0.4		
2077775	423450	10/20/89	0.3		
2077775	423475	10/20/89	0.3		
2077775	423500	10/23/89	0.9		
2077775	423525	10/23/89	0.8		
2077775	423550	10/23/89	0.6		
2077775	423575	10/23/89	0.7		
2077775	423600	10/23/89	0.7		
2077775	423625	10/23/89	0.8		
2077775	423650	10/23/89	0.6		
2077775	423675	10/23/89	0.7		
2077775	423700	10/23/89	0.7		
2077775	423725	10/23/89	0.3		
2077775	423750	10/24/89	1.1		Meter fluctuating
2077775	423775	10/24/89	0.6		
2077775	423800	10/24/89	0.8		
2077800	423350	10/20/89	0.4		
2077800	423375	10/20/89	0.4		
2077800	423400	10/20/89	0.8		
2077800	423425	10/20/89	0.4		
2077800	423450	10/20/89	0.3		
2077800	423475	10/20/89	0.4		

*Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 11 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2077800	423500	10/23/89	0.9		
2077800	423525	10/23/89	0.8		
2077800	423550	10/23/89	0.7		
2077800	423575	10/23/89	0.7		
2077800	423600	10/23/89	0.8		
2077800	423625	10/23/89	0.6		
2077800	423650	10/23/89	0.8		
2077800	423675	10/23/89	0.6		
2077800	423700	10/23/89	0.6		
2077800	423725	10/23/89	0.3		
2077800	423750	10/24/89	1.0		Meter fluctuating
2077800	423775	10/24/89	0.7		
2077800	423800	10/24/89	0.6		
2077825	423350	10/20/89	0.5		
2077825	423375	10/20/89	0.4		
2077825	423400	10/20/89	0.7		
2077825	423425	10/20/89	0.4		
2077825	423450	10/20/89	0.4	0.6	
2077825	423475	10/20/89	0.3		
2077825	423500	10/23/89	0.9		
2077825	423525	10/23/89	0.7		
2077825	423550	10/23/89	0.8		
2077825	423575	10/23/89	0.8		
2077825	423600	10/23/89	0.8		
2077825	423625	10/23/89	0.7		
2077825	423650	10/23/89	0.7		
2077825	423675	10/23/89	0.4		
2077825	423700	10/23/89	0.6		
2077825	423725	10/23/89	0.6		
2077825	423750	10/24/89	1.0		Meter fluctuating
2077825	423775	10/24/89	0.6		
2077825	423800	10/24/89	0.7		
2077850	423350	10/20/89	0.7		
2077850	423375	10/20/89	0.5		
2077850	423400	10/20/89	0.7		
2077850	423425	10/20/89	0.4		
2077850	423450	10/20/89	0.4		
2077850	423475	10/20/89	0.4		
2077850	423500	10/23/89	0.9	1.0	
2077850	423525	10/23/89	0.8		
2077850	423550	10/23/89	0.9		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 12 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2077850	423575	10/23/89	0.6		
2077850	423600	10/23/89	0.7		
2077850	423625	10/23/89	0.6		
2077850	423650	10/23/89	0.6		
2077850	423675	10/23/89	0.5		
2077850	423700	10/23/89	0.4		
2077850	423725	10/23/89	0.6		
2077850	423750	10/24/89	1.1	1.0	Meter fluctuating
2077850	423775	10/24/89	0.6		
2077875	423350	10/20/89	0.5		
2077875	423375	10/20/89	0.6		
2077875	423400	10/20/89	0.5		
2077875	423425	10/20/89	0.4		
2077875	423450	10/20/89	0.4		
2077875	423475	10/20/89	0.4		
2077875	423500	10/23/89	1.0		
2077875	423525	10/23/89	0.8		
2077875	423550	10/23/89	0.7		
2077875	423575	10/23/89	0.8		
2077875	423600	10/23/89	0.7		
2077875	423625	10/23/89	0.8		
2077875	423650	10/23/89	0.7		
2077875	423675	10/23/89	0.6		
2077875	423700	10/23/89	0.4		
2077875	423725	10/23/89	0.6		
2077875	423750	10/24/89	0.8		Meter fluctuating
2077875	423775	10/24/89	0.7		
2077900	423350	10/20/89	0.5		
2077900	423375	10/20/89	0.6		
2077900	423400	10/20/89	0.5		
2077900	423425	10/20/89	0.4		
2077900	423450	10/20/89	0.4		
2077900	423475	10/20/89	0.4		
2077900	423500	10/23/89	0.8		
2077900	423525	10/23/89	0.7		
2077900	423550	10/23/89	0.7		
2077900	423575	10/23/89	0.7		
2077900	423600	10/23/89	0.9		
2077900	423625	10/23/89	0.7		
2077900	423650	10/23/89	0.6		
2077900	423675	10/23/89	0.7		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 13 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2077900	423700	10/23/89	0.6		
2077900	423725	10/23/89	0.6		
2077900	423750	10/24/89	0.9		
2077900	423775	10/24/89	0.7		
2077925	423350	10/20/89	0.6		
2077925	423375	10/20/89	0.6	0.7	
2077925	423400	10/20/89	0.5		Soil discolored brownish gray
2077925	423425	10/20/89	0.3		
2077925	423450	10/20/89	0.4		
2077925	423475	10/20/89	0.4		
2077925	423500	10/23/89	0.9	1.0	
2077925	423525	10/23/89	0.8		
2077925	423550	10/23/89	0.8		
2077925	423575	10/23/89	0.9		
2077925	423600	10/23/89	0.8		
2077925	423625	10/23/89	0.7		
2077925	423650	10/23/89	0.8		
2077925	423675	10/23/89	0.7		
2077925	423700	10/23/89	0.3		
2077925	423725	10/23/89	0.8		
2077925	423750	10/24/89	0.9	1.0	
2077925	423775	10/24/89	0.8		
2077925	423800	10/24/89	0.7		
2077950	423350	10/20/89	0.6		
2077950	423375	10/20/89	0.6		
2077950	423400	10/20/89	0.5		
2077950	423425	10/20/89	0.3		
2077950	423450	10/20/89	0.4		
2077950	423475	10/20/89	0.4		
2077950	423500	10/23/89	0.8	0.9	
2077950	423525	10/23/89	0.8		
2077950	423550	10/23/89	0.8		
2077950	423575	10/23/89	0.7		
2077950	423600	10/23/89	0.7		
2077950	423625	10/23/89	0.7		
2077950	423650	10/23/89	0.6		
2077950	423675	10/23/89	0.6		
2077950	423700	10/23/89	0.6		
2077950	423725	10/23/89	0.6		
2077950	423750	10/24/89	0.7	0.8	
2077950	423775	10/24/89	0.8		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 14 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2077950	423800	10/24/89	0.6		
2077975	423350	10/20/89	0.6		
2077975	423375	10/20/89	0.6		
2077975	423400	10/20/89	0.5		
2077975	423425	10/20/89	0.6		
2077975	423450	10/20/89	0.5		
2077975	423475	10/20/89	0.3		
2077975	423500	10/23/89	0.9		
2077975	423525	10/23/89	0.8		
2077975	423550	10/23/89	0.8		
2077975	423575	10/23/89	0.8		
2077975	423600	10/23/89	0.7		
2077975	423625	10/23/89	0.7		
2077975	423650	10/23/89	0.6		
2077975	423675	10/23/89	0.6		
2077975	423700	10/23/89	0.4		
2077975	423725	10/23/89	0.8		
2077975	423750	10/24/89	1.0		
2077975	423775	10/24/89	0.7		
2077975	423800	10/24/89	0.7		
2078000	423350	10/20/89	0.6		
2078000	423375	10/20/89	0.6		
2078000	423400	10/20/89	0.6	0.8	
2078000	423425	10/20/89	0.5		
2078000	423450	10/20/89	0.4		
2078000	423475	10/20/89	0.2		
2078000	423500	10/23/89	0.8		
2078000	423525	10/23/89	0.8		
2078000	423550	10/23/89	0.7		
2078000	423575	10/23/89	0.8		
2078000	423600	10/23/89	0.6	0.7	
2078000	423625	10/23/89	0.8		
2078000	423650	10/23/89	0.6		
2078000	423675	10/23/89	0.6		
2078000	423700	10/23/89	0.4		
2078000	423725	10/23/89	0.6		
2078000	423750	10/24/89	0.8		
2078000	423775	10/24/89	0.8		
2078000	423800	10/24/89	0.8		
2078000	423825	10/24/89	0.6		
2078000	423850	10/24/89	1.0		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 15 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078000	423875	10/24/89	0.4		
2078025	423350	10/20/89	0.6	5.8	Soil = black carbonaceous material
2078025	423375	10/20/89	0.6	1.0	
2078025	423400	10/20/89	0.6		
2078025	423425	10/20/89	0.4		
2078025	423450	10/20/89	0.4		
2078025	423475	10/20/89	0.4		
2078025	423500	10/23/89	1.0		
2078025	423525	10/23/89	0.8		
2078025	423550	10/23/89	0.7		
2078025	423575	10/23/89	0.9		
2078025	423600	10/23/89	0.7		
2078025	423625	10/23/89	0.8		
2078025	423650	10/23/89	0.6		
2078025	423675	10/23/89	0.7		
2078025	423700	10/23/89	0.6		
2078025	423725	10/23/89	0.7		
2078025	423750	10/24/89	0.8		
2078025	423775	10/24/89	0.8		
2078025	423800	10/24/89	0.8		
2078025	423825	10/24/89	0.7		
2078025	423850	10/24/89	0.9		
2078025	423875	10/24/89	0.7		
2078025	423900	10/24/89	0.5		
2078050	423350	10/20/89	0.6		
2078050	423375	10/20/89	0.5		
2078050	423400	10/20/89	0.5	0.6	
2078050	423425	10/20/89	0.4		
2078050	423450	10/20/89	0.4		
2078050	423475	10/20/89	0.5		
2078050	423500	10/23/89	1.0		
2078050	423525	10/23/89	0.7		
2078050	423550	10/23/89	0.8		
2078050	423575	10/23/89	0.8		
2078050	423600	10/23/89	0.7		
2078050	423625	10/23/89	0.7		
2078050	423650	10/23/89	0.6		
2078050	423675	10/23/89	0.6		
2078050	423700	10/23/89	0.6		
2078050	423725	10/23/89	0.4		
2078050	423750	10/24/89	0.8		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 16 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078050	423775	10/24/89	0.7		
2078050	423800	10/24/89	0.8		
2078050	423825	10/24/89	0.7		
2078050	423850	10/24/89	0.9		
2078050	423875	10/24/89	0.6		
2078050	423900	10/24/89	0.7		
2078050	423925	10/24/89	0.6		
2078075	423350	10/20/89	0.5		
2078075	423375	10/20/89	0.6		
2078075	423400	10/20/89	0.5	0.7	
2078075	423425	10/20/89	0.4		
2078075	423450	10/20/89	0.5		
2078075	423475	10/20/89	0.4		
2078075	423500	10/23/89	0.9		
2078075	423525	10/23/89	0.7		
2078075	423550	10/23/89	0.8		
2078075	423575	10/23/89	0.6		
2078075	423600	10/23/89	0.6		
2078075	423625	10/23/89	0.8		
2078075	423650	10/23/89	0.8		
2078075	423675	10/23/89	0.8		
2078075	423700	10/23/89	0.4		
2078075	423725	10/23/89	0.6		
2078075	423750	10/24/89	0.7		
2078075	423775	10/24/89	0.6		
2078075	423800	10/24/89	0.7		
2078075	423825	10/24/89	0.8		
2078075	423850	10/24/89	0.9		
2078075	423875	10/24/89	0.8		
2078075	423900	10/24/89	0.7		
2078075	423925	10/24/89	0.6		
2078075	423950	10/24/89	0.6		
2078075	423975	10/24/89	0.4		
2078100	423350	10/20/89	0.5		
2078100	423375	10/20/89	0.5		
2078100	423400	10/20/89	0.6		
2078100	423425	10/20/89	0.4		
2078100	423450	10/20/89	0.4		
2078100	423475	10/20/89	0.3		
2078100	423500	10/23/89	0.8		
2078100	423525	10/23/89	0.8		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 17 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078100	423550	10/23/89	0.6		
2078100	423575	10/23/89	0.7		
2078100	423600	10/23/89	0.6		
2078100	423625	10/23/89	0.7		
2078100	423650	10/23/89	0.7		
2078100	423675	10/23/89	0.7		
2078100	423700	10/23/89	0.6		
2078100	423725	10/23/89	0.6		
2078100	423750	10/24/89	0.9		
2078100	423775	10/24/89	0.8		
2078100	423800	10/24/89	0.6		
2078100	423825	10/24/89	0.5		
2078100	423850	10/24/89	0.9		
2078100	423875	10/24/89	0.6		
2078100	423900	10/24/89	0.7		
2078100	423925	10/24/89	0.6		
2078100	423950	10/24/89	0.5		
2078100	423975	10/24/89	0.5		
2078100	424000	10/24/89	0.7		
2078100	424025	10/24/89	0.6		
2078100	424050	10/24/89	0.6		
2078100	424075	10/24/89	0.5		
2078100	424100	10/25/89	0.5		
2078125	423350	10/20/89	0.5		
2078125	423375	10/20/89	0.6		
2078125	423400	10/20/89	0.6		
2078125	423425	10/20/89	0.4		
2078125	423450	10/20/89	0.3		
2078125	423475	10/20/89	0.4		
2078125	423500	10/23/89	0.9		
2078125	423525	10/23/89	0.9		
2078125	423550	10/23/89	0.8		
2078125	423575	10/23/89	0.7		
2078125	423600	10/23/89	0.7		
2078125	423625	10/23/89	0.7		
2078125	423650	10/23/89	0.6		
2078125	423675	10/23/89	0.6		
2078125	423700	10/23/89	0.6		
2078125	423725	10/23/89	0.6		
2078125	423750	10/24/89	0.9		
2078125	423775	10/24/89	0.8		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 18 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078125	423800	10/24/89	0.8		
2078125	423825	10/24/89	0.9		
2078125	423850	10/24/89	0.9		
2078125	423875	10/24/89	0.5		
2078125	423900	10/24/89	0.5		
2078125	423925	10/24/89	0.7		
2078125	423950	10/24/89	0.7		
2078125	423975	10/24/89	0.5		
2078125	424000	10/24/89	0.6		
2078125	424025	10/24/89	0.6		
2078125	424050	10/24/89	0.6		
2078125	424075	10/24/89	0.7		
2078125	424100	10/25/89	0.5		
2078125	424125	10/25/89	0.6		
2078125	424150	10/25/89	0.6		
2078150	423350	10/20/89	0.6		
2078150	423375	10/20/89	0.5		
2078150	423400	10/20/89	0.6	0.7	
2078150	423425	10/20/89	0.5		
2078150	423450	10/20/89	0.4		
2078150	423475	10/20/89	0.3		
2078150	423500	10/23/89	0.8		
2078150	423525	10/23/89	0.8		
2078150	423550	10/23/89	0.8		
2078150	423575	10/23/89	0.6		
2078150	423600	10/23/89	0.6		
2078150	423625	10/23/89	0.7		
2078150	423650	10/23/89	0.6		
2078150	423675	10/23/89	0.7		
2078150	423700	10/23/89	0.6		
2078150	423725	10/23/89	0.5		
2078150	423750	10/24/89	0.8		
2078150	423775	10/24/89	0.8		
2078150	423800	10/24/89	0.7		
2078150	423825	10/24/89	0.8		
2078150	423850	10/24/89	0.9		
2078150	423875	10/24/89	0.7		
2078150	423900	10/24/89	0.5		
2078150	423925	10/24/89	0.6		
2078150	423950	10/24/89	0.5		
2078150	423975	10/24/89	0.6		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 19 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading*	Comments
2078150	424000	10/24/89	0.6		
2078150	424025	10/24/89	0.7		
2078150	424050	10/24/89	0.6		
2078150	424075	10/24/89	0.7		
2078150	424100	10/25/89	0.4		
2078150	424125	10/25/89	0.5		
2078150	424150	10/25/89	0.5		
2078150	424175	10/25/89	0.5		
2078150	424200	10/25/89	0.5		
2078175	423350	10/20/89	0.5		
2078175	423375	10/20/89	0.6		
2078175	423400	10/20/89	0.5		
2078175	423425	10/20/89	0.4		
2078175	423450	10/20/89	0.4		
2078175	423475	10/20/89	0.3		
2078175	423500	10/23/89	0.9		
2078175	423525	10/23/89	0.8		
2078175	423550	10/23/89	0.7		
2078175	423575	10/23/89	0.7		
2078175	423600	10/23/89	0.6		
2078175	423625	10/23/89	0.6		
2078175	423650	10/23/89	0.4		
2078175	423675	10/23/89	0.8		
2078175	423700	10/23/89	0.4		
2078175	423725	10/23/89	0.6		
2078175	423750	10/24/89	0.8		
2078175	423775	10/24/89	0.8		
2078175	423800	10/24/89	0.8		
2078175	423825	10/24/89	0.7		
2078175	423850	10/24/89	0.8		
2078175	423875	10/24/89	0.7		
2078175	423900	10/24/89	0.7		
2078175	423925	10/24/89	0.7		
2078175	423950	10/24/89	0.6		
2078175	423975	10/24/89	0.6		
2078175	424000	10/24/89	0.6		
2078175	424025	10/24/89	0.6		
2078175	424050	10/24/89	0.5		
2078175	424075	10/24/89	0.6		
2078175	424100	10/25/89	0.6		
2078175	424125	10/25/89	0.5		

*Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 20 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078175	424150	10/25/89	0.6		
2078175	424175	10/25/89	0.7		
2078175	424200	10/25/89	0.7		
2078175	424225	10/25/89	0.6		
2078175	424250	10/25/89	0.6		
2078200	423350	10/20/89	0.6		
2078200	423375	10/20/89	0.7		
2078200	423400	10/20/89	0.5		
2078200	423425	10/20/89	0.3		
2078200	423450	10/20/89	0.3		
2078200	423475	10/20/89	0.3		
2078200	423500	10/23/89	0.8		
2078200	423525	10/23/89	1.1		
2078200	423550	10/23/89	0.6		
2078200	423575	10/23/89	0.8		
2078200	423600	10/23/89	0.6		
2078200	423625	10/23/89	0.7		
2078200	423650	10/23/89	0.6		
2078200	423675	10/23/89	0.8		
2078200	423700	10/23/89	0.6		
2078200	423725	10/23/89	0.4		
2078200	423750	10/24/89	0.8		
2078200	423775	10/24/89	0.8		
2078200	423800	10/24/89	1.0		
2078200	423825	10/24/89	0.6		
2078200	423850	10/24/89	0.9		
2078200	423875	10/24/89	0.8		
2078200	423900	10/24/89	0.5		
2078200	423925	10/24/89	0.6		
2078200	423950	10/24/89	0.4		
2078200	423975	10/24/89	0.2		
2078200	424000	10/24/89	0.6		
2078200	424025	10/24/89	0.6		
2078200	424050	10/24/89	0.6		
2078200	424075	10/24/89	0.6		
2078200	424100	10/25/89	0.6		
2078200	424125	10/25/89	0.7		
2078200	424150	10/25/89	0.6		
2078200	424175	10/25/89	0.6		
2078200	424200	10/25/89	0.6		
2078200	424225	10/25/89	0.6		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 21 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078200	424250	10/25/89	0.6		
2078200	424275	10/25/89	0.5		
2078200	424300	10/25/89	0.5		
2078200	424325	10/25/89	0.6		
2078225	423350	10/20/89	0.5		
2078225	423375	10/20/89	0.5		
2078225	423400	10/20/89	0.5		
2078225	423425	10/20/89	0.4		
2078225	423450	10/20/89	0.4		
2078225	423475	10/20/89	0.3		
2078225	423500	10/23/89	0.8		
2078225	423525	10/23/89	0.9		
2078225	423550	10/23/89	0.4		
2078225	423575	10/23/89	0.8		
2078225	423600	10/23/89	0.7		
2078225	423625	10/23/89	0.8		
2078225	423650	10/23/89	0.6		
2078225	423675	10/23/89	0.6		
2078225	423700	10/23/89	0.6		
2078225	423725	10/23/89	0.6		
2078225	423750	10/24/89	0.7		
2078225	423775	10/24/89	0.9		
2078225	423800	10/24/89	0.8		
2078225	423825	10/24/89	0.7		
2078225	423850	10/24/89	0.8		
2078225	423875	10/24/89	0.8		
2078225	423900	10/24/89	0.7		
2078225	423925	10/24/89	0.7		
2078225	423950	10/24/89	0.7		
2078225	423975	10/24/89	0.7		
2078225	424000	10/24/89	0.6		
2078225	424025	10/24/89	0.6		
2078225	424050	10/24/89	0.6		
2078225	424075	10/24/89	0.6		
2078225	424100	10/25/89	0.5		
2078225	424125	10/25/89	0.5		
2078225	424150	10/25/89	0.5		
2078225	424175	10/25/89	0.6		
2078225	424200	10/25/89	0.6		
2078225	424225	10/25/89	0.6		
2078225	424250	10/25/89	0.6		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 22 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078225	424275	10/25/89	0.4		
2078225	424300	10/25/89	0.5		
2078225	424325	10/25/89	0.5		
2078250	423350	10/20/89	0.5		
2078250	423375	10/20/89	0.5		
2078250	423400	10/20/89	0.5		
2078250	423425	10/20/89	0.6		
2078250	423450	10/20/89	0.4		
2078250	423475	10/20/89	0.3		
2078250	423500	10/23/89	0.8		
2078250	423525	10/23/89	0.8		
2078250	423550	10/23/89	0.6		
2078250	423575	10/23/89	0.8		
2078250	423600	10/23/89	0.7		
2078250	423625	10/23/89	0.8		
2078250	423650	10/23/89	0.6		
2078250	423675	10/23/89	0.7		
2078250	423700	10/23/89	0.6		
2078250	423725	10/23/89	0.6		
2078250	423750	10/24/89	0.8		
2078250	423775	10/24/89	0.8		
2078250	423800	10/24/89	1.0		
2078250	423825	10/24/89	0.7		
2078250	423850	10/24/89	0.9		
2078250	423875	10/24/89	0.7		
2078250	423900	10/24/89	0.8		
2078250	423925	10/24/89	0.6		
2078250	423950	10/24/89	0.5		
2078250	423975	10/24/89	0.6		
2078250	424000	10/24/89	0.6		
2078250	424025	10/24/89	0.6		
2078250	424050	10/24/89	0.6		
2078250	424075	10/24/89	0.6		
2078250	424100	10/25/89	0.6		
2078250	424125	10/25/89	0.7		
2078250	424150	10/25/89	0.5		
2078250	424175	10/25/89	0.8		
2078250	424200	10/25/89	0.7		
2078250	424225	10/25/89	0.6		
2078250	424250	10/25/89	0.5		
2078250	424275	10/25/89	0.4		

[a]Only readings different from background levels are provided.

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading*	Comments
2078250	424300	10/25/89	0.6		
2078250	424325	10/25/89	0.6		
2078275	423350	10/20/89	0.4		
2078275	423375	10/20/89	0.5		
2078275	423400	10/20/89	0.5	0.8	
2078275	423425	10/20/89	0.4		
2078275	423450	10/20/89	0.4		
2078275	423475	10/20/89	0.4		
2078275	423500	10/23/89	0.8		
2078275	423525	10/23/89	0.8		
2078275	423550	10/23/89	0.8		
2078275	423575	10/23/89	0.8		
2078275	423600	10/23/89	0.6		
2078275	423625	10/23/89	0.7		
2078275	423650	10/23/89	0.7		
2078275	423675	10/23/89	0.6		
2078275	423700	10/23/89	0.6		
2078275	423725	10/23/89	0.6		
2078275	423750	10/24/89	0.8		
2078275	423775	10/24/89	0.8		
2078275	423800	10/24/89	1.0		
2078275	423825	10/24/89	0.7		
2078275	423850	10/24/89	0.9		
2078275	423875	10/24/89	0.8		
2078275	423900	10/24/89	0.6		
2078275	423925	10/24/89	0.7		
2078275	423950	10/24/89	0.7		
2078275	423975	10/24/89	0.6		
2078275	424000	10/24/89	0.6		
2078275	424025	10/24/89	0.6		
2078275	424050	10/24/89	0.6		
2078275	424075	10/24/89	0.6		
2078275	424100	10/25/89	0.6		
2078275	424125	10/25/89	0.7		
2078275	424150	10/25/89	0.7		
2078275	424175	10/25/89	0.7		
2078275	424200	10/25/89	0.6		
2078275	424225	10/25/89	0.7		
2078275	424250	10/25/89	0.7		
2078275	424275	10/25/89	0.5		
2078275	424300	10/25/89	0.5		

*Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 24 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078275	424325	10/25/89	0.6		
2078300	423350	10/20/89	0.6		
2078300	423375	10/20/89	0.6		
2078300	423400	10/20/89	0.5	0.8	
2078300	423425	10/20/89	0.5	0.4	
2078300	423450	10/20/89	0.5		
2078300	423475	10/20/89	0.5		
2078300	423500	10/23/89	0.9		
2078300	423525	10/23/89	0.8		
2078300	423550	10/23/89	0.8		
2078300	423575	10/23/89	0.8		
2078300	423600	10/23/89	0.7		
2078300	423625	10/23/89	0.8		
2078300	423650	10/23/89	0.6		
2078300	423675	10/23/89	0.7		
2078300	423700	10/23/89	0.6		
2078300	423725	10/23/89	0.6		
2078300	423750	10/24/89	0.9		
2078300	423775	10/24/89	0.8		
2078300	423800	10/24/89	0.8		
2078300	423825	10/24/89	0.8		
2078300	423850	10/24/89	0.7		
2078300	423875	10/24/89	0.7		
2078300	423900	10/24/89	0.7		
2078300	423925	10/24/89	0.8		
2078300	423950	10/24/89	0.6		
2078300	423975	10/24/89	0.5		
2078300	424000	10/24/89	0.6		
2078300	424025	10/24/89	0.7		
2078300	424050	10/24/89	0.6		
2078300	424075	10/24/89	0.6		
2078300	424100	10/25/89	0.7		
2078300	424125	10/25/89	0.8		
2078300	424150	10/25/89	0.7		
2078300	424175	10/25/89	0.5		
2078300	424200	10/25/89	0.6		
2078300	424225	10/25/89	0.6		
2078300	424250	10/25/89	0.7		
2078300	424275	10/25/89	0.4		
2078300	424300	10/25/89	0.5		
2078300	424325	10/25/89	0.6		

[a]Only readings different from background levels are provided.

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078325	423350	10/20/89	0.6		
2078325	423375	10/20/89	0.6		
2078325	423400	10/20/89	0.5	0.8	
2078325	423425	10/20/89	0.5		
2078325	423450	10/20/89	0.5		
2078325	423475	10/20/89	0.5		
2078325	423500	10/23/89	0.7	0.8	
2078325	423525	10/23/89	0.9		
2078325	423550	10/23/89	0.8		
2078325	423575	10/23/89	0.7		
2078325	423600	10/23/89	0.6		
2078325	423625	10/23/89	0.7		
2078325	423650	10/23/89	0.5		
2078325	423675	10/23/89	0.8		
2078325	423700	10/23/89	0.6		
2078325	423725	10/23/89	0.7		
2078325	423750	10/24/89	0.8		
2078325	423775	10/24/89	0.8		
2078325	423800	10/24/89	0.9		
2078325	423825	10/24/89	0.6		
2078325	423850	10/24/89	0.8		
2078325	423875	10/24/89	0.9		
2078325	423900	10/24/89	0.7		
2078325	423925	10/24/89	0.7		
2078325	423950	10/24/89	0.6		
2078325	423975	10/24/89	0.6		
2078325	424000	10/24/89	0.6		
2078325	424025	10/24/89	0.5		
2078325	424050	10/24/89	0.6		
2078325	424075	10/24/89	0.6		
2078325	424100	10/25/89	0.7		
2078325	424125	10/25/89	0.7		
2078325	424150	10/25/89	0.7		
2078325	424175	10/25/89	0.7		
2078325	424200	10/25/89	0.7		
2078325	424225	10/25/89	0.6		
2078325	424250	10/25/89	0.5		
2078325	424275	10/25/89	0.4		
2078325	424300	10/25/89	0.6		
2078325	424325	10/25/89	0.6		
2078350	423375	10/20/89	0.5		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 26 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078350	423400	10/20/89	0.5		
2078350	423425	10/20/89	0.4		
2078350	423450	10/20/89	0.4		
2078350	423475	10/20/89	0.4		
2078350	423500	10/23/89	0.8	0.9	
2078350	423525	10/23/89	0.7		
2078350	423550	10/23/89	0.9		
2078350	423575	10/23/89	0.8		
2078350	423600	10/23/89	0.6		
2078350	423625	10/23/89	1.1		
2078350	423650	10/23/89	0.5		
2078350	423675	10/23/89	0.9		
2078350	423700	10/23/89	0.8		
2078350	423725	10/23/89	0.8		
2078350	423750	10/24/89	0.6		
2078350	423775	10/24/89	0.8		
2078350	423800	10/24/89	0.8		
2078350	423825	10/24/89	0.8		
2078350	423850	10/24/89	0.8		
2078350	423875	10/24/89	1.0		
2078350	423900	10/24/89	0.5		
2078350	423925	10/24/89	0.7		
2078350	423950	10/24/89	0.5		
2078350	423975	10/24/89	0.6		
2078350	424000	10/24/89	0.7		
2078350	424025	10/24/89	0.5		
2078350	424050	10/24/89	0.6		
2078350	424075	10/24/89	0.6		
2078350	424100	10/25/89	0.9		
2078350	424125	10/25/89	0.7		
2078350	424150	10/25/89	0.7		
2078350	424175	10/25/89	0.6		
2078350	424200	10/25/89	0.8		
2078350	424225	10/25/89	0.6		
2078350	424250	10/25/89	0.6		
2078350	424275	10/25/89	0.5		
2078350	424300	10/25/89	0.5		
2078350	424325	10/25/89	0.6		
2078375	423375	10/20/89	0.5		
2078375	423400	10/20/89	0.5		
2078375	423425	10/20/89	0.6		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 27 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078375	423450	10/20/89	0.4		
2078375	423475	10/20/89	0.3		
2078375	423500	10/23/89	0.8		
2078375	423525	10/23/89	0.6		
2078375	423550	10/23/89	0.8		
2078375	423575	10/23/89	0.9		
2078375	423600	10/23/89	0.7		
2078375	423625	10/23/89	0.8		
2078375	423650	10/23/89	0.8		
2078375	423675	10/23/89	0.6		
2078375	423700	10/23/89	0.6		
2078375	423725	10/23/89	0.6		
2078375	423750	10/24/89	0.8		
2078375	423775	10/24/89	0.8		
2078375	423800	10/24/89	0.9		
2078375	423825	10/24/89	0.7		
2078375	423850	10/24/89	0.9		
2078375	423875	10/24/89	0.8		
2078375	423900	10/24/89	0.6		
2078375	423925	10/24/89	0.6		
2078375	423950	10/24/89	0.7		
2078375	423975	10/24/89	0.6		
2078375	424000	10/24/89	0.6		
2078375	424025	10/24/89	0.6		
2078375	424050	10/24/89	0.6		
2078375	424075	10/24/89	0.5		
2078375	424100	10/25/89	0.8		
2078375	424125	10/25/89	0.6		
2078375	424150	10/25/89	0.7		
2078375	424175	10/25/89	0.7		
2078375	424200	10/25/89	0.6		
2078375	424225	10/25/89	0.6		
2078375	424250	10/25/89	0.6		
2078375	424275	10/25/89	0.7		
2078375	424300	10/25/89	0.5		
2078375	424325	10/25/89	0.6		
2078400	423375	10/20/89	0.5		
2078400	423400	10/20/89	0.5		
2078400	423425	10/20/89	0.6		
2078400	423450	10/20/89	0.5		
2078400	423475	10/20/89	0.4		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 28 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078400	423500	10/23/89	0.8		
2078400	423525	10/23/89	0.9		
2078400	423550	10/23/89	0.7		
2078400	423575	10/23/89	0.7		
2078400	423600	10/23/89	0.7		
2078400	423625	10/23/89	0.8		
2078400	423650	10/23/89	0.5		
2078400	423675	10/23/89	0.7		
2078400	423700	10/23/89	0.5		
2078400	423725	10/23/89	0.6		
2078400	423750	10/24/89	0.7		
2078400	423775	10/24/89	0.8		
2078400	423800	10/24/89	0.8		
2078400	423825	10/24/89	0.7		
2078400	423850	10/24/89	1.0		
2078400	423875	10/24/89	0.8		
2078400	423900	10/24/89	0.6		
2078400	423925	10/24/89	0.5		
2078400	423950	10/24/89	0.5		
2078400	423975	10/24/89	0.6		
2078400	424000	10/24/89	0.6		
2078400	424025	10/24/89	0.6		
2078400	424050	10/24/89	0.6		
2078400	424075	10/24/89	0.6		
2078400	424100	10/25/89	0.7		
2078400	424125	10/25/89	0.8		
2078400	424150	10/25/89	0.7		
2078400	424175	10/25/89	0.7		
2078400	424200	10/25/89	0.7		
2078400	424225	10/25/89	0.6		
2078400	424250	10/25/89	0.6		
2078400	424275	10/25/89	0.5		
2078400	424300	10/25/89	0.5		
2078400	424325	10/25/89	0.3		
2078425	423400	10/20/89	0.5		
2078425	423425	10/20/89	0.6		
2078425	423450	10/20/89	0.4		
2078425	423475	10/20/89	0.5		
2078425	423500	10/23/89	0.7		
2078425	423525	10/23/89	0.8		
2078425	423550	10/23/89	0.8		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 29 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078425	423575	10/23/89	0.7		
2078425	423600	10/23/89	0.8		
2078425	423625	10/23/89	0.5		
2078425	423650	10/23/89	0.6		
2078425	423675	10/23/89	0.8		
2078425	423700	10/23/89	0.6		
2078425	423725	10/23/89	0.8		
2078425	423750	10/24/89	0.9		
2078425	423775	10/24/89	0.9		
2078425	423800	10/24/89	0.8		
2078425	423825	10/24/89	0.7		
2078425	423850	10/24/89	0.8		
2078425	423875	10/24/89	0.7		
2078425	423900	10/24/89	0.7		
2078425	423925	10/24/89	0.6		
2078425	423950	10/24/89	0.6		
2078425	423975	10/24/89	0.7		
2078425	424000	10/24/89	0.6		
2078425	424025	10/24/89	0.7		
2078425	424050	10/24/89	0.6		
2078425	424075	10/24/89	0.7		
2078425	424100	10/25/89	0.8		
2078425	424125	10/25/89	0.8		
2078425	424150	10/25/89	0.6		
2078425	424175	10/25/89	0.7		
2078425	424200	10/25/89	0.7		
2078425	424225	10/25/89	0.6		
2078425	424250	10/25/89	0.6		
2078425	424275	10/25/89	0.4		
2078425	424300	10/25/89	0.4		
2078425	424325	10/25/89	0.5		
2078450	423425	10/20/89	0.6		
2078450	423450	10/20/89	0.4		
2078450	423475	10/20/89	0.3		
2078450	423500	10/23/89	0.9		
2078450	423525	10/23/89	0.8		
2078450	423550	10/23/89	0.8		
2078450	423575	10/23/89	0.7		
2078450	423600	10/23/89	0.8		
2078450	423625	10/23/89	0.6		
2078450	423650	10/23/89	0.7		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 30 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078450	423675	10/23/89	0.6		
2078450	423700	10/23/89	0.5		
2078450	423725	10/23/89	0.6		
2078450	423750	10/24/89	0.8		
2078450	423775	10/24/89	0.7		
2078450	423800	10/24/89	0.8		
2078450	423825	10/24/89	0.9		
2078450	423850	10/24/89	0.8		
2078450	423875	10/24/89	0.8		
2078450	423900	10/24/89	0.6		
2078450	423925	10/24/89	0.6		
2078450	423950	10/24/89	0.7		
2078450	423975	10/24/89	0.6		
2078450	424000	10/24/89	0.6		
2078450	424025	10/24/89	0.5		
2078450	424050	10/24/89	0.6		
2078450	424075	10/24/89	0.7		
2078450	424100	10/25/89	0.9		
2078450	424125	10/25/89	0.8		
2078450	424150	10/25/89	0.6		
2078450	424175	10/25/89	0.7		
2078450	424200	10/25/89	0.7		
2078450	424225	10/25/89	0.6		
2078450	424250	10/25/89	0.6		
2078450	424275	10/25/89	0.5		
2078450	424300	10/25/89	0.6		
2078450	424325	10/25/89	0.5		
2078475	423450	10/20/89	0.6		
2078475	423475	10/20/89	0.4		
2078475	423500	10/23/89	0.8		
2078475	423525	10/23/89	0.8		
2078475	423550	10/23/89	0.8		
2078475	423575	10/23/89	0.8		
2078475	423600	10/23/89	0.8		
2078475	423625	10/23/89	0.6		
2078475	423650	10/23/89	0.6		
2078475	423675	10/23/89	1.0		
2078475	423700	10/23/89	0.6		
2078475	423725	10/23/89	0.6		
2078475	423750	10/24/89	0.8		
2078475	423775	10/24/89	0.8		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 31 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078475	423800	10/24/89	0.7		
2078475	423825	10/24/89	0.7		
2078475	423850	10/24/89	0.8		
2078475	423875	10/24/89	0.8		
2078475	423900	10/24/89	0.6		
2078475	423925	10/24/89	0.7		
2078475	423950	10/24/89	0.6		
2078475	423975	10/24/89	0.6		
2078475	424000	10/24/89	0.7		
2078475	424025	10/24/89	0.6		
2078475	424050	10/24/89	0.6		
2078475	424075	10/24/89	0.7		
2078475	424100	10/25/89	0.8		
2078475	424125	10/25/89	0.7		
2078475	424150	10/25/89	0.7		
2078475	424175	10/25/89	0.7		
2078475	424200	10/25/89	0.8		
2078475	424225	10/25/89	0.7		
2078475	424250	10/25/89	0.6		
2078475	424275	10/25/89	0.6		
2078475	424300	10/25/89	0.4		
2078475	424325	10/25/89	0.5		
2078500	423475	10/20/89	0.4		
2078500	423500	10/23/89	0.9		
2078500	423525	10/23/89	0.9		
2078500	423550	10/23/89	0.9		
2078500	423575	10/23/89	0.7		
2078500	423600	10/23/89	0.7		
2078500	423625	10/23/89	0.6		
2078500	423650	10/23/89	0.7		
2078500	423675	10/23/89	0.8		
2078500	423700	10/23/89	0.6		
2078500	423725	10/23/89	0.5		
2078500	423750	10/24/89	0.8		
2078500	423775	10/24/89	0.7		
2078500	423800	10/24/89	0.8		
2078500	423825	10/24/89	0.8		
2078500	423850	10/24/89	0.7		
2078500	423875	10/24/89	0.8		
2078500	423900	10/24/89	0.7		
2078500	423925	10/24/89	0.7		

[a]Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 32 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading*	Comments
2078500	423950	10/24/89	0.6		
2078500	423975	10/24/89	0.7		
2078500	424000	10/24/89	0.6		
2078500	424025	10/24/89	0.5		
2078500	424050	10/24/89	0.4		
2078500	424075	10/24/89	0.5		
2078500	424100	10/25/89	0.8		
2078500	424125	10/25/89	0.7		
2078500	424150	10/25/89	0.6		
2078500	424175	10/25/89	0.7		
2078500	424200	10/25/89	0.7		
2078500	424225	10/25/89	0.6		
2078500	424250	10/25/89	0.6		
2078500	424275	10/25/89	0.5		
2078500	424300	10/25/89	0.5		
2078500	424325	10/25/89	0.5		
2078525	423500	10/23/89	0.9		
2078525	423525	10/23/89	0.7		
2078525	423550	10/23/89	0.8		
2078525	423575	10/23/89	0.7		
2078525	423600	10/23/89	0.7		
2078525	423625	10/23/89	0.8		
2078525	423650	10/23/89	0.7		
2078525	423675	10/23/89	0.6		
2078525	423700	10/23/89	0.5		
2078525	423725	10/23/89	0.6		
2078525	423750	10/24/89	0.9		
2078525	423775	10/24/89	0.8		
2078525	423800	10/24/89	0.8		
2078525	423825	10/24/89	0.8		
2078525	423850	10/24/89	0.9		
2078525	423875	10/24/89	1.0		
2078525	423900	10/24/89	0.7		
2078525	423925	10/24/89	0.7		
2078525	423950	10/24/89	0.6		
2078525	423975	10/24/89	0.7		
2078525	424000	10/24/89	0.5		
2078525	424025	10/24/89	0.6		
2078525	424050	10/24/89	0.6		
2078525	424075	10/24/89	0.7		
2078525	424100	10/25/89	0.8		

*Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 33 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078525	424125	10/25/89	0.8		
2078525	424150	10/25/89	0.6		
2078525	424175	10/25/89	0.6		
2078525	424200	10/25/89	0.7		
2078525	424225	10/25/89	0.6		
2078525	424250	10/25/89	0.6		
2078525	424275	10/25/89	0.4		
2078525	424300	10/25/89	0.5		
2078525	424325	10/25/89	0.5		
2078550	423525	10/23/89	0.8	0.9	
2078550	423550	10/23/89	0.8		
2078550	423575	10/23/89	0.6		
2078550	423600	10/23/89	0.8		
2078550	423625	10/23/89	0.8		
2078550	423650	10/23/89	0.6		
2078550	423675	10/23/89	0.6		
2078550	423700	10/23/89	0.6		
2078550	423725	10/23/89	0.4		
2078550	423750	10/24/89	0.8		
2078550	423775	10/24/89	0.8		
2078550	423800	10/24/89	0.7		
2078550	423825	10/24/89	0.7		
2078550	423850	10/24/89	0.8		
2078550	423875	10/24/89	0.8		
2078550	423900	10/24/89	0.5		
2078550	423925	10/24/89	0.7		
2078550	423950	10/24/89	0.6		
2078550	423975	10/24/89	0.6		
2078550	424000	10/24/89	0.4		
2078550	424025	10/24/89	0.7		
2078550	424050	10/24/89	0.6		
2078550	424075	10/24/89	0.5		
2078550	424100	10/25/89	0.8		
2078550	424125	10/25/89	0.8		
2078550	424150	10/25/89	0.7		
2078550	424175	10/25/89	0.7		
2078550	424200	10/25/89	0.6		
2078550	424225	10/25/89	0.7		
2078550	424250	10/25/89	0.5		
2078550	424275	10/25/89	0.5		
2078550	424300	10/25/89	0.6		

[a]Only readings different from background levels are provided.

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading*	Comments
2078550	424325	10/25/89	0.4		
2078575	423550	10/23/89	0.8		
2078575	423575	10/23/89	0.9		
2078575	423600	10/23/89	0.8		
2078575	423625	10/23/89	0.7		
2078575	423650	10/23/89	0.7		
2078575	423675	10/23/89	0.6		
2078575	423700	10/23/89	0.6		
2078575	423725	10/23/89	0.5		
2078575	423750	10/24/89	0.7		
2078575	423775	10/24/89	0.9		
2078575	423800	10/24/89	0.7		
2078575	423825	10/24/89	0.7		
2078575	423850	10/24/89	0.6		
2078575	423875	10/24/89	0.9		
2078575	423900	10/24/89	0.6		
2078575	423925	10/24/89	0.8		
2078575	423950	10/24/89	0.6		
2078575	423975	10/24/89	0.7		
2078575	424000	10/24/89	0.6		
2078575	424025	10/24/89	0.6		
2078575	424050	10/24/89	0.6		
2078575	424075	10/24/89	0.5		
2078575	424100	10/25/89	0.8		
2078575	424125	10/25/89	0.8		
2078575	424150	10/25/89	0.7		
2078575	424175	10/25/89	0.8		
2078575	424200	10/25/89	0.6		
2078575	424225	10/25/89	0.7		
2078575	424250	10/25/89	0.6		
2078575	424275	10/25/89	0.4		
2078575	424300	10/25/89	0.4		
2078575	424325	10/25/89	0.4		
2078600	423575	10/23/89	1.0		
2078600	423600	10/23/89	0.7		
2078600	423625	10/23/89	0.8		
2078600	423650	10/23/89	0.7		
2078600	423675	10/23/89	0.6		
2078600	423700	10/23/89	0.4		
2078600	423725	10/23/89	0.7		
2078600	423750	10/24/89	0.8		

*Only readings different from background levels are provided.

Table 1. HNu Readings for the Lee Acres Landfill (page 35 of 35)

State Plane Coordinates					
Northing	Easting	Sample Date	Background Reading	Reading[a]	Comments
2078600	423775	10/24/89	0.8		
2078600	423800	10/24/89	0.2		
2078600	423825	10/24/89	0.3		
2078600	423850	10/24/89	0.8		
2078600	423875	10/24/89	0.8		
2078600	423900	10/24/89	0.8		
2078600	423925	10/24/89	0.8		
2078600	423950	10/24/89	0.5		
2078600	423975	10/24/89	0.8		
2078600	424000	10/24/89	0.5		
2078600	424025	10/24/89	0.5		
2078600	424050	10/24/89	0.6		
2078600	424075	10/24/89	0.6		

[a]Only readings different from background levels are provided.

Table 2. HNU Survey Calibration Information

QA/QC HNU INSTRUMENT CALIBRATION FROM 10/16/89-10/25/89 HNU-PI-101 INSTRUMENT SERIAL # 03074 HNU PROBE 11.7eV SERIAL # 06248 CALIBRATION GAS = ISOBUTYLENE LOT # LCCO-L1861032989				
DATE	TIME	INSTR. READING	HNU-SPAN SETTING	CAL GAS READING
10/16/89	1600	58.7ppm	4.962	58.7PPM
10/17/89	0820	58.5ppm	5.0	58.7PPM
10/18/89	0612	58.5ppm	4.46	58.7PPM
NO READINGS 10/18/89 CALIBRATION ONLY				
10/19/89	0611	58.5ppm	5.0	58.7PPM
NO READINGS 10/19/89 CALIBRATION ONLY				
10/20/89	0553	58.5ppm	5.0	58.7PPM
10/21/89	0636	58.5ppm	5.0	58.7PPM
NO READINGS 10/21/89 CALIBRATION ONLY				
10/23/89	1345	58.7ppm	4.6	58.7PPM
10/24/89	1000	58.7ppm	5.0	58.7PPM
10/25/89	1000	58.7ppm	4.7	58.7PPM

NOTE: BATTERY CHECKS WERE DONE DAILY AS PART OF THE QA/QC CHECK

APPENDIX F

BUREAU OF LAND MANAGEMENT POSITION PAPER
EVALUATION OF GROUNDWATER CONTAMINANT FATE AND TRANSPORT
PROPOSED APPROACH

REMEDIAL INVESTIGATION REPORT FOR THE LEE ACRES LANDFILL

BUREAU OF LAND MANAGEMENT POSITION PAPER - EVALUATION OF GROUNDWATER CONTAMINANT FATE AND TRANSPORT - PROPOSED APPROACH

INTRODUCTION

In response to U.S. Environmental Protection Agency (USEPA) comments on the Lee Acres Landfill Remedial Investigation Report (RIR) section on contaminant fate and transport within the groundwater system, a change of methodology is proposed. Previously a solute transport model was used which made simplified assumptions regarding the groundwater system. This approach was not accepted by USEPA. The spatial distribution of the groundwater quality data does not support a classical, continuous plume distribution. Modeling its shape with classical approaches do not create linear regression analyses with an R^2 of 0.90. An analytical approach to evaluate contaminant transport is proposed, rather than a numerical approach. BLM pursues discussion with EPA on this proposed approach and regards this paper as a request to USEPA to work with BLM toward developing an approach agreeable to all agencies.

The difficulty with modeling the solute transport is that the alluvial groundwater flow field is very narrow in the area of the Lee Acres Landfill. In the area of the Lee Acres Landfill to the south, the contaminant plume is confined to the alluvial channel, which is approximately 400 feet wide. Within the alluvium, there is sinuous, coarser-grained lithofacies that preferentially transport groundwater and chemical constituents. A monitoring well may intersect one such lithofacies and record relatively high contaminant concentrations while nearby wells may not detect the contaminant. For instance, well GBR-32 had a 1,2-*trans*-Dichloroethene (DCE) concentration of 135.00 μg/L and a well within 30 feet, well BLM-62, had no DCE detected. Well GBR-32 may intersect a coarser-grained lithofacies transporting contaminants, while wells BLM-62 may not.

In this paper, a three-step evaluation is proposed. The evaluation would culminate in an analytical approach, rather than a numerical modeling approach. This evaluation would provide the following:

- support for the groundwater conceptual model developed in the RIR;
- an improved understanding of present conditions;
- a determination of the rate of groundwater migration and retardation factors for key contaminants; and

- a resolution about the adequacy of existing data to draw conclusions of contaminant extent, levels, and rates of movement.

METHODOLOGY

BLM proposes to evaluate groundwater contaminant fate and transport of organic and inorganic constituents in the alluvial channel aquifer in three steps:

cis & trans 1,2 Dichloroethene

1) A list of selected chemical constituents will be developed and groundwater chemistry data from samples collected from the alluvial groundwater for these constituents will be tabulated and reviewed. The list should include those constituents that may be groundwater contaminants at the site and constituents whose concentration distribution help in developing the groundwater conceptual model. Based on previous evaluations, BLM recommends that this list of selected constituents include 1,1,1-trichloroethane (TCA), 1,1-dichloroethane (DCA), DCE, benzene, dichloromethane, tetrachloroethene (PCE), trichloroethene (TCE), vinyl chloride, chloride, chromium, and manganese. The analyses from samples collected in July 1991 and August 1992 will be emphasized.

2) The groundwater chemistry of samples for the selected constituents will be further evaluated in terms of concentration as functions of north-south position within the study area and change in concentration through time. The primary purpose of this step will be to determine the rate of contaminant migration and to observe any consistent spatial or temporal changes in concentrations. Based on comparisons of July 1991 groundwater chemistry data to August 1992 groundwater chemistry data, the rate of contaminant migration will be estimated. These estimates will be substantiated with evaluation of data collected before July 1991. If appropriate, general trends regarding potential source areas concentrations and durations, contaminant distributions, and rates of migration will be developed for individual constituents or groups of constituents.

3) All groundwater chemistry data for the selected constituents collected during the preliminary and remedial investigations from wells completed in the alluvium, including the most recent August 1992 sampling event will be compiled and tabulated by well

location, from north to south and from highest concentration to lowest concentration. The transport of these constituents will be simulated with an analytical solute transport equation and the results compared to actual data to refine the groundwater flow/solute transport conceptual model.

To simulate solute transport, the following equation is proposed:

$$C(x,y,t) = \frac{C_0 x}{4(\pi D_L)^{1/2}} \exp\left(\frac{vx}{2D_L} - \alpha t\right)$$

$$\cdot \int_0^{t/R} \exp\left[\left(\alpha R - \frac{v^2}{4D_L}\right)\tau - \frac{x^2}{4D_L \tau}\right] \tau^{-3/2}$$

$$\cdot \left[\operatorname{erf}\left(\frac{a-y}{2(D_T \tau)^{1/2}}\right) + \operatorname{erf}\left(\frac{a+y}{2(D_T \tau)^{1/2}}\right)\right] d\tau$$

(Javandel, Doughty, and Tsang 1984)

Where:

$C(x,y,t)$ is the calculated concentration at position x,y at time t (M/L^3);
C_0 is the initial source concentration (M/L^3);
x is the distance from the line source in the direction of groundwater flow (L);
D_L is the longitudinal dispersivity (L);
v is the groundwater velocity (L/T);
α is the source strength exponential decrease rate (T^{-1});
R is retardation factor;
τ is the integrand of time (T);
erf is the error function
a is the half-length of the line source (L);
y is the distance from the center of the line source, perpendicular to the direction of groundwater flow (L); and
D_T is the transverse dispersivity (L).

The equation assumes steady-state groundwater flow and line sources oriented perpendicular to the direction of groundwater flow. The equation will be used to allow multiple sources with differing locations, initial concentrations, source decrease rates and source initiation times.

SUMMARY

BLM considers the proposed approach, presented herein, as a reasonable method to achieve specific RI/FS goals. As stated in the introduction, this approach would

- support the groundwater conceptual model developed in the RIR;
- improve the understanding of present conditions;
- allow a determination of the rate of groundwater migration and retardation factors for key contaminants; and
- provide a resolution about the adequacy of existing data to draw conclusions of contaminant extent, levels, and rates of movement.

Following USEPA review of and concurrence with the evaluation using this approach, the approach can be extended to provide contaminant concentration estimates and other valuable information for use in risk assessment, feasibility study, and remedial design.

BLM anticipates that this position paper will open discussion between BLM and USEPA and will provide momentum toward efficient and satisfactory resolution of issues concerning groundwater contaminant fate and transport.

REFERENCE

Javandel,I., Doughty, C., and Tsang, C.F., Groundwater Transport: Handbook of Mathematical Models, Water Resources Monograph Series 10, American Geophysical Union, Washington D.C., 1984.

APPENDIX G

BUREAU OF LAND MANAGEMENT POSITION PAPER
BASELINE RISK ASSESSMENT

REMEDIAL INVESTIGATION REPORT FOR THE LEE ACRES LANDFILL

BUREAU OF LAND MANAGEMENT POSITION PAPER
BASELINE RISK ASSESSMENT

January 1993

BACKGROUND

In October 1989, the Bureau of Land Management (BLM) began a Remedial Investigation (RI) for the Lee Acres Landfill, in Farmington, New Mexico. The draft report was submitted to the U.S. Environmental Protection Agency (EPA) for review on 25 February 1992. This position paper broadly identifies the EPA's major comments pertaining to the human and ecological risk assessments, as well as BLM's responses and proposed actions to address these comments in a subsequent revision of the RI report.

PART I. HUMAN RISK ASSESSMENT

ORGANIZATION OF THE RISK ASSESSMENT

The EPA commented that the RI report is not in conformance with the EPA's Risk Assessment Guidance for Superfund (RAGS) documents. In fact, the RI Report contains all the elements of a baseline risk assessment (RA), although portions of the selection of chemicals of concern, the pathway analysis, and the conceptual site model do not appear wholly in the RA section. In order to provide a roadmap to other sections, but still retain the logical organization of the RI report, cross referencing in the RA section will be made wherever it is appropriate. In addition, better and more complete explanations will be used throughout, and necessary revisions will be made to complement the revised approach to groundwater modeling in the document.

CHEMICALS OF CONCERN

The EPA commented that the information on selecting the chemicals of concern occurs in Sections 1, 5, 6, and 10 of the RI report, and that it appeared that RAGS was not followed in selecting the chemicals of concern. BLM believes the procedures used were in substantial compliance with EPA guidance. The selection of chemicals of concern was a rigorous, multi-phased process which is presented in the RI Report in the most organized manner possible and in a way that focused discussion of the nature and extent of contamination. To summarize all this information again in the RA section would be redundant, however, additional cross referencing will be utilized. In addition, references to RAGS will be made in Sections 1, 5, 6, 8, and whenever appropriate. In response to EPA comments, comparisons and references to ARARs will be deemphasized in the document.

EXPOSURE ASSESSMENT

EPA commented that the exposure assessment was referenced only in sections 8 and 9, and was not evaluated against the criteria outlined yin RAGS. However, the exposure assessment and the evaluation of potential pathways were actually rigorously evaluated in the RI Report and organized in what was thought to be the clearest presentation of the data, and cross-referenced when necessary. The criteria outlined in RAGS for evaluating exposure pathways were addressed and tailored for this document in order to provide continuity between development and implementation of the field program, the results of the Remedial Investigation, and the identification of risk associated with the Lee Acres Landfill.

Additional explanation, revision, references to RAGS and format changes will be made in Sections 8 and 9, and a new summary of the pathway analysis itself will be included in Subsection 10.2.

The EPA commented that the RA did not evaluate all exposure locations and scenarios. EPA suggested that a RA should be prepared for Site 2. A two-site interpretation is presented in Subsection 1.1 of the RI Report. It is BLM's belief that further evaluation of Giant-Bloomfield Refinery data and the results of the revised groundwater modeling, the approach to which is described in the Groundwater Contaminant Fate and Transport Position Paper, will support the interpretation that landfill contaminants have not entered Site 2. If the revised groundwater modeling indicates that landfill contaminants have entered Site 2, the risk assessment will include Site 2.

The residential scenario is considered to be a hypothetical worst case scenario and uses the conservative assumption that future concentrations of contaminants are identical to concentrations presently found. This scenario was included even though it fails the probability test described in the preamble of the National Contingency Plan (e.g. the probability of future residential land use at the Lee Acres Landfill is very small). BLM even conceded inclusion of the groundwater ingestion exposure pathway even though RAGS (page 6-27) states: "In a few situations however, it may not be reasonable to assume that water will be drawn from directly beneath a specific source (e.g. a waste management unit such as a landfill) in the future."

Other suggested exposure scenarios are even more improbable. A construction worker scenario would not be worst case nor would it be likely except for remediation workers. Workers participating in RI data collection activities are protected according to procedures required by their health and safety plan (29 CFR 1910.120). Future remedial workers' exposure to contaminated soils is likely to be low, since the landfill cap will be upgraded per 40 CFR 257 standards and no intrusive activities will be allowed; therefore, workers were excluded as potential receptors. The trespasser scenario is also unlikely since future ingestion, inhalation, or contact with contaminated landfill soil via a trespasser scenario is prevented because BLM owns the land, BLM policy prevents transfer of the land and BLM will always restrict access to the site with a chain-link and barbed-wire fence, locked gate, and warning signs in three languages.

Residential soil exposure pathways are also improbable for the same reasons described above. The landfill cap will be upgraded according to 40 CFR 257 standards, and a soil cap precludes soil-associated exposure. BLM believes that since the landfill is capped and since BLM policy and surrounding land use preclude residential land use, that evaluation of soil exposure pathways is not warranted.

METHODOLOGY

The EPA commented that methodologies were not presented adequately, documentation was lacking, or may not have followed RAGS. In order to clarify this, an appendix with all calculations will be provided. The methodologies used to determine the concentrations used in calculating risks and all rationale for assumptions will be included.

AIR SAMPLING DATA

Air sampling was performed to support the RA. On-site air sampling via high volume samplers and canister samplers was performed. The location of the background air sampling station at the fire station provides a conservative representation of the air quality in the nearby industrial community. This location provides adequate and sufficient air data for the Lee Acres Landfill area, which itself is located adjacent to a refinery, gas wells, and a major highway. Since contaminants were not detected, this pathway was screened out. Additional explanation will be added to the text.

PART II: ECOLOGICAL RISK ASSESSMENT

The RI report did not contain an ecological risk assessment (ERA). The approach to the the ERA proposed below was prepared based on the example ERAs provided by EPA and EPA guidance. This approach makes maximum use of available data and recognized risk assessment methods while using most probable and reasonable maximum exposure assumptions to bracket the uncertainties associated with ecological risk assessment. The ERA approach and brief description follows:

SITE DESCRIPTION

This section will briefly summarize existing ecological environment of the site, drawing from Section 3.3 of RI and other references.

DATA EVALUATION

This section will be identical to the data evaluation portions of the human risk assessment in section 10.0.

SELECTION OF CHEMICALS OF CONCERN (COCs)

For the aquatic ecosystem, groundwater COCs will be selected based on the site conceptual model of the leaching of groundwater to surface water (San Juan River). For the terrestrial ecosystem, soil COCs selection will be based on toxicity, subsurface soil data and the tendency to bioaccumulate. To focus the ERA COCs on the most important chemicals, three criteria will be used: a 5% frequency of detection, a comparison to background where available, and a concentration-toxicity scan with published LD_{50} or LC_{50} data. Polynuclear aromatic hydrocarbons will be combined as in the example ERAs provided.

SELECTION OF INDICATOR SPECIES

Based on the ecological site description and in order to evaluate representative food chains, one food chain each will be evaluated for the aquatic ecosystem and terrestrial ecosystem. For the aquatic ecosystem, the following indicator species will be selected: algae, forage fish, and predator fish. For the terrestrial ecosystem, the following indicator species will be selected: grass, prairie dogs or mice, and raptor.

EXPOSURE ASSESSMENT

For both the aquatic and terrestrial ecosystems, a screening of exposure pathways will be performed and the most important will be selected for evaluation. Example aquatic pathways include:

direct contact with surface water
consumption of plants by fish
consumption of fish by fish

Example terrestrial pathways may include:

bioaccumulation from soil to grass
consumption of grass by mice or prairie dogs
consumption of mice or prairie dogs by raptors.

Exposure point concentrations for soils will employ geometric mean and maximum subsurface soil detections for soil exposure point concentrations. This is very conservative because subsurface soil data include samples of waste materials.
Exposure point concentrations for surface water will use analytical solutions for computing groundwater concentrations hypothetically entering the San Juan River (future scenario) followed by computing resulting aquatic concentrations.

Intakes will be compute using the following methods. For the aquatic ecosystem, using the projected aquatic concentrations and bioconcentration factors (BCFs), intakes will be computed for algae and the two fish trophic levels. For the terrestrial ecosystem, using subsurface soil concentrations and biaccumulation factors (BAFs), intakes will be computed for the mouse and raptors.

TOXICITY ASSESSMENT

Toxicity reference doses (TRVs) will be computed using: lowest-observed-adverse effect-levels (LOAELs) and no-observed-adverse-effect-levels (NOAELs) for algae, two trophic levels of fish, mice and raptors using the methodology of Ford, Applehans and Ober, 1992 (copy attached).

RISK CHARACTERIZATION

Hazard quotients (HQs) will be computed as a ratio of the intakes to the TRVs. These HQs will indicate the approximate magnitude of the risk to ecological receptors from the Lee Acres site. Due to the many sources of uncertainty in performing quantitative ERAs, a full assessment of the uncertainties will be presented for both the most probable and reasonable maximum scenarios.

PART III: SUMMARY

These changes are proposed to EPA in an effort to be responsive to EPA's comments on the risk assessment. It is believed that, with mutual agreement, these changes will satisfy the requirements of CERCLA.

APPENDIX H

DEVELOPMENT OF TOXICITY REFERENCE VALUES FOR TERRESTRIAL WILDLIFE

Proceedings of

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U.S. Environmental Protection Agency, Office of Emergency and Remedial Response
U.S. Environmental Protection Agency, Office of Environmental Engineering and Technology Demonstration
U.S. Environmental Protection Agency, Office of Solid Waste
U.S. Geological Survey

Development of Toxicity Reference Values for Terrestrial Wildlife

Karl L. Ford, Ph.D.
U.S. Bureau of Land Management
Denver, Colorado

Frederick M. Applehans, D.V.M
Harding Lawson Associates
Denver, Colorado

Roberta Ober
Rocky Mountain Arsenal
Commerce City, Colorado

ABSTRACT

The NCP requires assessment of ecological risks at Superfund sites. While the U.S. EPA has issued various ecological assessment guidance, it has not issued any toxicity factors for terrestrial wildlife. Toxicity factors are necessary for ecological assessment. The Toxicity Reference Value (TRV) approach is analogous to the reference dose for wildlife. TRVs were developed using acute-to-chronic extrapolation as well as species-to-species extrapolation using uncertainty factors derived from the literature.

INTRODUCTION

The purpose of this paper is to describe a usable and reliable method to derive nonhuman Toxicity Reference Values (TRVs) based on the derivation of a no-observed-adverse-effect level (NOAEL) through the consistent application of uncertainty factors that reflect various types of toxicity data sets (e.g., chronic/subchronic exposures, LD_{50} data, etc.) and similarly, consistent application of uncertainty factors related to phylogenetic differences. Where possible, toxicological effects were quantified to derive doses that are not expected to be harmful to nonhuman receptor populations or individuals of threatened or endangered species. The approach used in this section to estimate the effects of contaminants is intended to derive TRVs in a manner similar to that of the U.S. EPA reference dose.

The derivation of TRVs is considered an evolving process and subject to change as new information becomes available. Although a clear basis (i.e., explanation or definition) for the assignment of an uncertainty factor value may not be possible in all cases, the values selected were judged for reasonableness in relation to existing toxicological data.

TERRESTRIAL ORGANISMS

A satisfactory system was not identified in the literature for deriving uncertainty factors to be applied to the available toxicity data for birds, livestock, and terrestrial wildlife. However, several references (described below) did describe uncertainty associated with the extrapolation of aquatic toxicity data and offered guidance for possible mechanisms to arrive at uncertainty for terrestrial extrapolations.

The approach developed to derive TRVs for terrestrial nonhuman receptors is based on the method used by the U.S. EPA[1] in deriving human RfDs. The RfDs represent values protective of human health against systemic toxicity effects. The basic premise is that homeostatic, compensating, and adaptive mechanisms exist that must be overcome before a toxic end-point is manifested; thus, with systemic toxicity, there is a threshold effect. The RfD represents a benchmark dose operationally derived from a NOAEL by the consistent application of uncertainty factors that reflect various types of data sets used to estimate RfDs. Thus, to derive the RfD, the critical toxicity value from the literature is divided by a value representing the product of all uncertainty factors and modifying factors determined to be appropriate on the basis of the quality of the data used to arrive at the NOAEL.

The methodology for deriving TRVs observed similar concepts presented by the U.S. EPA in the RfD development. The resultant TRVs represent estimates of the daily dose in mg/kg/day to individual receptors within a population that are likely to be without an appreciable risk of deleterious effects to that population. If the receptor is an endangered species (e.g., bald eagle), an additional modifying factor is applied to these individual members of the animal population. This approach is similar to that used to derive a human RfD, where the RfD is routinely derived to protect the most sensitive subgroups of a population.

The derivation of a TRV for terrestrial organisms is a two-step process. First, a NOAEL is derived from an appropriate toxicity study through the application of an uncertainty factor, as depicted in Figure 1. Secondly, the NOAEL is modified to reflect uncertainty associated with phylogenetic effects. These steps are described below. The TRVs presented in Table 1 were derived for each species of concern for the sediment, soil, and surface water. The TRVs for cattle also include the groundwater pathway. The derived species-specific TRV for each contaminant was subsequently compared with the exposure intake developed in the exposure assessment to estimate the population hazard index.

Derivation of a NOAEL

The initial step in applying the TRV development process entails reviewing the available literature to ensure that all available data are considered during the development process. The resulting database is then searched to identify any data specific to species found at a site. If class-specific toxicity data for any of the target receptors are identified, the data are carried through the development of a NOAEL, as presented in Figure 1. The step-wise approach in Figure 1 indicates that the lowest uncertainty to derive a NOAEL is associated with a chronic NOEL or NOAEL, and the highest uncertainty is associated with an acute LD_{50} value. The primary variable considered was whether the study data represent a chronic, subchronic, or acute exposure. An uncertainty factor of 30 to 100 was applied to an acute value (including an LD_{50}) to equate it to a chronic exposure, and an uncertainty factor of 10 or 20 was applied to a subchronic exposure.

The greatest uncertainty in deriving a NOAEL from the available toxicity data is uncertainty associated with acute studies, particularly LD_{50} data. Layton and others[2] state that neither the LD_{50} nor the chronic NOEL should be considered as biological constants because both are subject to variations caused by inter- and intraspecies differences, as well as differences in test protocols and conditions.

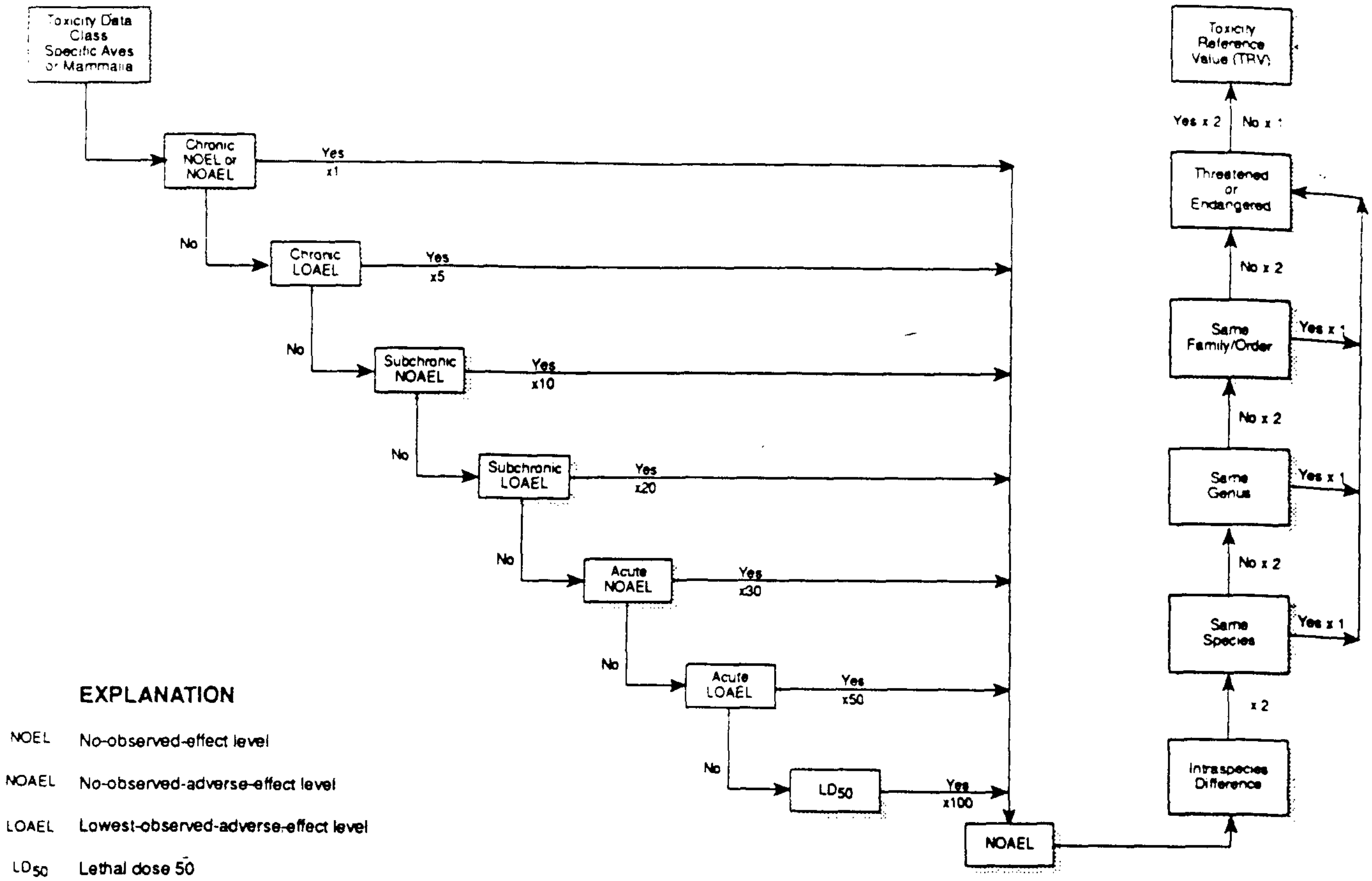

Figure 1
Methodology to Derive Toxicity Reference Values (TRVs)
from Class-Specific Toxicity Data

Frequently, LD_{50} data for specific chemicals are only specified by species, sex, and route of exposure, yet other intrinsic and extrinsic factors can influence an experimental animal's response to the test agent. These factors may include the animal's weight, age, and health status, as well as environmental conditions, such as diet, housing conditions, and ambient temperature. However, studies indicate that the actual variation in LD_{50} values for a given species is low, considering the various sources of uncertainty associated with lethal toxicities.[2] LD_{50} data are rarely, if ever, used to derive human RfDs.

Unfortunately, because of the shortage of chronic toxicity data for wildlife and livestock, ecological risk assessments must rely on acute studies to extrapolate to chronic effects in terrestrial biota. Therefore, an appropriate, but reasonable, level of uncertainty must be applied when deriving NOAELs from acute studies.

The uncertainty associated with extrapolation from acute LD_{50} studies to field conditions is further illustrated by comparing lethal concentration (e.g., LC_{50} data) with LD_{50} data. Wildlife are usually exposed to chemicals in food and drinking water, whereas laboratory animals used for oral LD_{50} studies are usually exposed to the chemical dissolved in a carrier substance and administered via gavage (stomach tube). Although both of these scenarios represent oral exposures, the LD_{50} studies are usually designed to promote maximum exposure (absorption) because less of the chemical is complexed with dietary material. Dietary (LC) studies may give a better indication of the real toxicity effects of the pesticides tested (i.e., in nature, the pesticide residues are likely to be associated with food items ingested).[3,4] However, there are inadequate numbers of these studies addressing the chemicals and target receptors in general, and the derivation of useful LC_{50}s from LD_{50} data is questionable.[5]

The use of LC_{50} and LD_{50} toxicity values to derive no-effect levels has precedent. The Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAM/CME) contains toxicological data for more than 400 substances. Using this model, hazard assessments for aquatic biota are conducted using LC_{50} and effective concentration (EC_{50}) data. A hazard value for each species group is derived by dividing the acute toxicity value by 100 to estimate a no-effect level. The NRDAM/CME approach assumes that the same dose-response relationship holds for all hazardous substances, and sources of uncertainty surrounding the hazard values are not addressed.[6] The application of an uncertainty factor of 100 to derive a NOAEL from an LD_{50} value as depicted in Figure 1 is supported by the NRDAM/CME approach.

Likewise, a Standard Evaluation Procedure (SEP) has been developed by the Office of Pesticide Programs, the U.S. EPA, for conducting ecological risk assessments to evaluate environmental toxicology and effects data submitted in support of pesticide registration.[6,7] The SEP approach is a modified quotient method (similar to the hazard index method used in this ecological assessment) in which estimated environmental concentrations are compared with environmental toxicity end-point values (regulatory risk criteria [RRCs]). Both aquatic and terrestrial receptors are addressed by this method. The assessments are focused at the population level; however, individual members of endangered species are considered by using a more stringent RRC.

For acute toxicity, the RRCs are equal to the LC_{50} or LD_{50} divided by a safety factor of 5, 10, or 20. According to the SEP, mortality of 0.1% is regarded as sufficiently protective of a population. For the typical (average) dose-response curve, a value one-fifth of the LC_{50} or LD_{50} corresponds to mortality in 0.1% of a population. Therefore, a safety factor of 5 is applied to the acute toxicity value to derive an RRC. An additional safety factor of 2 (total of 10) is used for aquatic species. An additional safety factor of 2 is applied if an endangered species might be at risk (total of 10 for terrestrial and 20 for aquatic endangered species).

Table 1
Toxicity References Values (TRV) for Avian and Terrestrial Vertebrate Species of Concern Identified at RMA

Chemical of Concern	Species of Concern	Study Type	Dose (mg/kg-bw/day)	Test Species	NOEL UF	Family/Order UF	Genus UF	Species UF	Intraspecies UF	T or E Species	Total UF	TRV (mg/kg-bw/day)
Arsenic	Mallard Duck	LOAEL	18.9	Duck	50	1	1	1	2	1	100	1.9E-01
Arsenic	Great Blue Heron	LOAEL	18.9	Duck	50	2	2	2	2	1	800	2.4E-02
Arsenic	Bald Eagle	LOAEL	18.9	Duck	50	2	2	2	2	2	1600	1.2E-02
Arsenic	Chicken	LOAEL	18.9	Duck	50	2	2	2	2	1	800	2.4E-02
Arsenic	Mouse	LD50	145	Mouse	250	2	2	2	2	1	4000	3.6E-02
Arsenic	Prairie Dog	LD50	145	Mouse	250	2	2	2	2	1	4000	3.6E-02
Arsenic	Cattle	LD	1.3	Cow	250	1	1	1	2	1	500	2.6E-03
Aldrin/Dieldrin	Mallard Duck	LOAEL	0.40	Duck	50	1	1	1	2	1	100	4.0E-03
Aldrin/Dieldrin	Great Blue Heron	LD50	9	Partridge	250	2	2	2	2	1	4000	2.3E-03
Aldrin/Dieldrin	Bald Eagle	LD50	9	Partridge	250	2	2	2	2	2	8000	1.1E-03
Aldrin/Dieldrin	Chicken	LD	0.52	Chicken	250	1	1	1	2	1	500	1.0E-03
Aldrin/Dieldrin	Mouse	LD50	43	Vole	250	2	2	2	2	1	4000	1.1E-02
Aldrin/Dieldrin	Prairie Dog	LD50	43	Vole	250	2	2	2	2	1	4000	1.1E-02
Aldrin/Dieldrin	Cattle	NOAEL	5	Cow	5	1	1	1	2	1	10	5.0E-01
Atrazine	Cattle	NOEL	10	Cow	1	1	1	1	2	1	2	5.0E+00
Benzene	Cattle	LOAEL	10	Rat	50	2	2	2	2	1	800	1.3E-02
Carbon tetrachloride	Cattle	LOAEL	20	Cow	50	1	1	1	2	1	100	2.0E-01
Chloroform	Cattle	NOEL	30	Rat	1	2	2	2	2	1	16	1.9E+00
Chlordane	Mallard Duck	LD50	1250	Duck	250	1	1	1	2	1	500	2.5E+00
Chlordane	Great Blue Heron	LD50	14.1	Quail	250	2	2	2	2	1	4000	3.5E-03
Chlordane	Bald Eagle	LD50	14.1	Quail	250	2	2	2	2	2	8000	1.8E-03
Chlordane	Chicken	LD50	14.1	Quail	250	2	2	2	2	1	4000	3.5E-03
Chlordane	Mouse	NOEL	1.2	Rat	5	2	2	2	2	1	80	1.5E-02
Chlordane	Prairie Dog	NOEL	1.2	Rat	5	2	2	2	2	1	80	1.5E-02
Chlordane	Cattle	NOEL	10	Cow	5	1	1	1	2	1	10	1.0E-00
Chlorobenzene	Cattle	NOEL	54.5	Dog	50	2	2	2	2	1	800	6.8E-02
CPMS	Cattle	LOAEL	14.1	Rat	50	2	2	2	2	1	800	1.8E-02
CPMSO	Cattle	LOAEL	14.1	Rat	50	2	2	2	2	1	800	1.8E-02
CPMSO2	Cattle	LOAEL	16.3	Rat	50	2	2	2	2	1	800	2.0E-02
Dichloroethene-1,2-	Cattle	LD50	670	RAT	250	2	2	2	2	1	4000	1.7E-01
DDE/DDT	Mallard Duck	LOAEL	4	Duck	50	1	1	1	2	1	100	4.0E-02
DDE/DDT	Great Blue Heron	NOEL	0.88	Quail	5	2	2	2	2	1	80	1.1E-02
DDE/DDT	Bald Eagle	NOEL	0.88	Quail	5	2	2	2	2	2	160	5.5E-03
DDE/DDT	Chicken	NOEL	0.88	Quail	5	2	2	2	2	1	80	1.1E-02
DDE/DDT	Mouse	LOAEL	35.7	Mouse	50	2	2	2	2	1	800	4.5E-02

Table 1: (Page 2 of 3)

Chemical of Concern	Species of Concern	Study Type	Dose (mg/kg-bw/day)	Test Species	NOEL UF	Family/Order UF	Genus UF	Species UF	Intraspecies UF	T or E Species	Total UF	TRV (mg/kg-bw/day)
DDE/DDT	Prairie Dog	LOAEL	12.1	Rat	50	2	2	2	2	1	800	1.5E-02
DDE/DDT	Cattle	LOAEL	12.1	Rat	50	2	2	2	2	1	800	1.5E-02
DIMP	Mallard Duck	LOAEL	410	Duck	50	1	1	1	2	1	100	4.1E+00
DIMP	Great Blue Heron	LOAEL	60	Quail	10	2	2	2	2	1	160	3.8E-01
DIMP	Bald Eagle	LOAEL	60	Quail	10	2	2	2	2	2	320	1.9E-01
DIMP	Chicken	LOAEL	60	Quail	10	2	2	2	2	1	160	3.8E-01
DIMP	Mouse	NOAEL	300	Mouse	2	2	2	2	2	1	32	9.4E+00
DIMP	Prairie Dog	NOEL	150	Rat	2	2	2	2	2	1	32	4.7E+00
DIMP	Cattle	NOEL	500	Cow	30	1	1	1	2	1	60	8.3E+00
Dibromochloropropane	Mallard Duck	LD50	66.8	Duck	250	1	1	1	2	1	500	1.3E-01
Dibromochloropropane	Great Blue Heron	LD50	66.8	Duck	250	2	2	2	2	1	4000	1.7E-02
Dibromochloropropane	Bald Eagle	LD50	66.8	Duck	250	2	2	2	2	2	8000	8.4E-03
Dibromochloropropane	Chicken	LD50	60	Chicken	250	1	1	1	2	1	500	1.2E-01
Dibromochloropropane	Mouse	NOEL	0.50	Rat	5	2	2	2	2	1	80	6.3E-03
Dibromochloropropane	Prairie Dog	NOEL	0.50	Rat	5	2	2	2	2	1	80	6.3E-03
Dibromochloropropane	Cattle	NOEL	0.50	Rat	5	2	2	2	2	1	80	6.3E-03
Dichlorobenzene, 1,3-	Cattle	LOEL	250	Rat	10	2	2	2	2	1	160	1.6E+00
Dicyclopentadiene	Mallard Duck	LD50	40000	Duck	250	1	1	1	2	1	500	8.0E+01
Dicyclopentadiene	Great Blue Heron	LD50	1010	BW Quail	250	2	2	2	2	1	4000	2.5E-01
Dicyclopentadiene	Bald Eagle	LD50	1010	BW Quail	250	2	2	2	2	2	8000	1.3E-01
Dicyclopentadiene	Chicken	LD50	1010	BW Quail	250	2	2	2	2	1	4000	2.5E-01
Dicyclopentadiene	Mouse	NOEL	32	Rat	1	2	2	2	2	1	16	2.0E+00
Dicyclopentadiene	Prairie Dog	NOEL	32	Rat	1	2	2	2	2	1	16	2.0E+00
Dicyclopentadiene	Cattle	LD50	1200	Cow	250	1	1	1	2	1	500	2.4E+00
Dithiane, 1,4-	Cattle	LOEL	105	Rat	50	2	2	2	2	1	800	1.3E-01
Endrin/Isodrin	Mallard Duck	NOAEL	0.30	Duck	10	1	1	1	2	1	20	1.5E-02
Endrin/Isodrin	Great Blue Heron	NOAEL	0.30	Duck	10	2	2	2	2	1	160	1.9E+03
Endrin/Isodrin	Bald Eagle	NOAEL	0.30	Duck	10	2	2	2	2	2	320	9.4E-04
Endrin/Isodrin	Chicken	LD	1.04	Chicken	250	1	1	1	2	1	500	2.1E-03
Endrin/Isodrin	Mouse	LOAEL	0.58	Mouse	50	2	2	2	2	1	800	7.3E-04
Endrin/Isodrin	Prairie Dog	LOAEL	0.58	Mouse	50	2	2	2	2	1	800	7.3E-04
Endrin/Isodrin	Cattle	LOAEL	0.05	Dog	50	2	2	2	2	1	800	6.3E-05
Ethylbenzene	Cattle	NOEL	97.1	Rat	5	2	2	2	2	1	80	1.2E+00
Fluoride	Mallard Duck	LOAEL	420	Duck	50	1	1	1	2	1	100	4.2E+00
Fluoride	Great Blue Heron	LOAEL	420	Duck	50	2	2	2	2	1	800	5.3E-01
Fluoride	Bald Eagle	LOAEL	420	Duck	50	2	2	2	2	2	1600	2.6E-01
Fluoride	Chicken	NOEL	28	Chicken	1	1	1	1	2	1	2	1.4E+01
Fluoride	Mouse	LOAEL	50	Rat	50	2	2	2	2	1	800	6.3E-02
Fluoride	Prairie Dog	LOAEL	50	Rat	50	2	2	2	2	1	800	6.3E-02
Fluoride	Cattle	NOAEL	0.60	Sheep	2	1	2	2	2	1	16	3.8E-02

Table 1: (Page 3 of 3)

Chemical of Concern	Species of Concern	Study Type	Dose (mg/kg-bw/day)	Test Species	NOEL UF	Family/Order UF	Genus UF	Species UF	Intraspecies UF	T or E Species	Total UF	TRV (mg/kg-bw/day)
Hexachlorocyclo-pentadiene	Cattle	LD50	113	Rat	250	2	2	2	2	1	4000	2.8E-02
Malathion	Cattle	NOEL	10	Cow	20	1	1	1	2	1	40	2.5E-01
Manganese	Cattle	NOEL	10	Cow	5	1	1	1	2	1	10	1.0E+00
Oxathiane, 1,4-	Cattle	LD50	3323	Rat	250	2	2	2	2	1	4000	8.3E-01
Sulfate	Mallard Duck	LOAEL	750	Fowl	10	2	2	2	2	1	160	4.7E+00
Sulfate	Great Blue Heron	LOAEL	750	Fowl	10	2	2	2	2	1	160	4.7E+00
Sulfate	Bald Eagle	LOAEL	750	Fowl	10	2	2	2	2	2	320	2.0E+00
Sulfate	Chicken	LOAEL	750	Fowl	10	2	2	2	2	1	160	4.7E+00
Sulfate	Mouse	LOAEL	750	Rat/Mice	10	2	2	2	2	1	160	4.7E+00
Sulfate	Prairie Dog	LOAEL	750	Rat/Mice	10	2	2	2	2	1	160	4.7E+00
Sulfate	Cattle	NOEL	130	Cow	5	1	1	1	2	1	10	1.3E+01
Trichloroethene	Cattle	LD50	5680	Dog	250	2	2	2	2	1	4000	1.4E+00
Tetrachloroethene	Cattle	LD50	8100	Mouse	250	2	2	2	2	1	4000	2.0E+00
Toluene	Cattle	NOAEL	422	Rat	2	2	2	2	2	1	32	1.3E+01
Xylene	Cattle	NOAEL	250	Rat	2	2	2	2	2	1	32	7.8E+00

LD = lethal dose
LD_{50} = lethal dose to 50 percent of test animal population
LOAEL = lowest-observed-adverse-effect level
LOEL = lowest-observed-effect level
NOAEL - no-observed-adverse-effect level
NOEL = no-observed-effect level
T or E = threatened or endangered
TRV = toxicity reference value
UF = uncertainty factor
mg/kg-bw/day = milligrams per kilogram-body weight per day

The total uncertainty associated with the SEP approach is intended to be applied to acute toxicity data (LC_{50} or LD_{50}) to extrapolate to acceptable concentrations for acute exposure scenarios. The SEP approach does not apply any safety (uncertainty) factors to chronic no-effect level toxicity values to account for uncertainty associated with laboratory-to-field extrapolations.[7] Although the SEP approach may not be fully protective for chronic exposure scenarios, it does support the application of smaller uncertainty factors to derive NOAELs from toxicity studies other than LD_{50}s.

Menzie and others,[8] when evaluating the potential of DDT intake and its metabolites (DDTR) for effects on bird survival, used the lowest NOAEL reported in the literature for DDTR (10 mg/kg) with no additional modifications by uncertainty factors. The high end of their toxicity range was estimated as one-tenth of the highest LC_{50} value reported for birds. Menzie and others report that this result is consistent with the application of uncertainty factors of 10 for deriving NOAEL values from LOAEL values.

The approach for this assessment uses an uncertainty range of 1 to 100 to derive a chronic NOAEL from toxicity study values other than LD_{50} studies (Figure 1). In this approach, additional uncertainty, based on phylogenetic effects, was applied to the derived NOAEL. A description of, and justification for, the phylogenetic effect uncertainties are described below.

Phylogenetic Differences

Phylogenetic differences applied to the extrapolation process are used to establish a comparison related to the separation of species. The assumption is that taxonomic similarity results in toxicological similarity and that a particular species response will be similar to that of congeneric species. Consequently, as the taxonomic similarity decreases, extrapolation uncertainty increases.[9]

A simple pragmatic test was used to arrive at the size of the uncertainty factor for each phylogenetic decision point in the TRV process. For example, there are potentially five decision points in the process (Figure 1) to derive TRVs from a NOAEL; if an uncertainty factor of 10 is applied to each decision point, extremely conservative estimates of uncertainty (100,000) would result. However, when a value of 2 is applied as an uncertainty factor to each appropriate, equally-weighted step in the decision process for the derivation of TRVs from a NOAEL derived from toxicity data, the result is an adequately represented uncertainty associated with the phylogenetic effects. In developing these uncertainty factors, it is imperative to remember that the values derived are not indicative of the potential toxicity of the contaminant being considered, but rather each value is a measure of the uncertainty associated with each of the variables involved in deriving a TRV for one species from toxicity data available for another species. The details of the development of specific TRVs and the scientific studies consulted for the justification of the uncertainty factors are described in greater detail in the following paragraphs.

The phylogenetic differences address the potential for dissimilarities as the taxonomic distance increases between the experimental animal and the target species. The concept of transphylogenetic similarities and differences was presented by Best[10] in presenting the potential use of planarians for toxicological evaluations.

The question of how much uncertainty to apply to the extrapolation process based on phylogenetic differences between test animal species and the target organism is open to debate based on the limited amount of knowledge that is currently available. Because it is not possible to test all wildlife species, particularly endangered species, it is necessary to identify surrogate species that are useful for answering problems of both acute and chronic toxicity. The open literature offers some guidance on the extrapolation of laboratory animal toxicity data to wildlife.[6,7,11-20]

Illustrating the phylogenetic differences in response to toxicants, a comparison of acute lethality values for the rat and bird (starling), starling, and red-winged blackbird, and mallard and bull frog, showed that the differences increased as the phylogenetic differences increased.[11] The starling was approximately five times more sensitive than the rats, the red-winged blackbird was more sensitive than the starling, and the bull frog-mallard comparison showed little predictive value. Toxicity effects can be found at all organizational levels: molecular, cellular, tissue, organ, and whole animal. Generally, the extent of phylogenetic variation increases from the molecular to the whole animal.[11]

Perhaps the best information on uncertainty related to taxonomic extrapolations is found in the aquatic literature. Suter and Rosen[16] summarized the freshwater and marine taxonomic extrapolations for LC_{50}s. From their study, the total uncertainty, at each taxonomic level, based on the n-weighed means of the 95% prediction intervals, progressively increased for freshwater and marine fish from the species level to the order level. The total uncertainties at the order level were 19 for marine fish and 22 for freshwater fish. The total uncertainty reported for marine crustaceans and freshwater arthropods was an order of magnitude higher, but fewer data were presented. The higher uncertainty for these organisms may be related to their more primitive evolutionary status.

Barnthouse and others[15] also summarized the n-weighed mean of 95% prediction intervals for taxonomic extrapolations of selected aquatic organisms. The uncertainty ranged from a geometric mean of 6 at the species level to a geometric mean of 20 at the order level (25 if a high anomalous value is included). Barnthouse and others[15] also determined the range of maximum amount of uncertainty required to permit extrapolation of different types of trifluralin toxicity data to obtain lifetime concentrations in water that would be protective of Gulf menhaden and Chesapeake striped bass. The different types of toxicity data used and the range of uncertainty included life-cycle tests using species of interest (1.7-3), life-cycle tests using nonspecies of interest (83-120), partial life-cycle tests using species of interest (50-53), partial life-cycle tests using nonspecies of interest (138-151), acute tests using species of interest (148-174), and acute tests using nonspecies of interest (282-417). These data are discussed further below.

The degree of extrapolation considered to be unacceptable for ecological risk assessment is the extrapolation across animal classes, i.e., extrapolation from mammalian to avian and vice versa. However, the extrapolation within class is acceptable, and the total uncertainty associated with the process can be reasonably derived and justified, although there is still some scientific uncertainty associated with the process.

Intraspecies Differences

Toxicity data collected from studies including male and female members of the same genus and species often demonstrate differences between the sexes. Cholakis and others[14] noted a two-fold sex difference when evaluating data from pesticide subacute toxicity feeding studies involving voles. Female voles were twice as sensitive as male voles to methyl parathion, and for pentachloronitrobenzene (PCNB), a fungicide, the male vole was twice as sensitive as the female vole. Cholakis and others[14] also noted a two-fold difference in sensitivity between two of the vole species tested.

It is generally accepted in the study of toxicology that difference in response can be influenced by the age of the animal.[21,22] Generally, the very young and older animals tend to be more susceptible to the toxic effects of chemicals. Although these differences are probably the result of different metabolic transformation processes in the animals, the effects associated with these differences should be treated above those associated at the genus/species level. Hence, an uncertainty factor of 2 was selected to address differences occurring at the intraspecies level. This uncertainty factor represents the minimum value applied to the NOAEL to derive a TRV.

Genus and Species Differences

The genus and species phylogenetic characteristics appear as separate decision points on the derivation scheme (Figure 1); however, for this discussion, they are considered as one decision point.

Although there is concern about the use of toxicity data gathered from laboratory animal species to extrapolate to wildlife species,[?] studies have revealed that laboratory rodents, when compared with their native wild counterparts, are generally more sensitive to the test chemicals.[12,14,17]

Because some laboratory animals tend to be more sensitive than wild species, toxicity data generated from experimental studies are appropriate to use, and, when adjusted with appropriate uncertainty factors, reasonable toxicity reference values may be determined. Cholakis and others[14] reported that laboratory rodents appeared to be more susceptible to 2,4-D, dieldrin, methyl parathion, parathion, propinal, and 2,4,5-T than voles. Cholakis and others[14] noted that laboratory rats were approximately 2 to 10 times more sensitive.

Perhaps one of the most important factors influencing interspecies/genus variation in susceptibility to toxicants is differential metabolism because of different enzyme systems and varying degrees of enzyme activity. For example, the mixed function oxidase (MFO) enzymes, which occur in several organ systems (especially the liver), transform lipid-soluble materials, like the organochlorine pesticides, to more polar molecules. The activity of these MFOs, as well as other metabolic enzymes, can vary greatly between the various animal species. Generally, the activities are highest in mammals and birds and decrease in lower life forms.[11,17]

Species variations in enzyme metabolizing chemicals have been reviewed and studied.[13,18-20] The relative concentrations of total cytochrome P-450 (a MFO) enzymes were determined for 11 animal species.[20] The study, reporting the results as a percentage of the value determined for rats, showed that of the livestock species tested, swine had the lowest concentration 52% and cattle had concentrations very similar to the rat >90%. Rabbits had 41% more P-450 than rats, but cats, dogs, and rainbow trout had approximately 35% less. The lowest concentrations were measured in the livers of quail and swine. The maximal difference in total cytochrome P-450 content was a three-fold variation between rabbits and quail. For 9 of the 11 species examined, the maximal difference was two-fold or less.

Because differential metabolism appears to be species-dependent, the approximate two- to three-fold difference in metabolic rates described above and the species sensitivity observations cited by Cholakis and others[14] support the uncertainty factor of 2 applied at these phylogenetic levels. Also, the total phylogenetic uncertainty at this point[8] is very close to that presented in the Suter and Rosen[16] and Barnthouse and others[15] papers, 6 to 7 and 6, respectively, for aquatic organisms.

Family/Order Differences

The next decision point (Figure 1) in the process to select uncertainty factors related to the phylogenetic effects is to determine whether the ecological receptor being considered is a member of the same family and/or order as the experimental test animal. A review of oral LD_{50} data depicted in Table 2[23] shows that the data for animals within the same family but of different orders (e.g., rat and mouse) differ by a factor of 1 to 4, thus supporting a reasonable uncertainty factor of 2 at this level of phylogenetic difference. The data are narrowly distributed between these two species for the organochlorine pesticides, the chemicals of primary importance because of their ability to bioaccumulate and biomagnify in the food chain. The volatile solvents, chloroform and carbon tetrachloride, differ the most between the rat and mouse; however, these chemicals are not likely to present long-term (chronic) concerns because they do not accumulate in tissues.

At the family/order level of phylogenetic effects, there may be some subtle influence from the trophic-level position coupled with the anatomical and physiological characteristics of the digestive systems of the animals. However, according to Stevens,[24] many of the digestive and absorptive processes are common to most species.

A comparison of LD_{50} data (Table 2) between rats (an omnivore) and rabbits (a herbivore), animals at slightly different trophic levels and having different digestive systems, shows that the data differ by a factor of 1 to 3. The rat and rabbit were chosen for comparison because more data are available on these species for comparison purposes. Dog (a carnivore) and rabbit data exist for a few of the OCPs (aldrin, dieldrin, and DDT) (Table 2), and again the difference between these two species is a factor of less than 2. These data also support the uncertainty factor of 2 applied at this level of phylogenetic difference. Although Table 2 also lists dog/rabbit data for 1,2-dichloroethane, the difference between the values (approximately a factor of 7) may not be significant because this compound is not expected to biomagnify like the organochlorine pesticides. The total uncertainty possible at this level, 16, is within the range reported by Suter and Rosen[16] and Barnthouse.[15] The antilog of the n-weighed mean of 95% prediction interval reported by Suter and Rosen[16] results in an uncertainty value of approximately 9 at the family level and approximately 20 at the order level for freshwater and marine fish. The geometric mean of the uncertainty values for the family and order levels reported in Barnthouse and others[15] results in similar values. Although these data were generated for aquatic extrapolations, they do tend to support the selection of an uncertainty factor of 2 for each decision point in the phylogenetic algorithm.

Threatened or Endangered Species

Because the bald eagle is protected under the Endangered Species Act, it was considered desirable to apply an additional level of uncertainty to protect individual members of the bald eagle population. The factor of 2 applied at this decision point to derive a TRV for the bald eagle is not a degree of uncertainty based in science because there is no empirical toxicological evidence that the bald eagle is at a greater risk to the chemicals than the other receptor organisms. Rather, this factor represents an adjustment, based on policy (an issue of social and political importance), to ensure protection of the species. The use of a factor of 2 is identical to that applied in the ecological risk assessment SEPs as developed by the U.S. Office of Pesticide Programs to protect threatened and endangered species.[5]

This factor was not applied to the TRV derivation process for animals covered by the Migratory Bird Treaty Act because the TRVs derived for these species were considered to provide sufficient protection based on professional scientific judgement.

UNCERTAINTIES

On initial inspection of the TRV derivation process, the use of an uncertainty factor of 2 to address uncertainty associated with each level of phylogenetic differences may appear to lack conservativeness. This concern is especially true when the traditional use of an uncertainty factor of 10 at each decision point in the derivation of human RfDs is considered. However, the reader is encouraged to focus on the overall (total) uncertainty associated with the NOAEL and phylogenetic differences calculated for each TRV. The individual and total uncertainty factors are depicted in Table 1 along with the final TRV.

The use of the number "10" to address safety (uncertainty) was initially proposed by Lehman and Fitzhugh when they introduced the concept of acceptable daily intake (ADI) in 1954 and presented a simple procedure to derive the ADI from toxicity data.[25] The ADI concept was intended to provide guidance for maximum allowable levels of contaminants in food items. To derive the ADI, Lehman and Fitzhugh proposed adjusting the selected toxicity data to a NOAEL through the application of safety factors, now referred to as uncertainty factors.

The first safety factor was selected to adjust for intraspecies variability. The downward adjustment of the NOAEL by an arbitrary factor of 10 was to account for the possibility that some members of the experimental animal population might be more sensitive to the toxic effect of the test chemical than had been the members of the relatively small test population.[25]

The second safety factor, an arbitrary factor of 10, was applied to adjust for the possible greater sensitivity among humans than had been observed among the test animal population. The factor was essentially an adjustment for interspecies variability on the basis of the conservative assumption that humans may be 10 times more susceptible to chemical toxicity than are laboratory animals.[26]

In 1954, when Lehman and Fitzhugh proposed this approach, a limited amount of data were available on the toxicity of many chemicals. The conservative approach using safety factors of 10 to extrapolate from laboratory animal data to humans probably was prudent.

Table 2
Nonprimate Mammalian Oral LD_{50} Data

Chemical Of Concern	Test Species	LD50[a]	Chemical Specific Uncertainty[b]
Aldrin	Rat	30	3
	Mouse	44	
	Rabbit	50	
	Hamster	100	
	Dog	65	
Arsenic	Rat	763	5
	Mouse	145	
Atrazine	Rat	672	2
	Mouse	850	
	Rabbit	750	
	Hamster	1000	
	Mammal	1400	
Benzene	Rat	930	5
	Mouse	4700	
Carbon tetrachloride	Rat	2350	4
	Mouse	8263	
	Rabbit	5760	
	G. pig	5760	
Chlordane	Rat	283	
Chlorobenzene	Rat	2290	1
	Mouse	2300	
	Rabbit	2250	
	G. pig	2250	
Chloroform	Rat	908	25
	Mouse	36	
	G. pig	820	
CPMS	Rat	400	2
	Mouse	672	
CPMSO	Rat	463	1
	Mouse	400	
$CPMSO_2$	Rat	400	2
	Mouse	606	
Dibromochloropropane	Rat	170	2
	Mouse	257	
	Rabbit	180	
	G. pig	150	
1,3-Dichlorobenzene	NA	NA	- NA
DDE	Rat	880	1
	Mouse	700	
DDT	Rat	87	3
	Mouse	135	
	Rabbit	250	
	G. pig	150	
	Dog	150	
	Mammal	200	
1,2-Dichloroethane	Rat	670	12
	Mouse	489	
	Rabbit	860	
	Dog	5700	
Dichlorocyclopentadi-ene	Rat	353	6
	Mouse	190	
	Cattle	1200	
Dieldrin	Rat	38	3
	Mouse	38	
	Rabbit	45	
	G. pig	49	
	Hamster	60	
	Dog	65	
	Pig	38	
	Mammal	25	
DIMP	Rat	826	2
	Mouse	1041	
	Cow	750	
	Mammal	503	
1,4-Dithiane	Rat	2768	
Endrin	Rat	3	5
	Mouse	1.4	
	Rabbit	7	
	G. pig	16	
	Hamster	10	
Ethylbenzene	Rat	3500	

Table 2
(continued)

Chemical Of Concern	Test Species	LD50[a]	Chemical Specific Uncertainty[b]
Isodrin	Rat	7	1
	Mouse	8.8	
	Mammal	7	
Malathion	Rat	290	11
	Mouse	190	
	Rabbit	250	
	G. pig	570	
	Cow	53	
	Goat/sheep	500	
	Mammal	500	
Manganese	Rat	9000	
1,4-Oxathiane	Rat	2830	
Tetrachloroethene	Mouse	8100	
Toluene	Rat	5000	
Trichloroethene	Mouse	2402	
Xylene	Rat	4300	

Source: RTECS, 1991

[a] Values shown in milligrams per kilogram (mg/kg)
[b] Ratio of highest LD50 divided by lowest LD50 for each chemical of concern (COC)

NA = not applicable

Lewis and others[25] present an argument for reducing the amount of uncertainty applied to a NOAEL to derive a reference dose (the replacement for ADI). Basically, the current uncertainty factors of 10 are retained as default adjustment factor values; however, depending on criteria set forth in the article, Lewis has allowed for greater flexibility in modifying the adjustment factors to values less than 10, typically 2 or 3, and in some cases, less than 1. Lewis has included a series of factors to adjust for data quality and a nonscientific, judgmental safety factor (i.e., social or political value) that may take a value from 1 to 10. Following this approach, an aggregate adjustment (uncertainty) of approximately 250 is typical and, as the authors state, "approaching the practical maximum."

The total uncertainty applied to the derivation of the TRV associated with phylogenetic effects can be further supported by an examination of available nonprimate mammalian oral LD_{50} data (Table 2). When the highest LD_{50} value for a specific chemical is divided by the lowest LD_{50} value for the same chemical, regardless of species, a chemical-specific uncertainty ratio can be obtained (Table 2). This chemical-specific uncertainty ratio encompasses the variations in toxicity responses resulting from the phylogenetic differences described above (i.e., family, order, genus, and species).

For the chemicals that have sufficient data to evaluate, the uncertainty ratios range from 1 to 25. Eliminating these two extreme values, the remaining data have a median value of 3 and a geometric mean of 3. These values are below the theoretical maximum of 16 (excluding the multiple of 2 for threatened and endangered species) for the total uncertainty associated with phylogenetic difference for the TRV approach. Also, the theoretical maximum uncertainty of 16 is near the values reported by Suter and Rosen[16] and Barnthouse[15] at the order taxonomic level for the extrapolation of acute toxicity data. These data indicate that the uncertainty applied to the phylogenetic differences is sufficient and the resulting TRV is adequate to protect the ecological receptors.

The total TRV uncertainty (NOAEL uncertainty multiplied by phylogenetic uncertainty) ranges from 2 to 3200 (Table 1). Most of the TRVs have uncertainty factors of 1 to 3 orders of magnitude representing a 16- to 3200-uncertainty factor, even greater than that proposed by Lamb and Kenaga[12] to be applied to acute toxicity data.

Although independent validation of the TRV process with actual field and receptor-specific data would be ideal, the reasonable conservativeness of the derived TRVs can be supported by the following example. A recent study on dieldrin toxicity to mallard ducklings reported a NOAEL of 0.08 mg/kg/day.[26] Using this value as the initial dose in the TRV process, a final TRV of 0.04 mg/kg-bw/day is derived. However, using a dieldrin LOAEL (less desirable) dose of 0.40 mg/kg/day for the mallard, the resulting TRV is 0.01 mg/kg-bw/day because of the greater uncertainty associated with the LOAEL. Although the range of these values differs by a factor of 4, the difference is less than an order of magnitude, and the difference is not likely to be toxicologically significant.

In summary, the TRVs represent dose values that are sufficiently conservative and thus are expected to be protective of ecological receptors.

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