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CLOSURE AND POST CLOSURE PLAN FOR LANDFILL CELL NO. 3 AT CANNON AIR FORCE BASE

QUALITY ASSURANCE PLAN

December 1988
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Submitted to:

Headquarters Tactical Air Command/DEEV
Langley Air Force Base, Virginia 23665

and

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TABLE OF CONTENTS

Section		Page
	TABLE OF CONTENTS	i
	DOCUMENT DISTRIBUTION LIST	iv
1	QUALITY ASSURANCE PROJECT (SITE ASSIGNMENT) Plan Approval	1-1
2	INTRODUCTION	2-1
3	PROJECT DESCRIPTION	3-1
4	PROJECT ORGANIZATION AND RESPONSIBILITIES	4-1
5	QA OBJECTIVES FOR MEASUREMENT DATA	5-1
	5.1 Precision and Accuracy	5-1
	5.2 Representativeness	5-1
	5.3 Completeness	5-2
	5.4 Comparability	5-4
6	SAMPLING PROCEDURES	6-1
7	SAMPLE CUSTODY	7-1
	7.1 Sample Planning and Preparation	7-1
	7.2 Sample Collection, Handling, and Identification Protocols	7-1
	7.3 Transfer of Custody and Shipment	7-2
	7.4 Laboratory Custody Procedures	7-4
8	CALIBRATION PROCEDURES AND FREQUENCY	8-1
9	ANALYTICAL PROCEDURES	9-1
	9.1 Target Compound List-Organic Compounds	9-1
	9.2 Target Compound List-Metals	9-9
	9.3 Petroleum Hydrocarbons	9-12
10	DATA REDUCTION, VALIDATION AND REPORTING	10-1
	10.1 Data Reduction	10-1
	10.2 Data Validation	10-3
	10.3 Identification and Treatment of Outliers	
11	INTERNAL QUALITY CONTROL CHECKS AND FREQUENCY	11-1
	11.1 Data Collection and Sampling QC Procedures	11-1
	11.2 Analytical QC Procedures	

12	PERFORMANCE AND SYSTEM AUDITS	12-1
	12.1 System Audits	12-1
	12.2 Performance Audits	12-1
13	PREVENTIVE MAINTENANCE	13-1
14	ROUTINE DATA ASSESSMENT PROCEDURES	14-1
15	CORRECTIVE ACTION	15-1
16	QUALITY ASSURANCE REPORTS TO MANAGEMENT	16-1

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SECTION 1

QUALITY ASSURANCE PROJECT (SITE ASSIGNMENT) PLAN APPROVAL

The Quality Assurance (QA) Plan for Landfill Cell No. 3 described in this document has been read and understood and is approved for use in Project Number _____.

(1) Name _____
Phone _____
Title Base Commander
Signature _____
Date _____

(2) Name _____
Phone _____
Title Base appointed QA/QC official
Signature _____
Date _____

(3) Name _____
Phone _____
Title Base Construction Oversight Official
Signature _____
Date _____

(4) Name _____
Phone _____
Title Contractor
Signature _____
Date _____

(5) Name _____

Phone _____

Title Contractor's QA/QC Supervisory Engineer

Signature _____

Date _____

Quality Assurance Site Plans are customized for a specific project. The following list gives examples of possible assignments within the Landfill Cell No. 3 project.

- Identification of soil characteristic necessitating a change in construction specifications.
- Leakage detection and correction around designed cover penetrating resulting from improper sealing and compaction.
- Detection and correction of erosion or desiccation from failure to provide protective cover when construction is interrupted after cap completion.
- Adjusting the soil moisture content in the event of a significant rain during construction.

SECTION 2

INTRODUCTION

This document constitutes the QA plan for the closure of Landfill Cell No. 3 for Cannon Air Force Base (AFB).

The prime contractor, supports an active QA program. A major requirement of the project is a QA on-site plan describing the specific procedures to be developed to control the work assignment performance. The major objective of this QA on-site plan is to enhance the validity of the data to be used for the Cannon AFB Project.

EPA's agency-wide QA policy stipulates that every monitoring and measurement program must have a written and approved QA plan. This plan follows EPA's guidelines and specifications for preparing QA on-site plans (QAMS-005/80).

SECTION 3

PROJECT DESCRIPTION

The purpose of this project is to close Cell No. 3 of Landfill Area 5 at Cannon AFB.

(Facility name, address)

A brief synopsis of the Closure follows. It includes:

- Site-Specific Project Management
- Remedial Planning
- Remedial Design
- Remedial Implementation
- Other Technical and Management Assistance

Specific objectives of the Plan will be to:

- Determine if the Base's sampling procedures are being followed and performed correctly.
- Determine if analytical results generated by owner/operator laboratories are reasonable.
- Determine if there is a contamination plume and the source of the plume.

Site investigations and remedial response planning and evaluation activities conducted in support of this project require the use of environmental and chemical measurements. It is essential that these measurements be representative of the matrix or parameter being measured and be legally supportable and defensible as to the precision, accuracy, and applicability of the acquired data. The documentation of these measurements and the procedures used in producing them, of analyses leading to the development or evaluation of remedial measures, the identification of responsible parties, and other project products, are subject to complete quality assurance procedures. Strict chain-of-custody and document control procedures are a vital part of an acceptable quality control program that is involved in developing data for possible legal action.

Detailed information regarding project schedules, budgets, and technical plans for implementation of the assigned tasks will be incorporated into the contractor's work plan.

SECTION 4

PROJECT ORGANIZATION AND RESPONSIBILITIES

The specific duties of the individuals in relationship to QA for this project are as follows:

The Project QA Manager provides specific QA support to the Site Managers and, directly and via the QC Coordinators, ensures that QA technical operations are efficiently coordinated in site teams. The Project QA Manager provides:

- Assistance and guidance in the development and revision of a specific QA site plan that defines the QA plan for each site team discipline area and integrates these into a unified plan.
- Performance of systems audits of site team QA/QC, and SOPs and operations manuals, to assure that the defined practices are appropriate.
- Prompt notification to top management officials Corporate Head and the Site Manager of any major QA/QC deficiencies.
- Guidance and coordination to resolve rapidly any QA/QC problems.
- Assembly of QA data for inspection by project management and Cannon AFB management.
- The QA of the project data/document control and security system that provides chain-of-custody and confidentiality protection for project data and documentation.

- Independent review to assure the quality of all documentation or outputs to Cannon AFB, including all progress reports, site specific reports, and final and year-end report components.

The QC Coordinator provides:

- Open lines of communication between the Site Manager and the Project QA Manager.
- QA/QC guidance as needed.
- Maintenance and preliminary review of all QA/QC records.
- Data validation audits.
- Implementation of audits during site team operation to assure that the defined operations are properly performed.

The Project Manager is responsible for effective day-to-day management of the total project staff as well as direct communication and liaison with Cannon AFB. His responsibility specific to QA is to ensure that all contractor and subcontractor project staff understand and comply with the QA/QC plans.

Site Managers are responsible for provision of accurate field or laboratory data produced by analysts and sampling personnel under their supervision, and for the quality of all other information and documentation produced by the team. They are responsible to the QC Coordinator, Project QA Manager and Project Manager to ensure that all QC procedures are followed and that complete documentation is provided.

It is the responsibility of the Site team members to perform the required QA/QC procedures and to document all observations, analyses, planning and engineering, and other information inputs. The team member brings any unusual quality problem to the immediate attention of his Site Manager.

SECTION 5

OBJECTIVES FOR MEASUREMENT DATA

The QA objectives for environmental measurements are to provide data that are in compliance with EPA Level 1 criteria for such measurements. This level is reserved for activities conducted in support of legal or compliance action. Strict NEIC-type, chain-of-custody documentation is required for all sample and record control; for all data transmissions, reductions, and transcriptions; and for all other types of documentation. Documented control of measurement systems, calibration, standardization and inclusion of reference measurements before and after unknown measurements is required. Field instruments used for performance of environmental measurements must be standardized and calibrated frequently according to approved procedures.

5.1 Precision and Accuracy

Precision is the degree of mutual agreement among individual measurements of the same property. For this project, duplicate sample analyses will be employed for the measurement of analytical precision, expressed as a relative percent difference (RPD). Assessments of sampling precision will not be conducted in that only a single sample of each targeted waste at a sampling site will be collected, and this will frequently be a grab sample (see discussion under representativeness).

Accuracy is the degree of agreement of a measurement or average of measurements with an accepted reference or true value. For this project, analytical accuracy will be assessed in terms of recovery of spiked compounds or surrogate compounds. For each analytical method employed, matrix spikes of the analyte (for single-component methods) will be employed in a separate analysis for the estimation of analytical accuracy.

5.2 Representativeness

There are two components to sample representativeness for this project. First, there is representativeness of the site, or specific waste types. This type of representativeness will be addressed through a selection of sites for sampling that incorporate the more common waste disposal processes/practices, or a range of these processes/practices. Second, there is representativeness of the specific site. This type of representativeness will be addressed through selection of appropriate sampling procedures.

Although substantial emphasis is placed on obtaining representive samples through the procedures described above, there is no means to quantitatively assess the degree of sample representativeness that is achieved. Furthermore, improvements in the representativeness of samples collected through long-term compositing or multiple analyses over time are frequently not practical due to limited access to industrial facilities and limited resources. As a result, the

goals for sample representativeness can only be stated in qualitative terms; i.e., to obtain analytical data that is as representative as practical of the waste/site under investigation.

5.3 Completeness

We define completeness as the degree to which a number of activities initiated are acutally finished. For this project, the first activity is acquiring samples and the final activity is the reporting of analytical data. The degree of completeness is the number of samples for which acceptable analytical data are generated provided by the total number of samples collected times 100 percent. The QA objective for this project is 100 percent.

5.4 Comparability

The comparability of analytical data will be maximized by the reporting of analytical data in the standard (SW 846), specified EPA/OSW format and by the use of standard EPA/OSW sampling and analytical methods, as defined in this QAPP. There is no specific quantitative objective for comparability.

SECTION 6

SAMPLING PROCEDURES

The sampling procedures used in this project comply with accepted good field practice and are suitable to provide representative samples of the hazardous waste or the environmental parameter of interest. The sampling process must not bias the experimental measurement and must provide a legally defensible representative sample matrix. Sampling process protocol is audited and approved by the Project QA Manager.

The sampling procedures for soils, sediments, and waters from a hazardous waste site and drums of hazardous material comply with EPA procedures described in EPA Technical Monographs Nos. 16, 17, 18, and 19 entitled, "Technical Methods for Investigating Sites Containing Hazardous Substance." These monographs are combined into a field operations manual. The preparation of an approved field sampling plan is required prior to beginning field work. The sampling plan addresses, but is not necessarily limited to, the following:

- Team organization.
- Degree of protective clothing and equipment required. Determined by the potential for exposure and the hazardous nature of the suspected contaminants.
- Number of samples to be taken. In general, a small number of samples is required to establish contaminant concentration ranges. Other factors affecting the number of samples required include the area of the site and sampling goals.
- Selection of background sampling points. Sampling points beyond the limits of site contamination, e.g., upwind ambient air samples or upstream surface water samples, are identified.
- Sampling containers, preservation techniques, sampling equipment and field measurement devices.
- Sample documentation. The sample tags, chain-of-custody forms, field logbooks and photographic equipment necessary to document the sampling process are prepared, serially numbered, and controlled.
- Analytical support. The analyses which are requested for the samples, based on background information, are identified. The laboratory facilities which receive the samples are notified.
- Quality control checks. The sampling points at which

field duplicate samples are taken for quality control are identified, and field and equipment blanks are prepared.

- Sample packaging and shipping. Prior to final approval of the sampling plan, the Project QA Manager will perform a systems audit of the plans and procedures for compliance with the objectives of this program.

SECTION 7

SAMPLE CUSTODY

Sample custody refers to tracking possession of a sample from the time it is collected in the field through analysis and final disposition. A record of sample custody (chain-of-custody) identifies in whose possession the sample was at all times, thereby fixing accountability on traceability of the sample. A complete chain-of-custody record ensures sample integrity. This minimizes the possibility of someone tampering with samples and is necessary for legal purposes.

A sample is in someone's "custody" if:

- It is in one's actual physical possession, or
- It is in one's view, after being in one's physical possession, or
- It is in one's physical possession and then locked up so that no one can tamper with it, or
- It is kept in a secured area, restricted to authorized personnel only.

Chain-of-custody and document control protocols for this project are those specified by the NEIC.

7.1 Sample Planning and Preparation

A copy of the work plan is distributed to all survey participants in advance of the survey date. A pre-survey briefing is utilized to reappraise survey participants of the objectives, sampling locations and chain-of-custody procedures to be used.

7.2 Sample Collection, Handling and Identification Protocols

A minimum number of persons are involved in sample collection and handling. Guidelines established in this plan for sample collection, preservation and handling are used. Field records are completed at the time the sample is collected and are signed or initialed, including the date and time, by the sample collector(s). Field records contain the following information:

- Unique sample identification number.
- Date and time of sample collection.
- Source of sample (including name, location, and sample type).
- Preservatives used.
- Analysis required.
- Name(s) of collectors.

- Field data (pH, DO, Cl_2 residual, etc.), to include field equipment identification.
- Serial numbers on seals and transportation cases.

Each sample is identified by affixing a pressure sensitive gummed label or standardized tag to the container. This label contains the sample identification number, date and time of sample collection, source of sample, preservative used and the collector's initials. Required analyses are identified. Where a label is not available, the same information is affixed to the sample container with an indelible, waterproof, marking pen. Labeling of sample lids is to be avoided as this can lead to confusion when the lids are removed.

The sample container is then placed in a transportation case along with the chain-of-custody record form, pertinent field records and analysis request form as needed. The transportation case is then sealed or labeled. All records are filled out legibly in pen. The use of the locked and sealed chests eliminates the need for close control of the individual sample containers. However, there will undoubtedly be occasions when the use of a chest is inconvenient. On those occasions, the sampler places a seal around the cap of the individual sample container which would indicate tampering if removed. A trip blank is included with every shipment.

When samples are composited over a time period, unsealed samples are transferred from one crew to the next. A list of samples is made by the transferring crew and signed for by a member of the receiving crew. They either transfer the samples to another crew or deliver them to laboratory personnel who then acknowledge receipt in a similar manner.

Color slides or photographs taken of the sampling location and of any visible pollution are used to facilitate identification and later recollection by the inspector. A photograph log is made at the time the photo is taken so that this information can be written later on the back of the photo or the margin of the slide. This includes the signature of the photographer, time, date, site location, a brief description of the subject of the photo, and what the photo is intended to show. Photographs and written records, which may be used as evidence, are handled in such a way that chain-of-custody can be established.

7.3 Transfer of Custody and Shipment

All samples collected for this program will be shipped and stored in Pyrex or amber glass bottles with Teflon lined screw-caps. The various types of samples that will be collected under this project have different preservation and shipping requirements. All samples will be stored and shipped in a cooler on ice (< 4°C) as a general preservation method. Any other specific preservation techniques that are required for specific analytes will be described in the site-specific sampling and analysis plan and implemented accordingly.

Chain-of-custody forms will be prepared in the field for each sample to ensure the integrity of the sample from collection through analysis. Individual sample bottles will be labeled to prevent misidentification. Once a sample bottle is filled, a sample seal will be applied across the cap and down the side to the sample bottle to provide visible indication, as to whether the bottle has been opened between the time of sampling and the time of analysis. The chain-of-custody documentation will be enclosed in each sample shipping

container, so as to be readily available upon arrival of the samples at the analytical laboratory. Once the shipping containers are closed, a container seal will be fixed in such a way as to positively indicate if the container has been opened in transit.

When transferring the possession of the samples, the transferree must sign and record the date and time on the chain-of-custody record. Custody transfers, if made to a sample custodian in the field, account for each individual sample, although samples may be transferred as a group. Every person who takes custody must fill in the appropriate section of the chain-of-custody record. To prevent undue proliferation of custody records, the number of custodians in the chain of possession is minimized.

The field custodian, or field inspector if a custodian has not been assigned, is responsible for properly packaging and dispatching samples to the appropriate laboratory for analysis. This responsibility includes filling out, dating, and signing the appropriate portion of the chain-of-custody record. A chain-of-custody record contains the following necessary procedural elements:

- Project Number. The facility's EPA Identification number (if appropriate).
- Project Name. The name and address of the facility.
- Sampler(s). The collector's name.
- Station Number. The number of the station from which a sample was taken.
- Date/Time. The date and time a sample was taken.
- Composite/Grab. Indicate if the sample was a composite or grab sample.
- Station Location. The direction (north, south, etc.) and proximity of the sample station to a benchmark.
- Number of Containers. Number of sample containers taken from a station and each method of sampling.
- Analyses Desired. Type of analyses desired to be performed on the waste (e.g., 800, metals, pesticides, etc.) to include maximum holding date for each analyte.
- Remarks. Additional information about the samples such as the type of media sampled or type of container sampled.
- Relinquished by: (Signature). The signature of the collector(s).
- Date/Time. The date and time the sample was relinquished.
- Received by: (Signature). The signature of whoever receives the sample.
- Received for Laboratory by: (Signature). The signature of a person at the lab who officially accepts the samples.
- Date/Time. The date and time the sample is received by the laboratory.
- Remarks. Final remarks about the samples after acceptance by the laboratory.

All packages sent to the laboratory are accompanied by the chain-of-custody record and other pertinent forms. A copy of these forms is retained by the originating office (either carbon or photo copy).

Mailed packages can be registered with return receipt requested. If packages are sent by common carrier, receipts are retained as part of the permanent chain-of-custody documentation.

Samples to be shipped must be so packed as not to break, and the package so sealed or locked that any evidence of tampering is readily detected.

7.4 Laboratory Custody Procedures

Chain-of-custody procedures are necessary in the laboratory from the time of sample receipt to the time the sample is discarded. The procedures recommended for the laboratory are described as follows.

A specific person shall be designated custodian and an alternate designated to act as custodian in the custodian's absence. All incoming samples shall be received by the custodian, who shall indicate receipt by signing the accompanying custody forms and who shall retain the signed forms as permanent records.

The sample custodian shall maintain a permanent logbook to record, for each sample, the person delivering the sample, the person receiving the sample, data and time received, source of sample, sample identification or log number, how transmitted to the laboratory and condition in which received (sealed, unsealed, broken container, or other pertinent remarks). A standardized format should be established for logbook entries.

A clean, dry isolated room, building, and/or refrigerated space that can be securely locked from the outside shall be designated as a "sample storage security area."

The custodian shall ensure that samples that are heat-sensitive, light-sensitive, or radioactive, and other sample materials that have unusual physical characteristics, or require special handling, are properly stored and maintained prior to analysis.

Distribution of samples to the section chiefs who are responsible for the laboratory performing the analyses shall be made only by the custodian.

The laboratory area shall be maintained as a secured area, restricted to authorized personnel only.

Laboratory personnel are responsible for the care and custody of the sample once it is received by them and shall be prepared to testify that the sample was in their possession and view, or secured in the laboratory, at all times from the moment it was received from the custodian until the time that the analyses were completed.

Once the sample analyses are completed, the unused portion of the sample, together with all identifying labels, must be returned to the custodian. The returned tagged sample should be retained in the custody room until permission to destroy the sample is received by the custodian.

Samples shall be destroyed only upon the written order of the Laboratory Director, in consultation with previously designated enforcement officials, or when it is certain that the information is no longer required or the samples have deteriorated. The same procedure is true for tags and laboratory records.

SECTION 8

CALIBRATION PROCEDURES AND FREQUENCY

Instruments and equipment used to gather, generate, or measure environmental data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer specifications.

Calibration procedures and frequency of laboratory instrumentation are specified in the CLP SOW, and will be strictly adhered to for those analytes analyzed by CLP protocols. For all other analyses for which EPA approved methods exist, the laboratory will employ such methods and follow the calibration procedures and frequencies specified. The selected laboratory quality control program includes strict adherence to routine calibration procedures. A description of calibration procedures and frequencies for non-CLP methods will be outlined in the selected laboratory's Standard Operating Procedures (SOP) which are provided in Appendix B.

Calibration of field instruments and equipment will be performed at approved intervals as specified by the manufacturer or more frequently as conditions dictate. Calibrations may also be performed at the start and completion of each test run. However, such calibrations will be re-initiated as a result of delay due to metals, work shift change, or damage incurred. Calibration standards used as references standards will be traceable to the National Bureau of Standards, when existent. Calibration procedures for field instruments are included in Appendix C of the QAPP.

Analysis of blank samples, duplicate samples, spiked blanks, and matrix blanks will be performed where possible to document the effectiveness of calibration procedures. The number, frequency, and type of these samples will be sufficient to verify the success of the calibration program (at least 10 percent of all samples).

Method blanks contain all the reagents used in the preparation and analysis of samples and are processed through the entire analytical scheme to assess spurious contamination from reagents, glassware and other materials used during analysis. The terms method blank and laboratory blank are interchangeable. A matrix blank denotes a blank of a similar matrix (e.g., for liquids a blank of distilled-deionized reagent grade high purity water may be used, or for soils/sediments high purity and may be used). A spike blank is a method blank which has had a known concentration of a particular compound or analyte added to it to assure adequate percent recovery of the compound/analyte.

Records of calibration, repair, or replacement will be filed and maintained by the designated laboratory personnel performing quality control activities. Calibration records of assigned laboratories will be filed and maintained at the laboratory location where the work is performed and subject to QA audit.

SECTION 9

ANALYTICAL PROCEDURES

EPA-approved methods will be used for all analyses for which such methods exist. TCL parameters will be analyzed by CLP protocols. The selected laboratory will follow methods detailed in the CLP SOW for Organic Analyses (SW787) and the SOW for Inorganic Analyses (SW787). If contaminant concentrations are high, then a departure from CLP protocols may be required. In this case, sample runs at lower dilutions will be performed to obtain quantitative results for parameters present at lower concentrations. That is, samples are pre-screened to estimate levels of concentration. According to EPA methodology, high concentration samples are diluted to bring them within a linear working range. Low concentration samples are set aside and then analyzed within the same linear working range. For samples where pure waste is encountered, it may not be possible to quantitate in parts per billion (ppb). In this event, a decision tree or infra-red approach will be followed. Detection limits will be raised for all analytes on the sample, in this case.

9.1 TARGET COMPOUND LIST-ORGANIC COMPOUNDS

The organic compounds contained in the TCL will be determined using proven instruments and techniques to identify and quantify volatile, semivolatile and pesticide compounds. The TCL compounds and CLP-required detection limits are shown in Tables 9-1 through 9-4. The actual detection limits obtainable for a specific sample depend upon matrix interferences. If the CLP detection limit is unachievable for a particular sample, an explanation of the problem and supporting evidence will be provided.

TABLE 9-1. TARGET COMPOUND LIST (TCL) VOLATILE COMPOUNDS DETECTION LIMITS

Volatiles	CAS Number	Detection Limits[a] Low water[b] (ug/L)	Low soil/sediment[c] (ug/kg)
Chloromethane	74-87-3	10	10
Bromomethane	74-83-9	10	10
Vinyl chloride	75-01-4	10	10
Chloroethane	75-00-3	10	10
Methylene chloride	75-09-2	5	5
Acetone	67-64-1	10	10
Carbon disulfide	75-15-0		
1,1-Dichloroethene	75-35-4	5	5
1,1-Dichloroethane	75-35-3	5	5
1,2-Dichloroethene (cis and trans)	156-60-5	5	5
Chloroform	67-66-3	5	5
1,2-Dichloroethane	107-06-2	5	5
2-Butanone	78-93-3	10	10
1,1,1-Trichloroethane	71-55-6	5	5
Carbon tetrachloride	56-23-5	5	5
Vinyl acetate	108-05-4	10	10
Bromodichloromethane	75-27-4	5	5
1,1,2,2-Tetrachloroethane	79-34-5	5	5
1,2-Dichloropropane	78-87-5	5	5
trans-1,3-Dichloropropene	10061-02-6	5	5
Trichloroethene	79-01-6	5	5
Dibromochloromethane	124-48-1	5	5
1,1,2-Trichloroethane	79-00-5	5	5
Benzene	71-43-2	5	5
cis-1,3-Dichloropropene	10061-01-5	5	5
2-Chloroethyl vinyl ether	110-75-8	10	10
Bromoform	75-25-2	5	5
2-Hexanone	591-78-6	10	10
4-Methyl-2-pentanone	108-10-1	10	10
Tetrachloroethene	127-18-4	5	5

TABLE 9-1. (continued)

Volatiles	CAS Number	Detection Limits[a] Low water[b] (ug/L)	Low soil/sediment[c] (ug/kg)
Toluene	108-88-3	5	5
Chlorobenzene	108-90-7	5	5
Ethyl benzene	100-41-4	5	5
Styrene	100-42-5	5	5
Total xylenes		5	5

[a]Detection limits listed for soil/sediment are based on wet weight. The detection limits calculated for soil/sediment calculated on dry weight basis will be higher.

[b]Medium water detection limits for volatile TCL compounds are 100 times the individual low water detection limits.

[c]Medium soil/sediment detection limits for volatile TCL compounds are 100 times the individual low soil/sediment detection limits.

Note: Specific detection limits are highly matrix dependent. The detection limits listed herein are provided for guidance and may not always be achievable.

TABLE 9-2. TARGET COMPOUND LIST (TCL) SEMIVOLATILE COMPOUNDS AND DETECTION LIMITS

Semivolatiles	CAS Number	Detection Limits[a] Low water[b] (ug/L)	Low soil/sediment[c] (ug/kg)
Phenol	108-95-2	10	330
Bis(2-chloroethyl) ether	111-44-4	10	330
2-Chlorophenol	95-57-8	10	330
1,3-Dichlorobenzene	541-73-1	10	330
1,4-Dichlorobenzene	106-46-7	10	330
Benzyl alcohol	100-51-6	10	330
1,2-Dichlorobenzene	95-50-1	10	330
2-Methylphenol	95-48-7	10	330
Bis(2-chloroisopropyl) ether	39638-32-9	10	330
4-Methylphenol	106-44-5	10	330
N-Nitroso-dipropylamine	621-64-7	10	330
Hexachloroethane	67-72-1	10	330
Nitrobenzene	98-95-3	10	330
Isophorone	78-59-1	10	330
2-Nitrophenol	88-75-5	10	330
2,4-Dimethylphenol	105-67-9	10	330
Benzoic acid	65-85-0	50	1600
Bis(2-chloroethoxy) methane	111-91-1	10	330
2,4-Dichlorophenol	120-83-2	10	330
1,2,4-Trichlorobenzene	120-82-1	10	330
Naphthalene	91-20-3	10	330
4-Chloroaniline	106-47-8	10	330
Hexachlorobutadiene	87-68-3	10	330
4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	10	330
2-Methylnaphthalene	91-57-6	10	330
Hexachlorocyclopentadiene	77-47-4	10	330
2,4,6-Trichlorophenol	88-06-2	10	330
2,4,5-Trichlorophenol	95-95-4	50	1600

TABLE 9-2. (continued)

Semivolatiles	CAS Number	Detection Limits[a] Low water[b] (ug/L)	Low soil/sediment[c] (ug/kg)
2-Chloronaphthalene	91-58-7	10	330
2-Nitroaniline	88-74-4	50	1600
Dimethyl phthalate	131-11-3	10	330
Acenaphthylene	208-96-8	10	330
3-Nitroaniline	99-09-2	50	1600
Acenaphthene	83-32-9	10	330
2,4-Dinitrophenol	51-28-5	50	1600
4-Nitrophenol	100-02-7	50	1600
Dibenzofuran	132-64-9	10	330
2,4-Dinitrotoluene	121-14-2	10	330
2,6-Dinitrotoluene	606-20-2	10	330
Diethylphthalate	84-66-2	10	330
4-Chlorophenyl phenyl ether	7005-72-3	10	330
Fluorene	86-73-7	10	330
4-Nitroaniline	100-01-6	50	1600
4,6-Dinitro-2-methylphenol	534-52-1	50	1600
N-nitrosodiphenylamine	86-30-6	10	330
4-Bromophenyl phenyl ether	101-55-3	10	330
Hexachlorobenzene	118-74-1	10	330
Pentachlorophenol	87-86-5	50	1600
Phenanthrene	85-01-8	10	330
Anthracene	120-12-7	10	330
Di-n-butylphthalate	84-74-2	10	330
Fluoranthene	206-44-0	10	330
Pyrene	129-00-0	10	330
Butyl benzyl phthalate	85-68-7	10	330
3,3'-Dichlorobenzidine	91-94-1	20	660
Benzo(a)anthracene	56-55-3	10	330
Bis(2-ethylhexyl)phthalate	117-81-7	10	330

TABLE 9-2. (continued)

Semivolatiles	CAS Number	Detection Limits[a] Low water[b] (ug/L)	Low soil/sediment[c] (ug/kg)
Chrysene	218-01-9	10	330
Di-n-octyl phthalate	117-84-0	10	330
Benzo(b)fluoranthene	205-99-2	10	330
Benzo(k)fluoranthene	207-08-9	10	330
Benzo(a)pyrene	50-32-8	10	330
Indeno(1,2,3-cd)pyrene	193-39-5	10	330
Dibenzo(a,h)anthracene	53-70-3	10	330
Benzo(g,h,i)perylene	191-24-2	10	330

[a]Detection limits listed for soil/sediment are based on wet weight. The detection limits calculated for soil/sediment calculated on dry weight basis will be higher.

[b]Medium water detection limits for volatile TCL compounds are 100 times the individual low water detection limits.

[c]Medium soil/sediment detection limits for volatile TCL compounds are 60 times the individual low soil/sediment detection limits.

Note: Specific detection limits are highly matrix dependent. The detection limits listed herein are provided for guidance and may not always be achievable.

TABLE 9-3. TARGET COMPOUND LIST (TCL) PESTICIDES, PCBs, AND DETECTION LIMITS

Pesticides	CAS Number	Detection Limits[a] Low water[b] (ug/L)	Low soil/sediment[c] (ug/kg)
alpha-BHC	319-84-6	0.05	8.0
beta-BHC	319-85-7	0.05	8.0
delta-BHC	319-86-8	0.05	8.0
gamma-BHC (Lindane)	58-89-9	0.05	8.0
Heptachlor	76-44-8	0.05	8.0
Aldrin	309-00-2	0.05	8.0
Heptachlor epoxide	1024-57-3	0.05	8.0
Endosulfan I	959-98-8	0.05	8.0
Dieldrin	60-57-1	0.10	16.0
4,4'-DDE	72-55-9	0.10	16.0
Endrin	72-20-8	0.10	16.0
Endosulfan II	33213-65-9	0.10	16.0
4,4'-DDD	72-54-8	0.10	16.0
Endrin adehyde	7421-93-4	0.10	16.0
Endosulfan sulfate	1031-07-8	0.10	16.0
4,4'-DDT	50-29-3	0.10	16.0
Endrin ketone	53494-70-5	0.10	16.0
Methoxychlor	72-43-5	0.5	80.0
Chlordane	57-74-9	0.5	80.0
Toxaphene	8001-35-2	1.0	160.0
AROCLOR-1016	12674-11-2	0.5	80.0
AROCLOR-1221	11104-28-2	0.5	80.0
AROCLOR-1232	11141-16-5	0.5	80.0
AROCLOR-1242	53469-21-9	0.5	80.0
AROCLOR-1248	12672-29-6	0.5	80.0
AROCLOR-1254	11097-69-1	1.0	160.0
AROCLOR-1260	11096-82-5	1.0	160.0

[a]Detection limits listed for soil/sediment are based on wet weight. The detection limits calculated for soil/sediment calculated on dry weight basis will be higher.

[b]Medium water detection limits for volatile TCL compounds are 100 times the individual low water detection limits.

[c]Medium soil/sediment detection limits for volatile TCL compounds are 60 times the individual low soil/sediment detection limits.

Note: Specific detection limits are highly matrix dependent. The detection limits listed herein are provided for guidance and may not always be achievable.

detection limits listed herein are provided for guidance and may not always be achievable.

TABLE 9-4. TARGET COMPOUND LIST (TCL) INORGANICS AND CONTRACT REQUIRED DETECTION LIMITS (CDRL)[a]

Element	Detection Limit	
	Water (ug/L)	Low soil/sediment (ug/g)
Aluminum	200	20
Antimony	60	6
Arsenic	10	1
Barium	200	20
Beryllium	5	0.5
Boron	5	0.5
Cadmium	5	0.5
Calcium	5,000	500
Chromium	10	1
Cobalt	50	5
Copper	25	2.5
Iron	100	10
Lead	5	0.5
Magnesium	5,000	500
Manganese	15	1.5
Mercury	0.2	0.1[b]
Nickel	40	4
Potassium	5,000	500
Selenium	5	0.5
Silver	10	1
Sodium	5,000	500
Thallium	10	1
Vanadium	50	5
Zinc	20	2
Cyanide	10	1

[a]Specific detection limits are highly matrix dependent. The detection limits listed herein are provided for guidance and may not always be achievable.

[b]Different aliquot.

A field duplicate sample will be analyzed for each waste type (e.g., soil, sediment, ground water, surface water). Each set of samples will be analyzed in conjunction with the analysis of a set of field duplicates, blanks, matrix spikes and matrix spike duplicates. The frequency of analyses of the QC samples will not be less than one set per 20 samples. All samples, field duplicates, blanks, matrix spiked and matrix spike duplicates to be analyzed for organic constituents will be fortified with surrogate spiking compounds as shown in Table 9-5. The CLP recommended guidelines for percentage recovery are shown in these tables. The percentage recovery of the matrix spiking compounds and relative percentage difference of duplicate analyses will be calculated to obtain measurements of accuracy and precision.

9.2 TARGET COMPOUND LIST-METALS

All water and soil samples will be prepared for analyses as described by procedures for each respective matrix and analysis method described in the U.S. EPA CLP Solicitation No. WA85-J838, September 3, 1985 or latest version at the time of analyses. Each set of samples, or 20 samples, whichever is greater, is analyzed with a preparation blank, duplicate sample, and matrix spiked sample. Each group of 20 samples is analyzed with a laboratory control sample of similar matrix.

The atomic absorption instrument is calibrated by use of a minimum of three calibration standards prepared by dilution of certified stock solutions. Calibration standards contain acid(s) at the same concentration as the digestates. An analysis blank is prepared, and one calibration standard is at the EPA-CLP required detection limit for the metal. The other standards bracket the concentration range of the samples. A continuing calibration standard, prepared from a different stock solution than used for the calibration standards, is prepared and analyzed after every ten samples or every 2 hours of continuous operation, whichever is more frequent. The value of the continuing calibration standard concentration must agree within CLP SOW.

The metals to be determined, analysis method(s), and required detection limits were previously shown in Table 9-4.

TABLE 9-5. SURROGATE SPIKE RECOVERY RANGE

Fraction	Surrogate compounds	Water % recovery	Soil/sediment % recovery
Volatiles	Toluene-d_8	86-119	50-160
	4-Bromofluorobenzene	85-121	50-160
	1,2-Dichloroethane-d_4	77-120	50-160
Semivolatiles	Nitrobenzene-d_5	41-120	20-140
	2-Fluorobiphenyl	44-119	20-140
	p-Terphenyl-d_{14}	33-128	20-150
	Phenol-d_5	15-103	20-140
	2-Fluorophenol	23-121	20-140
	2,4,6-Tribromophenol	10-131	10-141
Pesticides	Dibutylchlorendate	48-136	20-150

TABLE 9-6. MATRIX SPIKE RECOVERY LIMITS*

Fraction	Matrix spike compound	Water*	Soil/sediment*
VOA	1,1-Dichloroethene	61-145	59-172
VOA	Trichloroethene	71-120	62-137
VOA	Chlorobenzene	75-130	60-133
VOA	Toluene	76-125	59-139
VOA	Benzene	76-127	66-142
BN	1,2,4-Trichlorobenzene	39-98	38-107
BN	Acenaphthene	46-118	31-137
BN	2,4-Dinitrotoluene	24-96	28-89
BN	Pyrene	26-127	35-142
BN	N-Nitroso-di-n-propylamine	41-116	41-126
BN	1,4-Dichlorobenzene	36-97	28-104
Acid	Pentachlorophenol	9-103	17-109
Acid	Phenol	12-89	26-90
Acid	2-Chlorophenol	27-123	25-102
Acid	4-Chloro-3-methylphenol	23-97	26-103
Acid	4-Nitrophenol	10-80	11-114
Pesticide	Lindane	56-123	46-127
Pesticide	Heptachlor	40-131	35-130
Pesticide	Aldrin	40-120	34-132
Pesticide	Dieldrin	52-126	31-134
Pesticide	Endrin	56-121	42-139
Pesticide	4,4'-DDT	38-127	23-134

9.3 PETROLEUM HYDROCARBONS

EPA Method 418.1 is used for analysis of petroleum hydrocarbons. Petroleum hydrocarbons is a measure of the non-biodegradable mineral oils in the sample. The detection limit for a water sample is 2 mg/L and that for soil/sediment is 20 ug/g.

The method is applicable to measurement of light fuels, although loss of about half of any gasoline present during the extraction manipulations can be expected. In the procedure, the sample is acidified to a low pH (<2) and serially extracted with fluorocarbon-113 in a separatory funnel. Interferences are removed with silica gel adsorbent. Infrared analysis of the extract is performed by direct comparison with standards.

A representative sample of 1-liter volume should be collected in a glass bottle. Because losses of grease will occur on sampling equipment, the collection of a composite sample is impractical. The entire sample is consumed by this test; no other analyses may be performed using aliquots of the sample.

SECTION 10

DATA REDUCTION, VALIDATION, AND REPORTING

The procedures used for calculations and data reduction are specified in each analytical method referenced in Section 9. Raw data are entered in bound laboratory notebooks. A separate book is maintained for each analytical procedure. The data are entered such that sufficient space remains to enter all subsequent calculations required to arrive at the final (reported) value for each sample. Calculations include factors such as sample dilution ratios, corrections for blank readings and titrant normality, and conversion to dry-weight basis for solid samples. Instrument chart recordings and calculator printouts are labeled and attached to their respective pages except for voluminous gas chromatograph recordings which are cross-referenced and stored in a separate filing cabinet.

Calculations are checked from the raw data to final value stages prior to reporting the results of a group of samples. Results obtained from extreme ends of standard curves generated by linear regression calculator programs are checked against graphically-produced standard curves if the correlation coefficient of a program curve is less than 0.995.

Data are generally reported as milligrams of analyte per liter for aqueous samples or milligrams per kilogram for solid or non-aqueous liquid samples. Concentration units are always listed on reports and any special conditions, such as dry weight conversions, are noted. The data reporting form also includes the unique sample number given each sample, details of sample collection including the client's identification number, and the dates of sample receipt and report preparation.

10.1 DATA REDUCTION

10.1.1 Target Compound List Compounds

The instrument performance test data will accompany the raw data during data reduction. The following criteria must be attained to make a qualitative identification of an organic pollutant:

- Characteristic ions for each compound of interest must maximize in the same or within one scan of each other.
- Retention time must occur within ±1 percent of the retention time of the authentic compound.
- Relative peak heights of the three characteristic ions in the Extracted Ion Current Profile (EICP) must fall within ±20 percent of the relative intensities of these ions in a reference mass spectrum. The reference mass spectrum can be obtained by a

analyzed in the GC/MS system or from a reference library.

- The entire mass spectrum of the compound of interest is compared to the reference compound.

Structural isomers having similar mass spectra can be explicitly identified only if the resolution between authentic isomers in a standard mix is acceptable. Acceptable resolution is achieved if the baseline-to-valley height between the isomers is less than 25 percent of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

When a compound has been identified, the quantitation of that compound is based on the integrated abundance from the EICP of the primary characteristic ion. The base peak ion of internal and surrogate standards is used. If the sample produces an interference for the first listed ion, a secondary ion is used to quantitate. Quantification is performed using internal standard techniques.

When the internal standard calibration procedure is used, the concentration in the sample is calculated by using the response factor (RF), as determined by the following equation:

$$\text{Concentration, g/L} = \frac{(A_s)\ (I_s)}{(A_{is})(Rf)(V_o)}$$

where: g/L = Grams per liter

A_s = Area of the characteristic ion for the parameter to be measured.

A_{is} = Area of the characteristic ion for the internal standard.

I_s = Amount of internal standard added to each extract (g)

V_o = Volume of water extracted (liters).

Rf = Response factor.

To ensure that reported data are accurate, all such resultant data are verified. Retention items and area counts are checked carefully for correct identification and accurate quantification.

10.1.2 Metals and Cyanide

The concentrations of metals determined by AAS measurements are obtained by comparison of absorbance value with those obtained from the analyses of known standards. A linear regression plot of absorbance vs. concentration is used to

known standards. A linear regression plot of absorbance vs. concentration is used to determine a concentration factor for linearity of response.

In the event of low spike recovery, the analysis is repeated using the method of standard additions to determine potential matrix interferences. CLP criteria are maintained for analyses of samples of similar matrix. The mean percentage recovery, and standard deviation from a minimum of 20 analyses are calculated. A warning limit of ±2 standard deviations from the mean and a control limit of ±3 standard deviations are used to establish the test is providing accurate data.

10.2 DATA VALIDATION

Data validation is the process of filtering data and accepting or rejecting it on the basis of sound criteria. All data that are used to support this project must be valid for the intended purpose(s). Project supervisory and QC personnel will use validation methods and criteria appropriate to the type of data and the purpose of the measurement. Records of all data will be maintained, even that judged to be an "outlying" or spurious value. The persons validating the data will have sufficient knowledge of the technical work to identify questionable values.

10.2.1 Field Data Validation

Field sampling date will be validated by the Contractor FOL and/or the Field QC Coordinator, based on their judgment of the representativeness of the sample, maintenance and cleanliness of sampling equipment, and adherence to the approved, written sample collection procedure.

The following criteria will be used to evaluate the field sampling data:

- Use of approved sampling procedures;
- Use of reagents that have conformed to QC specified criteria; and
- Proper chain-of-custody maintained.

10.2.2 Analytical Data Validation

Data from laboratory analyses will be validated by the selected laboratory's QC Coordinator using criteria outlined in the QAPP. Results from field and laboratory method blanks, duplicate samples, and internal QC samples will be used to validate analytical results. Analytical results on field blanks and duplicate field samples are also valuable for validation of sample collection data.

Figure 10-1 presents the analytical data validation and reporting scheme routinely used. The analytical data validation is a subset of the overall measurement data flow scheme, as shown in Figure 10-2.

The criteria listed below will be used to evaluate the analytical data:

- Use of approved analytical procedures;
- Use of properly operating and calibrated instrumentation;
- Acceptable results from analyses of laboratory control samples (i.e., the reported values should fall within the appropriate confidence interval for these samples); and

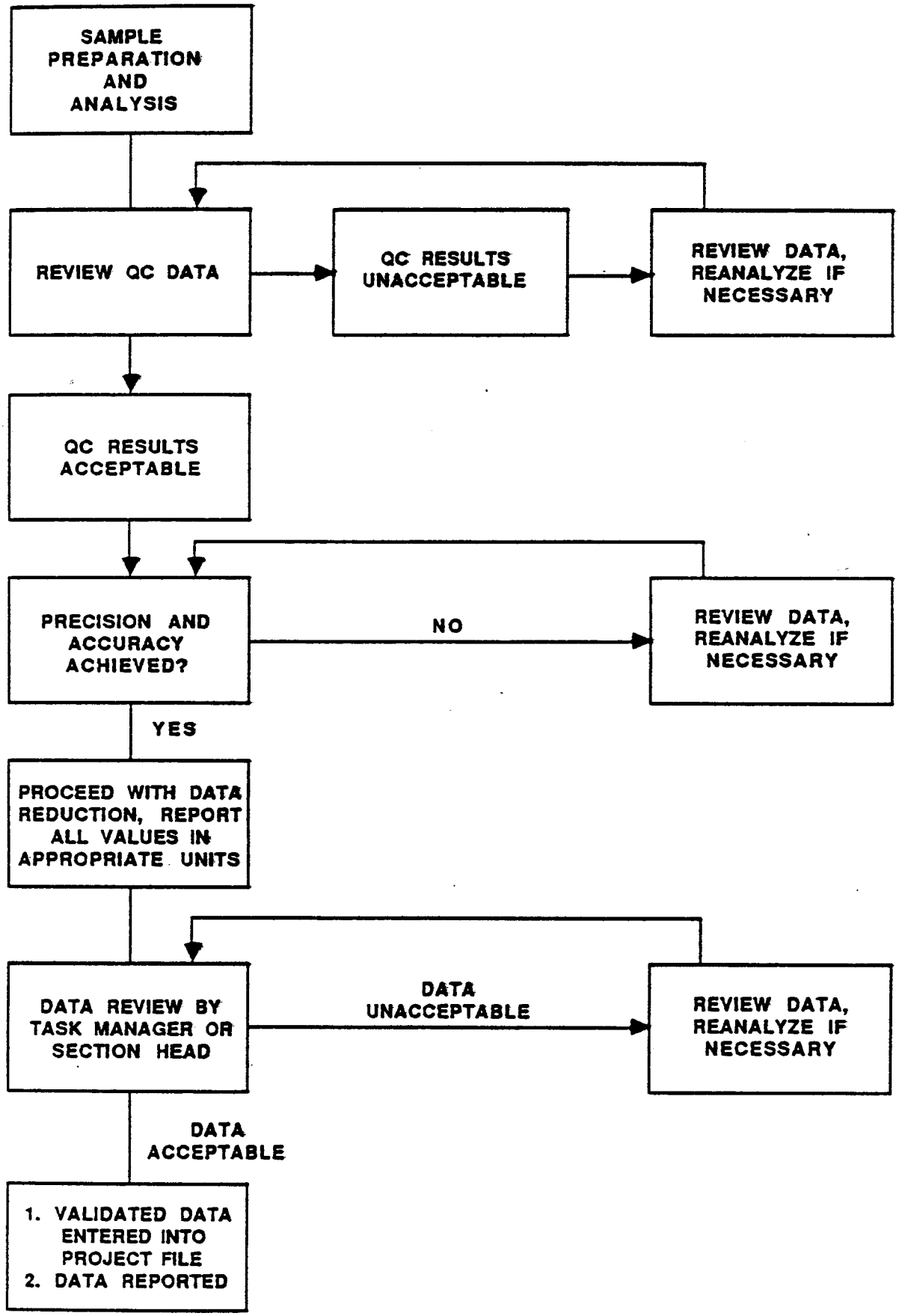

Figure 10 - 1. Analytical data validation and reporting scheme.

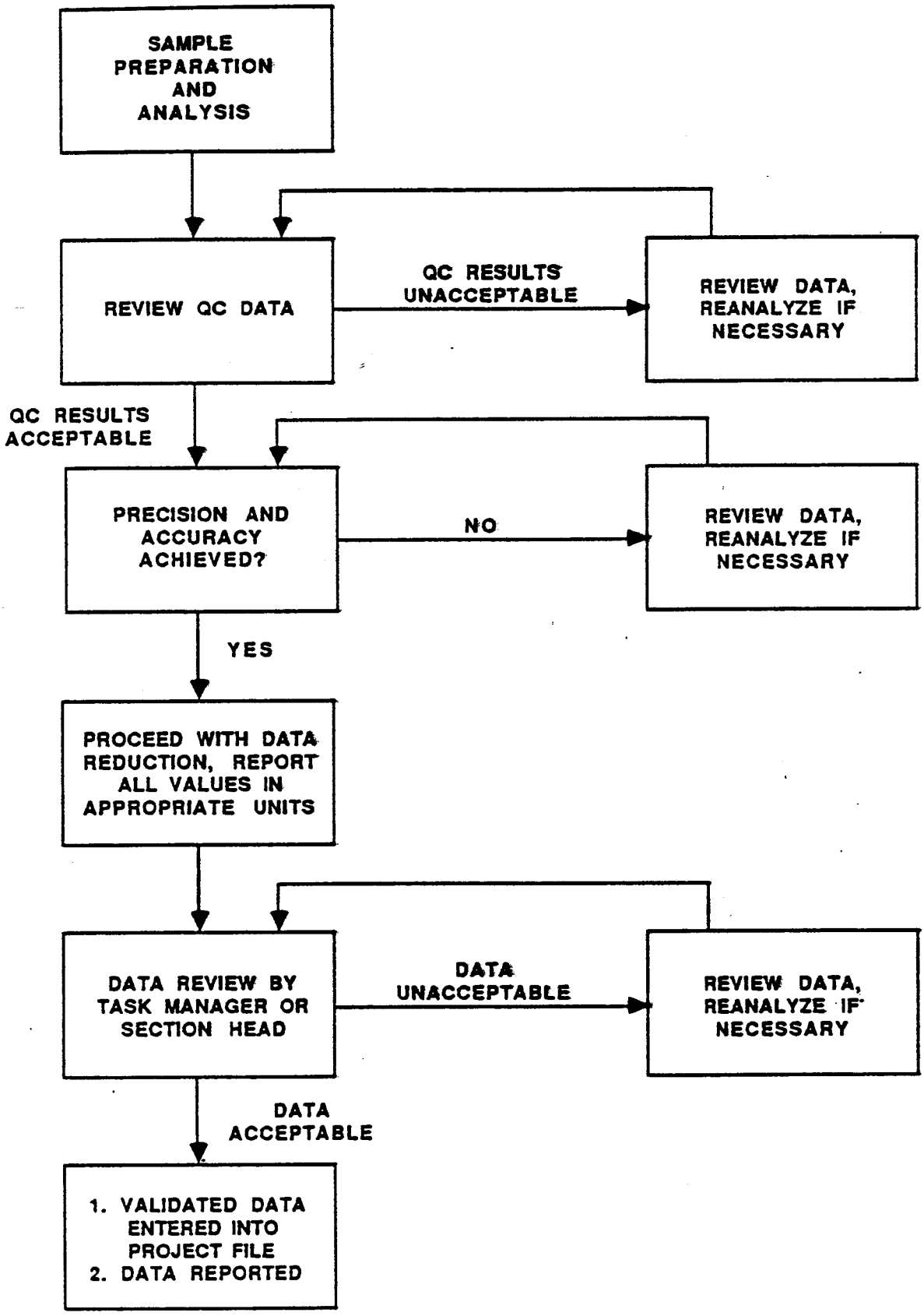

Figure 10 - 2. Analytical data reporting scheme.

- Precision and accuracy achieved should be comparable so that achieved in previous analytical programs and consistent with objectives stated in Section 3.0 of this QAPP.

Analytical data will be validated in accordance with the documents listed below:

- U.S. EPA, Laboratory Data Validation Functional Guidelines for Evaluating Organic Analysis, Technical Directive Document No. HQ-4810-01;
- U.S. EPA, Laboratory Data Validation Functional Guidelines for Evaluating Organic Analysis, Region V, October 1985; and
- U.S. EPA, Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analysis (Office of Emergency and Remedial Response).

For inorganic analyses, the following guidance from the above references is used to compare field and trip blanks with sample data:

> If a contaminant analyte is detected in samples at a concentration of less than five times the concentration found in the highest associated blank (preparation, field, or trip), these results should be considered suspect. The results should be flagged with a "J". This result should be discussed in the QC section of the final report.

For organics, the following guidance applies:

> No positive results are reported unless the concentration of the compound in the sample exceeds ten times the amount in any blank for the common contaminants or five times the amount of other compounds. The results should <u>not</u> be corrected by subtracting the blank value. Specific actions are as follows:
>
> 1. If common contaminant compounds are detected in samples at a concentration of less than ten times the concentration found in the blank, or other compounds at less than five times the concentration in the blank, report those compounds as not detected. Adjust the sample quantitation limit to the value reported in the sample and flag the limit as estimated (UJ).
>
> 2. If gross contamination exists (i.e., saturated peaks by GC/MS), all compounds affected should be reported as unusable (R) due to interference in all samples affected.

10.3 IDENTIFICATION AND TREATMENT OF OUTLIERS

Any data point which deviates markedly from others in its set of measurements will be investigated; however, the suspected outlier will be recorded and retained in the data set. One or both of the following tests will be used to identify outliers.

Dixon's test for extreme observations is an easily computed procedure for determine whether a single very large or very small value is consistent with the remaining data. The one-tailed t-test for difference may also be used in this case. It should be noted that these tests are designed for testing a single value. If more than one outlier is suspected in the same data set, other statistical sources will be consulted and the most appropriate test of hypothesis will be used and documented.

Since an outlier may result from unique circumstances at the time of sample analysis or data collection, those persons involved in the analysis and data reduction will be consulted. This may provide an experimental reason for the outlier. Further statistical analysis will be performed with and without the outlier to determine its effect on the conclusions. In many cases, two data sets will be reported, one including and one excluding the outlier.

In summary, every effort will be made to include the outlying values in the reported data. If the value is rejected, it will be identified as an outlier, reported with its data set and its omission noted.

10.4 REPORTING

Data reporting will following CLP procedures identified in the following references.:

- U.S. EPA Contract Laboratory Program, Statement of Work for Organic Analysis, July 1985 revision, Contract No. 68-01-7025, Solicitation No. WA 84A-267 (1FB); and
- U.S. EPA Contract Laboratory Program, Statement of Work for Inorganic Analysis, SOW No. 785, July 1985.

As a minimum, the laboratory report will show traceability to sample analyzed, and will contain the following information:

- Title of project;
- Project I.D. number;
- Name of report;
- Date of report preparation;

- Subcontractor's name, address, and telephone number;
- Sample I.D. number;
- Type of sample (water, soil, or waste);
- Analyses performed;
- Date sample collected; and
- Date sample analyzed.
- Results

SECTION 11
INTERNAL QUALITY CONTROL CHECKS AND FREQUENCY

Quality control checks will be performed to ensure the collection of representative samples and the generation of valid analytical results on these samples. These checks will be performed by project participants through the program under the guidance of the Contractor's QA Officer.

11.1 DATA COLLECTION AND SAMPLING QC PROCEDURES

The Contractor's internal QC checks for the sampling aspects of this program will include, but not be limited to, the following:

1. Use of field notebooks to ensure completeness, traceability, and comparability of the samples collected.

2. Field checking of field notebooks and sample labels by a second person to ensure accuracy and completeness.

3. Strict adherence to the sample chain-of-custody procedures outlined in Section 5.0 of the QAPP.

4. Submission of field biased blanks and equipment blanks.

Calibration of the field monitoring equipment (PID) will be performed daily. Equipment blanks of reagents and collection media (split-spoon samplers) will be prepared by rinsing the sampling device with pesticide-grade hexane which will then be analyzed in the same way as actual field samples, to provide a QC check on sampling device decontamination.

11.2 ANALYTICAL QC PROCEDURES

11.2.1 Trip (Bottle) Blank Analysis

Volatile organic samples are susceptible to contamination by diffusion of organic contaminants through the Teflon-faced silicone rubber septum of the sample vial. Therefore, trip (bottle) blanks will be analyzed to monitor for possible sample contamination during shipment. Trip (bottle) blanks will be prepared by filling two VOA vials from organic-free water and shipping the blanks with the field kit. Trip (bottle) blanks accompany the sample bottles through collection and shipment to the laboratory and are stored with the samples. Following the analyses, if the trip (bottle) blanks indicate possible contamination of the samples, depending upon the nature and extent of the

contamination, the samples may be corrected for the trip (bottle) blank concentration or the sources resampled. Results of trip blank analyses should be maintained with the corresponding sample analytical data in the project file.

11.2.2 Reagent Blank Analysis

A reagent blank is a volume of deionized, distilled laboratory water carried through the entire analytical procedure. The volume of the blank must be approximately equal to the sample volume processed. A reagent blank should be performed with each group of samples. Analysis of the blank verifies that method interferences caused by contaminants in solvents, reagents, glassware, and other sample processing hardware are known and minimized. Optimally, a reagent blank should meet CLP criteria. Results of reagent blank analyses will be maintained with the corresponding analytical data in the project file.

11.2.3 Duplicate Sample Analysis

Duplicate analyses are performed to evaluate the precision of an analysis. Results of the duplicate analyses are used to determine the relative percent differences between replicates samples. Field (blind) duplicate samples will be taken for each waste type (soil, ground water, surface water, and sediment). Duplicate analysis results will be summarized on the quality control data summary form.

11.2.4 Verification/Reference Standard

On a quarterly basis, the selected laboratory Quality Control Coordinator will introduce a group of prepared verification samples, or standard reference materials, into the analytical testing regime. Results of these data will be summarized, evaluated, and presented to laboratory management for review and corrective actions, if appropriate.

11.2.5 Other Laboratory Quality Control Checks

Quality control checks will be performed to ensure the collection of representative samples and the generation of valid analytical results on these samples. These checks are performed by project participants under the guidance of QC personnel. The selected laboratory's SOP (Appendix A) outlines these checks in further detail.

The selected laboratory will make use of different types of QC samples to document the validity of the generated data. The following types of QC samples are routinely used:

- Calibration Check Samples--One of the working calibration standards which is periodically used to check that the original calibration is still valid.

- Spiked Samples--Replicate aliquot of project samples are spiked with components of interest and carried through the entire preparative and analytical scheme.

- Laboratory Control Samples (LCS)--These samples are prepared from EPA Environmental Monitoring Systems Laboratory (EMSL) concentrates or NBS standard reference materials. The LCS are used to establish that an instrument or procedure is in control. An LCS is normally carried through the entire sample preparation and analysis procedure.

- Surrogate Spikes--Samples requiring analysis by GC/MS are routinely surrogate-spiked with a series of deuterated analogues of the components of interest. It is anticipated that these compounds would assess the behavior of actual components in individual program samples during the entire preparation and analysis scheme.

- Matrix Spikes/Matrix Spike Duplicates (MS/MSD)--One MS/MSD pair will be run per 20 samples for each different matrix analyzed. These pairs will be spiked with the target compounds of concern for that matrix.

All values which fall outside the QC limits described in the analytical method will be noted. The following guidelines will be used at the selected laboratory to check recovery values which fall outside the QC limits:

1. All recovery data are evaluated to determine if the QC limits are appropriate and if a problem may exist even though the limits are being achieved (e.g., one compound that is consistently barely within the lower limit).

2. All recovery data which are outside the established limits are evaluated. This evaluation includes an independent check of the calculation.

3. Corrective action is performed if any of the following are observed:

   - All recovery values in any one analysis are outside the established limits.

   - Over 50 percent of the values for a given sample set are outside limits.

   - One compound is outside the limits in over 50 percent of the samples.

The type and frequency of use of each of these QC measures at the selected laboratory's listed in Table 11-1.

Reagents used in the laboratory are normally of analytical reagent grade or higher purity; each lot of acid or solvent used is checked for acceptability prior to laboratory use. All reagents are labeled with the date received and date opened. All glassware is precleaned according to

specifications contained in the analytical method. Standard laboratory practices for laboratory cleanliness, personnel training, and other general procedures are used.

TABLE 11-1. LABORATORY QUALITY CONTROL ANALYSES

Analysis type	Frequency[a]	Control
Organic analyses		
Blank	1	Surrogate compounds
LCS and/or spiked blank	1	% recovery, analytes of interest
Duplicate	1	RPD
Matrix spike	1	% recovery of target analyte(s)
Matrix spike duplicate	1	RPD and % recovery
Inorganic Analyses		
Blank	1	No contamination
LCS and/or spiked blank	1	% recovery, analytes of interest
Duplicate	1	RPD
Matrix spike	1	% recovery of target analyte(s)

[a]Frequency is based on a batch of 20 samples or less of a similar matrix or whenever samples are extracted, whichever is more frequent.

LCS - Laboratory Control Sample

RPD - Relative Percent Difference

11.2.6 Laboratory Control Charts

The control chart displays data in a form which graphically compares the variability of all test results with the average or expected variability of small groups of data. The variability may be due to random (indeterminate) or to assignable (determinate) causes. The control chart distinguishes indeterminate from determinate variation in a process or method by its control limits. If a value falls outside the control limits, it is considered out-of-control, almost certainly due to a determinate cause which has been added to the indeterminate variations. The control chart signals the need to investigate, find the determinate cause and correct it.

The selected laboratory will use the Shewhart type of chart with control limits calculated on the basis of the mean plus of minus 2 or 3 times the standard deviation of the statistic used. If only indeterminate variations are occurring and control limits are set at plus or minus 2 standard deviations, 95.5 percent of the plotted values will fall within the control limits. If plus or minus 3 standard deviations from the mean are used as control limits, 99.7 percent of the plotted values fall within these limits. When this happens, the process or method is considered in control. Construction of a control chart requires a minimum of 14 to 20 duplicate sets of data points (which limits its use).

QC samples and instrument calibrations lend themselves most readily to the gathering of the data. The selected laboratory will use X, R charts for plotting accuracy and precision of analytical QC samples. Calculation of control limits and the values are usually plotted chronologically so that trends or cycles can be readily detected. If QC sample measurements show an out-of-control condition, it can be expected that subsequent sample analyses might yield invalid data. The control chart is an effective indicator of the need for corrective action.

For volatile analyses performed by GC/MS and semivolatile organics, surrogate recoveries from the method blank are the control sample. For other organics (e.g., pesticides/PCBs), an LCS (spiked blank) is used to plot the control charts. An LCS is also used as the control point for inorganic analyses.

SECTION 12

PERFORMANCE AND SYSTEM AUDITS

The laboratory selected for this project is subjected to performance and system audits by U.S. EPA Region VI for approval/disapproval. The Contract Project Management Section (CPMS) of the Central Regional Laboratory (CRL) is responsible for these audits.

A quality assurance audit may be performed by the Base appointed QA Officer. The QA Officer will plan, schedule, and approve system and performance audits based upon procedures customized to the project requirements. The audits will be implemented to evaluate the capability and performance of project and subcontractor personnel, items, activities, and documentation. Drilling, installation of monitoring wells, equipment decontamination, and sampling activities will be observed. At times, the QA Officer may request additional personnel with specific expertise from company and/or project groups to assist in conducting performance audits. However, these personnel will not have participated in nor have responsibility for the direct work associated with the performance audits.

12.1 SYSTEM AUDITS

System audits, performed by the Base appointed QA Officer or designated alternate, will encompass evaluation of measurement system components to ascertain their appropriate selection and application. In addition, field and laboratory quality control procedures and associated documentation will be system audited. These audits will be performed once during the project; however, if conditions adverse to quality are denoted or if the project manager requests unscheduled audits, these activities will be instituted.

For analytical work to be done for the Cannon AFB Naval Shipyard RI/FS, an internal system audit shall be performed prior to starting such work and will include,

12.2 PERFORMANCE AUDITS

Performance audits will be conducted periodically through the life of the project to determine the accuracy and implementation of the measurement system(s) and parameter(s). As in system audits, the QA Officer or assigned alternate will exercise planned and scheduled performance audits with the understanding that unplanned audits may be implemented if requested. Performance audits will be performed once the measurement systems are operational and initially generating measurement data.

The Base appointed QA Officer handles QA/QC for the Air Force projects managed by HAZWRAP. The group audits each laboratory and sends out performance samples for volatiles, semivolatiles, pesticide/PCBs, and priority pollutant metals. The data is compared to other laboratories performing similar analysis. The data is compared to other laboratories performing similar analysis. The data

is compared at the 95 percent confidence interval. This is done annually, unless questions arise on the quality of data for specific projects. If questions arise, a follow-up audit is done.

The selected laboratory will be audited by the Base QA group. The selected laboratory will pass all the performance samples on the first attempt. Copies of the audit report, performance sample results, and the audit response to any deficiencies found will be on file at Energy Systems and available for EPA or project review. All deficiencies found in the laboratory will be corrected promptly.

The data generated is reviewed by the Base QA group prior to use. At least 10 percent of the data is examined from calibration to reporting. CLP requirements will be used in reviewing this data. The review will be done for this project. The Base QA group also assures that all out-of-control occurrences which affect data are documented in the final report.

As part of the laboratory in-house performance audits, the QA Coordinator will arrange the audits so that they are unknown to the project staff, or a different operator/analyst will perform the audit operation to ensure the independence of the quantitative results. The auditing frequency is based on past experience with particular sampling the analysis procedures and project needs. An audit rate ranging from 5 to 10 percent will be used and results plotted on control charts to permit continuous, rapid evaluation of QC effectiveness. Reference standards may randomly dispersed among samples awaiting analysis to check the analytical procedures. Data handling will be checked by using the original raw data and performing all necessary calculations and entry of data. The audit results will be recorded and compared with routinely obtained data. In addition, the U.S. EPA CLP officials will submit quarterly Performance Evaluation samples, as well as performing periodic visits for a complete audit.

SECTION 13

PREVENTIVE MAINTENANCE

13.1 PREVENTATIVE MAINTENANCE PROCEDURES

Field equipment, instruments, tools, gauges, and other items requiring preventative maintenance will be serviced in accordance with the manufacturer's specified recommendations and written procedure developed by the operators.

The selected laboratory will follow an orderly program of positive actions to prevent the failure of laboratory equipment or instruments during use. This preventative maintenance and careful calibration helps to assure accurate measurements from instrumentation. Routine maintenance procedures are followed for all instruments, glassware, deionized water, reagents and analytical balances. Specific procedures are outlined in the selected laboratory SOPs.

13.2 SCHEDULES

Manufacturer's procedures identify the schedule for servicing critical items in order to minimize the downtime of the measurement system. It will be the responsibility of the operator to adhere to this maintenance schedule and to arrange any necessary and prompt service as required. Service to the equipment, instruments, tools, gauges, etc., shall be performed by qualified personnel.

In the absence of any manufacturer's recommended maintenance criteria, a maintenance procedure will be developed by the operator based upon experience and previous use of the equipment.

13.3 RECORDS

Logs are maintained to record maintenance and service procedures and schedules. All maintenance records will be documented and traceable to the specific equipment, instruments, tools, and gauges. Records produced shall be reviewed, maintained, and filed by the operators at the laboratories and by the data and sample control personnel when and if equipment, instruments, tools and gauges are used at the sites. The project QA officer may audit these records to verify complete adherence to these procedures.

13.4 SPARE PARTS

Critical spare parts are maintained by the Contractor and the selected laboratory for field and analytical equipment, respectively. These spare parts are to be stored for availability and use in order to reduce the downtime.

SECTION 14

SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

Procedures used to assess data precision and accuracy are in accordance with 44 FR 69533 "Guidelines Establishing Test Procedures for the Analyses of Pollutants", Appendix III Example Quality Assurance and Quality Control Procedures for Organic Priority Pollutants", December 3, 1979. Completeness is recorded by comparing the number of parameters initially analyzed with the number of parameters successfully completed and validated. For this project a target, control limit of greater than 90 percent will be used.

14.1 ACCURACY

The percent recovery is calculated as:

$$\% = \frac{S_s - S_o}{S} \times 100$$

where: S_o = The background value, i.e., the value obtained by analyzing the sample.

S = Concentration of the spike added to the sample.

S_s = Value obtained by analyzing the sample with the spike added.

% = Percent recovery.

14.2 PRECISION

The relative percent difference is calculated as:

$$1/2 \times \frac{V_1 - V_2}{(V_1 + V_2)} \times 100 = \% \text{ difference}$$

where: V_1, V_2 = The two values obtained by analyzing the duplicate samples.

14.3 COMPLETENESS

Completeness will be reported as the percentage of all measurements made whose results are judged to be valid. The procedures to be used for validating data and determination of outliers are contained in Section 8.0 of this QAPP. The following formula will be used to estimate completeness:

$$C = 100 \frac{V}{T}$$

where: C = Percent completeness.

V = Number of measurements judged valid.

T = Total number of measurements.

SECTION 15

CORRECTIVE ACTION

The acceptance limits for the sampling and analyses under this program will be those stated in the method or defined by other means in the QAPP. Corrective actions are often immediate in nature, implemented by the analyst or Project Manager. The corrective action usually involves recalculations, reanalysis, or repeating sample collection.

15.1 IMMEDIATE CORRECTIVE ACTION

If an immediate corrective action can be taken, as part of normal operating procedures, the collection of poor quality data can be avoided. Instrument and equipment malfunctions are amenable to this type of action. QC procedures include troubleshooting guides and corrective action suggestions. The actions taken will be noted in field or laboratory notebooks, but no other formal documentation is required, unless further corrective action is necessary. These on-the-spot corrective actions are an everyday part of the QA/QC system.

Corrective action during the field sampling portion of a program is most often a result of equipment failure or an operator oversight and may require repeating a sampling run. Operator oversight is best avoided by having field crew members audit each others' work before and after a test. Every effort will be made by the FOL to ensure that all QC procedures are followed. If potential problems are not solved as an immediate corrective action, the Contractor will apply formalized long-term corrective action if necessary.

Corrective action for analytical work will include recalibration of instruments, reanalysis of known QC samples and, if necessary, reanalysis of actual field samples. Specific QC procedures and checklists are used to help analysts detect the need for corrective action. Technical experience will be valuable in alerting the operator to substandard data or malfunctioning equipment.

15.2 LONG-TERM CORRECTIVE ACTION

The need for long-term corrective action may be identified by standard procedures, control charts, performance or system audits. Any quality procedures which cannot be solved by immediate corrective action falls into the long-term category. The Contractor's QA system ensures that the quality problem is reported to the person responsible for correcting it, and who is part of a closed-loop action system and follow-up plan.

The essential steps in the closed-loop corrective action system are listed below:

- Identify and define the problem;
- Assign responsibility for investigating the problem;

- Investigate and determine the cause of the problem;
- Determine a corrective action to eliminate the problem;
- Assign and accept responsibility for implementing the corrective action
- Establish effectiveness of the corrective action and implement it; and
- Verify that the corrective action has eliminated the problem.

Documentation of the problem is important to the system. A Corrective Action Request Form is filled out by the person finding the quality problem. This form identifies the problem, possible causes, and the person responsible for action on the problem. The responsible persons may be an analyst, FOL, QC Coordinator, or the QA Officer. If no person is identified as responsible for action, the QA Officer investigates the situation and determines who is responsible in each case.

The Corrective Action Request Form includes a description of the corrective action planned and the date it was taken, and space for follow-up. The QA Officer checks to be sure that initial action has been taken and appears effective and, at an appropriate later date, checks again to see if the problem has been fully solved. The QA Officer receives a copy of all Corrective Action Forms and enters them in the Corrective Action Log. This permanent record aids the QA Officer in follow-up and makes any quality problems visible to management. The log may also prove valuable in listing a similar problem and its solution.

15.3 OUT-OF-CONTROL EVENTS AND CORRECTIVE ACTION

Procedures are outlined as to what corrective action is taken if an out-of-control event occurs, and how it is documented and used to improve laboratory performance. The documentation is easily used by all personnel and is part of routine laboratory procedure. Procedures for assuring that results for samples processed during out-of-control conditions are not reported are outlined. The conditions necessary to reestablish control and criteria for assuring the system is operating properly are also outlines.

It is recognized that several levels of out-of-control events may occur. Three examples are given with corrective actions to be taken:

1. Observations Corrected by Analyst at the Bench-- The calibration of an instrument is not linear. The analyst finds this and corrects it prior to continuing to analyze samples. The laboratory documents this event and notes that the corrective action was to recalibrate, and that no samples were affected as none were analyzed prior to calibration.

2. Corrective Actions Taken by Supervisor-- A matrix spike recovery is out-of-control and the laboratory supervisor finds this after the samples for the day have been analyzed. The supervisor documents that the laboratory blank spiked with surrogates or standards was in control and that other sample spikes were in control, therefore, no re-analysis of the sample is required.

3. Corrective Actions at the Receiving Level-- The sample container is broken. The analyst notes this and documents whether or not more sample is available. If no more sample is available, the Contractor is notified and the decision documented.

Corrective Action Request Form No. _____

Originator _____ Date _____

Person Responsible for Replying _____ Contract Involved _____

Description of problem and when identified: _____

State cause of problem, if known or suspected: _____

Sequence of Corrective Action: (If no responsible person is identified, notify QA Officer immediately. Submit all CA forms to QA Officer for initial approval of CA.)

State Date, Person, and Action Planned:

CA Initially Approved By: _____ Date: _____

Follow-up Dates _____

Final CA Approval By: _____ Date: _____

Information copies to:

RESPONSIBLE PERSON/QC COORDINATOR: _____

QA OFFICER: _____

PROJECT MANAGER: _____

Figure 15-1. Corrective action request form.

SECTION 16

QUALITY ASSURANCE REPORTS TO MANAGEMENT

16.1 INTERNAL CORPORATE REPORTS

The Project QC Coordinator will provide monthly reports of QC activities for the Contractor's QA Officer. These reports detail the results of quality control analysis, problems encountered, and any corrective action required.

All Corrective Action Forms will be submitted to the Contractor's QA Officer for initial approval of the corrective action planned. A copy will be provided to the appropriate technical division manager. All system audit reports will be provided to the Project Manager, Division Manager, and Corporate President.

16.2 The Selected Laboratory

The selected laboratory QC Coordinator will prepare written quarterly reports on QC activities for the laboratory Technical Director and QA Manager. These reports detail the results of QA procedures, problems encountered, and any corrective action which may have been required. All Corrective Action Forms are submitted to the QA Manager for initial approval of the planned corrective action, and a copy is provided to the Technical Director. All system audit reports are provided to the Technical Director.

Each data transmittal contains a summary of QA/QC activities; this summary will include:

- Estimates of precision, accuracy and completeness of data;
- Reports of performance and system audits;
- Quality problems found; and
- Corrective actions taken.

The final data report to the Contractor will include a summary of QA/QC activities during the project. The QC Coordinator and QA Manager will participate in preparing this report. The summary of QA/QC results for the analytical work conducted for Cannon AFB be included in the final RI and FS Reports.

COPY

CLOSURE AND POST CLOSURE PLAN FOR LANDFILL CELL NO. 3 AT CANNON AIR FORCE BASE

REVISED

FINAL

October 1988

REVISED

July 1992

Submitted to:

Headquarters Tactical Air Command/DEEV
Langley Air Force Base, Virginia 23665

Submitted by:

Hazardous Materials Technical Center
The Dynamac Building
11140 Rockville Pike
Rockville, Maryland 20852

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
INSTALLATIONON DESCRIPTION AND HISTORY	1
SITE PHYSICAL DESCRIPTION	3
Meteorology	3
Hydrology	6
Soils	8
Clovis Soils	10
Mansker Soils	10
Potter Soils	10
WASTE DISPOSAL AND MIGRATION	14
Maximum Inventory of Waste	14
Core Sample Results	15
Groundwater Monitoring Results	15
FINAL CLOSURE	17
General Design of the Final Cover	18
Gas Venting	25
Surface Drainage Control	27
Security of the Closed Cell	27
ESTIMATED CONSTRUCTION SCHEDULE	28

TABLE OF CONTENTS (Continued)

	Page
COMPLETION REPORT	28
Quality Assurance/Quality Control	30
Soil Cover Stabilization	35
Equipment Decontamination	37
Certification of Closure	37
Deed Recording	38
Survey Plat	38
POST CLOSURE MONITORING PLAN	38
Post Closure Groundwater Monitoring	39
Exhibit 1	44
Post Closure Cover Maintenance	47
Vent Monitoring	48
Inspection Schedule	48
REFERENCES	49
APPENDIX I	50
APPENDIX II	59
APPENDIX III	69

LIST OF FIGURES

		Page
1.	Location Map of Cannon AFB, Melrose Bombing Range, and Conchas Lake Recreation Annex	2
2.	Site Map of Cannon AFB	4
3.	Topography and Surface Drainage Map	7
4.	Soils Map	9
4a.	Core Sample Location Map	16
5.	Cross Section of Final Cover.	18
5a.	Edge Detail of Final Cover	19
5b.	Juncture New Soil Cap to Existing Soil Cap	20
6.	Gas Vent Cross Section	26
7.	Monitoring Well Locations for Landfill No 5	40
8.	Typical Monitoring Well Installation	41

LIST OF TABLES

		Page
1.	Meteorologicall Data Summary for Cannon AFB, New Mexico . . .	5
2.	Permeability Coefficients.	12
3.	Hazardous Waste Inventory	14
4.	Core Analyses	15
5.	Estimated Construction Schedule	29
6.	Earth Work Construction Inspection Methods	31
7.	Quality Assurance/Quality Control Testing Procedures	32
8.	Seed Mix	36
9.	EPA Interim Primary Drinking Water Standards	47

DEFINITIONS

The acronyms used in this report and their corresponding definitions are:

AFB	Air Force Base
EID	Environmental Improvement Division of New Mexico Health and Environment Department
ppb	parts per billion
ppm	parts per million
SCS	Soil Conservation Service
TOC	Total Organic Carbon
TOX	Total Organic Halogen
USAF	United States Air Force
USCS	Unified Soil Classification System

INTRODUCTION

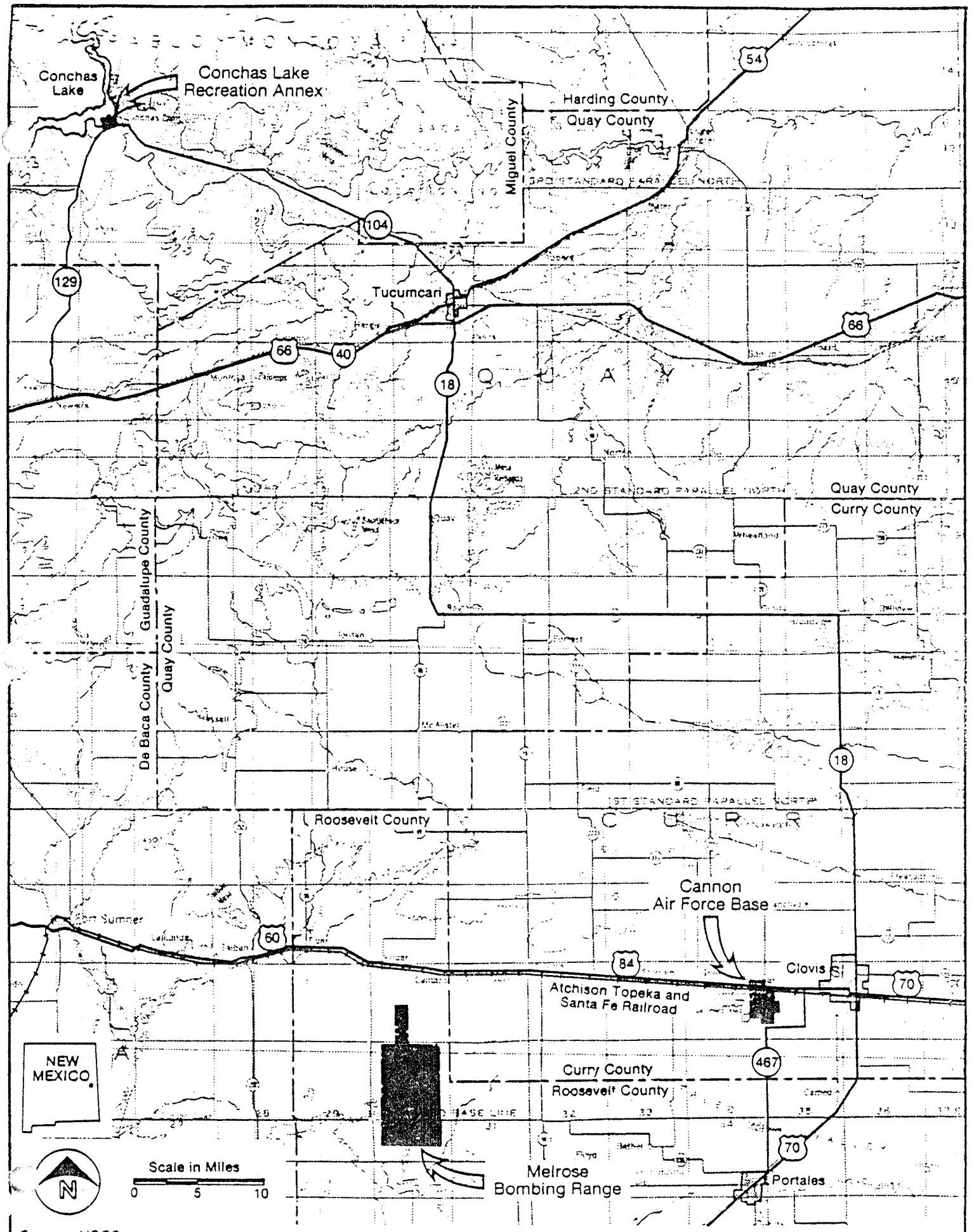
This amended approved closure plan is submitted in accordance with the requirements promulgated by the Federal Government and the State of New Mexico. Any facility that stores hazardous wastes for 90 days or longer, treats hazardous wastes, or disposes of such wastes must plan for eventual closure. This closure plan identifies all the steps that will be necessary to completely close Cell No. 3 at Landfill No. 5 at Cannon Air Force Base (CAFB). The owner or operator must complete closure activities in accordance with the submitted closure plan.

The amended closure plan is designed to conform to the closure performance standards (Section 206C, NMHWMR-4). Specifically, the plan ensures that Cell No. 3 will require minimum further maintenance and controls; provide long-term minimization of migration of liquids; promote drainage and minimize erosion and abrasion of the cover; accommodate settling and subsidence; and have a permeability less than or equal to the permeability of any bottom liner system of natural subsoils present. CAFB required that the cap be designed for ease of integration and tie-in to future landfill cell cap(s). The completed sanitary landfill site will be retained as grassland. All citations to the New Mexico Hazardous Waste Regulations are in reference to the New Mexico Hazardous Waste Management Regulation-6 (NMHWMR-6).

INSTALLATION DESCRIPTION AND HISTORY

Cannon AFB is located in Curry County, New Mexico, and is approximately 7 miles west of the city of Clovis (Figure 1). The base is situated on approximately 4,320 acres of land. Off-base facilities include the Melrose Bombing Range and the Conchas Lake Recreation Annex.

The history of Cannon AFB dates back to 1929, when Portair Field was established on the site. Portair Field was a civilian passenger terminal for early commercial transcontinental flights. In 1942, the Army Air Corps took control of the civilian airfield and it became known as the Clovis Army Air Base. In early 1945, the base was renamed Clovis Army Air Field. The installation was deactivated in May 1947. In July 1951, the base was assigned to the Tactical Air Command. The first units arrived in October of that year, but the airfield was formally reactivated in November 1951 as Clovis Air Force Base. In June 1957, the base became a permanent installation and was renamed Cannon Air Force Base in honor of the late General John K. Cannon, a former commander of the Tactical Air Command.



Source: USGS

FIGURE 1

Location Map of Cannon AFB, Melrose Bombing Range, and Conchas Lake Recreation Annex.

The primary mission of Cannon AFB has remained unchanged since 1965; that being to develop and maintain an F-111 fighter wing capable of day, night, and all-weather combat operations and to provide replacement training of combat aircrews for tactical organizations worldwide. Aircraft stationed at Cannon AFB since 1965 include the F-100 "Super Sabre" fighter jet, the F-111A, the F-111D, the F-111E, the F-111G, the F-111F, and the EF-111. The total work force at Cannon AFB is approximately 5,680. The major organizations at Cannon AFB are the 27th Support Group, the 27th Fighter Wing, and the 27th Medical Group.

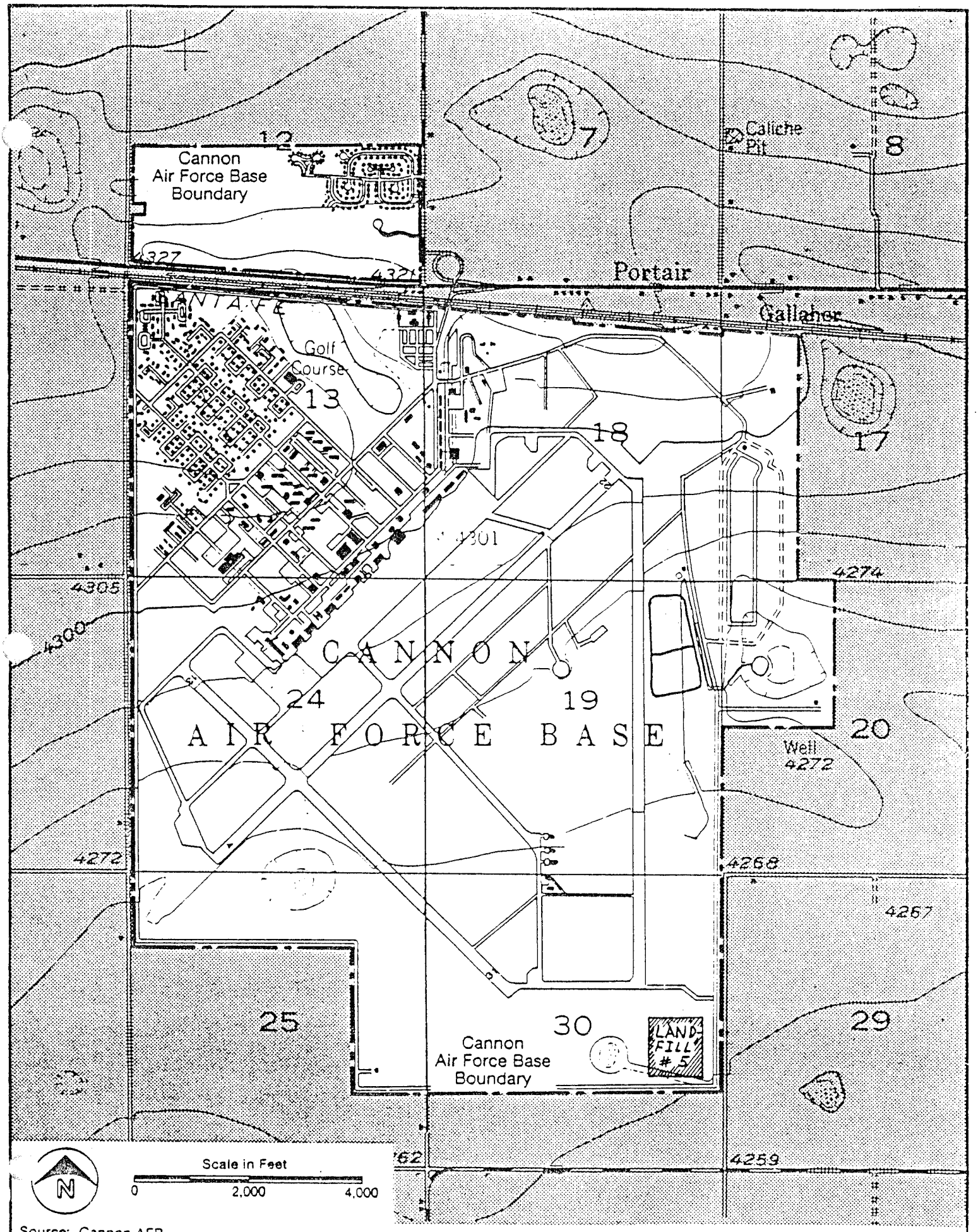
SITE PHYSICAL DESCRIPTION

Cannon AFB is located in the Southern High Plains section of the Great Plains physiographic region. The Southern High Plains includes parts of eastern New Mexico and western Texas and covers approximately 32,000 square miles. The section is a plateau, bounded on the north and west by cliffs as much as 300 feet above the surrounding area. The southern and eastern boundaries are less well defined.

Cannon AFB is situated near the center of this plateau and is typified by flat, featureless terrain with almost no relief. Elevations at the base range from 4,327 feet above sea level at the northwest corner to approximately 4,260 feet above sea level at the southeast corner where Landfill No. 5 is located (Figure 2). The base slopes very gently downward toward the southeast corner. The only features of relief occurring on the base are playas, sand dunes, and small stream valleys.

METEOROLOGY

The area around Cannon AFB is semiarid. (See Table 1 for meteorological data) The annual precipitation is approximately 14 inches; at Clovis, 7 miles east of the base, it is approximately 16 inches.



Source: Cannon AFB

FIGURE 2
Site Map of Cannon AFB.

TABLE 1. Meteorological Data Summary for Cannon AFB , N.M.

CB DATED OCT 81 OBSOLETE

PREPARED BY: USAFETAC
NOVEMBER 1986

STATION NAME: CANNON AFB NM
LOCATION : N34 23 W103 19

PERIOD: JAN 43-JUN 86 B
ELEV : 4295 FT

STN LTRS: KCVS
WSC NO: 722066

AWS CLIMATIC BRIEF

MONTH	TEMPERATURE (°F) MEAN DAILY MAX	MEAN DAILY MIN	MEAN MONTHLY	EXTREME MAX	EXTREME MIN	PRECIPITATION (IN) MONTHLY MEAN	MONTHLY MAX	MONTHLY MIN	MAX 24 HRS	SNOWFALL (IN) MONTHLY MEAN	MONTHLY MAX	MAX 24 HRS
JAN	53	25	39	77	-11	.4	1.4	.0	.9	3	12	8
FEB	54	28	42	80	1	.4	1.8	#	1.2	3	19	7
MAR	62	34	43	89	8	.5	2.4	#	1.3	2	12	7
APR	71	43	57	94	14	.7	2.1	.0	1.6	#	5	4
MAY	79	51	65	98	31	1.7	6.7	.1	2.0	#	1	1
JUN	88	61	74	106	42	2.2	5.5	#	2.5	0	0	0
JUL	90	65	78	105	55	2.7	11.4	.3	3.7	0	0	0
AUG	85	64	76	105	49	2.5	7.1	.2	4.8	0	0	0
SEP	81	57	69	100	29	1.7	5.9	#	3.0	0	0	0
OCT	71	46	59	95	22	1.5	6.2	.0	2.8	#	7	4
NOV	59	34	47	84	4	.5	2.1	#	1.7	2	12	5
DEC	51	27	39	77	-11	.4	1.9	#	.6	3	9	8
ANN	70	45	58	106	-11	15.2	11.4	.0	4.8	13	19	8
YR	39	39	39	39	39	36	36	36	36	36	36	36

MONTH	MEAN RELATIVE HUMIDITY (%) LST 07	13	MEAN VAPOR PRESSURE (IN Hg)	MEAN DEW PT (°F)	PRESSURE ALTITUDE (FT) 99.95%	SURFACE WINDS PVLG DRCTN (16 PT)	SPEED MEAN (KT)	SPEED MAX (KT) **	MEAN CLOUD COVER (tenths)	MEAN NUMBER OF DAYS OCCURRENCE OF: PRECIP (IN) ≥ 0.01	≥ 0.5	SNOWFALL (IN) ≥ 0.1	≥ 1.0	THUNDERSTORMS	FOG VSBY < 7 MI	TEMPERATURE (°F) MAX ≥ 95	MAX ≥ 90	MIN ≤ 32	MIN ≤ 20
JAN	68	45	.11	21	4750	W	8	60	5	3	#	2	1	#	6	0	0	26	8
FEB	68	42	.13	24	4750	W	8	61	5	3	#	2	1	#	7	0	0	20	4
MAR	61	33	.14	26	4900	W	9	73	5	3	#	1	#	1	5	0	0	13	2
APR	56	30	.18	32	4850	W	9	59	5	3	#	#	#	3	5	0	#	3	#
MAY	62	34	.27	42	4750	W	8	65	5	5	1	#	0	7	5	#	3	#	0
JUN	63	36	.39	52	4600	S	7	64	5	7	1	0	0	9	3	5	14	0	0
JUL	61	35	.45	56	4400	S	6	66	5	8	2	0	0	10	3	6	17	0	0
AUG	68	40	.47	57	4400	S	5	69	5	8	1	0	0	10	4	4	15	0	0
SEP	68	41	.38	51	4550	S	6	70	5	6	1	0	0	4	6	1	5	#	0
OCT	67	41	.25	40	4650	W	7	64	4	5	1	#	#	2	6	#	#	1	0
NOV	68	41	.16	29	4750	W	7	59	5	3	#	1	1	1	5	0	0	12	1
DEC	66	43	.12	22	4800	W	8	67	5	3	#	2	1	#	6	0	0	25	5
ANN	65	38	.23	38	4700	W	7	73	5	57	7	8	4	47	61	16	54	100	20
YR	10	10	10	10	10	10	10	34	10	36	36	36	36	36	36	39	39	39	39

REMARKS:

RUSSWO POR:
HOURLY OBS: JUL 76-JUN 86
SUMMARY OF DAY DATA: JAN 43-NOV 46, DEC 51-JUN 86

NOTE: * DATA NOT AVAILABLE # AMTS < UNITS SHOWN IN HEADING ** INSTANTANEOUS PEAK WINDS $ % CALM GRTR % PLVG. DRCTN @ BASED ON < FULL MONTHS

CAV FREQ (%)	HRS LST	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	YR
CEILING LESS THAN 3000 FT AND/OR VISIBILITY LESS THAN 3 MI	00-02	17	18	11	8	13	6	3	4	12	14	15	14	11	
	03-05	17	20	15	10	19	9	5	7	14	17	18	14	14	
	06-08	18	22	16	14	22	13	7	8	18	18	19	16	16	
	09-11	16	19	13	10	11	9	4	7	15	15	17	14	13	
	12-14	13	15	10	6	6	4	1	3	8	11	12	13	9	
	15-17	11	11	8	4	4	1	1	2	6	7	9	10	6	
	18-20	12	12	7	4	4	2	1	1	6	9	10	12	7	
	21-23	14	14	9	5	7	3	2	2	7	12	14	13	9	
	ALL HRS	15	16	11	8	11	6	3	4	11	13	14	13	10	10
CEILING LESS THAN 1500 FT AND/OR VISIBILITY LESS THAN 3 MI	00-02	14	16	9	5	9	5	3	3	9	11	13	12	9	
	03-05	14	18	11	8	14	7	4	6	11	14	15	12	11	
	06-08	16	20	13	10	16	10	5	6	14	14	16	13	13	
	09-11	14	16	10	6	6	3	2	4	9	11	15	12	9	
	12-14	11	11	5	3	3	2	#	1	5	5	8	10	5	
	15-17	10	8	5	2	3	1	1	1	5	4	6	8	5	
	18-20	10	9	4	3	3	1	1	1	4	6	8	10	5	
	21-23	12	13	8	4	5	2	1	2	6	9	11	12	7	
	ALL HRS	13	14	8	5	7	4	2	3	8	9	12	11	8	10
CEILING LESS THAN 1000 FT AND/OR VISIBILITY LESS THAN 2 MI	00-02	12	14	7	4	7	4	2	2	7	10	11	10	8	
	03-05	13	16	9	6	10	5	3	4	8	12	13	10	9	
	06-08	14	18	10	7	10	6	3	4	11	12	14	11	10	
	09-11	10	12	7	4	4	2	1	2	6	7	11	10	6	
	12-14	8	7	4	2	1	1	#	1	3	3	5	7	4	
	15-17	7	6	3	2	1	#	1	1	4	3	4	7	3	
	18-20	8	8	3	2	2	1	#	1	3	4	6	8	4	
	21-23	10	11	6	4	3	1	1	2	4	8	9	10	6	
	ALL HRS	10	12	6	4	5	3	1	2	6	7	9	9	6	10
CEILING LESS THAN 200 FT AND/OR VISIBILITY LESS THAN 1/2 MI	00-02	4	6	2	1	1	#	0	#	#	3	2	3	2	
	03-05	4	5	2	1	1	#	#	1	1	3	3	3	2	
	06-08	4	6	2	1	#	0	#	#	#	3	4	3	2	
	09-11	2	2	#	#	0	0	0	0	0	1	2	2	1	
	12-14	1	1	#	1	0	0	0	0	#	#	1	1	#	
	15-17	1	1	#	#	0	0	#	0	0	0	#	#	#	
	18-20	1	2	#	#	0	0	0	#	0	#	1	1	#	
	21-23	3	4	1	#	0	0	0	#	0	1	2	2	1	
	ALL HRS	3	3	1	1	#	#	#	#	#	1	2	2	1	10

The annual lake evaporation used to estimate the annual evapotranspiration rate, is about 69 inches per year. Therefore, the annual net precipitation, which is the annual precipitation minus annual evapotranspiration, is approximately minus 55 inches per year. The wettest months are during the summer, and virtually all of the precipitation is due to thunderstorms. Winters in the Cannon AFB area are relatively dry, with about 13 inches of snow occurring. Due to the warm temperature (average daily maximum of 51°F, snow usually melts within a 24-hour period.

During the summer, temperatures are cooler than in the lower elevations to the east, and the air is drier. The dryness is due to the "Marfa" or "dewpoint" front, which usually lies to the east. Whenever this front moves to the west of Cannon AFB, the relative humidity rises dramatically. Frontal passages throughout the year are normally dry and only contribute to gusty winds. The wind usually blows from the west during the winter and shifts to the south as the temperatures rise in the spring and summer. In the spring the winds gust to approximately 25 knots.

HYDROLOGY

Due to the low precipitation, the high evapotranspiration, and low relief, the area around Cannon AFB has poorly developed surface drainage systems (Figure 3). Cannon AFB lies at the headwaters of the Brazos River. Little, if any, water that falls as rain or snow at Cannon AFB ever reaches the river. Most of the rain or snow is lost to evapotranspiration and shallow infiltration. Most of the surface drainage from Cannon AFB is directed through a series of ditches to a large playa near the intersection of the primary NE-SW runway and the NW-SE runway. However, surface drainage in the vicinity of the landfill flows to the south during episodes of heavy rainfall. The Phase I IRP report states that a low potential for contaminant migration exists at Cannon AFB due primarily to: (1) depth to groundwater, (2) low precipitation, (3) high evapotranspiration rate, and (4) the occurrence of a very low permeability caliche layer under most of the base. In other words, very little precipitation is available for infiltration, and what little does infiltrate is impeded first by the cap and then by the caliche before it begins a descent of over 200 feet to the aquifer system.

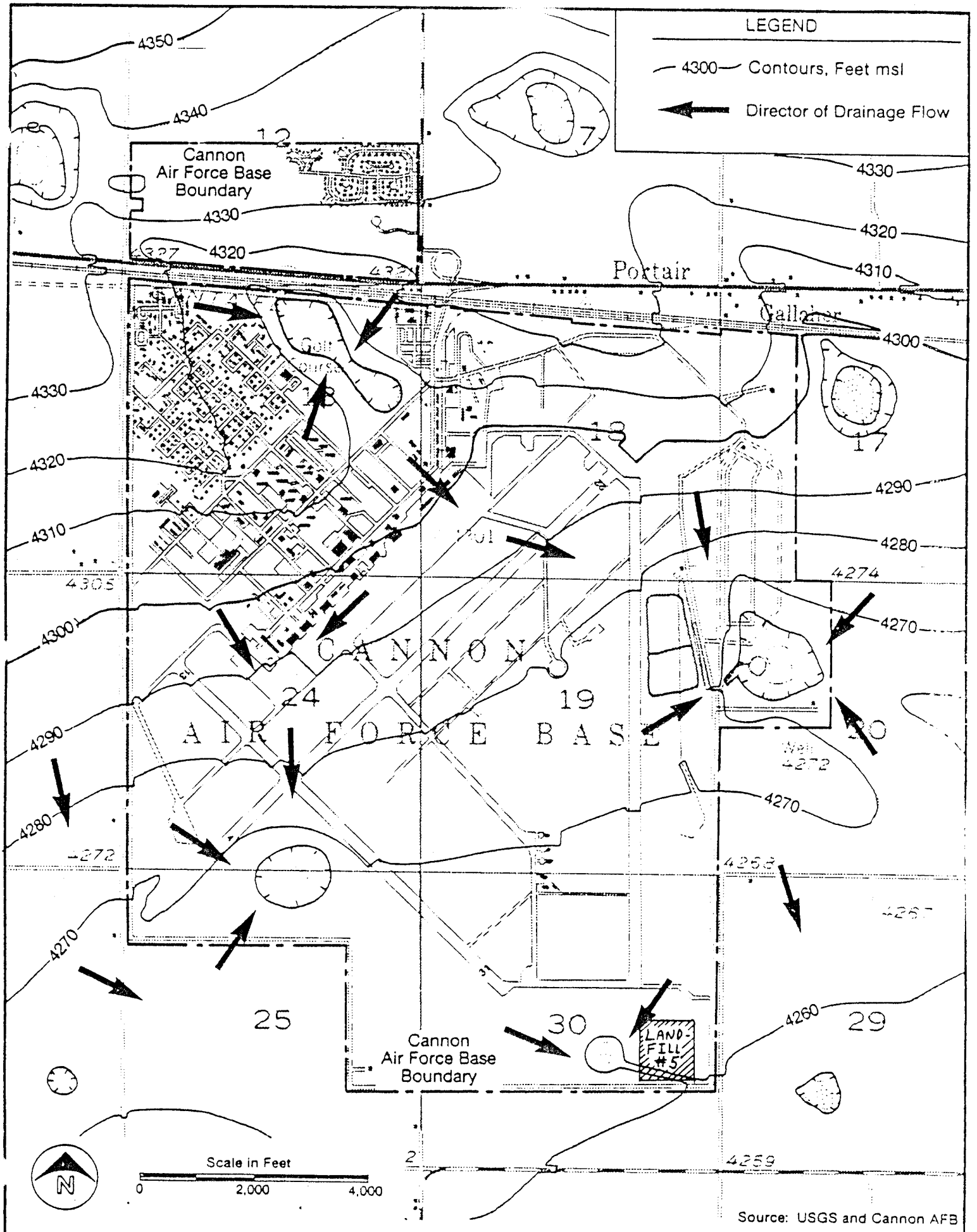


FIGURE 3
Topography and Surface Drainage Map.

Groundwater occurs under unconfined conditions at Cannon AFB. The base is underlaid by a portion of the High Plains Aquifer developed in the unconsolidated sediments of the Ogallala Formation. The High Plains Aquifer is the major and in some places the only source of water. The Ogallala Formation consists of clay, silt, fine to coarse grained sand, gravel, and caliche (calcium carbonate crusted soil). Groundwater quality within the Ogallala is acceptable for most uses. Water is typically hard and high in silica and fluoride. The potential for contamination of the High Plains Aquifer at Cannon AFB is low, because of the low rainfall, depth to water table, and the occurrence of a caliche layer of low permeability.

SOILS

The following is a general description of soils at Cannon AFB. (See Figure 4 for soils map.) The soils in question are Ab-Amarillo Fine Sandy Loam and Ag-Amarillo Loamy Fine Sand. The Amarillo loams resemble the Pullman loams with which they merged but the structure of their B horizon is not so strongly developed, and their profile is sandier throughout. Except that they are less sandy and their surface layers are thinner, the Amarillo loamy fine sands are like the Brownfield fine sands with which they merge. The Amarillo loamy fine sands are less sandy and are better developed structurally than the Springer loamy fine sands.

The Amarillo soils overlie a white chalky zone that begins at depths of 3 to 6 or more feet (but generally about 4 feet). From 40 to 70 percent of this zone is lime. The amount of lime in the profile above the chalky zone varies. The Amarillo fine sandy loams and loamy fine sands are deeper over calcareous material than the Amarillo loams. In places, the Amarillo loamy fine sands are noncalcareous to within 1 or 2 inches of the chalky zone. Some areas of the Amarillo loams are calcareous at a depth of about 18 inches.

The color of the surface soil ranges from brown to reddish brown in the Amarillo loams, through yellowish red in the loamy fine sands. The color of the subsoil ranges from dark reddish brown in some areas of Amarillo loam to yellowish red in the loamy fine sands.

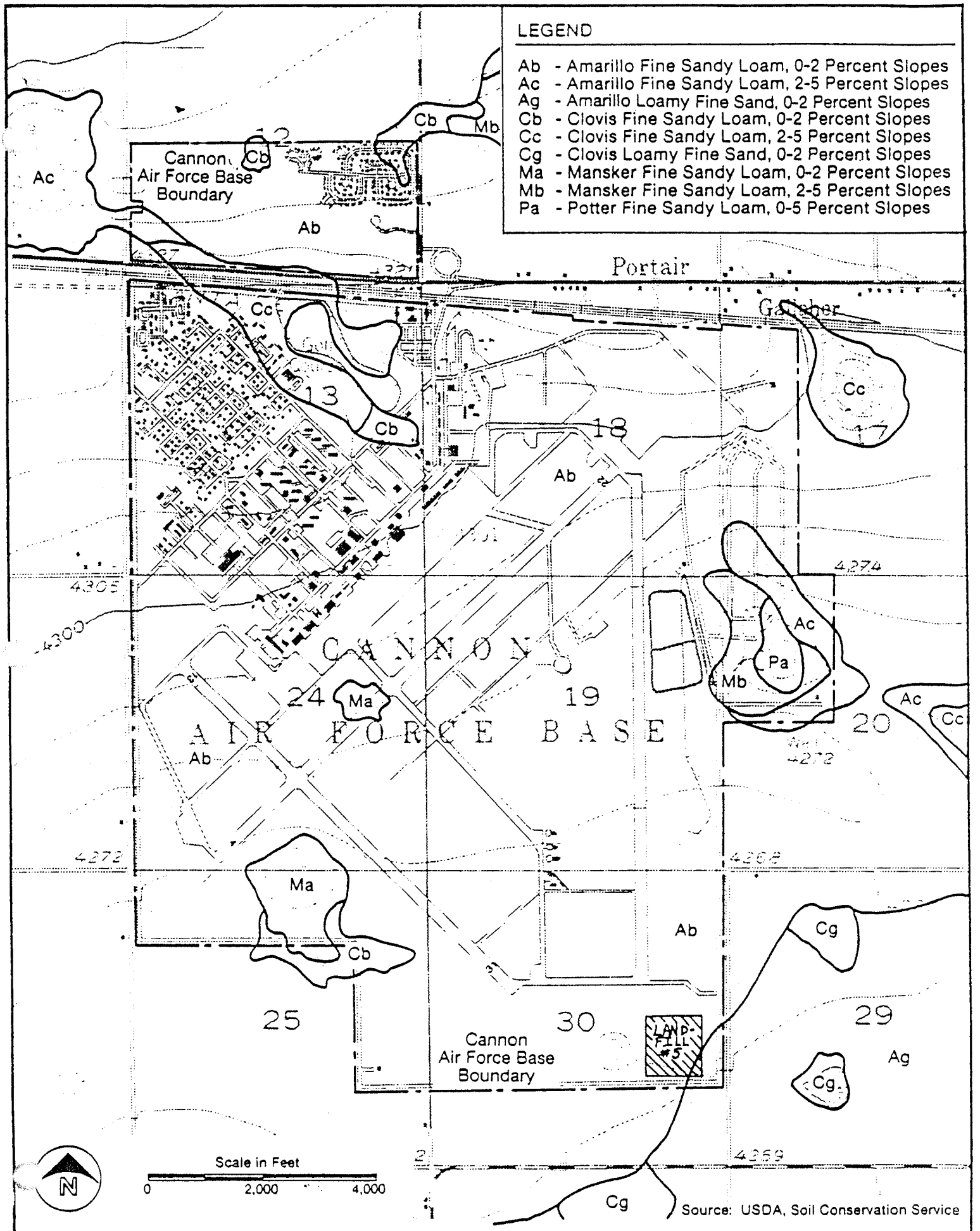


FIGURE 4
Soils Map.

Amarillo soils cover over 90 percent of Cannon AFB. Typical permeabilities are moderate and range from 1 x 10-3 to 4 x 10 -4 cm/sec.

Other soil associations occurring at Cannon AFB, primarily in the vicinity of playa "lakes." include Clovis soils, Mansker soils, and Potter soils. Together, these soil types account for less than 10 percent of the area at Cannon AFB. The Soil Conservation Service (SCS) describes these soils as follows.

Clovis Soils. These soils generally occur in small areas within broader areas of Amarillo soils. They occupy the upper margins of many of the draws and playas. The Clovis soils are similar to the Amarillo, but the chalky zone occurs at shallower depths (16 to 36 inches) and in many places the profile is not so well-developed. In Curry County, the Clovis series is represented by three soil types: they are Clovis loam, Clovis fine sandy loam, and Clovis loamy fine sand. The Clovis loams resemble the thin solum phases of the Pullman loams except for weaker structural development in the B horizon.

Mansker Soils. Mansker soils are strongly calcareous. They normally occupy the slopes of draws and playas. However, small, nearly level to gently sloping areas occur within larger areas of Pullman, Amarillo, and Clovis soils. The Mansker soils are extensive throughout Curry County. They have formed where the upper part of some other soil has been lost through erosion, and the strongly calcareous substratum has been exposed. These soils show very little profile development.

Potter Soils. The Potter soils are shallow and strongly calcareous. They overlie hard, consolidated caliche. The degree of cementation in the caliche varies. In some places, the caliche resembles limestone; in others, it consists of lime-cemented pebbles and nodules. The material from which these soils developed was mainly weathered caliche, but it was intermixed with wind-deposited materials. The Potter soils occur throughout the county, normally in areas of less than 100 acres. In many places, they are closely associated with the Mansker soils.

Permeability of all three soil types is toward the lower end of the range typical for the Amarillo soils.

At Cannon AFB, the soil layer is underlaid by a fairly thick (approximately 25 feet) caliche layer which is part of the Ogallala Formation. This caliche varies in depth and thickness across the base. Geologic logs indicate that caliche occurs as shallow as 2 feet below the surface and is up to 54 feet in thickness. Observations made at the current landfill operation (not the cell addressed in this report) indicate that the top of the caliche laver is approximately 5 feet below the surface and becomes harder with depth. In fact, at a depth of approximately 15 feet, heavy-duty earth-moving equipment could not penetrate the caliche.

Although there are no specific boring data for the landfill area, boring data do exist for much of the base, especially the northwest region of the base. Some inferences about boring data at the landfill are made by the Department of the Air Force Tactical Air Command, Cannon AFB, New Mexico, in their publication entitled, "Sanitary Landfill Design, Construction and Operations" 15 December 1976:

"Site Soils. No soils tests have been made at the landfill site; however, the uniformity of soil conditions in the area and on the base allow for fairly accurate prediction of site soil conditions from other soil borings. Inspection of the existing 16-foot deep trench verifies the textural classification expected loamy fine sand or fine sandy loam underlain by sandy clay loam and light sandy clay loam with caliche pockets. Under the Unified Soil Classification System (USCS), the predominate soils are SC, CL, or combinations of them with some areas of SM or ML and a few pockets of GP, GL, GC. and caliche."

Of particular interest is the frequent occurrence of clay with intermittent layers of caliche in the boring profiles (uses Type CL). Examination of the profiles reveals that approximately 70 percent of the 191 borings taken show clay in the top 10 feet of the borings. The profile chart describes the clay as inorganic clav of low to medium elasticity. Table 2 shows that clays, especially colloidal clay, has the lowest permeability coefficient.

In the case of this particular landfill, the underlying material is caliche. While it is generally understood that caliche is very impermeable, a question arises as to the complete occlusive properties of large expanses of caliche.

Table 2. Permeability Coefficients

Typical Values of Permeability Coefficients

		PARTICLE SIZE RANGE				"EFFECTIVE" SIZE		PERMEABILITY COEFFICIENT—k		
		Inches		Millimeters						
		$D_{max.}$	D_{min}	D_{max}	D_{min}	D_{20} in.	D_{10} mm.	Ft./yr.	Ft./mo.	Cm./sec.
TURBULENT FLOW	Derrick STONE	120	36	—	—	48	—	100×10^6	100×10^5	100
	One-man STONE	12	4	—	—	6	—	30×10^6	30×10^5	30
	Clean, fine to coarse GRAVEL	3	1/4	80	10	1/2	—	10×10^6	10×10^5	10
	Fine, uniform GRAVEL	3/8	1/16	8	1.5	1/8	—	5×10^6	5×10^5	5
	Very coarse, clean, uniform SAND	1/8	1/32	3	0.8	1/16	—	3×10^6	3×10^5	3
LAMINAR FLOW	Uniform, coarse SAND	1/8	1/64	2	0.5	—	0.6	0.4×10^6	0.4×10^5	0.4
	Uniform, medium SAND	—	—	0.5	0.25	—	0.3	0.1×10^6	0.1×10^5	0.1
	Clean, well-graded SAND & GRAVEL	—	—	10	0.05	—	0.1	0.01×10^6	0.01×10^5	0.01
	Uniform, fine SAND	—	—	0.25	0.05	—	0.06	4000	400	40×10^{-4}
	Well-graded, silty SAND & GRAVEL	—	—	5	0.01	—	0.02	400	40	4×10^{-4}
	Silty SAND	—	—	2	0.005	—	0.01	100	10	10^{-4}
	Uniform SILT	—	—	0.05	0.005	—	0.006	50	5	0.5×10^{-4}
	Sandy CLAY	—	—	1.0	0.001	—	0.002	5	0.5	0.05×10^{-4}
	Silty CLAY	—	—	0.05	0.001	—	0.0015	1	0.1	0.01×10^{-4}
	CLAY (30 to 50% clay sizes)	—	—	0.05	0.0005	—	0.0008	0.1	0.01	0.001×10^{-4}
	Colloidal CLAY ($-2\mu \geq 50\%$)	—	—	0.01	10Å	—	40Å	0.001	10^{-4}	10^{-9}

On the basis of available data and field experience, the caliche occurring at the landfill site is probably young in nature and not entirely cemented. This would lead to the belief that the caliche formations here would exhibit some permeability, albeit low. While caliche in and of itself can be very impermeable. One would expect that a large expanse of the material would exhibit many fractures due to its relative hardness and brittle characteristics if mature, and incomplete cementation if young. Hence, while the material itself is very impermeable, these fractures would afford avenues for some percolation to occur.

The following is a description of caliche that is characteristic of the Central High Plains region of New Mexico where Cannon AFB is located which supports these conclusions (New Mexico State Highway Department. "Geology and Aggregate Resources, District 11," 1972).

> Many geologists believe that the Central High Plains and the Llano Estacado are universally underlaid by caliche deposits, but anyone who has had an occasion to explore this hypothesis on the working end of a jack-hammer will disagree, at least about the top 25 to 50 feet. Nevertheless, exposures along the escarpment indicate that some form of caliche does exist below a large part of these surfaces. The stages of development of these caliche profiles will vary from very youthful to late in maturity. As previously mentioned, some of the profiles may be over one million years old. Some of the older profiles have undergone attacks from solution and weathering and, therefore can be expected to be extremely discontinuous across the plain. Although these surfaces have remained quite stable for hundreds of thousands of years, aggradation and degradiation have continued at a slow steady pace. The result, considering the climatic fluctuations of the past one million years has been degradation and recementation of the profiles on the windward and uphill side of the plains and aggradation on the lee side of the plains. The rock-house type structure being more common in older profiles, and lamination more common in younger profiles. Perhaps this helps explain the variations in soundness, loss, and Los Angeles abrasion test values from different locations across the plains or even within a local pit area."

WASTE DISPOSAL AND MIGRATION

MAXIMUM INVENTORY OF WASTE

Landfill No. 5 began operation in 1968 and is in current use. The site is located in the southeast corner of the base and covers approximately 30 acres. Cell No. 3, the specific cell for which this closure plan is applicable, was closed in 1981. The cell covers an area of approximate dimensions 800 feet long by 50 feet wide.

Materials received at this landfill in 1981 are similar to those received at the former base landfills and include waste oils and solvents, paints, paint removers and thinners, pesticide containers, empty cans, and general construction debris. Materials from drums were generally deposited on absorbent materials placed in the cell. The drums were then reclaimed for reuse.

From 1968 to about 1972, wastes were burned and then buried in cells. Since 1972, the standard procedure has been direct burial of the wastes in cells. There are 11 covered cells at the site. No volatile organics were found in Cell No. 3. The estimated maximum inventory of hazardous waste in Cell No. 3 is shown in Table 3.

Table 3. Hazardous Waste Inventory

Hazardous Waste	Percent	Amount in Pounds
Methyl ethyl ketone	39.6	3,564
Toluene	43.4	3,906
Methyl isobutyl ketone	10.4	936
Cyclohexanone	2.4	216
Xylene	1.6	144
Ethylene glycol monobutyl ether	1.6	144
Lead	0.6	54
Chromate	0.4	36

CORE SAMPLE RESULTS

Two 9-inch diameter cores of 40-foot depth were removed from the landfill cell on January 22, 1985. (Figure 4a) Six samples from each core depths of 10, 15, 20, 25, 30, and 40 feet were analyzed for chromium, lead, arsenic, tin, mercury, and volatile organics. The metals analyses were accomplished by nitric acid digestion/atomic adsorption spectroscopy and the volatile organics were analyzed using gas chromatograph mass spectrometry. Table 4 summarizes the composite results of these analyses.

TABLE 4. Core Analyses

Constituent	Concentration (Dpm)	Detection Limit (ppm)
Chromium	14 - 36	0.005
Lead	0.2 - 10.5	0.001
Arsenic	3.70 - 9.61	0.002
Tin	0.5 - 2.0	0.002
Mercury	0.04 - 0.68	0.002
Volatile Organics	0.01	0.01

The metal levels appear to be high in these analytical results, but this is not significant because the lowest level of the value ranges are reached at the 40-foot depth. Very little would be available to groundwater which is 200 feet deeper still.

GROUNDWATER MONITORING RESULTS

Four groundwater monitoring wells (A,B,C,and D) were installed near the landfill cell during December 1984 and January 1985. Two additional wells (I and J) were installed in 1988; and the final two wells (L and M) were installed in 1992. Wells A, I, L and M are currently being monitored. Monitoring of wells A,B,C, and D began with first-quarter samples taken on January 25, 1985. For indicator parameters (pH, specific conductance, TOC, and TOX), heavy metals, pesticides, endrin, lindane, methoxychlor, toxaphene, 2, 4-D and 2, 4, 5-TP-Silvex, radioactivity, coliform bacteria, chloride, iron, manganese, phenols, sodium, and sulfate

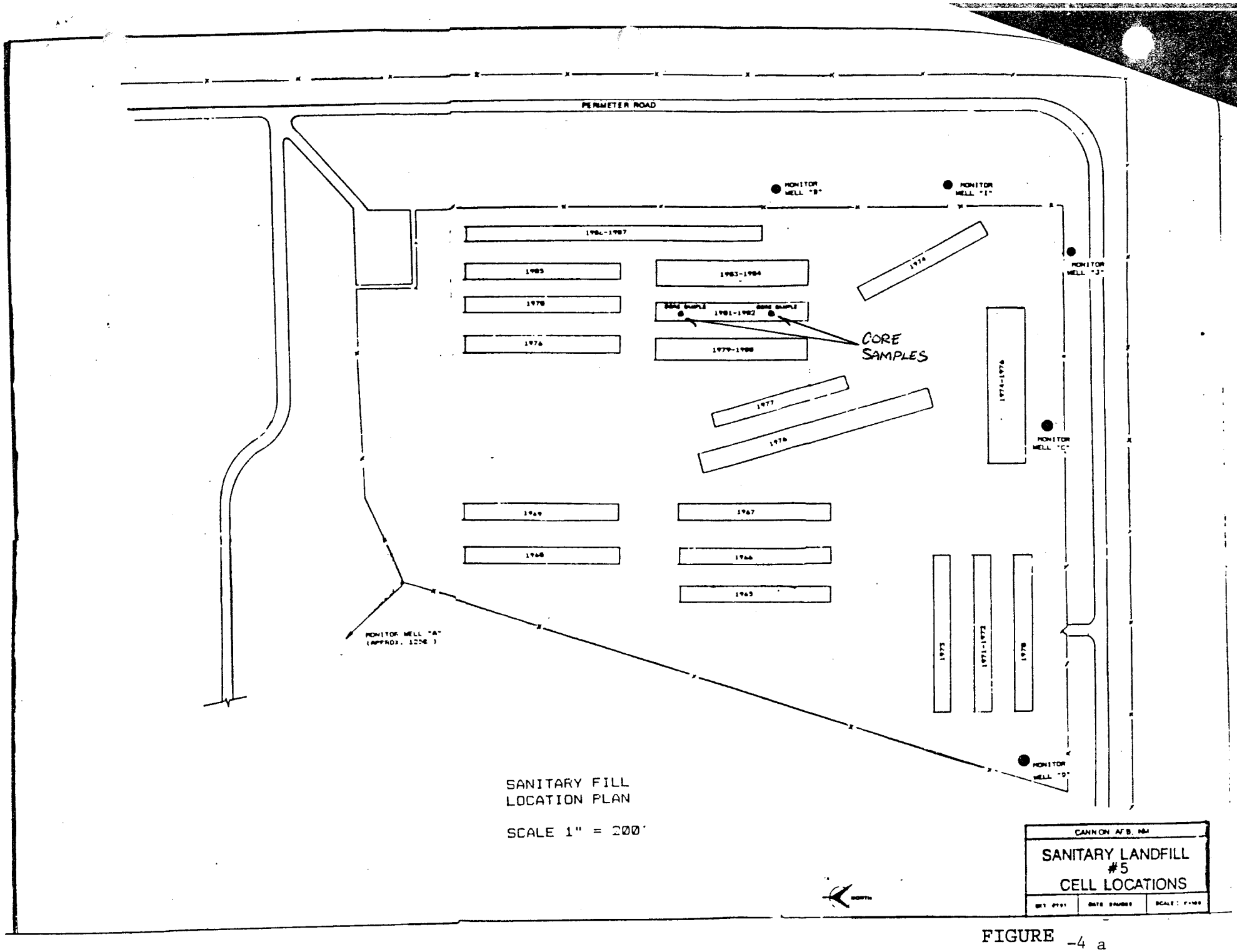


FIGURE -4 a

REPRODUCED AT GOVERNMENT EXPENSE

the sample analyses show that there are no significant increases over background levels of groundwater constituents evidenced in the three downgradient wells compared to the upgradient well. Preliminary examination of data from analyses of second quarter groundwater samples received by the laboratory on April 30, 1985, indicates that there continues to be no significant increase over background levels of groundwater constituents in the vicinity of landfill Cell No. 3. (See post closure groundwater monitoring section for details about monitoring well locations.)

FINAL CLOSURE

Final closure of the landfill cell will involve covering it with a combination Sodium Bentonite clay liner, high density polyethylene (HDPE) liner,and soil protective cover. The combination cover will keep liquids from reaching the cell contents, thus minimizing leachate generation and also will prevent any wastes present in the cell from coming in contact with the above-ground environment. A post closure maintenance inspection program will guarantee the integrity of the protective cover.

A discussion of the general design of the final protective cover follows. Figures 5, 5a, 5b illustrate the proposed components of the cover structure for Cell No. 3 in a cross-sectional view.

GENERAL DESIGN OF THE FINAL COVER

The final cover was chosen with the following considerations:

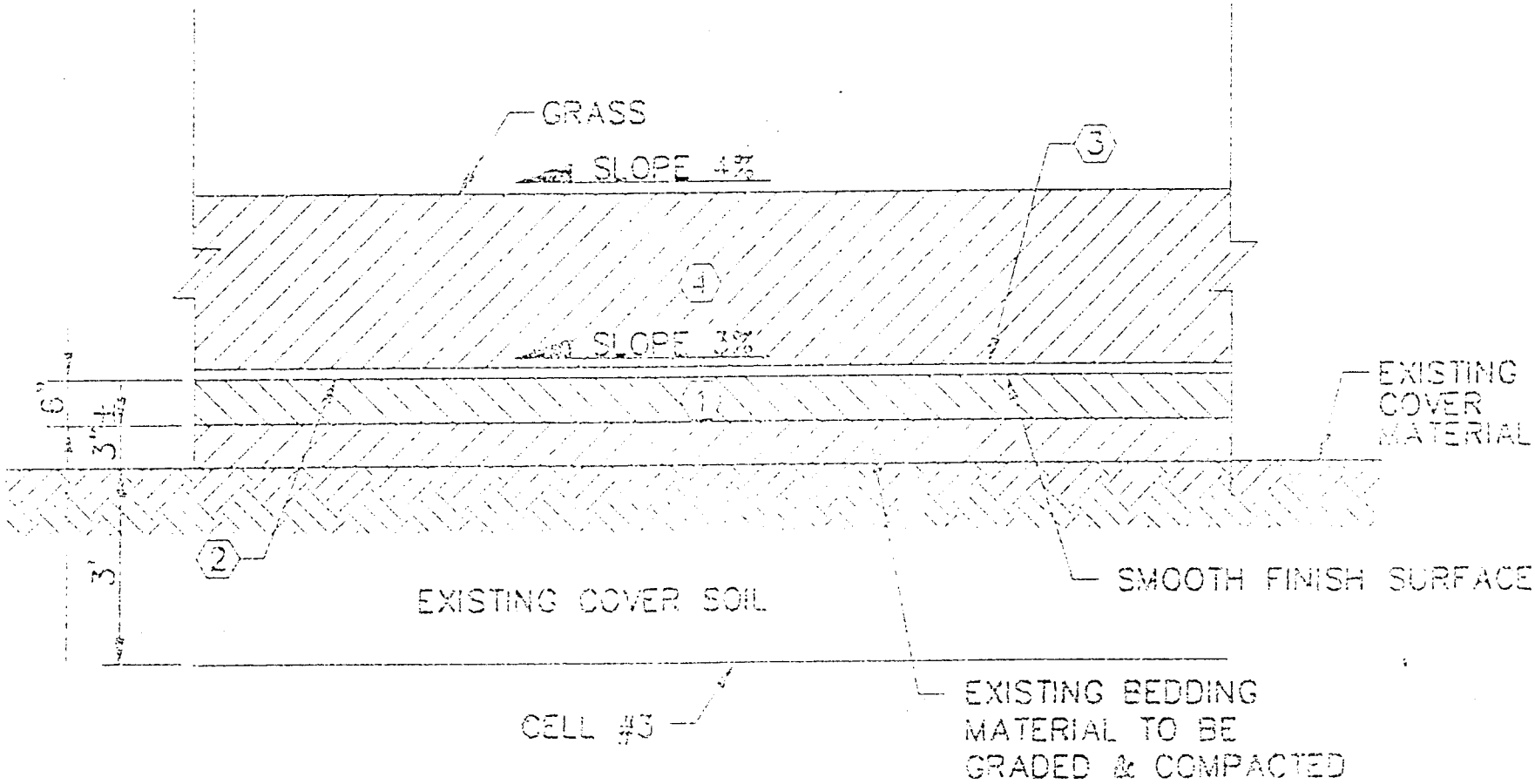
(1) Long-term minimization of liquid migration through the closed landfill;

(2) Minimum maintenance requirements;

(3) Promotion of drainage and minimization of cover erosion;

(4) Accommodation of settling and subsidence; and

(5) Obtaining a cover that will act as seal against passage of fluids.

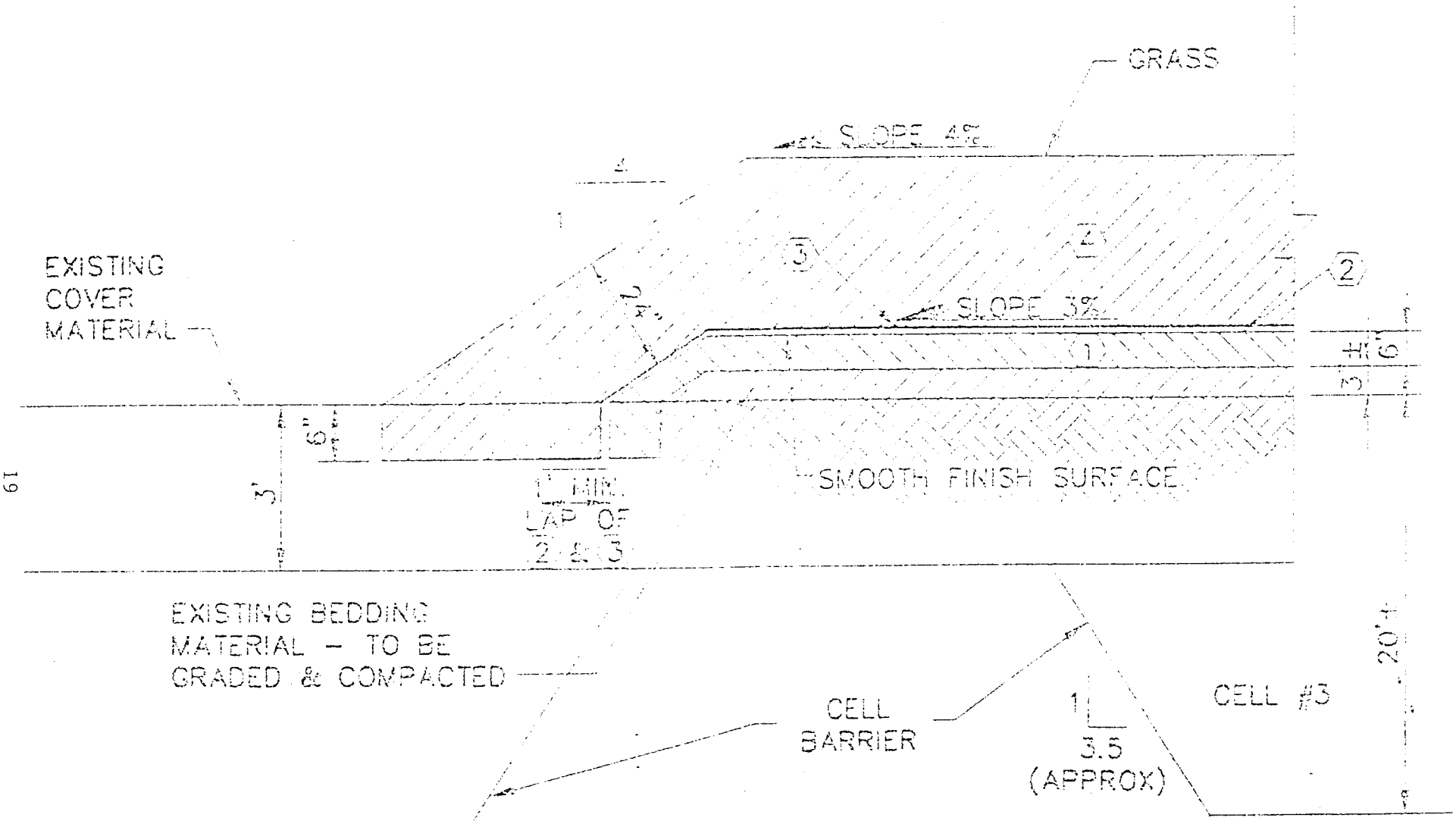


TYPICAL CROSS SECTION A

N.T.S.

C3 | C5

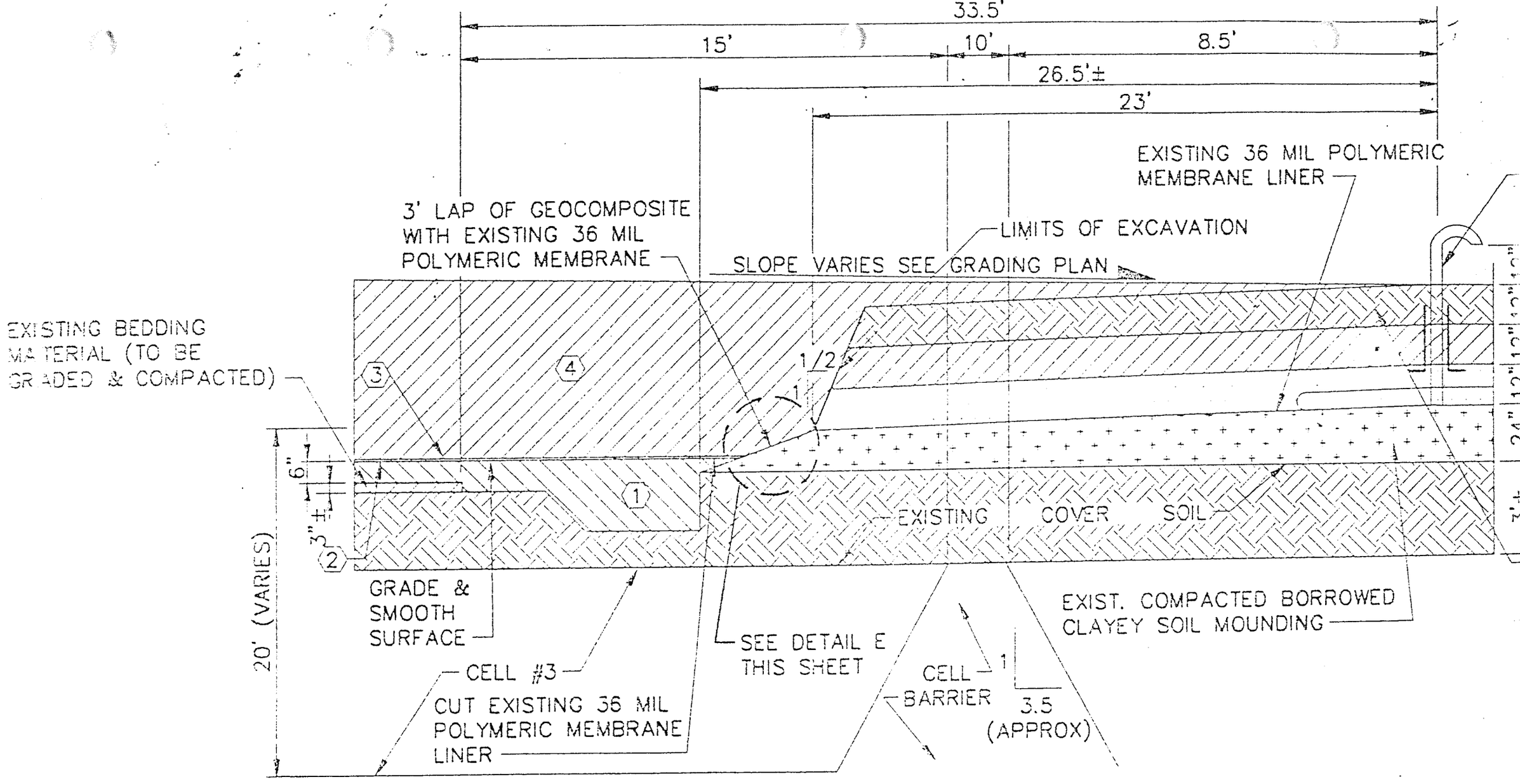
Figure 5



TYPICAL EDGE DETAIL B C3 C5

N.T.S.

Figure 5a



JUNCTURE NEW SOIL CAP TO EXISTING SOIL CAP

N.T.S.

C
C3C5

Figure 5b

The following components will constitute the cover system planned for landfill cell No. 3:

- Buffer layer
- Bedding layer
- Gas Vent Sand layer
- Geotextite filter
- Bentonite layer
- High Density Polythylene Liner (HDPE)
- Compacted protective layer with vegetative cover.
- Horizontal vent pipe.
- Barbed wire fence

A general description of each of the aforementioned components and the function of each component is presented here. Specific design plans and detailed specifications are presented in the document." Specifications for Landfill # 5 Cell # 3 Soil Cap July 92 " located in Appendix III.

Presently, a buffer layer (existing 2-feet-thick cap) exists immediately above the actual waste and serves to protect the geocomposite-soil cap (to be installed above the buffer layer from penetration by protruding objects in the landfill by minimizing the effects of settling on the geocomposite-soil cap. In addition, the buffer layer is usually more porous, so that gases can migrate through it and so that siltation from the bedding and sand layers will be contained in the upper part of the buffer. In the case of this landfill, where the climate is semiarid and the net precipitation is quite low (minus 55 in/yr) and a HDPE membrane liner will be present, no appreciable siltation from the bedding layer is anticipated to occur.

The construction of the buffer has been completed for about 10 years. The document by the Department of the Air Force, Tactical Air Command, Cannon AFB, New Mexico, entitled "Sanitary Landfill -- Design, Construction, and Operation," 15 December 1976, indicates that this buffer layer is constructed

of soils from the cell excavation. The document specifies a minimum thickness of 2 feet for this layer and calls for it to be compacted in four 6-inch lifts. During a site visit in March 1985, it was observed that the site was "criss- crossed" with bulldozer tracks, implying that this cover was "tracked in" for compaction, as per the regulation.

Settling and subsidence typically occur immediately following the final cover of a landfill. The rate of this settling is fastest in the first few years following final cover and slows to a minimal rate after 5 years or so. Total settling might amount from 5 to 50 percent of a landfill's height, depending on such factors as the depth of the fill. composition of the waste, and the climate and groundwater characteristics. At this site, the depth of the fill is estimated at 25 feet. The waste consists of construction/demolition debris and hazardous wastes consisting mainly of paints and solvents (noncontainerized). The semiarid climate and very deep aquifer system would suggest that decomposition of organics would occur rather slowly after the first several years.

The relatively small volume of compacted waste in the landfill, placed in a shallow configuration of maximum depth of 25 feet, would also suggest a low total settling of the fill. In support of this contention is the fact that no cracks, craters. or depressions were observed during the site visit. Therefore, it is anticipated that little additional settling will occur in the fuure and that the existing buffer layer is adequate.

The planned final cover will consist of the following components to be installed above the buffer layer:

- A one eighth thick Sodium Bentonite clay liner on top of and in direct contact with the smooth finished surface of the cell No. 3 non - woven fabric. The Sodium Bentonite liner will extend a distance of 7 feet from the edge of the cell in all directions to a perimeter anchor trench.The maximum permeability of the clay layer will be 10-9 cm per sec.

- A non-woven geotextile filter fabric will cover the compacted gas vent layer to prevent mixing of the Sodium Bentonite with the filter sand. The geotextile filter has the capacity to vent any gases that may be generated in Cell No. 3. The filter fabric will have 5% slack for any subsidence and will be anchored in the anchor trench. Documentation in the form of a manufacturer's warranty on the geotextile filter fabric, indicating that it has 30 years of excellent aging and weathering characteristics will be provided to the Contracting Officer by the Contractor.

- A layer of filter sand below the geotextile filter and in contact with the bedding soil. The filter sand serves to allow gases to properly vent. The filter sand will be of 6 inches depth at the cell No. 3 centerline and slope toward the perimeter anchor trench reinforced cross-sectionally. The minimum thickness of the sand layer at the inside edge of the anchor trench will be 6 inches. The minimum saturated hydraulic conductivity of the emplaced sand layer will be approximately 10-2 cm per sec.

- A 40 mil high density polyethylene membrane liner of low permeability (10-12 cm/sec) installed on top of the Sodium Bentonite clay liner, and extending a distance of approximately 7 feet from the edge of the cell to a anchor trench. Any percolation that reaches the membrane liner surface from above will be shed to beyond the perimeter of the cell.

- Documentation in the form of a manufacturing warranty on the HDPE membrane liner, indicating that it has 30 years of excellent aging and weathering characteristic will be provided to the Contracting Officer by the Contractor.

- The Installation Contractor will certify that the final cover system was constructed according to the designs and specifications and industrial standards and is free of any damages, leaks, and other defects to provide a leak proof cover system and the quality of construction and workmanship is guaranteed.

- A compacted protective cover of clayey sand and/or sandy clay borrow, installed on top of the membrane liner, and extending a distance of 7 feet from the edge of the cell in all directions, and terminating at the perimeter trench. The protective cover will be a minimum of 24 inches deep at Cell No. 3 centerline and slope (crosssectionally) to the perimeter slide slopes. The slope of the compacted protective cover surface is of a suitable gradient to allow diversion of rainwater and surface runoff away from cell No. 3 in a reasonable manner toward the perimeter side slopes. The designed shallow slopes to the cover system also will reduce the surface area exposed to high winds.

The protective cover material will be screened through a one-inch or smaller screen to remove foreign objects and large rocks which may puncture or abrade the membrane liner. A visual check of the emplacement will be made to assure effective removal.

The protective cover will preserve the integrity of the membrane liner by preventing direct exposure of the liner to ultraviolet solar radiation and will deter liner wear due to weather and direct physical contact. The protective cover will be graded so that a constant level is maintained along the north-south axis of the cell. The protective cover will extend 12 feet beyond the edges of cell No. 3.

A supply of common borrow identical in characteristics to the common borrow installed on top of the membrane liner will be kept in reserve in the event of future cover repair activities. The common borrow supply should be maintained in a protected pile in a convenient location outside of the Cell No. 3 perimeter fence.

- A 4-inch diameter perforated PVC horizontal vent pipe installed at the bottom of the filter sand layer residing under the geotextile filter, approximately 3 inches above the surface of Cell No. 3. The PVC vent pipe will be wrapped with geotextile fabric and will be oriented along the length of the centerline of Cell No. 3. The horizontal vent pipe will collect any gases permeating through the layer of filter sand.

- Three 4-inch diameter PVC vertical vent pipes (with vent caps) 200 feet apart from each other, will extend up from the horizontal vent pipe through the filter sand, penetrating the membrane liner and through the protective cover, finally venting to the ambient atmosphere at a height of 12 inches above cover crown. A leakproof seal boot between the vent pipes and the membrane liner will ensure continuity in liner protection integrity.

- A 24 inch by 6 inch deep perimeter anchor trench to anchor the geotextile filter and HDPE/Bentonite membrane liner under a protective common borrow cover. The inside edge of the anchor trench will be a minimum of 7 feet from the edge of the cell.

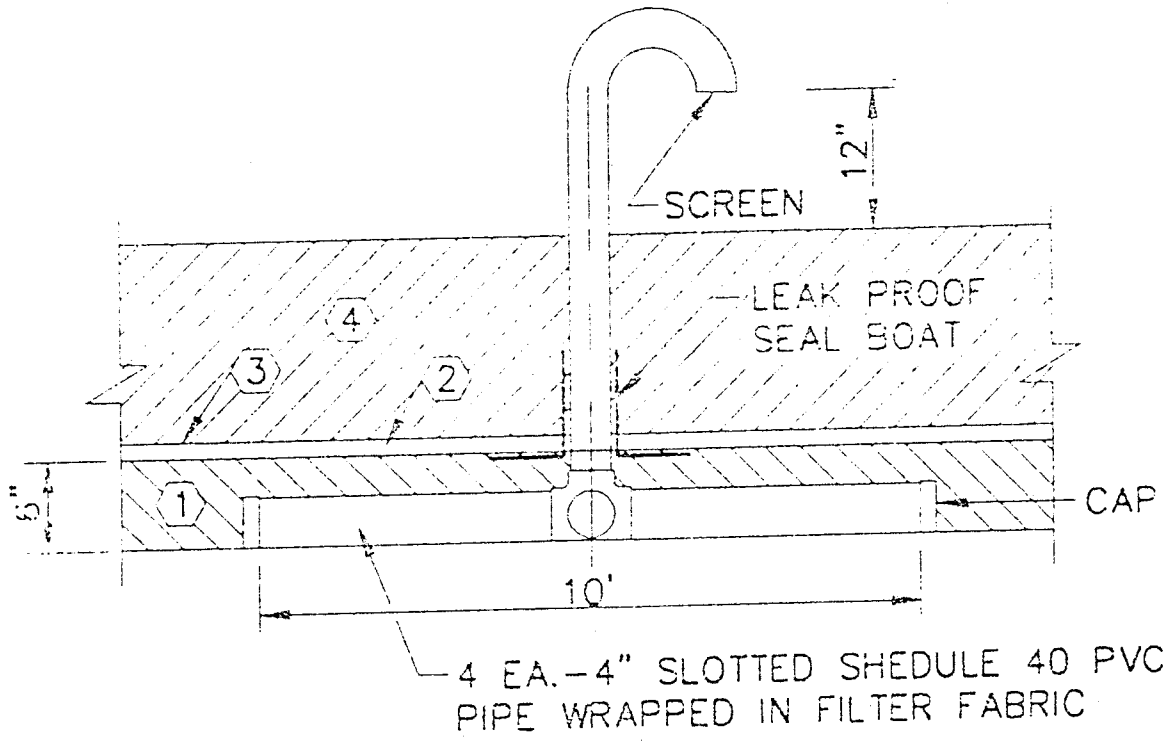
- A 4-strand barbed wire fence with a metal panel gate will protect the perimeter of Cell No. 3 from nearby activities on adjacent cells. The fence will be located 20 feet from the edge of Cell No. 3. The fence will withstand the stress of high winds, tumble weeds, and blowing sand and will require no maintenance.

- A temporary barricade will be established 2 feet and 6 inches away from the centerline of space between Cell No. 3 and adjoining Cells No. 2 and No. 4. The temporary barricade will prevent damage to adjoining cells by delineating a work zone for equipment used in capping cell No. 3. The temporary barricade will be removed once the 4-strand barbed wire is constructed.

- To prevent any impact on the adjacent cells, all designs have been kept within 2 feet of the mid-point of the distance between Cell No. 3 and the adjacent cells.

GAS VENTING

Cell No. 3 has received solvents, paints, paint removers, and thinners which, after closure, could volatilize and release gases. Core analyses (Table 4) detected <0.01 ppm of volatile organics and no organic solvents in cell No. 3 core samples. Complete volatilization may have occurred in the 11 years since 1981; however, the general design of the final protective cover allows for venting of any potential gases, through the use of 4 gas vents (Figure 6).



GAS VENT DETAIL D C2 C5

N.T.S.

Figure 6

SURFACE DRAINAGE CONTROL

Drainage of surface rainwater runoff shall be accomplished so that infiltration is minimized between cell Nos. 3 and 2 and between cell Nos. 3 and 4. To effect positive sheet flow drainage in these areas without causing soil erosion and subsequent undermining/failure of the seal created by the protective soil cover, a 3-4% slope for the cover and a 4:1 (horizontal/vertical) side slope are provided.

SECURITY OF THE CLOSED CELL

Security for the closed cell will follow the rules governing security for the working portion of the landfill. Access to the site shall be controlled by a lockable entry gate attached to a permanently anchored 4-strand barbed wire fence surrounding the perimeter of the landfill cell, a distance of 20 feet from the edge of Cell No. 3. A placard that identifies the landfill cell shall be permanently attached to the fence. The gate shall be closed and locked when an operator is not on duty. The following access categories shall be utilized:

1. Unlimited Entry--unlimited entry to the landfill site shall be authorized for landfill operators.

2. Limited Entry--personnel with authorized limited entry shall make their presence known to the landfill operator before conducting business on the site.

3. Restricted Entry-personnel with authorized restricted entry shall make their presence known to and be accompanied by the landfill operator while on the site.

4. Unauthorized Entry--access to the site by persons other than those listed above is not authorized and shall be prohibited.

The fence, gate, and placard shall be durable enough to last the duration of the post closure period and shall remain in place throughout this time.

No future use is planned or allowed. The base master plan will restrict subject to Civil Engineering and Base Commander approval.

The placard with the legend, "Danger-Unauthorized Personnel Keep Out" will be posted at each entrance to the facility. These warning signs will also be posted at intervals no greater than 100 feet apart on the fence around the closed unit. The legend will be written in English and Spanish and will be legible from a distance of at least 25 feet.

ESTIMATED CONSTRUCTION SCHEDULE

Table 5 presents an estimated construction schedule for the closure of Cell No. 3 of Landfill Area 5. A detailed description of each of the activities listed in Table 5 is presented in the document, "Specifications for Landfill #5 Cell #3 Soil Cap " July 1992.

COMPLETION REPORT

Upon completion of the closure, the Commander will submit, in support of the Certification of Closure, the following information:

1. A certified survey showing the location of the cap.

2 A copy of the QA/QC report.

TABLE 5. Estimated Construction Schedule

Cannon Force Base
Amended Closure of
Cell No. 3 of Landfill Area 5

Activity	Completion Date (Weeks)
o Contract Award	A
o Preconstruction Conference	A + 2
o Submit QA/QC Plan to EID	A + 3
o Review and Approve Contractor's Submittals	A + 4
o Onsite Operations Begin	A + 4
o Complete Mobilization and Construction of Contractor's Facilities	A + 6
o Subgrade Preparation	A + 7
o Bedding Soil	A + 8
o Review and Approve Layout Pattern for Liner and Fabric and the Materials for Final Cover System	A + 10
o Filter Fabric, Sand Filter. and Venting System	A + 13
o Polymeric Membrane and Protective Layer	A + 18
o Turfing	A + 19
o Fence and Caution Sign	A + 20
o Demobilization and Project Closeout	A + 21

NOTE: A = date of contract award

QUALITY ASSURANCE/QUALITY CONTROL

The Commander will appoint an individual to oversee the quality control effort and report directly to the Commander upon closure completion.

During construction the inspection procedures listed in Table 6 will be conducted to document the acceptability of installation procedures.

In order to ensure that the final cover is constructed per design specifications. The following parameters will be closely observed and followed:

- Construction of the final cover will use the same soil material, design, equipment, and procedures as specified in the specifications.
- All applicable parts of the QA/QC test requirements will be followed precisely to monitor and document cap construction and testing. (Table 7)

Table 6. Earth Work Construction Inspection Methods

Factor To Be Inspected	Inspection Methods	Test Method Reference
Coverage	Observation	NA
Thickness	Surveying: Measurement	NA
Clod size	Observation	NA
Tying together of lifts	Observation	NA
Slope	Surveying	
Installation of protective cover	Observation	NA
Soil type (index properties)	Particle size analysis Atterberg limits Classification of soils	ASTM D422-63 ASTM D4318-87 ASTMD2487-85
Moisture-density relation	Modified proctor (Bedding & Core soil)	ASTM D1557-7B
	Maximum Index Density (Gas vent sand layer)	ASTM D4253-83

TABLE 7. Quality Assurance/Quality Control Testing Procedures

	Moisture/Density Test Frequency
Mass earthworks (embankments, dikes)	1 per 10,000 ft /lift
Hand-compacted Backfill	1 per 100 cubic yard
Minimum per Shift (mass earthwork)	1
Doubtful Areas (inspector's discretion)	1

Inspection personnel will monitor and thoroughly document construction of the cap. The cap documentation will be extremely important because it will verify all data involved in facility construction and provide a complete description of the construction equipment and procedures used during the construction of the final cover.

As construction of the final cover proceeds, all procedures shall be documented in a dedicated construction/inspection record book. This will ensure that the final cover meets or exceeds the design criteria, including the use of the optimal materials, equipment and construction methodologies. During construction of the final cover, the following inspection procedures will be used to ensure that it is constructed according to specifications:

- Removal of roots, rocks, rubbish, or off-spec soil from the cover materials
- Identification of changes in soil characteristics necessitating a change in construction specifications
- Adequate spreading of materials to obtain complete coverage and the specified loose lift thickness
- Adequate clod size reduction of cover material
- Adequate spreading and incorporation of any certified amendments to obtain the specified amount uniformly in the amended cover material
- Adequate spreading and incorporation of water to obtain full penetration through clods and uniform distribution of the specified water content
- Procedures to be followed to adjust the soil moisture content in the event of a significant prolonged rain during construction
- Prevention of significant water loss before and after compaction
- Use of compaction equipment of the same type, configuration, and weight
- Use of the same equipment speed and number of equipment passes for compaction
- Uniformity of coverage by compaction equipment, especially at fill edges, in equipment turn-around areas, and at the tops and bottoms of slopes

- Consistent achievement of the specified soil density/water content/compactive effort throughout each completed lift

- Use of methods sufficient to tie the soil lifts together

- Achievement of sufficient soil strength to maintain stable sidewalls and to supply a stable base for supporting overlying materials

- Application of water to prevent desiccation of soil material between the installation of lifts or after completion of the cover (where necessary)

- Prevention of accidental damage of installed portions of the cover by equipment traffic

Climatic conditions will also be monitored to be sure that they do not adversely affect the compaction process and cause variabilities in the permeation rate of the final cover.

As detailed in this section, a rigorous construction QA/QC program will be conducted to ensure that the following non-specification conditions are prevented or, if they should inadvertently occur, are detected and corrected:

- Regions of use of unspecified materials, inadequate moisture control, insufficient compactive effort, failure to fill test holes properly or construction during periods of freezing temperature

- Less-than-specified thickness or coverage from failure to observe, monitor, and control soil placement and compaction operations

- Partings between lifts from failure to scarify and control moisture in adjacent lifts

- Leaks around designed cover penetrations resulting from improper sealing and compaction

- Erosion or desiccation from failure to provide protective cover when construction is interrupted or after cap completion

The low permeability Sodium Bentonite liner will be inspected for cracks, holes, defects, or any other features that may increase its field permeability. All defective areas will be removed and repaired. If the underlying foundation is defective (soft or wet), then this material will also be removed and recompacted. Special attention will be paid to the final inspections of the side slopes and bottom slopes, cap coverage, and cap thickness. The completed cap will be protected from desiccation, erosion, and freezing immediately following completion of the uppermost lift.

All seams made in the synthetic liner will be constructed in accordance with the manufacturer's specifications.

Upon completion of the closure, a written report will be prepared and submitted to the Commander and the EID. This report will summarize the QA/QC plan and report fully all observations and accumulated data.

SOIL COVER STABILIZATION

The final phase of closure consists of placing a compacted surface for the cap and seeding the topsoil with a native grass seed mixture (see Table 8). The soil mantle will average a minimum of 24 inches in thickness to allow for some erosional loss during the establishment of the vegetation. The mantle's composition will be that of the local soils described in the soil characterization.

The soil mantle will be applied uniformly with compaction and will be graded to approximately 3% (See Appendix I) across the cap axis to all sides. A tiller will be used to pulverize the clods and smooth the surface to a 4-inch depth and a moderately fluffed composition.

Soil pH, nitrogen, organic matter, phosphorus and potassium will be tested to determine the type and quantity of fertilizer necessary for the soil to sustain the vegetative cover.

The vegetation shall consist of a mixture of perennial grasses that readily thrive in this climate and need little maintenance.

If closure commences within the first six months of 1993, then seeding can occur during the proper season. The seeds will be planted by drilling them at the proper density to ensure a thick vegetative cover from the first growth.

TABLE 8. Seed Mix

	Mixture % by weight
BLUE GRAMA, Bouteloua gracilis 'Lovington' or 'Hachita'	17
SIDEOATS GRAMA, Bouleloua curtipendula 'El Reno'	35
BUFFALO GRASS, Buchloe dactyloides 'Texoka'	35
BERMUDA GRASS, Cynodon dactylon	9
ALKALI SACATON, Sporbolus airoides	4

A straw mulch will be evenly applied to help retain moisture, prevent erosion, and protect the vegetation until it matures.

Establishment of the vegetative cover will be monitored to ensure adequate cover to prevent erosion and stabilize the soil. If inadequate rainfall occurs to establish adequate cover, a temporary watering system will be installed.

EQUIPMENT DECONTAMINATION

The construction of the final cover over the landfill has been planned such that there mav be some limited contact between construction equipment and the waste mass. The following steps will be taken to decontaminate equipment:

1. As much as possible of the waste and/or contaminated soil clinging to the equipment after contact will be removed and redeposited within the landfill, such that it can be covered by the cap.

2. Tools and/or equipment contacting the waste or contaminated soil will be taken to an onbase area where they will be steam cleaned on an impervious catchment apron with the wash waters collected, tested, and properly disposed of. Decon will be appropriate with the type of waste encountered.

CERTIFICATION OF CLOSURE

According to NMHWMR-4 Section 206.C.2.f which addresses certification of closure at disposal facilities with interim status, the Combat Support Group Commander will submit a certificate of closure to the director. Such certificate will be made by both himself and an independent registered professional engineer that the facility has been closed in accordance with the specifications in the approved closure plan.

Closure is not complete until the closure performance standard is met (NMHWMR-4 Section 206.C.2.b). This standard requires that the facility is closed so that further maintenance is minimized and that human health and the environment are protected from post closure escape of hazardous wastes.

The appropriate time to submit the Certification of Closure for cell No. 3 at landfill No. 5 will be at the time that the protective cover has been constructed and the final inspection of the vegetative cover is complete.

DEED RECORDING

The exact location of the closed landfill cell as well as a general description of the waste that it contains will be annotated in the Air Force Base Master Plan with a statement that this information is to be transferred to any new documents should the parcel of land be sold. The landfill boundaries and description will also be recorded in the facility folder and by facility number at the base. The closure will be included in the base master plan maps C-1E and M-5.

The Support Group Commander will ensure proper recording in accordance with New Mexico law, of a notation on the deed to the facility property or on some other instrument which is normally examined during title source - that will, in perpetuity, notify any potential purchaser of the property that the land has been used to manage hazardous wastes, and its use is restricted under the NMHWMR-4 Section 206.C.2.g(3).

SURVEY PLAT

Within 90 days after closure is completed, notice to Curry County Commissioners and to the Director will be submitted in the form of a survey plat in accordance with HWMR-4, Section 206.C.2.i.

POST CLOSURE MONITORING PLAN

The post closure monitoring program includes three concurrent activities. The first is a groundwater monitoring program designed to detect containment

migration from the landfill through the existing aquifer system. The second is an inspection and maintenance program designed to ensure the integrity of the cap. The third is a vent monitoring program designed to detect releases of volatile organic gases to the atmosphere.

POST CLOSURE GROUNDWATER MONITORING

The post closure groundwater monitoring program will utilize the four existing wells installed in December 1984 and January 1985 and identified as wells A, B, C, and D in the base records (see Figure 7). These four wells, one upgradient and three downgradient, as determined by the actual well water elevations measured after installation, are appropriate to monitor for contaminant migration from the landfill, since no contamination was detected from the first analytical samples taken in January 1985. They are screened into the uppermost aquifer (a depth of approximately 300 feet) and installed as shown in Figure 8.

The sampling and analysis of each well will occur on the schedule discussed below. Parameter selection includes those analyses identified by Cannon AFB personnel in the base groundwater monitoring plan, those recommended by New Mexico State officials, and those suggested by a review of the wastes known to be present in the landfill (i.e., chromium, lead, toluene, xylene, cyclohexanone, MEK, and MIBK).

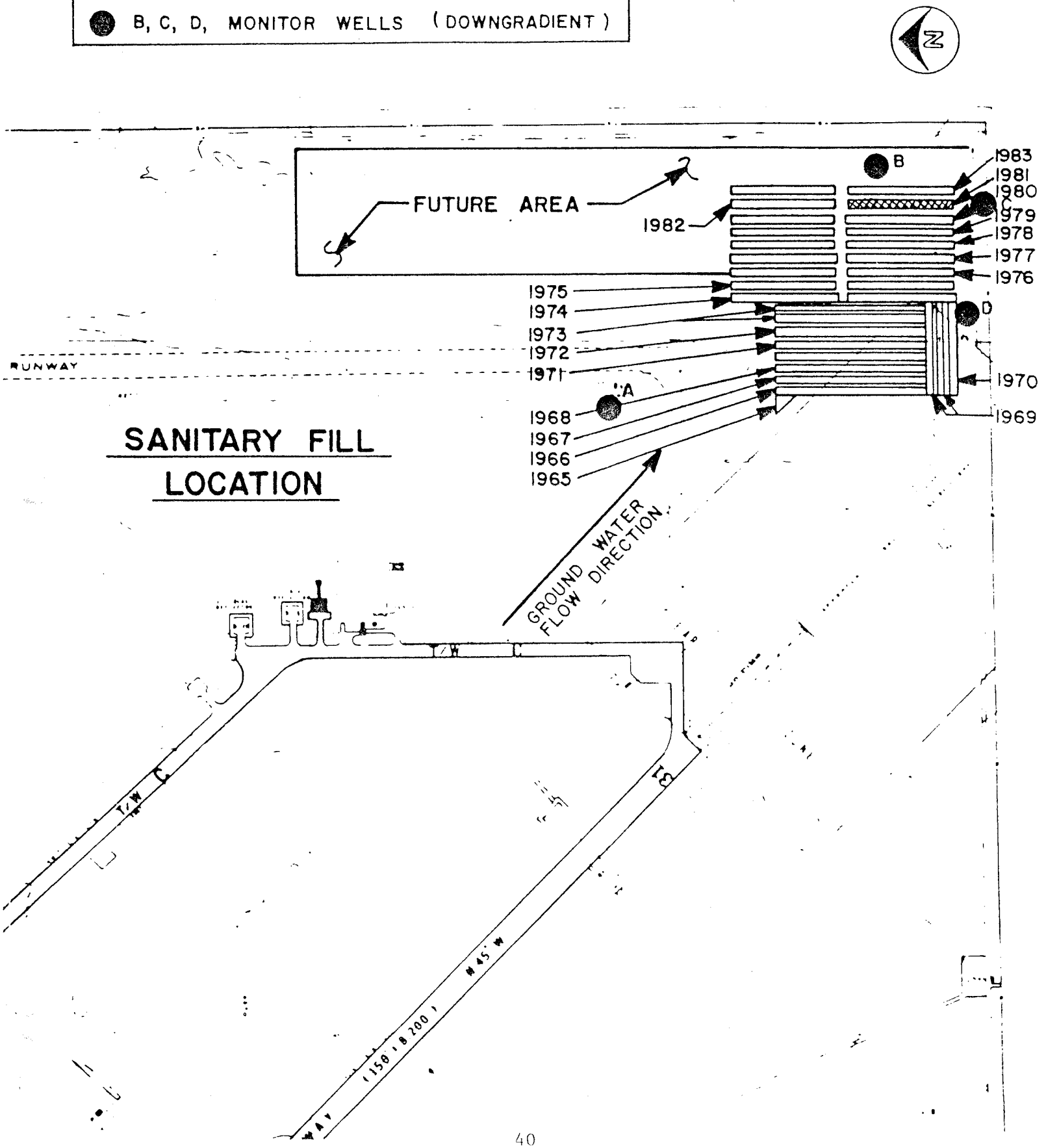
The procedures and techniques for sample collection, preservation, and shipment, as well as specified analytical procedures and chain of custody, are described in the Cannon AFB Groundwater Sampling and Analysis Plan. The plan appears as Appendix II of this report. In addition to obtaining samples for the laboratory analyses, the elevation, pH, and conductivity of the water in the wells will be measured and recorded.

Samples were collected and analyzed quarterly for the first year of monitoring. The sampling and analysis did cover all parameters required by NMHWMR-4. Sampling and analysis will be performed annually for chloride, iron, manganese, phenols, sodium and sulfate. Sampling and analysis will be performed semiannually for pH, conductivity, total organic carbon (TOC) and total organic

FIGURE 7

MONITORING WELL LOCATIONS FOR LANDFILL No. 5

- A MONITOR WELL (UPGRADIENT)
- B, C, D, MONITOR WELLS (DOWNGRADIENT)



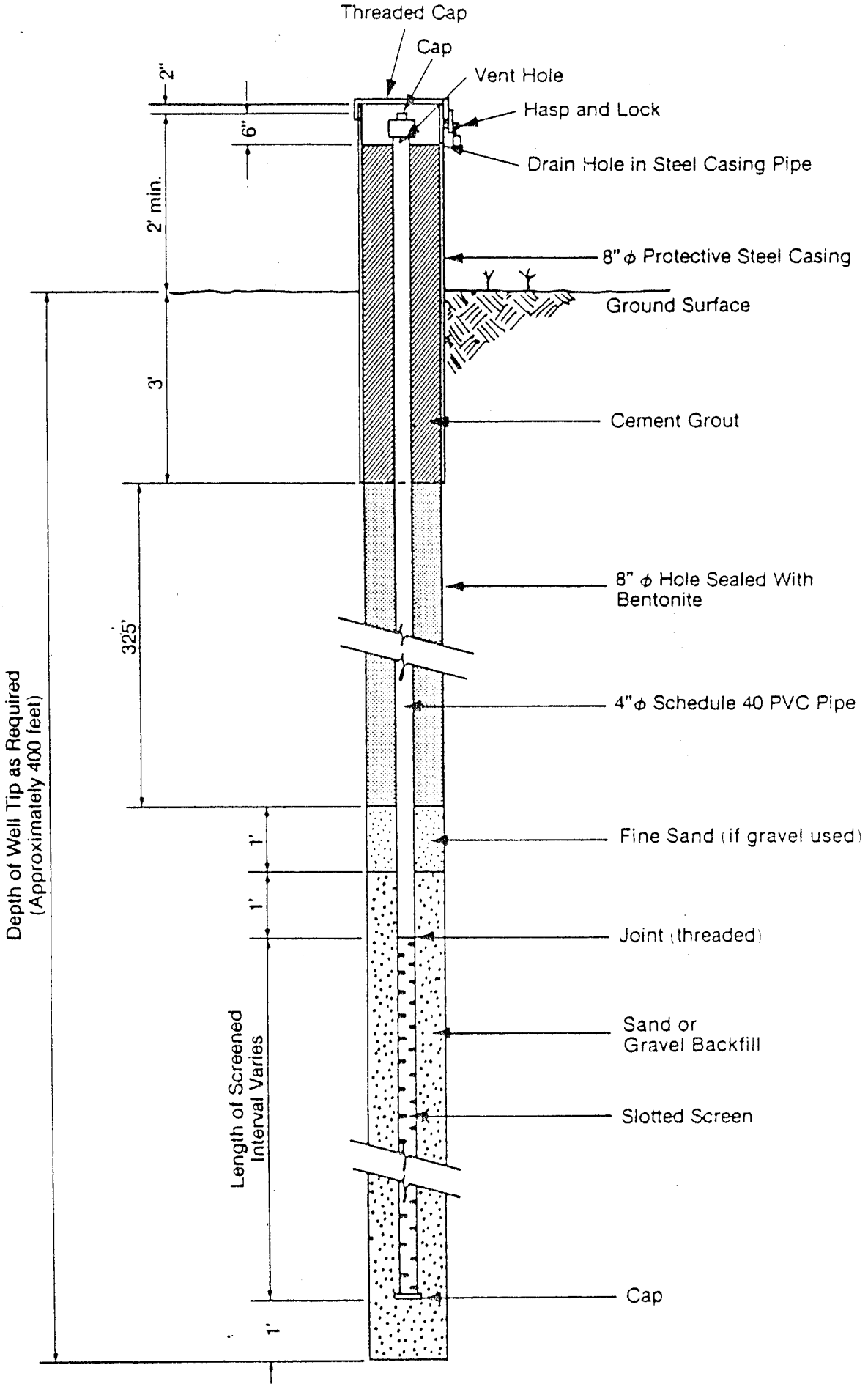


FIGURE 8
Typical Monitoring Well Installation.

halogen (TOX). Groundwater elevations will be measured before the collection of any sample and the locations of the monitoring wells and well performance will be evaluated. Additional wells will be installed if problems develop.

The analytical data obtained during the first year's quarterly monitoring will be used to establish initial background concentrations against which subsequent results will be assessed. Arithmetic means and variances based on four replicate measurements on each sample will be calculated for each of the indicator parameters, pH, conductivity, TOC, and TOX over the four quarters of the first year's sampling. Subsequently, each well's sample analysis for an indicator parameter will be compared to the initial background concentrations by calculating the arithmetic mean and variance for the parameter based on four replicate measurements and using the Student's t-test at the 0.01 level of significance to determine statistically significant increases (or decreases) over the initial background concentration. The GC/MS scans for priority pollutants will be evaluated on a present/nonpresent basis at the limit of detectability in all cases.

If the comparisons of the indicator parameters in the upgradient well show a significant deviation from initial background concentrations after a sampling effort, or if the GC/MS scan in the upgradient well shows positive results, the Director of the Environmental Improvement Division of the State of New Mexico will be notified no later than March 1 following each calendar year (New Mexico Hazardous Waste Regulations - 206.C.1.e.(1).(b).(ii)). If the comparisons of the indicator parameters in any of the downgradient wells show a significant deviation from initial background concentrations after a sampling effort, or if the GC/MS scan shows positive, the well or wells will be immediately resampled and the samples split in two and reanalyzed. If neither of the split samples confirms the deviation, it will be attributed to laboratory error, documented, and reported as such on the regular reporting schedule described below. If either of the reanalyses confirms the significant deviation from the initial background concentrations, the Director will be notified within 7 days [206.C.1.d.(5)].

Within 15 days of that confirmation of significant deviation, a specific plan for a groundwater quality assessment program will be developed and submitted to the Director [206.C.1.d.(6)]. The outline of the groundwater quality assessment program is shown in Exhibit 1. It will provide mechanisms to confirm or refute the presence of contaminants in the groundwater, determine the concentration of confirmed contaminants in the groundwater, and determine the rate and extent of migration of confirmed contaminants through the groundwater system. The first determination of the groundwater quality assessment program will be made as soon as it is technically feasible, and a written report of the determination will be submitted to the Director within 15 days [206.C.1.d.(8)]. If the results of the determination indicate that no landfill contamination has entered the groundwater, the groundwater monitoring program described herein will be reinstated and the Director so notified [206.C.1.d.(9)]. If the results indicate that contaminants have entered the groundwater, the Director will be so notified, and planning will be undertaken to develop remediation measures [206.C.1.d(10)].

The groundwater elevations in all wells (those already installed for the groundwater monitoring program and any that may have been installed as part of a groundwater quality assessment program) will be measured during every sampling effort. There will be an annual review to ensure that monitoring wells are placed correctly with respect to groundwater flow directions.

Exhibit 1

GROUNDWATER QUALITY ASSESSMENT PROGRAM OUTLINE

NOTE: The initiation of this program is triggered by the confirmation of a significant deviation from quality standards as discussed. It is not triggered by a deviation from quality standards in a normal monitoring sample but by the confirmation of that deviation in a subsequent split sample reanalysis.

I. Quantification

A. A predictive model will be developed to project the extent of the contaminant plume based on the existing well data.

B. Additional monitoring wells will be installed at the locations and depths suggested by the predictive model.

C. Samples from all wells will be quantitatively analyzed for the standard semiannual analyses, for use in the predictive model to calculate the extent of the contaminant plume and the rate of migration.

D. Samples from all wells will be analyzed to quantify those parameters appearing in Appendix VIII of 40 CFR Part 261. The list of those parameters and the appropriate test methods (as per SW-846, Test Methods for Evaluating Solid Waste) are as follows:

Parameter	Method(s)
Chromium	7190,7191
Lead	7420,7421
Arsenic	7060,7061
Mercury	7470,7471
Total organic halogens	9020
Methyl ethyl ketone	8015,8240
Methyl isobutyl ketone	8015,8240
Toluene	8020,8024
Xylene	8020,8024

Exhibit 1 (Continued)

E. A determination will be made whether the landfill is affecting the water quality.

II. Remediation

A. A decision will be made whether emergency remedial action is necessary and technically possible (i.e., pumping the existing wells to minimize migration).

B. A feasibility study will be undertaken to provide a permanent solution to the contamination problem and the cleanup of affected areas. Possible remedial alternatives include groundwater pumping and/or removal of landfill contents.

C. Upon approval, the design specifications for the selected remedial alternative will be prepared and the work performed.

Records of all analytical and water elevation data will be kept at the base throughout the post closure care period of 15 years (through 2000). Additionally, the following reports will be made to the Director (206.C.1.e):

- The results of the quarterly sampling and analysis efforts during the first year of monitoring will be submitted with 15 days after receipt of such information by the base. In this report, any well exhibiting a parameter or parameters that exceed the maximum contaminant level listed in Appendix II of the New Mexico State regulations (reproduced as Table 9 in this report) will be separately identified.

- Annually, no later than March 1 following each calendar year, the results of the semiannual and annual monitoring will be submitted, including deviations from the background concentrations in the upgradient well, as previously discussed.

- If a groundwater quality assessment program is initiated, reports containing calculated concentrations and migration rates will be submitted annually, no later than March 1, following each calendar year.

POST CLOSURE COVER MAINTENANCE

The second activity of the post closure monitoring plan is the inspection and maintenance program to ensure the integrity of the cover. On a quarterly basis and after a heavy precipitation, a prolonged drought, and/or a high wind, the cover will be inspected. Any rill erosion, damage to the vegetative cover or minor settling will be corrected with common borrow patching or seeding of the problem area. Weeding will be conducted at every inspection to control undesirable weeds which may take root. If rills are deeper than 10 inches, then it will be necessary to regrade the problem area in accordance with the specifications of the closure plan .

Equipment to be used during post closure maintenance is essentially the same as that used to construct the final cover system. If inadequate rainfall occurs to establish adequate cover, a temporary watering system will be installed. If regrading and/or removal becomes necessary, then a backhoe will secure necessary common borrow for the cover from an existing pile outside of the fence. Heavy machinery will not be allowed to travel on the cover. All repair work on the cover will be done by hand compaction, using a vibrating plate.

TABLE 9. EPA Interim Primary Drinking Water Standards

PARAMETER	MAXIMUM LEVEL (mg/l)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Fluoride	1.4-2.4
Lead	0.05
Mercury	0.002
Nitrate (as N)	10
Selenium	0.01
Silver	0.05
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2,4-D	0.1
2,4,5-TP Silvex	0.01
Radium	5 pCi/l
Gross alpha	15 pCi/l
Gross beta	4 millirem/yr
Turbidity*	1/TU
Coliform bacteria	1/100 ml

*Turbidity is applicable only to surface water supplies.

VENT MONITORING

On a periodic basis, the four vents along the centerline of cell No. 3 will be monitored for evidence of gaseous emission to the ambient atmosphere. Monitoring results will be maintained at Cannon AFB.

INSPECTION SCHEDULE

These inspections and maintenance activities will be maintained for 30 years following the receipt of certification of final closure for landfill cell No. 3.

Should any difficulties arise during the post closure period, the base environmental coordinator should be contacted. The office is located at Cannon AFB, New Mexico, and the phone number is (505) 784-4639.

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7. Lutton, R. J., "Evaluating Cover Systems for Solid and Hazardous Waste," EPA SW - 867, 1980.

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9. Lutton, R. J., U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, personal communication, 1985.

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APPENDIX I

EVALUATION OF EROSION POTENTIAL

Using the USDA universal soil loss equation (USLE):

$$A = R \cdot K \cdot LS \cdot C \cdot P$$

Where:
- A = average annual soil loss (tons/acres)
- R = rainfall and runoff erosivity index
- K = soil erodibility factor (tons/acres)
- LS = combination of slope-length factor and slope-steepness factor
- C = cover management factor
- P = practice factor

For 3% Grade:

for Eastern NM,	R = 100	(See Figure 1.1)
for 4% organic matter and sandy clay loam,	K = 0.21	(See Table 1.1)
for 3% slope and 800 ft slope length, (worst case)	LS = 0.62	(See Table 1.2)
for moderately productive grass,	C = 0.01	(See Table 1.3)
for spring-seeded grain,	P = 0.60	(See Table 1.4)

Thus:
$$A = 100 \cdot 0.21 \text{ tons/acre} \cdot 0.62 \cdot 0.01 \cdot 0.6$$
$$A = 0.068 \text{ tons/acre}$$
$$A = 136 \text{ lbs/acre}$$

Assumed density of topsoil = 90 lbs/ft^3

Surface Area of final cover $= \dfrac{60 \text{ ft} \cdot 810 \text{ ft}}{43{,}600 \text{ ft/acre}} = 1.115$ acres

EROSION PER YEAR $= \dfrac{136 \text{ lbs/acre} \cdot 1.115 \text{ acres}}{90 \text{ lbs/ft}^3}$

$= 1.69 \text{ ft}^3$

For 25% Grade:

for Eastern NM,	R = 100	(See Figure 1.1)
for 4% organic matter and sandy clay loam,	K = 0.21	(See Table 1.1)
for 25% slope and 12.5 ft slope length, (use 25 ft)	LS = 3	(See Table 1.2)
for moderately productive grass,	C = 0.01	(See Table 1.3)
for spring-seeded grain,	P = 0.60	(See Table 1.4)

Thus: $A = 100 \cdot 0.21 \text{ tons/acre} \cdot 3 \cdot 0.01 \cdot 0.6$

$A = 0.378 \text{ tons/acre}$

$A = 756 \text{ lbs/acre}$

Assumed density of topsoil $= 90 \text{ lbs/ft}^3$

Surface Area of final cover $= \dfrac{1440 \text{ ft} \cdot 12.5 \text{ ft}}{43{,}600 \text{ ft/acre}} = 0.413 \text{ acres}$

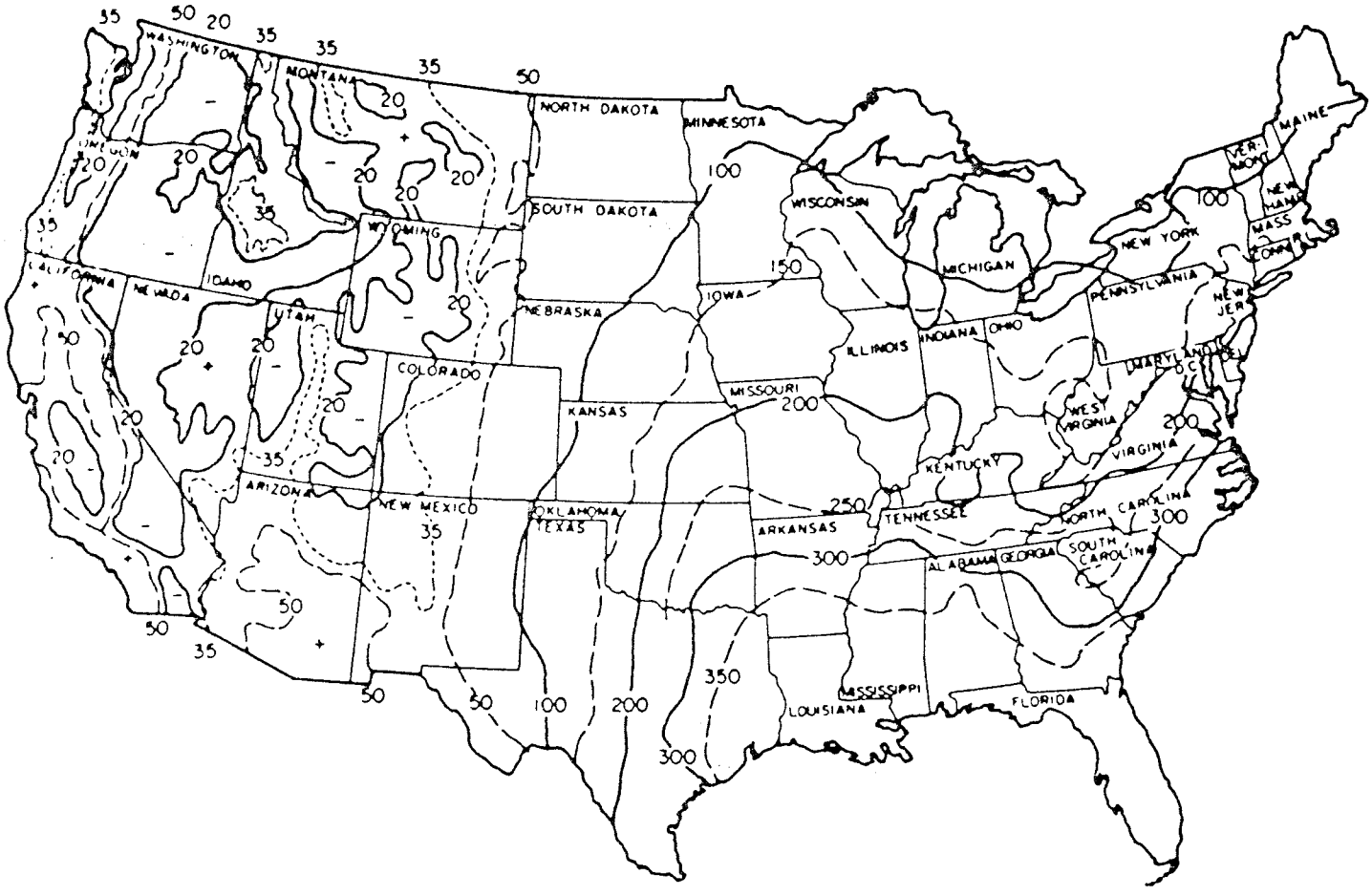
EROSION PER YEAR $= \dfrac{756 \text{ lbs/acre} \cdot 0.413 \text{ acres}}{90 \text{ lbs/ft}^3}$

$= 3.47 \text{ ft}^3$

TOTAL EROSION PER YEAR $= 1.69 \text{ ft}^3 + 3.47 \text{ ft}^3$

$= 5.16 \text{ ft}^3$

Figure 1.1. Average annual values of rainfall-erosivity factor R.*



*See Ref. 7, p. 46.

TABLE 1.1 Approximate Values of Factor K for USDA Textural Classes*

Texture Class	Organic matter content <0.5% K	2% K	4% K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sand loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25	.21
Silty clay loam	.37	.32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay		0.13-0.29	

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

*See Ref. 7, p. 46.

TABLE 1.2 Values of the Factor LS for Specific Combinations of Slope Length and Steepness*

% Slope	Slope length (feet) 25	50	75	100	150	200	300	400	500	600	800	1000
0.5	0.07	0.08	0.09	0.10	0.11	0.12	0.14	0.15	0.16	0.17	0.19	0.20
1	0.09	0.10	0.12	0.13	0.15	0.16	0.18	0.20	0.21	0.22	0.24	0.26
2	0.13	0.16	0.19	0.20	0.23	0.25	0.28	0.31	0.33	0.34	0.38	0.40
3	0.19	0.23	0.26	0.29	0.33	0.35	0.40	0.44	0.47	0.49	0.54	0.57
4	0.23	0.30	0.36	0.40	0.47	0.53	0.62	0.70	0.76	0.82	0.92	1.0
5	0.27	0.38	0.46	0.54	0.66	0.76	0.93	1.1	1.2	1.3	1.5	1.7
6	0.34	0.48	0.58	0.67	0.82	0.95	1.2	1.4	1.5	1.7	1.9	2.1
8	0.50	0.70	0.86	0.99	1.2	1.4	1.7	2.0	2.2	2.4	2.8	3.1
10	0.69	0.97	1.2	1.4	1.7	1.9	2.4	2.7	3.1	3.4	3.9	4.3
12	0.90	1.3	1.6	1.8	2.2	2.6	3.1	3.6	4.0	4.4	5.1	5.7
14	1.2	1.6	2.0	2.3	2.8	3.3	4.0	4.6	5.1	5.6	6.5	7.3
16	1.4	2.0	2.5	2.8	3.5	4.0	4.9	5.7	6.4	7.0	8.0	9.0
18	1.7	2.4	3.0	3.4	4.2	4.9	6.0	6.9	7.7	8.4	9.7	11.0
20	2.0	2.9	3.5	4.1	5.0	5.8	7.1	8.2	9.1	10.0	12.0	13.0
25	3.0	4.2	5.1	5.9	7.2	8.3	10.0	12.0	13.0	14.0	17.0	19.0
30	4.0	5.6	6.9	8.0	9.7	11.0	14.0	16.0	18.0	20.0	23.0	25.0
40	6.3	9.0	11.0	13.0	16.0	18.0	22.0	25.0	28.0	31.0	--	--
50	8.9	13.0	15.0	18.0	22.0	25.0	31.0	--	--	--	--	--
60	12.0	16.0	20.0	23.0	28.0	--	--	--	--	--	--	--

Values given for slopes longer than 300 feet or steeper than 18% are extrapolations beyond the range of the research data and, therefore, less certain than the others.

*See Ref. 7, p. 46.

TABLE 1.3 Generalized Values of Factor C for States East of the Rocky Mountains*

Crop, rotation, and management	Productivity level High	Productivity level Mod.
	C value	
Base value: continuous fallow, tilled up and down slope	1.00	1.00
CORN		
C, RdR, fall TP, conv	0.54	0.62
C, RdR, spring TP, conv	.50	.59
C, RdL, fall TP, conv	.42	.52
C, RdR, wc seeding, spring TP, conv	.40	.49
C, RdL, standing, spring TP, conv	.38	.48
C-W-M-M, RdL, TP for C, disk for W	.039	.074
C-W-M-M-M, RdL, TP for C, disk for W	.032	.061
C, no-till pl in c-k sod, 95-80% rc	.017	.053
COTTON		
Cot, conv (Western Plains)	0.42	0.49
Cot, conv (South)	.34	.40
MEADOW		
Grass & Legume mix	0.004	0.01
Alfalfa, lespedeza or Sericia	.020	
Sweet clover	.025	

Abbreviations defined:

B - soybeans
C - corn
c-k - chemically killed
conv - conventional
cot - cotton
F - fallow
M - grass & legume hay
pl - plant
W - wheat
wc - winter cover

lbs rc - pounds of crop residue per acre remaining on surface after new crop seeding
% rc - percentage of soil surface covered by residue mulch after new crop seeding
70-50% rc - 70% cover for C values in first column; 50% for second column
RdR - residues (corn stover, straw, etc.) removed or burned
RdL - all residues left on field (on surface or incorporated)
TP - turn plowed (upper 5 or more inches of soil inverted, covering residues)

*See Ref. 7, p. 46.

TABLE 1.3 Generalized Values of Factor C for States East of the Rocky Mountains* (continued)

Crop, rotation, and management	Productivity level High	Productivity level Mod.
	C value	
Base value: continuous fallow, tilled up and down slope	1.00	1.00
SORGHUM, GRAIN (Western Plains)		
RdL, spring TP, conv	0.43	0.53
No-till pl in shredded 70-50% rc	.11	.18
SOYBEANS		
B, RdL, spring TP, conv	0.48	0.54
C-B, TP annually, conv	.43	.51
B, no-till pl	.22	.28
C-B, no-till pl, fall shred C stalks	.18	.22
WHEAT		
W-F, fall TP after W	0.38	
W-F, stubble mulch, 500 lbs rc	.32	
W-F, stubble mulch, 1000 lbs rc	.21	

Abbreviations defined:

B - soybeans
C - corn
c-k - chemically killed
conv - conventional
cot - cotton
F - fallow
M - grass & legume hay
pl - plant
W - wheat
wc - winter cover

lbs rc - pounds of crop residue per acre remaining on surface after new crop seeding
% rc - percentage of soil surface covered by residue mulch after new crop seeding
70-50% rc - 70% cover for C values in first column; 50% for second column
RdR - residues (corn stover, straw, etc.) removed or burned
RdL - all residues left on field (on surface or incorporated)
TP - turn plowed (upper 5 or more inches of soil inverted, covering residues)

*See Ref. 7, p. 46.

TABLE 1.4 Values of Factor P*

Practice	Land slope (percent) 1.1-2	2.1-7	7.1-12 (Factor P)	12.1-18	18.1-24
Contouring (P_c)	0.60	0.50	0.60	0.80	0.90
Contour strip cropping (P_{sc})					
R-R-M-M[1]	0.30	0.25	0.30	0.40	0.45
R-W-M-M	0.30	0.25	0.30	0.40	0.45
R-R-W-M	0.45	0.38	0.45	0.60	0.68
R-W	0.52	0.44	0.52	0.70	0.90
R-O	0.60	0.50	0.60	0.80	0.90
Contour listing or ridge planting (P_{cl})	0.30	0.25	0.30	0.40	0.45
Contour terracing (P_t)[2]	[3]$0.6/n^{1/2}$	$0.5/n^{1/2}$	$0.6/n^{1/2}$	$0.8/n^{1/2}$	$0.9/n^{1/2}$
No support practice	1.0	1.0	1.0	1.0	1.0

[1]R = rowcrop, W = fall-seeded grain, O = spring-seeded grain, M = meadow. The crops are grown in rotation and so arranged on the field that rowcrop strips are always separated by a meadow or winter-grain strip.

[2]These P_t values estimate the amount of soil eroded to the terrace channels and are used for conservation planning. For prediction of off-field sediment, the P_t values are multiplied by 0.2.

[3]n = number of approximately equal-length intervals into which the field slope is divided by the terraces. Tillage operations must be parallel to the terraces.

*See Ref. 7, p. 46.

APPENDIX II

GROUNDWATER SAMPLING AND ANALYSIS PLAN

A. SAMPLE COLLECTION

1. Determine the static water elevation to the nearest 0.01 inch using an electronic well probe.

2. Calculate the wetted well volume.

3. Pump out 5 wetted well volumes or until pH, conductivity and temperature stabilize (whichever is greater).

4. For total organic carbon (TOC) and total organic halogen (TOX), fill the sample container until overfilled, place the cap on it, and tighten. Turn the container upside down and check for air bubbles. If any air is present retake the sample (see Table 2.3, Note E).

5. For all other samples, fill the sample container full enough to ensure a sufficient volume for the analytical test to be performed.

B. SAMPLE PRESERVATION AND SHIPMENT

1. Sampling Parameters Used to Indicate Suitability of the Groundwater as a Drinking Water Supply (see Table 2.1).

2. Sampling Parameters Used to Establish Groundwater Quality (see Table 2.2).

3. Sampling Parameters Used as Indicators of Groundwater Contamination (see Table 2.3).

C. CHAIN OF CUSTODY. Samples will be sent to USAF OEHL in a sealed shipping container. A Chain-Of-Custody record (see Figure C-4) will be filled out, signed and placed in a plastic bag along with the usual sample submission form (see Figure C-5) and sealed in the shipping container. A duplicate will be kept by SGPB with the duplicates of the sample submission forms. OEHL personnel will acknowledge receipt of the samples in good condition by signing the Chain-Of-Custody form and returning it to Cannon AFB. If the container is damaged in any way or not sealed when the lab receives the package, the technician will so annotate on the form.

TABLE 2.2

ANALYSIS	PRESERVATIVE GROUP	STORET#	PRESERVATIVE/ WORK CENTER	NOTES	REF
ARSENIC	F	01002	F1XX-10510	B	E206
BARIUM	F	01007	F1XX-10510	B	E208
CADMIUM	F	01027	F1XX-10510	B	E213
CHROMIUM	F	01034	F1XX-10510	B	E218
FLUORIDE	G	00951	G1XX-10630	C	E340
LEAD	F	01051	F1XX-10510	B	E239
MERCURY	F	71900	F1XX-10510	B	E245
NITRATE	A	00620	A1XX-10110	B,X	E353
SELENIUM	F	01147	F1XX-10510	B	E270
SILVER	F	01077	F1XX-10510	B	E272
ENDRIN	H	39390	H1XX-10700	D	E608
LINDANE	H	39782	H1XX-10700	D	E608
METHOXYCHLOR	H	39480	H1XX-10700	D	E608
TOXAPHENE	H	39400	H1XX-10700	D	E608
2,4-D	H	39730	H1XX-10700	D	A509
2,4,5-TP-SILVEX	H	39760	H1XX-10700	D	A509
RADIUM	R1				E600
GROSS ALPHA	R1				E600
GROSS BETA	R1				E600
COLIFORM BACT.	G	31501	G1XX-10000	G	A908A

TABLE 2.2

ANALYSIS	PRESERVATIVE GROUP	STORET#	PRESERVATIVE/ WORK CENTER	NOTES	REF
CHLORIDE	G	00940	G1XX-10630	B	E325
IRON	F	01045	F1XX-10510	B	E236
MANGANESE	F	01055	F1XX-10510	B	E243
PHENOLS	E	32730	E1XX-10400	B	E420
SODIUM	F	00929	F1XX-10510	B	E273
SULFATE	G	00945	G1XX-10630	B	E375

TABLE 2.3

ANALYSIS	PRESERVATIVE GROUP	STORET#	PRESERVATIVE/ WORK CENTER	NOTES	REF
SPECIFIC COND.	G	00095	G1XX-10620	B	E120
ORGANIC CARBON	A	00680	A1XX-10130	B	E415
TOT ORG HALOGENS	T			E	E9020
PH	G	00400	G1XX-10000	F	A423

NOTES

NOTE A. STORET# is a number assigned by EPA to a specific environmental parameter such as a physical characteristic or a chemical.

REF is the source for the analytical method.

E = EPA Manual for Chemical Analysis of Water and Wastes, EPA Manual of Methods, Pesticide Residues in Human and Environmental Samples, or Prescribed Procedures for Measurement of Radioactivity in Drinking Water

A = APHA Standard Methods for the Examination of Water and Waste Water.

NOTE B. Sample containers for environmental samples may be either polyethylene (plastic) or glass except where a specific container and/or special sampling techniques are called for in the notes.

NOTE C. Samples must be submitted in polyethylene (plastic) containers for this analysis.

NOTE D. Samples must be submitted in glass containers for this test.

NOTE E. Volatile Halocarbon Compounds; Sample Collection and Handling.

1. Sample containers are 40 ml glass screw cap bottles with TFE fluorocarbon faced silicon septa liners. These containers will be supplied by the USAF OEHL.

2. Sample Collection

a. Collect samples from each sampling site in triplicate. Mark the bottles A, B, and C.

b. Fill the sample bottles in such a manner that no air bubbles pass through the sample as the bottle is filled to overflowing.

c. Place bottle on a level surface and position the TFE side of the septum liner upon the convex meniscus of the sample. Seal the bottle by screwing the cap on tightly.

NOTE: If the septum liner is inverted (i.e., the silicon side against the sample), then significant losses of volatile compounds will occur in shipment and storage.

d. Invert the sample bottle and slightly tap the cap on a solid surface. The absence of entrapped air (bubble) indicates a successful seal. If bubbles are present, open the bottle, pour out the sample, and collect a fresh sample again.

NOTE F. In the field we will calibrate a digital pH meter using two standardized pH solutions. The solutions will be made using deionized water and two standard pH capsules. The pH sample will be collected in a 50 ml plastic beaker and analyzed before any further sampling is accomplished.

NOTE G. A sample for total coliform bacteria will be collected from each of the monitor wells in a 120 ml thio-bag or an autoclaved, sodium thiosulfate treated 100 ml glass jar. After collection, the sample will be taken to the Clovis Branch of the Scientific Laboratory Division of the State of New Mexico Environmental Improvement Division where they will run a total coliform analysis using the Most Probable Number (MPN) method.

NOTE X. Holding time for the chemical/compound is 7 days. Consult the chemist at USAF OEHL/SA or the Water Quality Function at USAF OEHL/ECQ and alert them that we are sending nitrates to be analyzed. This way we can be assured that the recommended maximum holding time will not be exceeded.

PRESERVATION

A1XX. Cool to 4 degrees C. Add sulfuric acid to pH <2. Submit 1 liter in a polyethylene or glass container.

E1XX. Cool to 4 degrees C. Add sulfuric acid to pH <2. Submit 1 liter in a polyethylene or glass container.

F1XX. Add nitric acid to pH <2. Submit 1 liter in a polyethylene or glass container.

G1XX. Cool to 4 degrees C. Add no other preservative. Submit 1 liter in a glass or polyethylene container.

H1XX. Cool to 4 degrees C. Submit 1 liter in glass container with Teflon (R) lined cap for the OCL screen. Submit 1 liter in glass container with Teflon (R) lined cap for 2,4-D and 2,4,5-TP-Silvex.

R1. Add Nitric acid to pH <2. Submit 1 liter in a polyethylene container.

T1XX. Submit only in special containers obtained from USAF OEHL/SAN [AUTOVON 240-3626 or (512) 536-3626/Mr. Rodriguez].

Figure C-4 Chain-of-Custody Record

Survey

Samplers: *Signature*

Station Number	Station Location	Date	Time	Sample Type Water Comp.	Sample Type Water Grab	Sample Type Air	Seq. No.	No. of Containers	Analysis Required

Relinquished by: *Signature*	Received by: *Signature*	Date/Time
Relinquished by: *Signature*	Received by: *Signature*	Date/Time
Relinquished by: *Signature*	Received by: *Signature*	Date/Time
Relinquished by: *Signature*	Received by Mobile Laboratory for Field analysis: *Signature*	Date/Time

Dispatched by: *Signature*	Date/Time	Received for Laboratory by:	Date/Time

Method of Shipment:

Distribution: Orig.—Accompany Shipment
1 Copy—Survey Coordinator Field Files

ENVIRONMENTAL SAMPLING DATA

(Use this space for mechanical imprint)

OEHL USE ONLY

SAMPLING SITE IDENTIFIER (AFR 19-7)

BASE WHERE SAMPLE COLLECTED

SAMPLING SITE DESCRIPTION

DATE COLLECTION BEGAN (YYMMDD)

TIME COLLECTION BEGAN (24 hour clock)

COLLECTION METHOD [ ] GRAB [ ] COMPOSITE _____ HOURS

MAIL REPORTS TO (circle if changed): ORIGINAL / COPY 1 / COPY 2

SAMPLE COLLECTED BY (Name, Grade, AFSC)

SIGNATURE

AUTOVON

REASON FOR SUBMISSION: A-ACCIDENT/INCIDENT, R-ROUTINE/PERIODIC, C-COMPLAINT, N-NPDES, F-FOLLOWUP/CLEANUP, O-OTHER (specify)

BASE SAMPLE NUMBER

OEHL PID

ANALYSES REQUESTED (check appropriate blocks)

	GROUP A		GROUP D		GROUP E		GROUP F		GROUP G		GROUP H		GROUP J		GROUP T
	Ammonia 00610		Cyanide, Total 00720		Phenols 32730		Antimony 01097		Acidity, Total 70508		BHC Isomers 39340		Residue, Settleable 50086		Bromoform 32104
	Chemical Oxygen Demand 00340		Cyanide, Free 00722				Arsenic 01002		Alkalinity, Total 00410		Chlordane 39350		Residue, Volatile 00505		Bromodichloromethane 32101
	Kjeldahl Nitrogen 00625						Barium 01007		Alkalinity, Bicarbonate 00425		DDT Isomers 39370		Silica 00955		Carbon Tetrachloride 32102
	Nitrate 00620						Beryllium 01012		Bromide 71870		Dieldrin 39380		Specific Conductance 00095		Chloroform 32106
	Nitrite 00615						Boron 01022		Carbon Dioxide 00405		Endrin 39390		Sulfate 00945		Chloromethane 34418
	Oil & Grease 00560						Cadmium 01027		Chloride 00940		Heptachlor 39410		Sulfite 00740		Dibromochloromethane 32105
	Organic Carbon 00680						Calcium 00916		Color 00080		Heptachlor Epoxide 39420		Surfactants -MBAS 38260		Methylene Chloride 34423
	Orthophosphate 00671						Chromium, Total 01034		Fluoride 00951		Lindane 39782		Turbidity 00076		Tetrachloroethylene 34475
	Phosphorus, Total 00665						Chromium VI 01032		Iodide 71865		Methoxychlor 39480				1,1,1-Trichloroethane 34506
							Copper 01042		Odor 00086		Toxaphene 39400				Trichloroethylene 39180
									Residue, Total 00500		2,4-D 39730				Trihalomethanes 82080
									Residue, Filterable (TDS) 70300		2,4,5-TP-Silvex 39760				PCBs 39516
									Residue, Nonfilterable 00530		2,4,5-T 39740		Sulfides 00745		
									Hardness 00900						
									Iron 01045						
									Lead 01051						
									Magnesium 00927						
									Manganese 01055						
									Mercury 71900						
									Nickel 01067						
									Potassium 00937						
									Selenium 01147						
									Silver 01077						
									Sodium 00929						
									Thallium 01059						
									Zinc 01092						

ON SITE ANALYSES

Parameter		Value
Flow	50050	mgd
Chlorine, Total	50060	mg/l
Dissolved Oxygen	00300	mg/l
pH	00400	units
Temperature	00010	°C

COMMENTS: Need Barium, Cadmium, Chromium, Copper 2753 California

AF FORM JAN 81 2752

figure C

D. SAMPLING FREQUENCY

1. Sampling for all parameters will be performed on a quarterly basis for the first year in order to establish initial concentrations for all groundwater parameters.

2. For the first year, samples collected for the parameters used as indicators of groundwater contamination (pH, specific conductance, TOC, and TOX) from the upgradient well (well A) must be taken in replicates of four. The initial background arithmetic mean and variance must be determined by pooling the replicate measurements for the respective parameter concentrations or values.

3. After the first year, samples collected to establish groundwater quality, i.e., chloride, iron, manganese, phenols, sodium, and sulfate, will be collected annually. Whereas, samples collected to indicate groundwater contamination, i.e., pH, specific conductance, TOC, and TOX, will be collected semi-annually and will be collected from each well in replicates of four. The arithmetic mean and variance will be calculated based on the four replicate samples and the results from each will be compared to its respective initial background arithmetic mean.

4. The comparison will consider each of the wells in the monitoring system individually and will use the student's t-test (see 206.C -Appendix III of the New Mexico Hazardous Waste Management Regulation [NMHWMR]) at the 0.01 level of significance to determine statistically significant increases (and decreases, in the case of pH) over initial background.

5. If the comparison for the upgradient well shows a significant increase (or pH decrease), in accordance with the NMHWMR section 206.C.1.d. (3) the owner or operator will submit this information to the director of the State of New Mexico Environmental Improvement Division (NMEID) no later than March 1 following the calendar year in which the reportable incident occurred.

6. If the comparisons for the downgradient wells show a significant increase (or pH decrease), the owner or operator will immediately obtain additional groundwater samples from those downgradient wells where a significant difference was detected. These samples will be split in two, and analyses obtained for all additional samples to determine whether the significant difference was a result of laboratory error. If the analyses performed confirm the significant increase (or pH decrease), the owner or operator will provide written notice to the director of the State of New Mexico Environmental Improvement Division (NMEID) within seven calendar days of the date of such confirmation that the facility may be affecting groundwater quality.

7. Within fifteen days after the notification, the owner or operator will develop and submit to the director of the State NMEID a specific plan, based on the groundwater assessment outline and certified by a qualified geologist or geotechnical engineer, for a groundwater quality assessment program.

E. RECORDKEEPING AND REPORTING

1. In accordance with the NMHWMR section 206.C.1.e(1)(a) records of the required analyses will be maintained in both the Bioenvironmental Engineering Section and the Environmental Coordinator's office at Cannon AFB, NM throughout the post-closure care period.

2. The following groundwater monitoring information will be reported to the director of the State NMEID in Santa Fe.

a. During the first year when initial background concentrations are being established, concentrations or values of the parameters characterizing the suitability of the groundwater as a drinking water supply for each groundwater monitoring well must be received within fifteen days after completing each quarterly analysis. The owner or operator must separately identify for each monitoring well any parameter whose concentration or value has been found to exceed EPA's maximum contaminant levels.

b. Annually: Concentrations or values of the parameters used as indicators of groundwater contamination for each groundwater monitoring well along with the required evaluations for these parameters in accordance with NMHWMR section 206.C.1.d. (2).

c. Not later than March 1 following each calendar year, results of the evaluation of groundwater surface elevations and a description of the response to that evaluation, if applicable, will be reported to the director of the NMEID.

3. There is no requirement after the first year for periodic sampling for parameters indicating suitability as potable water (EPA Interim Primary Drinking Water Standards).

F. POST-CLOSURE SAMPLING. Sampling of the groundwater monitoring wells for the required parameters will continue for 30 years after the date of completing closure in accordance with the NMHWMR section 206.C.2.g. (1) unless the director of the NMEID reduces this requirement due to a lack of significant findings.