DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 49TH FIGHTER WING (ACC)
HOLLOMAN AIR FORCE BASE, NEW MEXICO

8 JAN 1998

MEMORANDUM FOR NEW MEXICO ENVIRONMENT DEPARTMENT
Attn: Mr. Cornelius Amindyas
Hazardous and Radioactive Materials Bureau
2044 Galisteo
P.O. Box 26110
Santa Fe NM 87502

FROM: 49 CES/CEVR
550 Tabosa Avenue
Holloman AFB NM 88330-8458

SUBJECT: Submittal of 20,000 Pound Open Detonation Unit (ODU) Background Study and Quarterly Monitoring Report

1. Attached are the 20,000 pound ODU *Program Overview, Background Study* and the 3rd Quarter 1997 *First Quarterly Monitoring Report* (Atchs 1, 2 and 3, respectively). The program overview contains a synopsis of the background study and quarterly monitoring report requirements per New Mexico Environment Department (NMED) RCRA Permit for Open Detonation Treatment Unit, EPA Number NM6572124422. The background study meets the permit requirement to establish site specific naturally-occurring levels of metals and anthropomorphic levels of explosives. The quarterly monitoring report contains the results of soil sampling following a detonation. These results where then compared to background levels and risk-based levels. Results from the analysis show that the ODU is effectively treating material and residual soil contaminants are below risk-based action levels.

2. The NMED RCRA permit states, "The permittee shall carry out quarterly soil sampling within 72 hours after the last quarterly Open Detonation event." Initially, the 2nd Quarter 1997 sampling was scheduled to occur following the 27 June 1997 detonation event. However, due to an unavoidable schedule change, this event was postponed to July 1997. Per directive from NMED, Holloman AFB (HAFB) was to sample the next scheduled detonation event and use the results for the 2nd Quarter 1997 monitoring report. The next scheduled detonation event occurred 21 July 1997, but was the only event during the 3rd Quarter 1997. Therefore, HAFB used this event for the 3rd Quarter 1997 reporting requirements and was forced to deviate from the RCRA permit by not sampling the ODU soil during the 2nd Quarter 1997.

3. The detonation event corresponding to the 3rd Quarter 1997 *First Quarterly Monitoring Report* was performed on 21 July 97. The soil sampling for the quarterly monitoring report occurred the day after the detonation, 22 July 97. All permit conditions related to the soil sampling and analysis were met for the quarterly monitoring report.

4. There were no scheduled detonation events at the 20,000 pound ODU during the 4th quarter of 1997 and, therefore, no sampling occurred.

5. If you have any questions or require additional information, please contact Drew Lessard at (505) 475-5177.

HOWARD E. MOFFITT
Deputy Base Civil Engineer

Attachments:
1. Program Overview
2. Background Study
3. First Quarterly Monitoring Report

cc w/o Atch:
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Virginia

Background Study and Quarterly Monitoring Reports

20,000-Pound Open Detonation Unit

49th FIGHTER WING

49 CES/CEV
Holloman Air Force Base,
New Mexico

Part I—Program Overview

20,000-Pound Open Detonation Unit
Background Study and Quarterly Monitoring Program

Final

Prepared for:

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December 1997

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LIST OF ACRONYMS

ACC................. Air Combat Command
AFB .... Air Force Base
ASTM.............. American Society for Testing and Materials
bgs .... below ground surface
CFR .... *Code of Federal Regulations*
EOD................. explosive ordnance disposal
EPA .... Environmental Protection Agency
GIS .... geographic information system
GPS .... global positioning system
HHSs .... human health standards
HMX Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
IRP................... Installation Restoration Program
MS .... matrix spike
MSD .... matrix spike duplicate
NB .... nitrobenzene
NG .... nitroglycerin
NMED............. New Mexico Environment Department
NM WQCC ..... New Mexico Water Quality Control Commission
NT .... nitrotoluene
OD .... open detonation
PETN............... pentaerythritol tetranitrate
PRG .... preliminary remediation goal
QA/QC .... quality assurance/quality control
QC .... quality control
RBC .... risk-based concentration
RCRA.............. Resource Conservation and Recovery Act
RDX Hexahydro-1,3,5-trinitro-1,3,5-triazine
SWMUs........... solid waste management units
TDS .... total dissolved solids
UTL................. upper tolerance limit

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1.0 Report Organization and Content

This document presents information on the development, implementation, and results of background sampling and quarterly monitoring for the 20,000-Pound Open Detonation (OD) Unit at Holloman Air Force Base (AFB). This section provides an overview of the document and includes a description of Parts I, II, and III.

1.1 Document Structure

The document is organized so that information regarding the entire program is contained in this bound report, Part I. Part I provides an overview of the site description, regulatory history, technical approach, and sampling and analysis requirements for the background study and quarterly monitoring reports.

The issues discussed in this document are common to all sampling and analysis issues required by the Resource Conservation and Recovery Act (RCRA) operating permit for the 20,000-Pound OD Unit. Subsequent bound "Parts" will be stand alone and will not cover these same issues unless changes occur to the program. This format was selected to streamline reporting and to create a "living" document. The living portion of the document will be the subsequent quarterly monitoring results that will be added over time.

Information specific to the background study is included in the separately bound *Part II: Background Study*. Information specific to quarterly monitoring is included in separately bound *Part III: Quarterly Monitoring Reports*.

Following each future quarterly sampling event, a bound report will be prepared that will summarize the results of the sampling event and discuss any trends to date. As each quarterly monitoring report is received, it should be placed behind the tab titled "Part III" in the 3-ring binder.

All bound Parts related to the background study and quarterly monitoring sampling events will be located in one binder so that data for the entire 20,000-Pound OD Unit Monitoring Program is readily available and in one location.

1.2 Overview of *Part II: Background Study*

Part II: Background Study contains a separately bound report presenting the results of the background study. The report provides details about the field operations, quality assurance/quality control (QA/QC) findings, analytical results, and a discussion of the results. Appendices to the report include laboratory analytical reports and chain-of-custody forms.

1.3 Overview of *Part III: Quarterly Monitoring Reports*

Part III: Quarterly Monitoring Reports contains separately bound monitoring reports, each presenting the results of an individual sampling event. Each report contains a detailed description of field operations, QA/QC findings, and analytical results of quarterly monitoring.

In addition, the results from each quarterly event are compared to previous sampling events and the findings of the background study. The report presents an analysis of data trends and conclusions based on findings of the quarterly monitoring events to date. Appendices to each report include laboratory analytical and statistical reports and chain-of-custody forms.

2.0 Site Description

Holloman AFB is located in Otero County in south-central New Mexico, 7 miles west of Alamogordo and adjacent to White Sands Missile Range. Figure 2-1 shows the location of the 20,000-Pound OD Unit on the

Base, as well as the location of other Solid Waste Management Units (SWMUs) and Installation Restoration Program (IRP) sites.

Within the 20,000-Pound OD Unit, the upper zone of the soil to a depth of about 10 ft is an eolian-type deposit of light tan, yellowish tan, and light brown fine-grained sand. Topographic maps of the area indicate that the 20,000-Pound OD Unit is located in relatively flat terrain and not within the 100-year floodplain boundaries. No surface water of constant flow conditions is located in the area, although nearby arroyos contain runoff.

The uppermost saturated zone beneath the 20,000-Pound OD Unit ranges from 27 to 31 ft below ground surface (bgs). On the basis of New Mexico Water Quality Control Commission Regulations (NM WQCC 82-1, as amended through 18 August 1991, Parts 3-100 through 3-103), the groundwater beneath Holloman AFB is designated as unfit for human consumption because it exceeds New Mexico human health standards (HHSs) for total dissolved solids (TDS) and sulfate. Currently, there are no potable supplies of ground or surface water located on Base. The nearest production well downgradient of Holloman AFB is a livestock well located 3.5 miles west of the Base (Radian, 1995).

3.0 Regulatory History

The primary Air Force Materiel Command component located at Holloman AFB is the 46th Test Group, which is responsible for evaluation of propulsion and navigational systems for aircraft, space vehicles, and missiles. As a result of Air Combat Command (ACC) readiness requirements and the 46th Test Group activities, a variety of ordnance, munitions, incendiaries, and propellants have become waste because they exceed their intended shelf-life, deteriorate, or fail to attain specifications that render them non-serviceable.

These waste ordnances are considered characteristically hazardous under RCRA due to reactivity (D003) or ignitability (D001). Rocket motors that exceed 300 pounds are treated at the 20,000-Pound OD Unit. This unit is operated in accordance with 40 CFR Part 264, Subpart X §264.600. Holloman AFB received a RCRA operating permit for this unit in late February 1997.

As a condition of the RCRA operating permit, quarterly monitoring of the surface soils within the 20,000-Pound OD Unit will be conducted to confirm that residual waste constituents are not contaminating soils above risk-based levels or background concentrations.

4.0 Technical Approach

The monitoring program consists of 1) a background study and 2) quarterly monitoring. These are explained below.

4.1 Overview of Background Study

The background study defined naturally-occurring or anthropomorphic levels of constituents (e.g., metals and explosives, respectively) in the soil surrounding the 20,000-Pound OD Unit. From this data, Upper Tolerance Limits (UTLs) were calculated to represent background concentrations. The data collected during the background study for the 20,000-Pound OD Unit supplement existing data collected for the Base-wide background study which is documented in the *Phase I—Groundwater Assessment Monitoring Report* (Radian, 1993).

Six background samples were obtained at a distance between 600 ft and 750 ft from the edge of the 20,000-Pound OD Unit in soils of similar lithology. Detailed information about the approach for and results of the background study are included in *Part II: Background Study.*

These site-specific background levels are used to distinguish between site-related constituent levels (i.e., based on data from the quarterly monitoring) and background UTLs. Table 4-1 lists the UTLs resulting from the site-specific background study.

Base-wide background UTLs are also included in Table 4-1 as a reference only. The Base-wide background UTLs are not used to assess the data gathered during the quarterly monitoring events.

4.2 Overview of Quarterly Monitoring

The 20,000-Pound OD Unit is sampled quarterly to monitor the effectiveness of treatment and the impact of the treatment process on the soils. A summary of the requirements for quarterly monitoring follows in Section 5 of this report.

4.3 Assessment Approach

To assess the impact of OD treatment operations on soils at the 20,000-Pound OD Unit, the quarterly monitoring results will first be compared to the site-specific background UTLs. If any of the constituent concentrations in the quarterly monitoring data exceed background UTLs, a risk-based screen will be performed for those constituents. These decision criteria adhere to the methodology presented on page 33 in Attachment J of the operating permit.

In the event that quarterly sampling results exceed risk-based concentrations, the sampling point will be immediately resampled to confirm the presence of contamination. If an exceedance of risk-based concentrations is confirmed, such an occurrence will be noted, NMED will be duly notified in writing, and a report describing the occurrence will be submitted to NMED within seven days of the sample confirmation. Subsequent actions may include a more detailed evaluation of risk or excavation and disposal of the contaminated soil. These actions will be coordinated with the NMED.

4.4 Overview of Risk-based Screen

The risk-based screen provides a conservative estimate of the potential health risks to site workers from exposure to constituents present in soils at the 20,000-Pound OD Unit.

Rather than design a site-specific exposure scenario, the comparison is based upon an established exposure scenario outlined in the current version of the *EPA Region III Risk-based Concentration (RBC) Table* (EPA, 1997).

Typical exposure at the 20,000-Pound OD Unit is far less than the industrial exposure scenario upon which the screening levels are based. Access is closely controlled to ensure that unauthorized personnel do not have access to the facility. Table 4-2 provides a comparison of the exposure scenario used for the Region III industrial RBCs and the estimated exposure scenario at the 20,000-Pound OD Unit. The exposure scenario for the 20,000-Pound OD Unit is based on explosive ordnance disposal (EOD) personnel working at the site during a detonation.

The estimate assumes that ten detonations are performed each year and that personnel are at the site for two days during each detonation. It also assumes that the same person attends all detonations for five years. This is highly unlikely, but it provides a conservative estimate for comparison.

The Region III industrial RBCs are used in all cases when available. However, when no Region III RBC is available, EPA Region IX Preliminary Remediation Goals (PRGs) may be used. The PRGs are similar to RBCs but are promulgated by EPA Region IX.

Table 4-1
Summary of Upper Tolerance Limits

Analyte	Units	Upper Tolerance Limit	Base-wide UTLs[1]
Antimony	mg/kg	3.5279	7.2844
Arsenic	mg/kg	1.4963	36.8833
Barium	mg/kg	79.4971	84.3632
Beryllium	mg/kg	0.42	0.4000
Cadmium	mg/kg	0.5417	1.0359
Chromium (total)	mg/kg	9.5027	6.6049
Copper	mg/kg	9.1595	4.8438
Lead	mg/kg	7.6508	--
Nickel	mg/kg	6.5898	5.6125
Selenium	mg/kg	2.2645	10.5310
Silver	mg/kg	0.7328	0.7342
Mercury	mg/kg	0.0269	--
Nitroglycerin	μg/kg	93.6772	NA
PETN	μg/kg	61.3	NA

[1] These UTLs are based upon the normal distribution for all constituents.

Table 4-2
Comparison of Exposure Scenarios

Parameter	Industrial RBCs	Estimated OD Unit Exposure
Exposure frequency	250 days/year	20 days/year
Exposure duration	25 years	5 years
Fraction from contaminated source	0.5	0.5

5.0 Quarterly Monitoring Approach

For the purposes of quarterly monitoring, the 20,000-Pound OD Unit is defined as four distinct horizontal strata. Each stratum represents a distinct area in which the soils would be affected similarly by treatment activities. Table 5-1 describes each stratum, the expected distribution of potential residuals, the number of discrete samples to be collected, and the rationale for the chosen sampling depths. The strata are shown in a cross-sectional view in Figure 5-1. The following section provides a summary of the details found in the *20,000-Pound Open Detonation Unit Background Study and Quarterly Monitoring Work Plan* (Radian, 1997).

5.1 Wind Direction Considerations

Because of prevailing wind direction, higher concentrations of residual constituents could exist in a downwind direction. To compensate for this possibility, the prevailing wind direction will be noted for each detonation period. It is assumed that the area 45° on either side of the prevailing wind direction at the time of detonation could be the most affected.

Therefore, samples for Strata B and C will be collected in this area to produce a more conservative estimate of residual concentrations in the soil. Because multiple detonation events may occur between sampling events, wind direction from all detonation events prior to sampling will be considered.

5.2 Grid Development

Prior to the sampling event, the detonation center from the most recent detonation event will be located. The detonation center will be used to determine the exact position of the three strata for that sampling event. Using the dimensions of the strata, a grid will be placed across each of the strata.

The grid will be of sufficient spacing so that each stratum includes four to six times as many potential sampling locations as the number of samples to be collected (four per strata). Each grid node will then be numbered sequentially from left to right and north to south.

To determine the location of each sample, a random number will be generated from 0 to 1. The random number will then be scaled to the range of possible grid nodes. The result rounded to the nearest integer will be the grid location to be sampled. Figure 5-2 illustrates an example of a grid and sampling locations.

5.3 Procedures

The sampling procedures presented in this section will be used for both background and quarterly sampling. These procedures are taken from the *Work Plan* (Radian, 1997). The number of samples required is presented in Table 5-2.

5.3.1 Required Sampling Equipment

Required sampling equipment includes a hand-powered soil auger for excavation, containers consisting of 100- to 500-mL glass bottles, plastic caps, a small stainless steel or Teflon®-lined trowel, small stainless steel or Teflon®-lined spatulas, scoops and/or spoons, and adhesive labels for sample identification.

5.3.2 Sample Collection Procedures

Sampling procedures will be performed in accordance with American Society for Testing and Materials (ASTM) D 1452, "Standard Practice for Soil Investigation and Sampling by Auger Borings," where applicable.

For quarterly sampling in Strata A and B and background sampling, samples will be collected by initially advancing the hand auger the length of the bucket (approximately 3 to 6 in.) into the soil. The sample will be removed from the auger and placed in a stainless steel bowl. The auger will then be inserted back into the hole and advanced. This procedure will be repeated until the desired depth for the stratum has been reached.

Table 5-1
Sample Location Descriptions and Rationale

Strata	Strata Definition	Expected Distribution of Potential Detonation Residuals	Sample Type/Location	Basis for Sampling Strategy	Number of Samples per Sampling Event
A	The depression left by the detonation, regardless of the size of the depression. Stratum includes the walls of the depression.	Stratum will include fallout from the most recent detonation. Soil and residuals will be substantially thicker in the detonation center than at outlying areas.	Four discrete surface samples composited from a depth of 0 to 12 in. Each sample selected randomly from a predetermined grid across the depression (that includes the sides).	Samples from the pit at the center of the detonation to assess levels of chemical residues. The estimated thickness of fallout in the depression is 12 inches.	4
B	From the edge of the depression left by the detonation to the 100-ft-diameter area where detonations occur.	Previous detonations may have occurred in this area. Soil will include fallout from the most recent detonation as well as homogenized surface soils from previous detonation events and grading. A moderately thick layer of fallout is expected due to the proximity to the detonation center.	Four discrete, near-surface samples composited from a depth of 0 to 2 ft. Each sample selected randomly from a predetermined grid.	Composite samples collected to a depth of approximately 2 ft, compositing the entire interval. Samples are intended to gauge potential contamination from fallout and reworked soil from grading activities and filled-in pits.	4
C	100-ft detonation area to edge of the OD Unit.	No detonations occur in this area. Soil may reflect only a thin layer of fallout material.	Four discrete surface samples from 0 to 2 in. Each sample selected randomly from a predetermined grid.	Composite samples to detect residuals from fallout. Two inches is the maximum anticipated depth of fallout in this stratum.	4
D	150 ft outside of OD Unit boundary.	Minimal to low possibility of stratum being affected.	No sampling planned.	To be determined if sampling becomes required in future.	0
Total					12

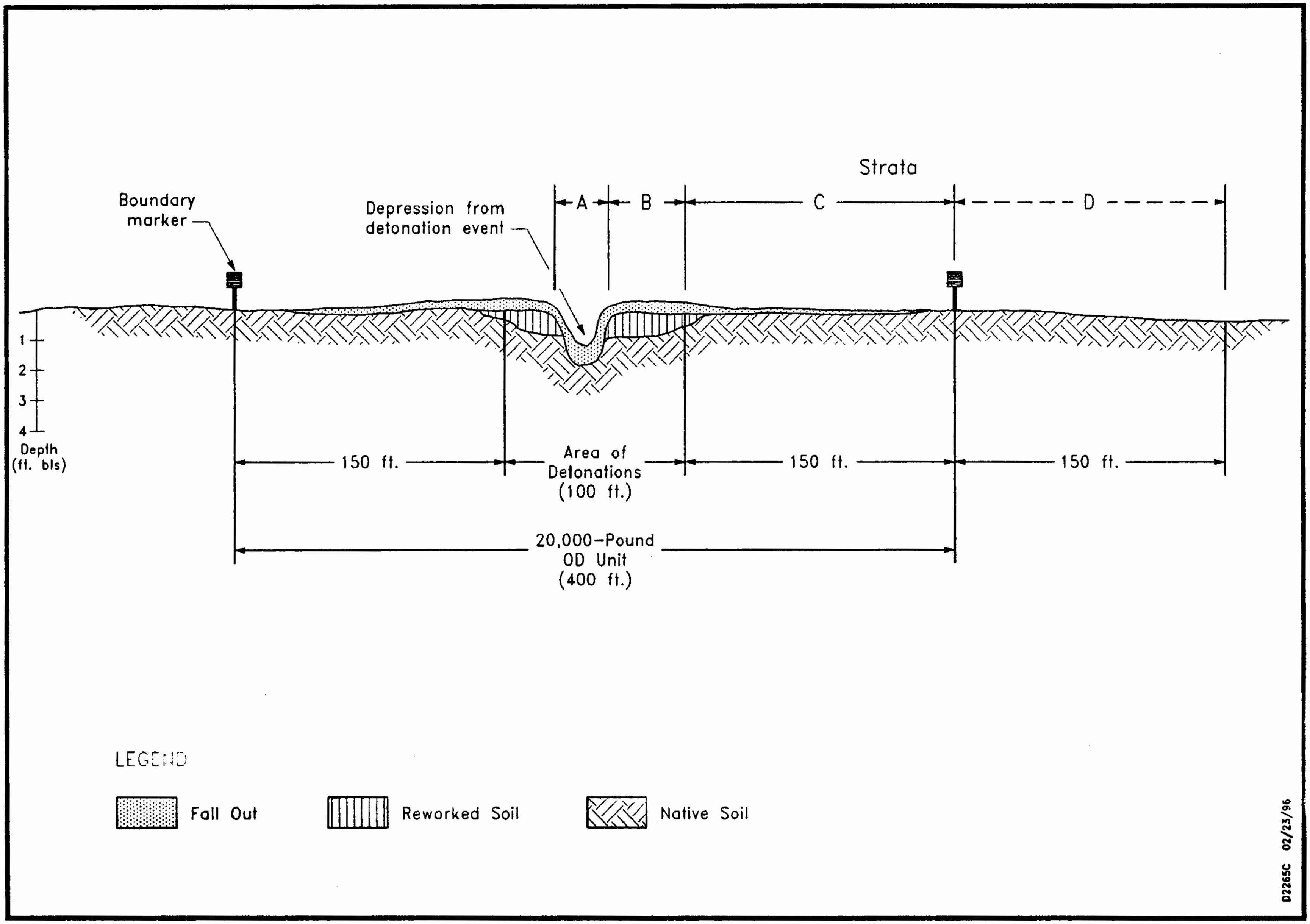

Figure 5-1. Cross-Sectional View of 20,000-Pound OD Unit and Strata

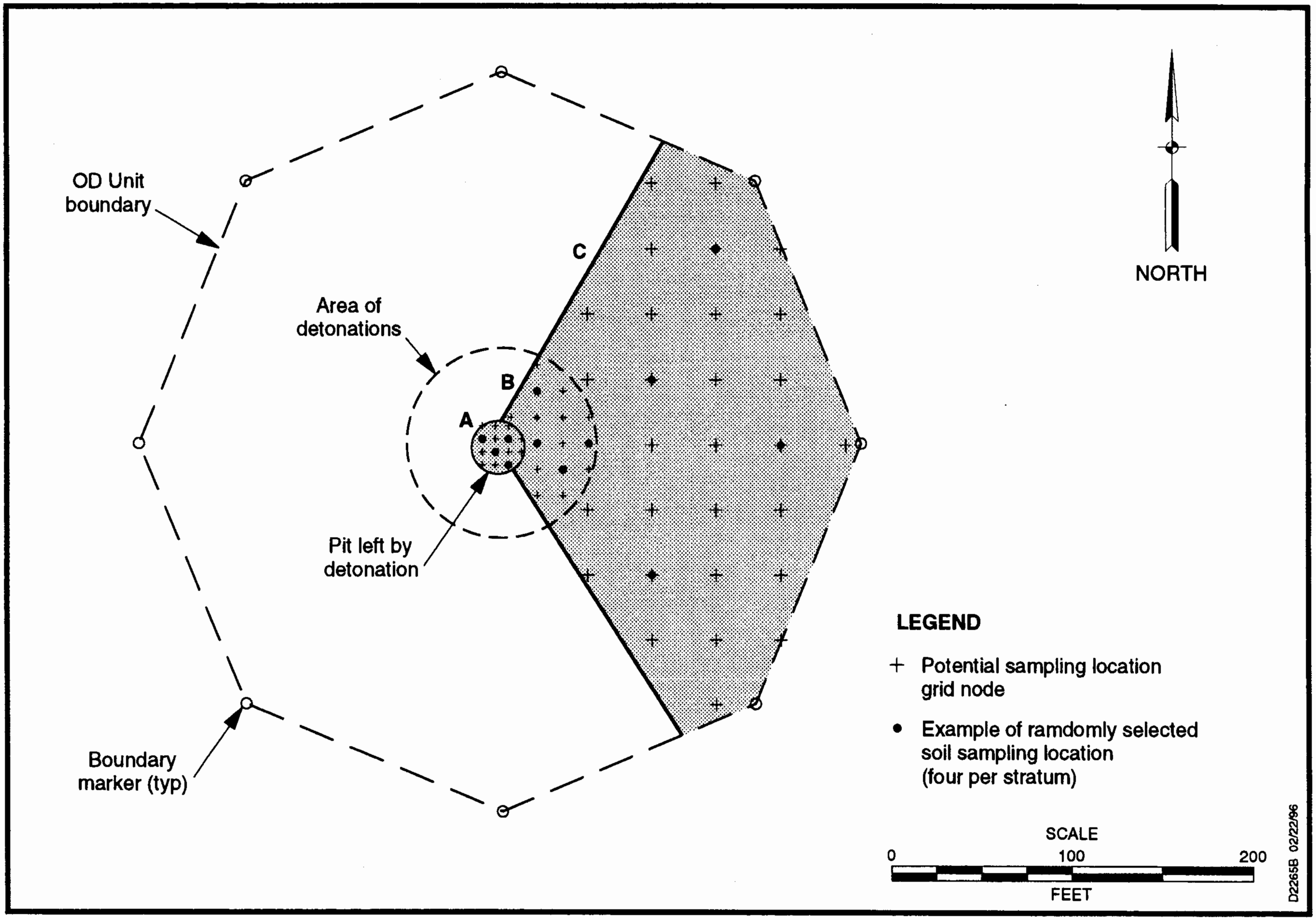

Figure 5-2. Sampling Strata and Potential Random Sampling Locations

Table 5-2
Laboratory Analytical Requirements

Analyses	Field Samples	Duplicates	Equipment Blanks	MS/MSD	Total Samples
Background Sampling					
SW-846 8330 Explosives	6	1	1	1/1	7
SW-846 8332 PETN and NG	6	1	1	1/1	7
SW-846 6010A Total Metals	6	1	1	1/1	9
SW-846 7471A Mercury	6	1	1	1/1	9
ASTM D2216 Percent Moisture	6	1	1	0	7
Analyses	**Field Samples**	**Duplicates**	**Equipment Blanks**	**MS/MSD**	**Total Samples**
Quarterly Sampling					
SW-846 8330 Explosives	12	1	1	1/1	13
SW-846 8332 PETN and NG	12	1	1	1/1	13
SW-846 6010A Total Metals	12	1	1	1/1	15
SW-846 7471A Mercury	12	1	1	1/1	15
ASTM D2216 Percent Moisture	12	1	1	0	13

NG = Nitroglycerin
PETN = Pentaerythritol tetranitrate

For Stratum C, where the desired sampling depth is 0 to 2 in., the auger will be advanced only 2 in. into the soil. To fill the required sample containers, additional soil may need to be obtained adjacent to the original sampling location.

At this point, the collected soil will be homogenized in the bowl using the spatulas or spoons described above. Appropriate quantities of the soil will be transferred to the sample containers for analysis. Decontaminated sampling equipment will be used at each sampling location. Appropriate sampling information and observations about the sample location will be recorded in the field logbook.

At the completion of the background sampling and each round of quarterly sampling, all sampling locations will be recorded on a site map, taped into a bound sampling log, and loaded into the existing Base Geographic Information System (GIS). All sampling locations (i.e., background, first quarter) will be located using the Global Positioning System (GPS) during the second quarterly monitoring event.

5.3.3 Sample Preservation and Shipping

Samples will be collected in precleaned sampling containers and will be kept cold during transportation and shipping. Table 5-3 summarizes the containers, preservatives, and holding time requirements for the samples to be collected.

At the end of each sampling day, samples will be packaged in shipping containers with double-bagged ice packs to maintain a temperature of less than 4°C. The samples will be carefully packaged so that they will not break during shipping, and the package will contain absorbent material capable of containing all liquid. Each shipping container will be sealed with custody seals and shipped to the analytical laboratory by an overnight delivery service.

5.3.4 Chemical Analyses

Soil samples will be analyzed for toxic metals, including priority pollutant metals (listed in the New Mexico Hazardous Waste Management Regulations-7, Part V, Appendix IX), explosive residues, and soil moisture. Table 5-3 lists all analytes that will be measured, along with their EPA SW-846 test method.

The analytical test methods listed in Table 5-3 were selected based on knowledge of the 20,000-Pound OD Unit's operational history. Holloman AFB has never been used for the research and development of nuclear, chemical warfare, or other exotic warfare types of weapons. The 20,000-Pound OD Unit is used solely for the disposal/treatment of conventional waste-ordnance, munitions, incendiaries, single- and double-based propellants, and rocket motors. The only munitions delivered or disposed of at Holloman AFB have been conventional live and training munitions. The chemical components and combustion by-products are consistent with what is typical for military munitions items; thus, the focus of sampling and analysis for the 20,000-Pound OD Unit is for only the constituents present in these types of wastes.

5.3.5 Quality Control Samples

Field quality control (QC) samples include duplicates, equipment blanks, and matrix spike/matrix spike duplicate (MS/MSD) pairs. (Refer to Table 5-4 for an explanation of the field QC requirements and procedures.) Because no volatile or semivolatile constituents are present at the site, trip blanks would not yield useful QC data and, therefore, will not be collected.

Table 5-3
Summary of Requirements for Sample Containers, Preservatives, and Holding Times for Soil Samples

SW 846 Method	Analyte	Container	Preservative	Holding Time
6010	Metals (As, Sb, Ba, Be, Cd, Cr, Cu, Pb, Ni, Ag, Se)	250-mL wide-mouthed glass or plastic jar	None, cool, 4°C	Six months for digestion and analysis except for mercury, which must be digested and analyzed in 28 days
7471	Mercury (Hg)			
8330	Explosive residues HMX RDX 1,3,5-TNB 1,3-DNB Tetryl NB 2,4,6-TNT 2,4-DNT 2,6-DNT 2-NT 3-NT 4-NT	500-mL wide-mouthed glass jar with Teflon-lined cap	None, cool, 4°C	Fourteen days to extraction, 40 days after extraction
8332	PETN and NG			

Table 5-4
QC Sample Requirements

Sample Type	Frequency[a]	Purpose	Method
Field Duplicate	10%[b]	Ensure sampling procedures are reproducible and that the sample is representative of the location.	Collect twice the normally required sample volume. Split the sample into two aliquots. Treat each portion as if it were a separate sample, and submit each for analysis.[c]
Equipment Blank	5%	Ensure that proper decontamination, sample collection, handling, transportation, and storage procedures were used.	Distilled water is poured over decontaminated sampling equipment into a sample container.
MS/MSD	5% or minimum 1 per sampling event	Assess the efficiency of extraction, accuracy of the analysis, and possible matrix effects. The MSD assesses the precision at known concentrations.	Collect twice the normally required sample volume and specify MS/MSD analysis at laboratory.

[a] Standard rounding conventions will be used. For example, 10% of 14 samples equals 1 field duplicate; 10% of 15 samples equals 2 field duplicates, and so on.
[b] Location will be selected from one of the three strata. A different location and stratum will be selected for each sampling event.
[c] Analytical methods, sample container requirements, and holding times are listed in Table 5-3.

6.0 References

1. ASTM D 1452. "Standard Practice for Soil Investigation and Sampling by Auger Borings."

2. EPA, 1997. *EPA Region III Risk-based Concentration Table.*

3. Radian, 1993. *Phase 1—Groundwater Assessment Monitoring Report.*

4. Radian, 1995. *20,000-Pound Open Detonation Unit RCRA Part B Permit Application.*

5. Radian, 1997. *20,000-Pound Open Detonation Unit Background Study and Quarterly Monitoring Work Plan.*

Headquarters, Air Combat Command
Langley Air Force Base,
Virginia

Final

Background Study
20,000-Pound Open Detonation Unit

December 1997

49th FIGHTER WING

49 CES/CEV
Holloman Air Force Base,
New Mexico

Part II—Background Study

20,000-Pound Open Detonation Unit

Final

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December 1997

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LIST OF ACRONYMS

AFB .... Air Force Base

ASTM............. American Society for Testing and Materials

CERCLA .... Comprehensive Environmental Response, Compensation, and Liability Act

EPA .... Environmental Protection Agency

ND .... non-detect

OD .... open detonation

PETN............... pentaerythritol tetranitrate

QA .... quality assurance

QAPP............... quality assurance project plan

QA/QC .... quality assurance/quality control

QC .... quality control

RCRA .... Resource Conservation and Recovery Act

UCL................. upper confidence limit

UTL .... upper tolerance limit

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1.0 Introduction

The operating permit for the 20,000-Pound OD Unit requires Holloman AFB to perform a site-specific background study to establish naturally-occurring and anthropomorphic levels of constituents (i.e., metals and explosives) surrounding the 20,000-Pound OD Unit. This report presents the results of the study and describes the field activities, statistical analyses, and sample quality assurance/quality control (QA/QC) results. The report also presents the potential uses and limitations of these data.

1.1 Objectives

The objectives of this study were to:

- Collect samples that represent typical background concentrations of metals and explosives in soils surrounding the 20,000-Pound OD Unit;
- Develop summary statistics that represent these background constituent levels; and
- Present guidance for the use of these summary statistics.

1.2 Scope of Study

To meet the objectives of this study, the following activities were implemented:

- Sampling of the soil surrounding the 20,000-Pound OD Unit in areas unaffected by historical treatment operations;
- An evaluation of potential interference during performance of analytical methods; and
- Statistical analysis of measurements of metals and explosives in soil samples to develop summary statistics [i.e., Upper Tolerance Limits (UTLs)] to represent background concentrations.

1.3 Field Activities

Field sampling for the background study was conducted on 22 July 1997. Six soil samples were obtained at a distance between 600 and 750 ft from the boundary of the 20,000-Pound OD Unit. Sampling locations are illustrated in Figure 1-1.

Samples were collected by advancing a hand auger from 0 to 6 inches below the surface of the soil. Soil from the hand auger was placed in a stainless steel bowl and homogenized with a stainless steel spoon. The soil was then placed in sealed containers and shipped in coolers containing double-bagged ice to the laboratory. All sampling equipment was decontaminated before sampling at each location.

Analytical results of background samples are presented in Appendix A. Samples were labeled using the following numbering sequence: HOL20K-BK-0x-y1,

where:

x = **sample number**—These are illustrated in Figure 1-1.

y = **sample type**—The number 0 indicates a normal sample, 1 indicates a duplicate.

1.4 Report Contents

The remainder of this report contains an evaluation of analytical chemistry methods for measuring concentrations of metals and explosives in soil, methods used to conduct statistical tests, statistical results including UTLs, and overall conclusions.

2.0 Quality Assurance Overview

The quality control (QC) data for the analytical measurement data were reviewed to determine the usability and defensibility of the chemical measurement data for the 20,000-Pound OD Unit background study. The review focused on field and laboratory blanks, matrix spikes, surrogate recoveries, and laboratory control samples. Overall, QC data associated with this program indicate that measurement data are acceptable and defensible. The data indicate that the QC mechanisms were effective in ensuring

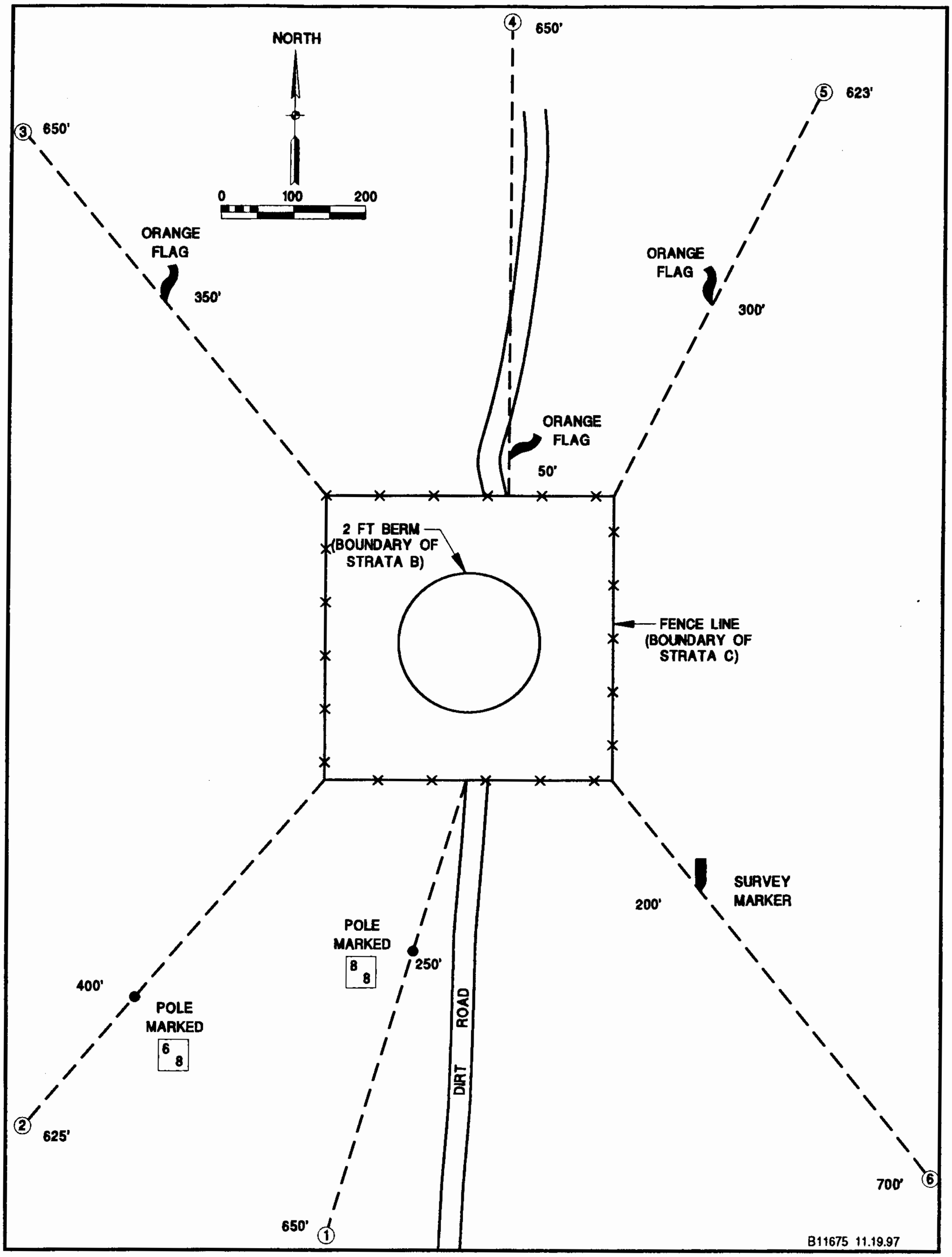


Figure 1-1. Background Sampling Locations

measurement data reliability within the expected limits of sampling and analytical error.

3.0 Statistical Methodology

The primary objective of the background study was to obtain information about concentrations of metal and explosive constituents in background soils for the 20,000-Pound OD Unit at Holloman AFB. Estimates of background concentrations can then be used for comparison with data collected during monitoring investigations to help distinguish between naturally-occurring constituent concentrations and elevated concentrations that may be attributable to contamination.

The data reduction approach for each of these objectives follows U.S. EPA guidance for Resource Conservation and Recovery Act (RCRA), and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) activities, especially as related to human-health risk assessments. This approach, shown in Figure 3-1, was chosen to ensure that the data analysis used and the decisions made can support future risk assessment activities where appropriate.

This section presents the results of background sampling. To assist in the statistical analysis of analytical results, data was reported "uncensored." This reporting convention is explained in Section 3.1. Section 3.2 provides the data analysis approach and results. Finally, a discussion of how this background data can be used in future studies is given in Section 3.3.

3.1 Uncensored Data

An important consideration in the analysis of background data is the specification of an uncensored data reporting convention for sample and blank results. Often, numerical measurement results below a specified concentration are reported with a qualitative descriptor such as "not detected" or "less than" rather than as a numerical value. This practice, called censoring, complicates statistical analysis and data interpretation because an important part of the information about measurement variability is unavailable for consideration. Traditionally, proxy concentrations must be assigned to these censored results for statistical analyses. The use of proxy concentrations (e.g., one-half the detection limit) for these qualitative results introduces another source of uncertainty in estimates derived from censored data sets.

A better approach is to use the uncensored data generated by the analytical laboratory and prevent the need for proxy concentrations based on arbitrary algorithms (EPA 1992a and Gilbert, 1987). While these measurements below the detection limit may not indicate the presence of target constituents as reliably as measurements above the detection limit, the uncensored measurement is a better estimate of the concentration than any proxy concentration and will allow a better characterization of site conditions for data users and decision makers.

Uncensored data were used for this study to preserve all available information in the data and thus more accurately estimate the variability of background measurements. They include all instrument response values; numerical results are never cut off ("censored") at some pre-established value (i.e., instrument detection limits, project-required reporting limit, etc.). For some analytical procedures (e.g., inorganic methods) there is always an instrument response and sometimes the instrument response, calibrated to a negative result. A negative uncensored value does not indicate a negative concentration (a physical impossibility). For practical application, negative analytical results (and calculated statistics, including upper tolerance limits or UTLs) can be interpreted as results that are at, or very near, a concentration of zero. Because of differences in methodology, negative values are not reported for organic analytical procedures.

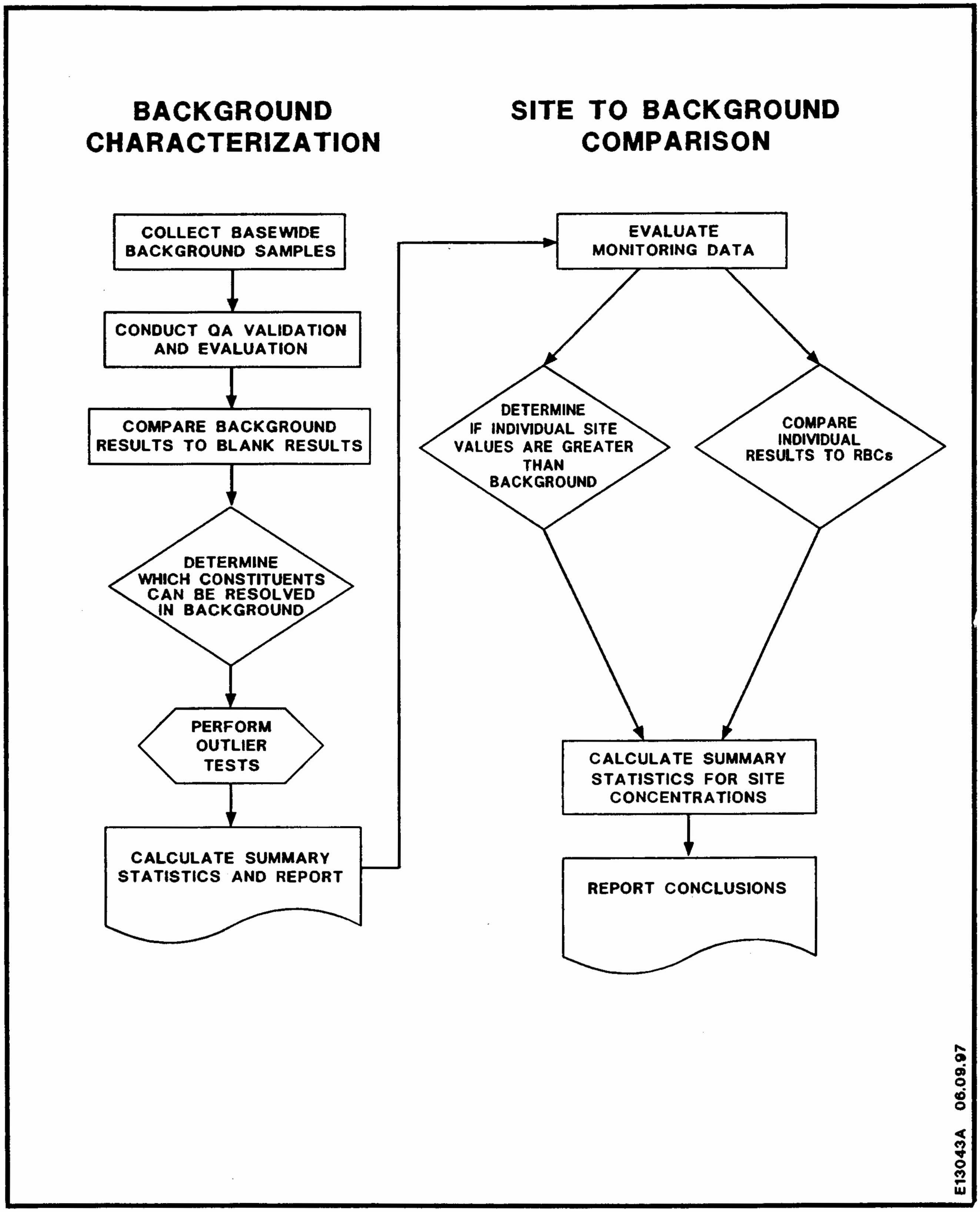


Figure 3-1. Data Reduction Approach

Data from these procedures are reported as non-detect (ND) when there is no measurable instrument response. For statistical calculations, proxy concentrations will be calculated for ND results using random uniform numbers between zero and the detection limit or the lowest (below detection limit) result reported.

The use of uncensored analytical results (including negative results) in statistical calculations contributes to more accurate characterization of conditions than the use of proxy concentrations (e.g., one-half of the detection limit, etc.). Calculations that are made using censored data bias the mean and the standard error of the data set because information about variability is lost. (See ASTM D-44210-89 for further discussion on this topic.)

3.2 Data Analysis Approach

The data analysis approach consisted of the following steps:

- Evaluated whether background concentrations could be distinguished from blank concentrations (i.e., determine whether measured background results are due to sampling and analytical noise only);
- Identified potential outliers;
- Determined the statistical distribution of background concentrations for each constituent; and
- Calculated summary statistics (e.g., UTLs, means, medians, etc.) that can be used in comparisons with site results and to describe the background results.

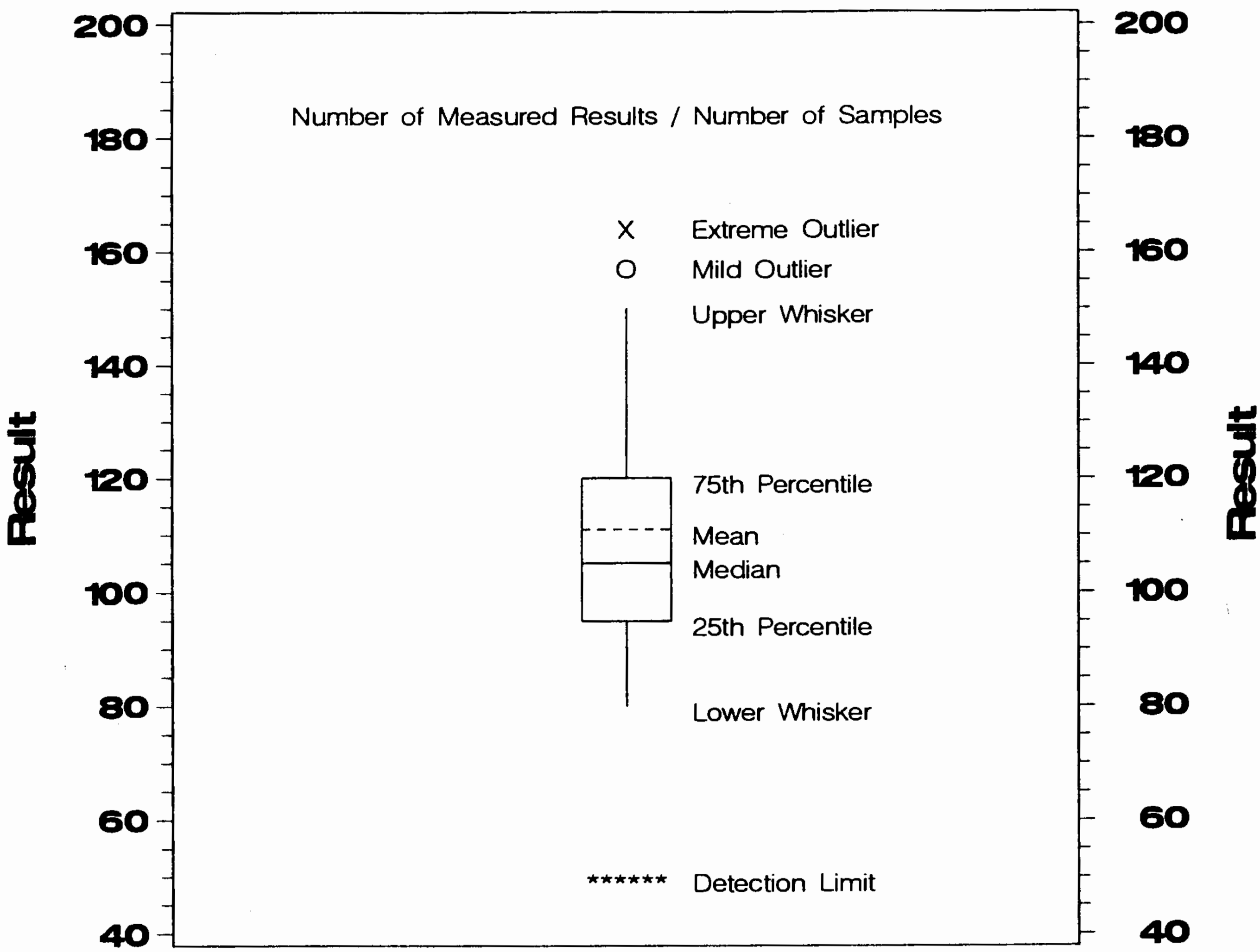
Descriptions of these steps in the data analysis process follow.

Comparison of Background Results and Blank Results—All data generated during the background sampling efforts were validated to ensure that they were of known and sufficient quality to characterize background concentrations. This validation was described in Section 2.0. The QA/QC results report that is provided to the Base provides a detailed description of validation procedures and results. As part of this validation, background sample results were compared with the results of laboratory and field blank sample results to determine whether naturally-occurring concentrations could be resolved, given the allowable field and analytical system noise. If a background sample result fell within the blank sample result noise, it was assigned a "B" flag.

Decisions on which samples were B-flagged were made using the "5x10x" rule. If a constituent was detected in a blank, then the same constituent was B-flagged in associated background samples if it was measured at a concentration less than five times the concentration in the blank. For common laboratory contaminants, this limit is ten times the concentration in the blank.

After the necessary background results were B-flagged, it was possible to determine which constituents, if any, could be resolved in background. This would be the case if all background results for a given constituent were B-flagged (considered to fall within the blank sample result noise). This situation did not occur (all constituents with measurable background results had at least one result which was not B-flagged). This indicates that the analytical methods were sensitive enough to resolve naturally-occurring concentrations.

To aid in the visual interpretation of the comparison between background and blank results, box plots were developed for each constituent's method blank, equipment blank, and background data. Box plots are useful graphical tools for displaying the central tendency and variability of data distributions. Figure 3-2 shows an example box plot that identifies and defines statistics given in a box plot. In Figure 3-2, the bottom and top of the box are the 25th and 75th percentiles of the data, respectively; the bottom and the top of the



IQR = Interquartile Range = 75th Percentile — 25th Percentile
Mild Outlier = result greater than 75th Percentile + (1.5 x IQR)
or result less than 25th Percentile — (1.5 x IQR)
Extreme Outlier = result greater than 75th Percentile + (3 x IQR)
or result less than 25th Percentile — (3 x IQR)
Lower Whisker = greater of the minimum and the (25th Percentile — 1.5 x IQR)
Upper Whisker = lesser of the maximum and the (75th Percentile + 1.5 x IQR)

Figure 3-2. Example Box Plot

vertical lines extending from the box are the lower and upper whiskers of the data, respectively. The solid horizontal line contained within the box is the median (the 50th percentile); and, the dashed horizontal line is the mean. The sample size is also identified at the top of each box plot.

The lower whisker on the box plot is the greater of the minimum detected result and the difference between the 25th percentile and 1.5 times the interquartile range. (The interquartile range is the 75th percentile minus the 25th percentile.) The upper whisker is the lesser of the maximum detected result and the sum of the 75th percentile and 1.5 times the interquartile range. Overlaid on the box plots are horizontal stars indicating the median reported detection limit. Finally, an "o" on the box plot indicates a statistical outlier that is above the top of the box or below the bottom of the box by a distance greater than 1.5 times the interquartile range. An "x" on the box plot indicates a statistical outlier that is above the top of the box or below the bottom of the box by a distance greater than 3.0 times the interquartile range (i.e., a larger outlier than an "o").

Although B-flagging of the background data is based upon comparison to the laboratory blank concentration and field blank results, the side-by-side box plots, presented in Appendix B, afford the opportunity for a visual interpretation of the results. Figure 3-3 presents two situations that illustrate how box plots can provide additional useful information. As shown in the first set of box plots in Figure 3-3, the background sample results, with the exception of two outliers, fall mostly within blank noise (the results overlap considerably). The second set of box plots shown in Figure 3-3 illustrates a case where the background sample results are clearly distinguishable from the blank results. In this case, the lower range of the background sample results is larger then the upper range of the blank results.

Outlier Testing—Potential outliers can be identified using the methodology employed in the construction of box plots. Using this approach, the only possible outliers identified were for PETN for which only two of six samples had measurable results (while the other four were ND). With this sparcity of detected results, it is inappropriate to make conclusions on outliers. Thus for the background data set from the 20,000-Pound OD Unit, no credible outliers were identified.

Determination of the Statistical Distribution for Background Concentrations for Each Constituent—The distribution of background data for each matrix and constituent was determined by performing appropriate statistical analyses.

The Shapiro-Wilk W-test was used for determining how background data were distributed (Shapiro and Wilk, 1965). The Shapiro-Wilk test was performed first on the raw data to test if the data followed a normal distribution. A p-value greater than 0.05 indicates that the hypothesis of normality cannot be rejected. If the data were not normally distributed, then the Shapiro-Wilk test was performed on the natural logarithms of the data to test for lognormality. A p-value greater than 0.05 for the lognormal Shapiro-Wilk test indicates that the hypothesis of lognormality cannot be rejected. Table 3-1 presents the results of the Shapiro-Wilk test for constituents at the 20,000-Pound OD Unit.

In Table 3-1, the other summary statistics are presented (i.e., the mean, median, skewness, and kurtosis) to provide information on why the data were or were not normally distributed. For data sets that are normally distributed, the mean and median tend to be close together. As the data set becomes further skewed to the right, the mean becomes increasingly larger than the median. Skewness and kurtosis describe further departures from normality. Skewness is characterized by a lack

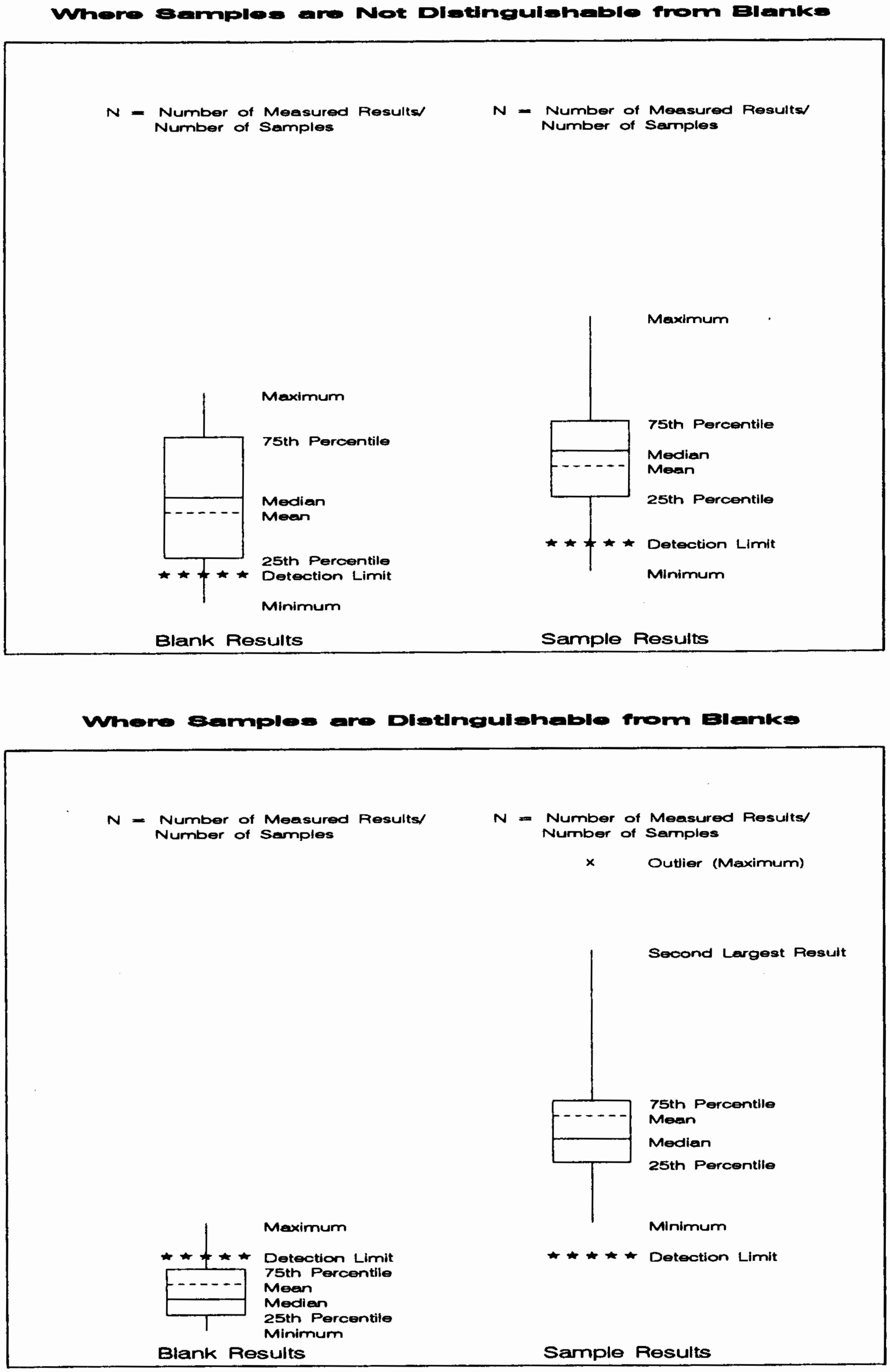


Figure 3-3. How to Distinguish Between Blank Results and Background Sample Results

Table 3-1
Distributional Test Results for Background Soils

Analytical Method	Analyte	Summary Statistics						Conclusion to Distributional Tests		
		Units	Sample Size	Mean	Median	Skewness	Kurtosis	P-value for Shapiro-Wilk Normal Test	P-value for Shapiro-Wilk Lognormal Test	Distribution of Background Data
SW6010	Antimony	mg/kg	6	0.0068	0.1335	-0.4305	-1.4091	0.6923	0.5401	Normal
SW6010	Arsenic	mg/kg	6	-0.3113	-0.367	0.7628	0.2979	0.8046	NC	Normal
SW6010	Barium	mg/kg	6	51.1	50	0.3795	-2.0022	0.227	0.2161	Normal
SW6010	Beryllium	mg/kg	6	0.1538	0.2134	-0.1974	-2.8623	0.0329	0.0001	Nonparametric
SW6010	Cadmium	mg/kg	6	0.1342	0.0905	0.7222	-1.8091	0.1377	0.6625	Normal
SW6010	Chromium (total)	mg/kg	6	5.0983	5.19	0.5479	0.1267	0.6733	0.7602	Normal
SW6010	Copper	mg/kg	6	3.9817	3.555	1.1715	0.6842	0.2457	0.4413	Normal
SW6010	Lead	mg/kg	6	3.6767	3.62	0.2885	-1.8424	0.3656	0.3881	Normal
SW6010	Nickel	mg/kg	6	3.86	4.02	-0.1271	-1.1328	0.7036	0.5967	Normal
SW6010	Selenium	mg/kg	6	-0.9758	-1.0005	0.6708	0.7566	0.8704	NC	Normal
SW6010	Silver	mg/kg	6	0.04	0.1025	-0.6685	-1.6407	0.1469	0.0072	Normal
SW7471	Mercury	mg/kg	6	0.0147	0.0153	-0.6225	-0.4216	0.8398	0.5861	Normal
SW8332	Nitroglycerin	µg/kg	6	22.1395	19.9393	0.219	-2.5654	0.1455	0.1945	Normal
SW8332	PETN	µg/kg	6	28.3691	24.3192	0.6283	-0.6989	0.677	0.7187	Nonparametric

NC = Not Calculated. Lognormal test cannot be performed with negative results.

of symmetry in the data distribution. The skewness is close to zero for normal populations. The skewness is positive for populations with a positive skewness in which the upper tail is the extended one. The skewness is negative for populations with a negative skewness in which the lower tail is the extended one. Finally, the kurtosis is a measure of the heaviness of the tail of a distribution. Normal populations have a kurtosis close to zero, long-tailed distributions show positive kurtosis, and flat-topped distributions show negative kurtosis.

Calculation of Upper Tolerance Limits and Summary Statistics—Table 3-2 presents summary statistics for constituents at the 20,000-Pound OD Unit. This table includes the following statistics: sample size, minimum, maximum, mean, one-sided 95% upper confidence limit (UCL) for the mean, median, and UTL. Calculated UTLs are presented for those instances in which decisions must be made on the basis of a comparison of individual site sample results to background. UTLs from the Base-wide Background Study (which is part of the *Phase 1—Groundwater Assessment Monitoring Report*, Radian, 1993) are provided for reference only. Base-wide background UTLs are not used to assess the data gathered during the quarterly monitoring results.

Results of the Shapiro-Wilk tests (shown in Table 3-2) were used to determine whether parametric or nonparametric statistical methods were most appropriate for calculating the UTLs. Parametric methods were used when the data were shown to follow a normal or lognormal distribution. For background soils, no constituent data followed a lognormal distribution. Nonparametric methods were used for those constituents whose data did not fit a normal distribution. Nonparametric methods are not based on the assumption of normality and are sometimes referred to as distribution-free methods. Parametric methods offer the advantage of achieving greater statistical certainty using smaller numbers of samples than required for corresponding nonparametric methods. Both the parametric UTLs (U.S. EPA, 1992b) and the nonparametric UTLs (Conover, 1980) were calculated at the 95% confidence level.

The decision tree for calculating background UTLs is provided in Figure 3-4. It shows the flow of decisions to be made based on the frequency of detections and Shapiro-Wilk results for each constituent. The frequency of detections is the percentage of samples for which a measured result was available (as opposed to results reported as ND). The UTLs were calculated as follows:

For data sets that were normally distributed, UTLs were calculated using the following equation:

$$UTL = \bar{x} + (K \times s)$$

where:

$\bar{x}$ is the estimated sample mean;

K is the tolerance factor; and

s is the estimated sample standard deviation.

Normal UTLs were calculated for the 95th percentile with a 95% confidence level.

No data sets for the 20,000-Pound OD Unit background data were lognormally distributed; therefore, no lognormal UTLs were calculated.

For data sets that were neither normally nor lognormally distributed, nonparametric UTLs were calculated. (Nonparametric UTLs were also calculated when the number of samples was fewer than five or the frequency of detections was less than 50%). A nonparametric UTL is simply the maximum reported value (if there are fewer than 60 samples), and is the second, third, fourth, and so on, largest reported value for greater numbers of samples. Coverage for nonparametric UTLs, however, is a function of the sample size and may be less than the coverage of 95% used for the normal or lognormal UTLs.

Table 3-2
Summary Statistics for Background Soils

Analytical Method	Analyte	Summary Statistics							Tolerance Limits			Base-wide Background Study UTLs[2]
		Units	Sample Size	Minimum	Maximum	Mean	One-sided 95% UCL for Mean[1]	Median	Tolerance Type	Upper Tolerance Limit	Coverage %	
SW6010	Antimony	mg/kg	6	-1.37	1.05	0.0068	0.7881	0.1335	Normal	3.5279	95	7.2844
SW6010	Arsenic	mg/kg	6	-0.859	0.487	-0.3113	0.0898	-0.367	Normal	1.4963	95	36.8833
SW6010	Barium	mg/kg	6	43.6	61.9	51.1	57.4006	50	Normal	79.4971	95	84.3632
SW6010	Beryllium	mg/kg	6	-0.17	0.42	0.1538	0.3949	0.2134	Nonparametric	0.42	61	0.4000
SW6010	Cadmium	mg/kg	6	0.0266	0.283	0.1342	0.2246	0.0905	Normal	0.5417	95	1.0359
SW6010	Chromium (total)	mg/kg	6	3.73	7	5.0983	6.0755	5.19	Normal	9.5027	95	6.6049
SW6010	Copper	mg/kg	6	2.78	6.38	3.9817	5.1305	3.555	Normal	9.1595	95	4.8438
SW6010	Lead	mg/kg	6	2.47	5.18	3.6767	4.5584	3.62	Normal	7.6508	95	--
SW6010	Nickel	mg/kg	6	2.91	4.86	3.86	4.4657	4.02	Normal	6.5898	95	5.6125
SW6010	Selenium	mg/kg	6	-2.05	0.464	-0.9758	-0.2569	-1.0005	Normal	2.2645	95	10.5310
SW6010	Silver	mg/kg	6	-0.231	0.201	0.04	0.1937	0.1025	Normal	0.7328	95	0.7342
SW7471	Mercury	mg/kg	6	0.00951	0.0185	0.0147	0.0174	0.0153	Normal	0.0269	95	--
SW8332	Nitroglycerin	µg/kg	6	32.7	47.1	22.1395	38.0119	19.9393	Normal	93.6772	95	NA
SW8332	PETN	µg/kg	6	45.6	61.3	28.3691	46.0836	24.3192	Nonparametric	61.3	61	NA

[1] These UCLs are based upon the normal distribution for all constituents.

[2] These UTLs were taken from Table 3-7, Upper Tolerance Limit and Warning Limit Soil, in the *Phase 1—Groundwater Assessment Monitoring Report* (Radian, 1993). Note that analytical methods were different for some constituents. Method numbers are found in the Base-wide Background Study.

NA = Not Available

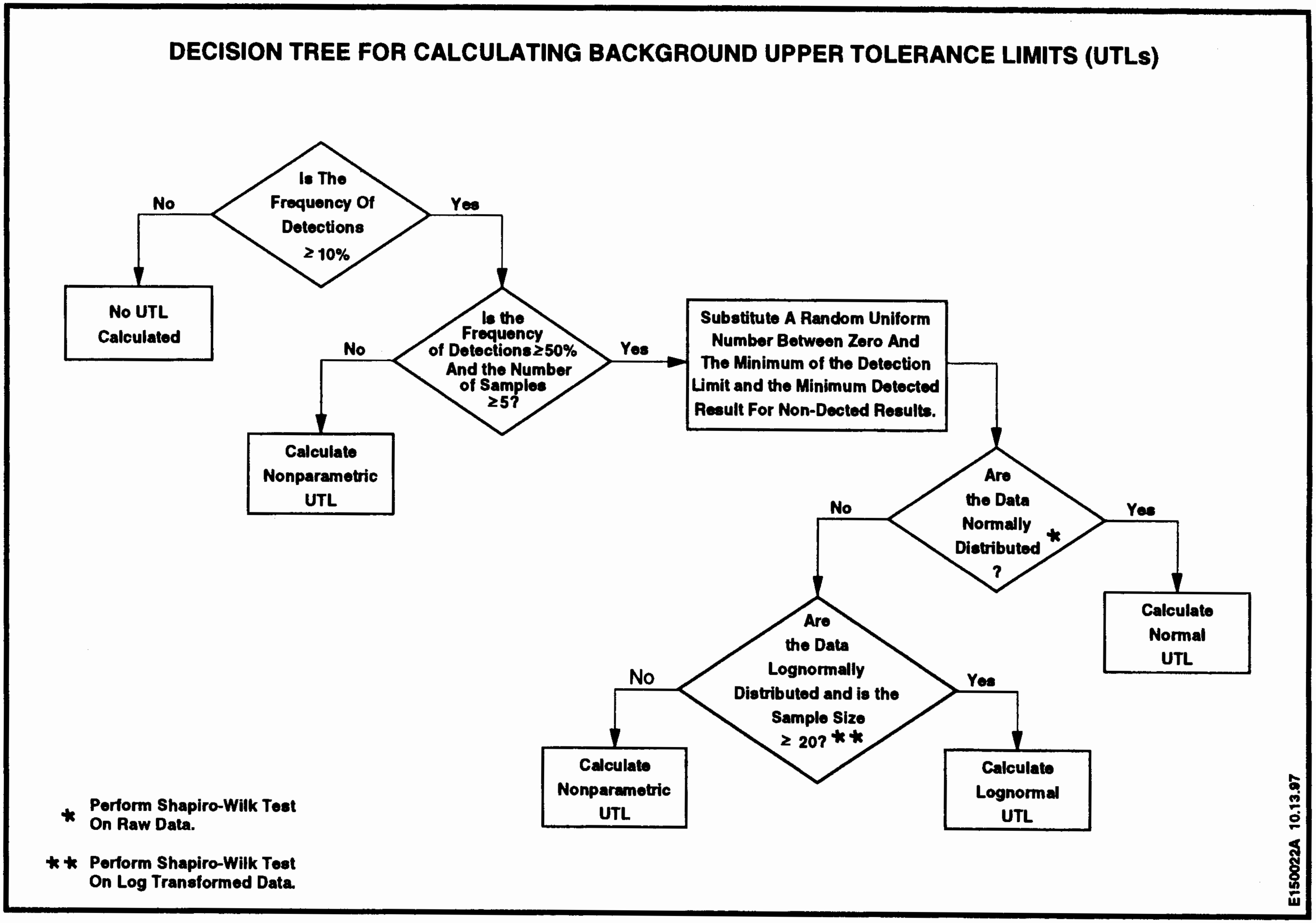


Figure 3-4. Decision Tree for Calculating Upper Tolerance Limits

3.3 Comparison of Site Sample Results to Background UTLs

Individual site results will be compared to background upper tolerance limits as a way of determining whether the site results appear to come from a population that is different than the background. The 95% UTL represents an estimate of the upper 95th percentile of the true background concentration of the constituent of interest. For the 95% UTL, there is a relatively small chance, on the order of one in twenty, of an uncontaminated site sample (i.e., site data that are no different from background) having a constituent concentration greater than the UTL. When individual sample results are compared to UTLs, they are interpreted to indicate the presence of contamination when they exceed the UTLs. On the other hand, constituent concentrations that do not exceed the UTLs are considered to be background concentrations, not the result of contamination.

4.0 References

1. Conover, W.J., 1980. *Practical Nonparametric Statistics*, 2nd ed., Wiley, New York.

2. Gilbert, Richard O., 1987. *Statistical Methods for Environmental Pollution Monitoring*, Van Nostrand Reinhold Company.

3. Radian, 1993. *Phase I—Groundwater Assessment Monitoring Report.*

4. Shapiro, S. S., and M. B. Wilk, 1965. "An Analysis of Variance Test for Normality (complete samples)," *Biometrika*, 52, 591-611.

5. U.S. EPA, 1992a. *Guidance for Data Usability and Risk Assessment, Part A Final.* Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington D.C., April 1992.

6. U.S. EPA, 1992b. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Addendum to Interim Final Guidance*, Office of Solid Waste, Washington D.C., June 1992.

APPENDIX A
Analytical Results

Background Study Analytical Results
Organic Constituents

Sample ID	HOL20K-BK-01-01	HOL20K-BK-02-01	HOL20K-BK-02-11 Dup of HOL20K-BK-02-01	HOL20K-BK-03-01
Date and Time Sampled	22-JUL-97 @ 900	22-JUL-97 @ 920	22-JUL-97 @ 920	22-JUL-97 @ 930
Sample Depth (ft)	0-0.5	0-0.5	0-0.5	0-0.5
PARAMETER				
Percent moisture	14.6 () [1]	15.4 () [1]	15.8 () [1]	15.1 () [1]
SW-846 8330 - Explosives (ug/g)				
1,3,5-Trinitrobenzene	ND (0.0970) [1]	ND (0.0970) [1]	ND (0.0970) [1]	ND (0.0970) [1]
1,3-Dinitrobenzene	ND (0.0626) [1]	ND (0.0626) [1]	ND (0.0626) [1]	ND (0.0626) [1]
2,4,6-Trinitrotoluene	ND (0.133) [1]	ND (0.133) [1]	ND (0.133) [1]	ND (0.133) [1]
2,4-Dinitrotoluene	ND (0.0721) [1]	ND (0.0721) [1]	ND (0.0721) [1]	ND (0.0721) [1]
2,6-Dinitrotoluene	ND (0.130) [1]	ND (0.130) [1]	ND (0.130) [1]	ND (0.130) [1]
2-Nitrotoluene	ND (0.209) [1]	ND (0.209) [1]	ND (0.209) [1]	ND (0.209) [1]
3-Nitrotoluene	ND (0.253) [1]	ND (0.253) [1]	ND (0.253) [1]	ND (0.253) [1]
4-Nitrotoluene	ND (0.191) [1]	ND (0.191) [1]	ND (0.191) [1]	ND (0.191) [1]
HMX	ND (0.0830) [1]	ND (0.0830) [1]	ND (0.0830) [1]	ND (0.0830) [1]
Nitrobenzene	ND (0.0584) [1]	ND (0.0584) [1]	ND (0.0584) [1]	ND (0.0584) [1]
RDX	ND (0.133) [1]	ND (0.133) [1]	ND (0.133) [1]	ND (0.133) [1]
TETRYL	ND (0.145) [1]	ND (0.145) [1]	ND (0.145) [1]	ND (0.145) [1]
SW8332 - HPLC NITROGLYCERIN AND PETN				
Nitroglycerin	ND (0.0865) [1]	ND (0.0865) [1]	0.00646 BJ (0.0865) [1]	0.0471 BJ (0.0865) [1]
PETN	ND (0.0598) [1]	ND (0.0598) [1]	ND (0.0598) [1]	ND (0.0598) [1]

(Detection Limit) [Dilution Factor]

B - Indicates that concentration is within 5 times the method blank concentration

J - Indicates that concentration is less than the specified method detection limit

ND - Not Detected

Background Study Analytical Results
Organic Constituents

Sample ID	HOL20K-BK-04-01	HOL20K-BK-05-01	HOL20K-BK-06-01
Date and Time Sampled	22-JUL-97 @ 940	22-JUL-97 @ 950	22-JUL-97 @ 1000
Sample Depth (ft)	0-0.5	0-0.5	0-0.5
PARAMETER			
Percent moisture	11.4 () [1]	13.8 () [1]	12.8 () [1]
SW-846 8330 - Explosives (ug/g)			
1,3,5-Trinitrobenzene	ND (0.0970) [1]	ND (0.0970) [1]	ND (0.0970) [1]
1,3-Dinitrobenzene	ND (0.0626) [1]	ND (0.0626) [1]	ND (0.0626) [1]
2,4,6-Trinitrotoluene	ND (0.133) [1]	ND (0.133) [1]	ND (0.133) [1]
2,4-Dinitrotoluene	ND (0.0721) [1]	ND (0.0721) [1]	ND (0.0721) [1]
2,6-Dinitrotoluene	ND (0.130) [1]	ND (0.130) [1]	ND (0.130) [1]
2-Nitrotoluene	ND (0.209) [1]	ND (0.209) [1]	ND (0.209) [1]
3-Nitrotoluene	ND (0.253) [1]	ND (0.253) [1]	ND (0.253) [1]
4-Nitrotoluene	ND (0.191) [1]	ND (0.191) [1]	ND (0.191) [1]
HMX	ND (0.0830) [1]	ND (0.0830) [1]	ND (0.0830) [1]
Nitrobenzene	ND (0.0584) [1]	ND (0.0584) [1]	ND (0.0584) [1]
RDX	ND (0.133) [1]	ND (0.133) [1]	ND (0.133) [1]
TETRYL	ND (0.145) [1]	ND (0.145) [1]	ND (0.145) [1]
SW8332 - HPLC NITROGLYCERIN AND PETN (ug/g)			
Nitroglycerin	0.0378 BJ (0.0865) [1]	ND (0.0865) [1]	0.0327 BJ (0.0865) [1]
PETN	0.0613 J (0.0598) [1]	0.0456 J (0.0598) [1]	ND (0.0598) [1]

(Detection Limit) [Dilution Factor]

B - Indicates that concentration is within 5 times the method blank concentration

J - Indicates that concentration is less than the specified method detection limit

ND - Not Detected