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BASE-WIDE BACKGROUND STUDY

SEWAGE LAGOONS AND LAKES INVESTIGATION
HOLLOMAN AIR FORCE BASE, NM

DRAFT FINAL

Prepared for:

49 CES/CEV
Holloman Air Force Base, NM

and

HQ ACC/DEVC
Langley Air Force Base, VA

Prepared by:

Radian Corporation
8501 N. MoPac Boulevard
P.O. Box 201088
Austin, Texas 78720-1088
512/454-4797

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GLOSSARY OF TERMS

Censored Data	A data set in which numerical measurement results below a specified concentration are replaced with a qualitative descriptor such as "not detected" or "less than." Censored data complicates statistical analyses and data interpretation because an important part of the information about measurement variability is lost or hidden from consideration.
F-Pseudosigma	A nonparametric measure of dispersion (i.e., measurement variability), analogous to the standard deviation.
Fourth-Spread Outlier Test	A statistical procedure to test extreme values as possible outliers. The test uses a multiple of (three times) the observed range of measurement values falling between the 25th and 75th percentiles (the interquartile range) of the data set to derive upper and lower bounds for "expected" measurement results. The bounds are set at the median plus and minus three times the interquartile range. Results falling outside these bounds are considered possible outliers.
Kolmogorov-Smirnov Test	A nonparametric statistical test used to determine if a data set has been drawn from a population represented by another data set. In this study the Kolmogorov-Smirnov test was used to determine if the results for background samples could be assumed to be from the same underlying population as the blanks.
Non-Parametric Upper Tolerance Limit	Upper tolerance limit calculated based on the highest observed concentration in a sample data set. Used when the sample data do not support the assumption of normality (i.e., when the sample results do not appear to be random samples from a normally distributed population).
Non-Parametric	Refers to that class of statistical methods which does not require prior knowledge or assumptions about the nature of the underlying distribution of the population of interest. Non-parametric methods generally require larger sample sizes to achieve the same level of certainty

as corresponding parametric methods. (See Parametric.)

Parametric	Refers to that class of statistical methods that are based on underlying assumptions about certain distributional characteristics of the populations of interest. Parametric methods are appropriate when the population is known or can be assumed to follow a normal (i.e., Guassian) distribution, or when it can be modeled by some other distribution (such as the lognormal) that allows the data to be transformed to a normal distribution. Parametric methods take advantage of the known or assumed distributional information to achieve greater certainty in conclusions with smaller numbers of samples than required for corresponding non-parametric methods. (See Non-Parametric.)
Parametric Upper Tolerance Limit	Upper tolerance limit calculated based on the mean and standard deviation of sample data that are known or assumed to have come from a parent population for which concentrations are normally distributed.
Population	A population is what is characterized by sample data. For example, "base-wide background" is (conceptually) the population of all possible measurement results for all possible samples that could be collected at all uncontaminated areas at Holloman AFB. "Site data," which is compared to background data, is considered to respresent the population that includes all possible measurement results for all possible samples from a particular area of interest. Because we can usually not look at every member of a population (indeed, the two examples here represent infinite populations), the *true* values for the population mean, standard deviation, 95th percentile, and other parameters cannot be determined. Statistical methods allow us to develop estimates of these parameters and have some understinging of the probable uncertainty in these estimates.
Robust	Relatively insensitive to distributional assumptions or other underlying assumptions.
Shapiro-Wilk *W* Test	A statistical test for determining if a data set has been drawn from an underlying normal distribution. It may also be used as a test for lognormality by applying the

	test to logarithms of the data.
Transformation	Mathematical manipulation of results used to convert non-normally distributed data to normally-distributed data to enable the use of parametric statistical tests. Log transformation is commonly used for environmental data, which can often be modeled using a log-normal distribution. Log transformation involves substituting each measurement result with the natural logarithm of the result prior to perfoming the statistical test. After performing the test, results are back-transformed to their original scale by exponentiation.
Uncensored Data	A data set in which all measurement results are reported, without screening based on concentration. (See Censored Data)
Upper Tolerance Limit (UTL)	The upper boundary for an interval that has a defined probability of containing a specified proportion of a population of interest. Parametric upper tolerance limits used in this study were calculated at a 95% confidence level to contain 95% of the population. This is interpreted to mean that there is a 95% probablilty that fewer than 5% of future samples collected from background locations would exceed the calculated UTL (providing that the samples used to derive the UTL are representative of base-wide background). Conversely, if a sample result exceeds the UTL, (we can be 95% confident that) there is only approximately a 5% chance that the sample came from an uncontaminated area.

1.0 INTRODUCTION

Environmental investigations conducted at Holloman Air Force Base (AFB), New Mexico, often must evaluate whether metals concentrations in soil and groundwater exceed naturally occurring background concentrations in those media. This study was conducted to generate Base-wide background data for metals and establish background concentrations for metals in soil and groundwater that will be used for ongoing environmental investigations at the Base. For example, the data will help determine the presence or absence, or nature and extent of contamination at sites under investigation. This report presents the results of the background study and illustrates the potential uses and limitations of these data.

1.1 Project Background

Previous investigations at Holloman AFB have attempted to compare data from waste sites to background concentrations. A background study of soil and unfiltered groundwater was conducted for the *Remedial Investigation: Investigation, Study and Recommendation for 29 Waste Sites* (Radian, 1993). For that study, data for soils were sufficient to determine background concentrations for most metals; however, because of the large number of groundwater samples reported as not detected, it was not possible to conduct meaningful statistical analyses. The effectiveness of the earlier investigations was limited by the standard laboratory practice of censoring data at analytical detection limits. The practice of censoring data at a detection limit was especially troublesome because high levels of total dissolved solids (TDS) in groundwater at Holloman AFB caused detection limits to be elevated; thus many sample results were reported as "not detected" (ND). Frequent ND results limit quantitative characterizations of, and comparisons between, background and sites under investigation.

1.2 Objective

The objectives of this study were to:

- Collect additional samples to represent background metals concentrations in soil and groundwater;
- Develop summary statistics that represent background;
- Present guidance for the use of these summary statistics; and,
- Identify and evaluate potential analytical method limitations to guide future chemical analyses of soil and groundwater samples.

1.3 Scope of Study

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

- Sampling of the Holloman Land Gypsum-Yesum soil complex and groundwater in areas unaffected by historical waste management practices;
- An evaluation of the potential for interference by cations and TDS in analytical methods requiring inductively coupled plasma atomic emission spectroscopy (ICPES) and atomic absorption spectroscopy (AA);
- Statistical analysis of measurements of metals in soil and groundwater samples to develop summary statistics to represent background concentrations; and,
- Develop an approach for the use of these summary statistics in future investigations at Holloman AFB.

Additional detail for the scope of sampling and chemical analysis activities is described below. Additional detail for the scope and technical approach to be used for activities

related to a statistical characterization of background is provided in Section 3, Technical Approach and Section 4, Use of Background Data in Future Investigations.

To characterize background soil conditions, 10 sampling locations were selected from within the Holloman Land Gypsum-Yesum soil complex. This complex is representative of the surface soil throughout the Base. To minimize the risk of sampling a contaminated area, each location was carefully selected and situated in an area of the Base unaffected by historical waste management practices (Figure 1-1). In February 1993, shallow subsurface soil samples were collected at each location with a stainless steel hand auger. Soil samples were analyzed using EPA Method SW6010 for 29 metals, SW7041 for antimony, SW7471 for mercury, and SW7841 for thallium.

Four new monitor wells were installed on the Base in areas upgradient of potential contamination and areas unaffected by historical waste management practices. Samples were collected from the new monitor wells, along with 10 existing background monitor wells, in March 1993. Each background monitor well was sampled for total metals using unfiltered groundwater and dissolved metals using groundwater filtered through a 0.45-micron filter. The background monitor wells are listed in Table 1-1 and shown in Figure 1-2. Groundwater samples were analyzed by EPA Method SW6010 for 13 metals, SW7060 for arsenic, SW7421 for lead, SW7740 for selenium, and SW7470 for mercury. Attachment 1 contains records of sampling activities, lithologic logs for borings of new monitor wells, well completion diagrams, and well development records.

1.4 Contents of Report

The remainder of this report contains information regarding the evaluation of analytical chemistry methods for measuring metals concentrations in soil and groundwater, methods used to conduct statistical tests, statistical results, alternative methods for evaluating background conditions, and overall conclusions.

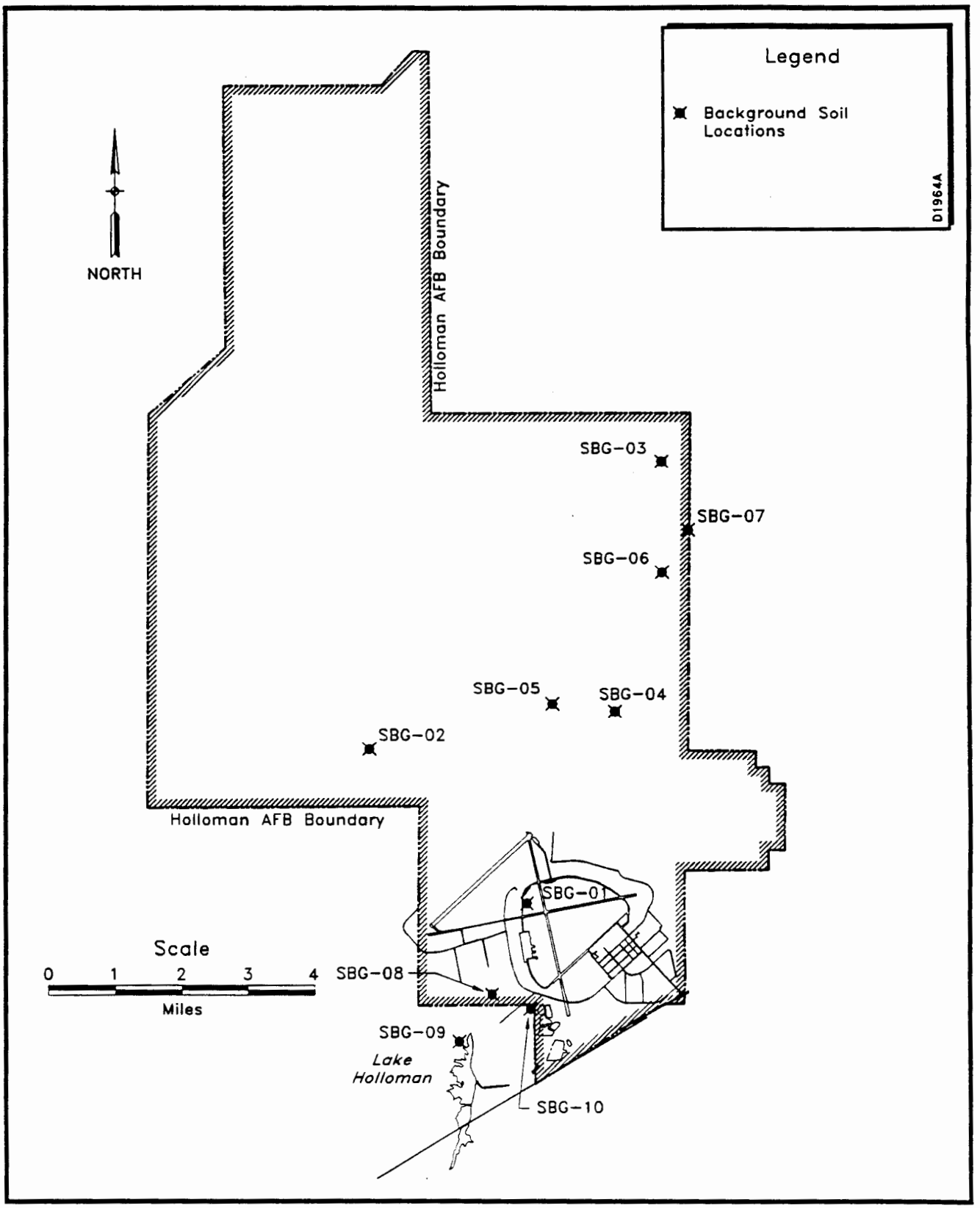

Figure 1-1. Location of Background Soil Samples

Table 1-1

Existing and New Background Monitor Well Locations

Well ID	Date of Establishment
MW-04-01	September, 1991
MW-09-01	August, 1991
MW-21-01	August, 1991
MW-22-01	August, 1991
MW-23-01	September, 1991
MW-26-01	September, 1991
MW-29-01	September, 1991
MW-30&33-01	August,1991
MW-36-01	September, 1991
MW-39-01	September, 1991
MW-BG-01	March, 1993
MW-BG-02	February, 1993
MW-BG-03	March, 1993
MW-BG-04	March, 1993

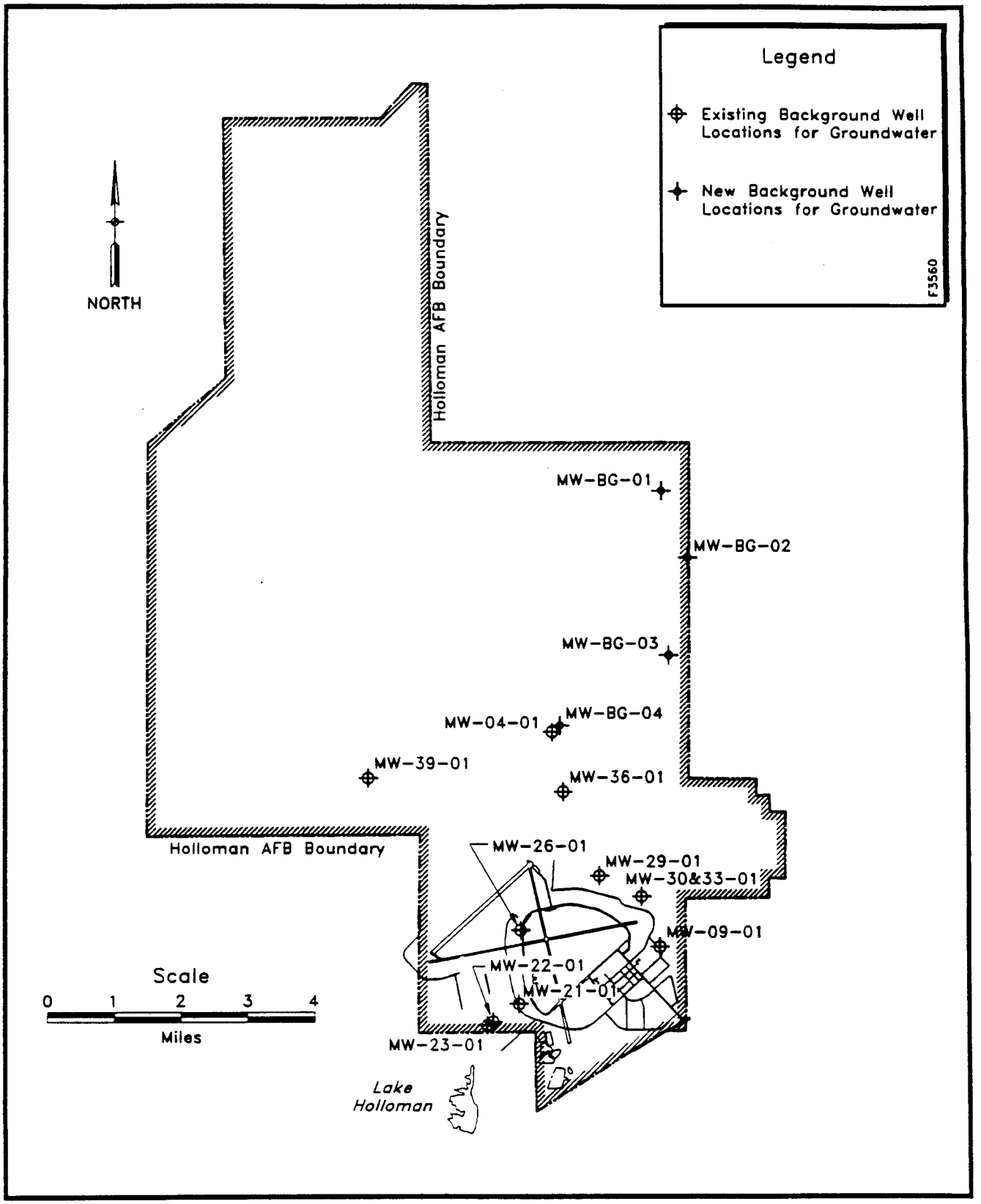

Figure 1-2. Location of Background Monitor Wells

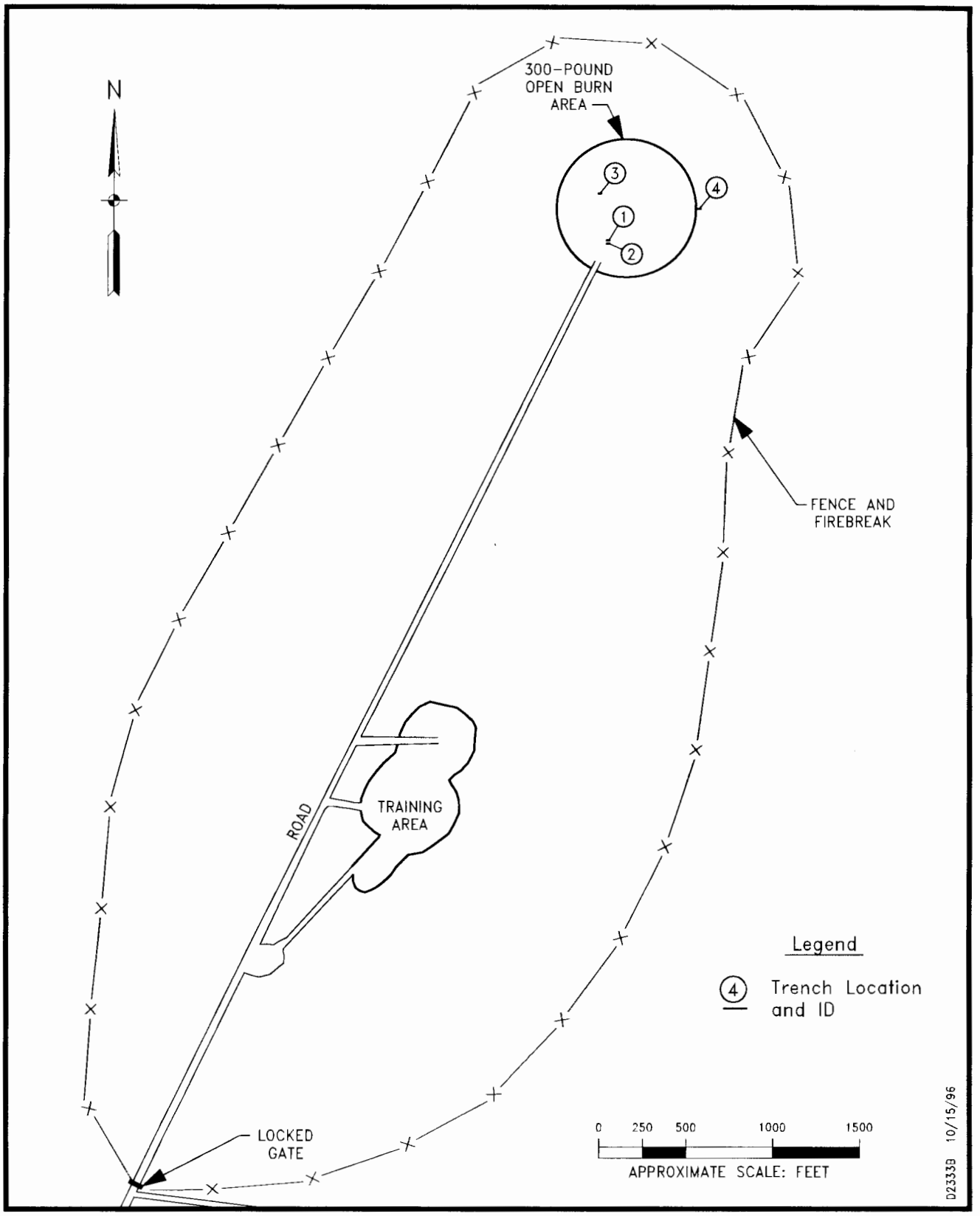

Figure 2-1. Site Map of 300-Pound Open Burn Area at Holloman AFB, N.M.

TO VIEW THE MAP AND/OR MAPS WITH THIS DOCUMENT, PLEASE CALL THE HAZARDOUS WASTE BUREAU AT 505-476-6000 TO MAKE AN APPOINTMENT