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Central Facilities Area Landfills I, II, and III Five-Year Review Supporting Documentation

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Five-Year Review Supporting Documentation

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Approved by

Robert E. James
WAG 4 Project Manager

11/12/02
Date

Douglas H. Preussner
WAG 4 Project Engineer

11/12/02
Date

ABSTRACT

This report summarizes the documentation submitted in support of the 5-year review of the remedial action for Central Facilities Area (CFA) Landfills I, II, and III. The remedial action was conducted pursuant to the requirements delineated in the *Record of Decision Declaration for Central Facilities Area Landfills I, II, and III (Operable Unit 4-12), and No Action Sites (Operable Unit 4-03)*. The remedy included the installation of a native soil cover over each landfill to mitigate infiltration of surface water, implementation of administrative controls to prevent unauthorized access to the site, and environmental monitoring to ensure the effectiveness of the remedy. Routine inspections and maintenance of the covers are performed to ensure their integrity, and institutional controls have been implemented to restrict access.

The major components of the remedial action included the emplacement of a native soil cover over the landfills and the implementation of administrative controls and routine monitoring to ensure the effectiveness of the remedial action. The installation of the soil covers and time-domain reflectometry arrays was completed in 1997, with new deep, time-domain reflectometry arrays installed in 2000. Monitoring of the groundwater commenced in 1996, and monitoring of the time-domain reflectometry arrays, soil gas, and neutron-probe access tubes began in 1997. Groundwater monitoring was conducted on a quarterly basis for the first year and annually thereafter. Data collection from the neutron-probe access tubes occurred from December 1996 through August 1998 and October 2000 to the present. For the time-domain reflectometry arrays, the shallow arrays were monitored from March 1997 through September 1998, and data were collected from the deep arrays from October 2000 to the present. Soil gas samples were collected semiannually from December 1996 through July 1998 and from August 2000 to July 2001.

The implementation of institutional controls coincided with the installation of the landfill covers. In accordance with Section 6 of the *Remedial Design/Remedial Action Work Plan for Central Facilities Area Landfills I, II, and III Native Soil Cover Project Operable Unit 4-12*, it was established that the 5-year review of the CFA landfills' remedial action would take place 5 years following the commencement of landfill monitoring efforts. Based upon cover infiltration monitoring commencing in the spring of 1997, the 5-year review would take place in the spring of 2002.

The 5-year review includes a review of the past site inspections and monitoring data collected in support of the remedial action. Specific data assessments include soil gas monitoring and results, groundwater monitoring, and landfill moisture monitoring. The landfill moisture monitoring consisted of neutron-probe monitoring data and time-domain reflectometer data analysis. The

technical analysis addresses the issues of whether the remedy is functioning as intended; whether the assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time are still valid; and whether any other information has come to light that could affect the protectiveness of the remedy.

From the review of the analytical data and the technical assessment thereof, it is recommended that annual inspections of the institutional controls be continued and the soil gas and groundwater monitoring be continued on an annual basis.

For the past 5 years since the remedial action, precipitation levels have been less than normal. These dry conditions do not allow for an adequate review of the landfill moisture-monitoring efforts. It is recommended that moisture monitoring be continued for 2002 and 2003 through September 2003. Modeling of the infiltration will be performed based upon the moisture-monitoring data obtained. Based on this modeling, a decision on whether to continue moisture infiltration monitoring or to perform an “artificial rain” infiltration test will be made by September 2003. The written results of the moisture infiltration modeling will be included in the FY 2003 monitoring report. Based upon the information presented herein, the determination as to whether the remedy for the CFA Landfills I, II, and III is expected to remain protective of human health and the environment has been deferred until the recommendations in this report are implemented. These recommendations include moisture infiltration monitoring and data modeling as previously discussed, performance of digital gyroscopic deviation surveys of some groundwater wells and redrawing of the groundwater contour maps using this information, re-evaluation of the need for another groundwater monitoring well, and re-evaluation of the source of nitrates in the groundwater. The next 5-year review is scheduled for 2006.

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ACRONYMS

BBWI	Bechtel BWXT Idaho, LLC
BLM	Bureau of Land Management
bls	below land surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Central Facilities Area
CFR	Code of Federal Regulations
COCA	Consent Order and Compliance Agreement
DOE	U.S. Department of Energy
DOE-ID	U.S. Department of Energy Idaho Operations Office
EG&G	Edgerton, Germeshausen, and Grier
EPA	U.S. Environmental Protection Agency
ET	evapotranspiration
FFA/CO	Federal Facility Agreement and Consent Order
FR	Federal Register
FSP	field sampling plan
FY	fiscal year
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
INEEL	Idaho National Engineering and Environmental Laboratory
INEL	Idaho National Engineering Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
MCL	maximum contaminant level
NA	not applicable
NAT	neutron-probe access tube
ND	not detected

NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
O&M	operations and maintenance
OU	operable unit
ROD	Record of Decision
SMCL	secondary maximum contaminant level
SRPA	Snake River Plain Aquifer
USGS	United States Geological Survey
USC	United States Code
VOC	volatile organic compound
WAG	Waste Area Group

Central Facilities Area Landfills I, II, and III Five-Year Review Supporting Documentation

1. INTRODUCTION

In accordance with the *Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory* (DOE-ID 1991) between the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Idaho Department of Environmental Quality (IDEQ), hereafter referred to as the Agencies, DOE submits this supporting documentation for the 5-year review for the Central Facilities Area (CFA) Landfills I, II, and III. Under the current remediation management strategy outlined in the Federal Facility Agreement and Consent Order (FFA/CO) (DOE-ID 1991), the location identified for the remedial action is designated as Waste Area Group (WAG) 4, Operable Unit (OU) 4-12 at the Idaho National Engineering and Environmental Laboratory (INEEL), as shown in Figure 1-1. This report documents the review period covering from 1996 when the remedial action began and from 1997 when all landfill monitoring activities commenced through the summer of 2002.

The remedial action objectives outlined in the *Record of Decision Declaration for Central Facilities Area Landfills I, II, and III (Operable Unit 4-12), and No Action Sites (Operable Unit 4-03)* (DOE-ID 1995) are (1) prevent direct contact with the landfill contents, (2) minimize the potential for erosion and infiltration at the surface, and (3) ensure that the migration of contaminants in the landfills does not cause drinking water standards to be exceeded in the Snake River Plain Aquifer (SRPA). The scope of the remedial action was detailed in the *Remedial Design/Remedial Action Work Plan for Central Facilities Area Landfills I, II, and III Native Soil Cover Project Operable Unit 4-12* (DOE-ID 1996). The major components of the remedial action included the following:

- A native soil cover (in combination with the existing soil cover) was placed over the landfills to a minimum depth of 0.6 m (2 ft). The cover was compacted and graded to minimize erosion and infiltration by controlling surface water run-on and run-off resulting from seasonal precipitation.

- Administrative controls on future land use are implemented, including the posting of signs.

- Groundwater, infiltration, and/or vadose-zone monitoring are conducted to monitor the effectiveness of the remedial action.

- The cover is periodically inspected and routinely maintained to ensure its integrity.

- The institutional controls are maintained, including signs, postings, and land use restrictions.

The results of the remedial action are summarized in the *Remedial Action Report CFA Landfills I, II, and III Native Soil Cover Project Operable Unit 4-12* (DOE-ID 1997). The procedures required to maintain the CFA landfills are outlined in the *Operations and Maintenance Plan for the Central Facilities Area Landfills I, II, and III Native Soil Cover Project Operable Unit 4-12* (INEL 1997a), which is provided in Appendix J to the Remedial Action Report (DOE-ID 1997). This Operations and Maintenance (O&M) Plan was superceded by the *Operations and Maintenance Plan for the Final Selected Remedies and Institutional Controls at Central Facilities Area, Operable Unit 4-13* (DOE-ID 2002a). Post-remedial action monitoring required by the Record of Decision (ROD) (DOE-ID 1995) is being carried out per the *Post Record of Decision Monitoring Work Plan Central Facilities Area Landfills I, II, and III Operable Unit 4-12* (INEL 1997b) and the *Field Sampling Plan for the Post Record of Decision Monitoring Central Facilities Area Landfills I, II, and III Operable Unit 4-12* (INEL 1997c).

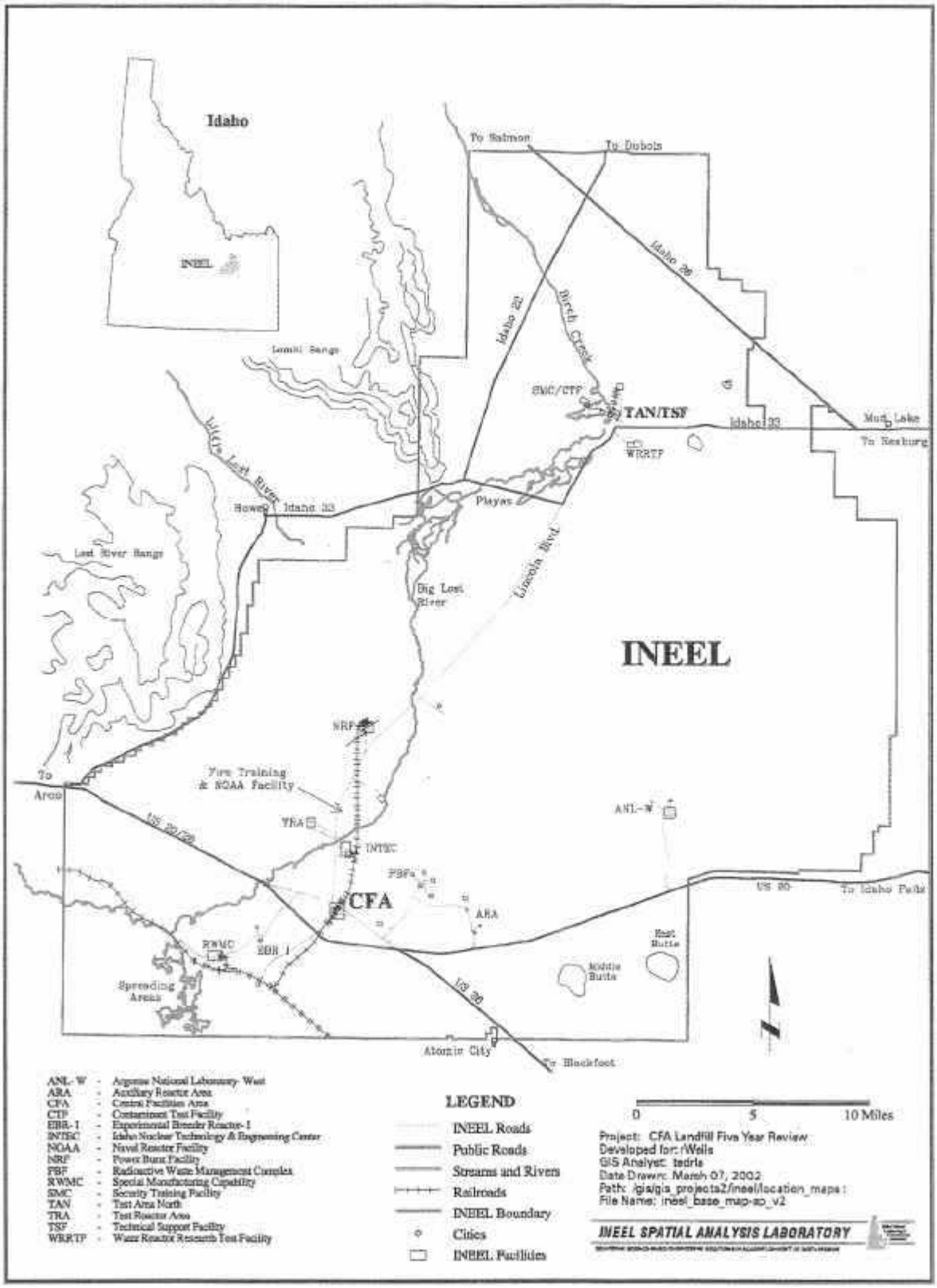

Figure 1-1. Location of Waste Area Group 4 at the Idaho National Engineering and Environmental Laboratory.

1.1 Purpose

The purpose of this 5-year review is to ensure that the remedy prescribed by the ROD (DOE-ID 1995) remains protective of human health and the environment. The 5-year review is being conducted in accordance with the requirements delineated in Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as provided in Title 42 of the *United States Code* (USC), Chapter 103, Subchapter I, Section 9621 and is considered a statutory review. As delegated to DOE for the INEEL site under Section 2(d) of Executive Order 12580, pursuant to the President's authority to delegate conferred by Section 115 of CERCLA, DOE has the duty and authority, by law, to conduct the 5-year reviews. Furthermore, the "National Oil and Hazardous Substances Pollution Contingency Plan" as promulgated in the *Code of Federal Regulations* (CFR) recognizes at 40 CFR 300.5, "Definitions," that DOE will be the lead agency for the INEEL with regard to conducting 5-year reviews.

Given the stipulation that DOE is required and has the authority to conduct 5-year reviews at sites remediated at the INEEL, the U.S. Department of Energy Idaho Operations Office (DOE-ID) initiated the 5-year review of the remedial action conducted at the CFA landfills in January 2002. Upon agreement between DOE-ID, IDEQ, and EPA, this document is being submitted as supporting documentation for the 5-year review with the EPA providing the final 5-year review report for the CFA landfills following concurrence of IDEQ and DOE-ID. The review is being conducted in accordance with the guidance provided in the EPA document, *Comprehensive Five-Year Review Guidance* (EPA 2001). The results of the review will become final with the completion of this report. This review covers the period from 1996 when the remedial action commenced and 1997 when all monitoring activities were implemented through the spring of 2002. It represents the first 5-year review of the CFA landfills' remedial action.

2. SITE CHRONOLOGY

2.1 History of the Idaho National Engineering and Environmental Laboratory

The INEEL, originally established in 1949 as the National Reactor Testing Station, is a DOE-managed reservation that historically has been devoted to energy research and related activities. The National Reactor Testing Station was re-designated as the Idaho National Engineering Laboratory (INEL) in 1974 to reflect the broad scope of engineering activities that were being conducted at various laboratory facilities. In 1997, the INEL was re-designated as the INEEL in keeping with contemporary emphasis on environmental research.

Historically, facilities at the INEEL were dedicated to the development and testing of peaceful applications for nuclear power. Throughout the 50 years of INEEL operations, disposal practices have been implemented in compliance with state and federal regulations and with policies established by DOE and its predecessors. Some of these practices are unacceptable by contemporary standards and have been discontinued. Contaminated structures and environmental media such as soil and water are the legacy of some historical disposals. Occasional accidental releases have also occurred over time. In keeping with the contemporary emphasis on environmental issues, INEEL research is now focused on environmental restoration to address these contaminated media and on waste management issues to minimize additional contamination from current and future operations. As described in the *INEEL Comprehensive Facility and Land Use Plan* (DOE-ID 2001a), the emphasis of work at the INEEL is moving toward management of radiological and hazardous waste, restoration of the environment, development of environmental cleanup technologies, preservation of national security, and development of nuclear technologies and applications.

2.2 Regulatory Background

On July 28, 1986, the DOE-ID entered into a *Consent Order and Compliance Agreement* (COCA) with Region 10 of the EPA and the United States Geological Survey (USGS) (DOE-ID 1986). The agreement called for implementing an action plan to remediate active and inactive waste disposal sites at the INEEL under the authority of the Resource Conservation and Recovery Act (42 USC 6901 et seq.), which regulates the generation, transportation, treatment, storage, and disposal of hazardous waste. The sites identified for further evaluation during the INEEL installation assessment (EG&G 1986), including those located within WAG 4, were covered by the COCA. Under the COCA, the CFA landfills were identified as Hazardous Waste Land Disposal Units.

On November 15, 1989, the EPA added the INEEL to the National Priorities List (NPL) under CERCLA (42 USC 9601 et seq.), also known as the Superfund Act. The NPL identifies high-priority sites for investigation and remediation. The Superfund Act also requires that the public be provided with opportunities to participate in the decision-making process. The decision to add the INEEL to the NPL was based on the detection of contaminants in the environment at INEEL sites.

The FFA/CO and its associated action plan (DOE-ID 1991) were negotiated and signed by DOE-ID, EPA, and the Idaho Department of Health and Welfare in December 1991 to implement the remediation of the INEEL under CERCLA. Effective December 9, 1991, the FFA/CO superseded the COCA. The FFA/CO (DOE-ID 1991) established the procedural framework and schedule for developing, prioritizing, implementing, and monitoring response actions at the INEEL in accordance with CERCLA and Resource Conservation and Recovery Act legislation and the Idaho Hazardous Waste Management Act. The FFA/CO (DOE-ID 1991) is consistent with a general approach approved by the EPA and DOE in which agreements with states as full partners would allow site investigation and cleanup to proceed

using a single road map to minimize conflicting requirements and maximize limited remediation resources. For management purposes, the FFA/CO (DOE-ID 1991) divided the INEEL into 10 WAGs.

2.3 Waste Area Group 4 Overview

Three time-critical removal actions, four non-time-critical removal actions, and three RODs have been or are being performed at WAG 4. The three time-critical removal actions were performed at WAG 4 for the CFA-04 Pond, CFA-06 and CFA-43 Lead Sites, and CFA-42 Tank Farm Spills. Three non-time-critical removal actions were performed in 1997 at CFA-13, CFA-15, and CFA-17/47. A fourth non-time-critical removal action was performed for sites CFA-17 and CFA-47, bermed fire pits and associated asphalt pad, and an adjacent fire station chemical disposal area.

The first ROD for WAG 4 was for the OU 4-11 Motor Pool Pond—*Record of Decision, Central Facilities Area Motor Pool Pond, Operable Unit 4-11, Waste Area Group* 4—and was signed on December 31, 1992 (DOE-ID 1992). This ROD resulted in no action, with further evaluation of potential risk via the groundwater pathway to be conducted in the *Comprehensive Remedial Investigation/Feasibility Study for the Central Facilities Area Operable Unit 4-13 at the Idaho National Engineering and Environmental Laboratory* (DOE-ID 2000a).

The second ROD—issued on October 10, 1995—addressed the OU 4-03 Underground Storage Tank sites and OU 4-12 Landfills I, II, and III (DOE-ID 1995), which are the subject of this review. This ROD (DOE-ID 1995) resulted in 19 No Further Action determinations for the underground storage tanks and installation of compacted native soil covers over the three landfills as a presumptive remedy. The ROD (DOE-ID 1995) also called for cover and groundwater monitoring along with institutional controls. Groundwater monitoring wells were installed in 1995 and 1996. The landfill covers and monitoring systems were emplaced in 1997. Groundwater monitoring at WAG 4 is being carried out under the OU 4-12 Post Record of Decision Monitoring Work Plan (INEL 1997b). The monitoring commenced in 1996 and will continue until it is determined during a 5-year review that some or all of the monitoring activities can cease. The *Post-Record of Decision Monitoring Report from 1996-1998 at Operable Unit 4-12, Central Facilities Area Landfills I, II, and III (CFA-01, CFA-02, and CFA-03)* (INEEL 2000) summarizes data from the first 2 years of monitoring. This report summarizes the results of the first 5-year review being conducted in accordance with the FFA/CO (DOE-ID 1991).

The third ROD for WAG 4 is the *Final Comprehensive Record of Decision for Central Facilities Area Operable Unit 4-13* (DOE-ID 2000b), which was signed in July 2000. Remediation of sites and establishment of institutional controls, as defined by this ROD, are ongoing. The locations of the WAG 4 CERCLA sites, including the CFA Landfills I, II, and III, are shown in Figure 2-1.

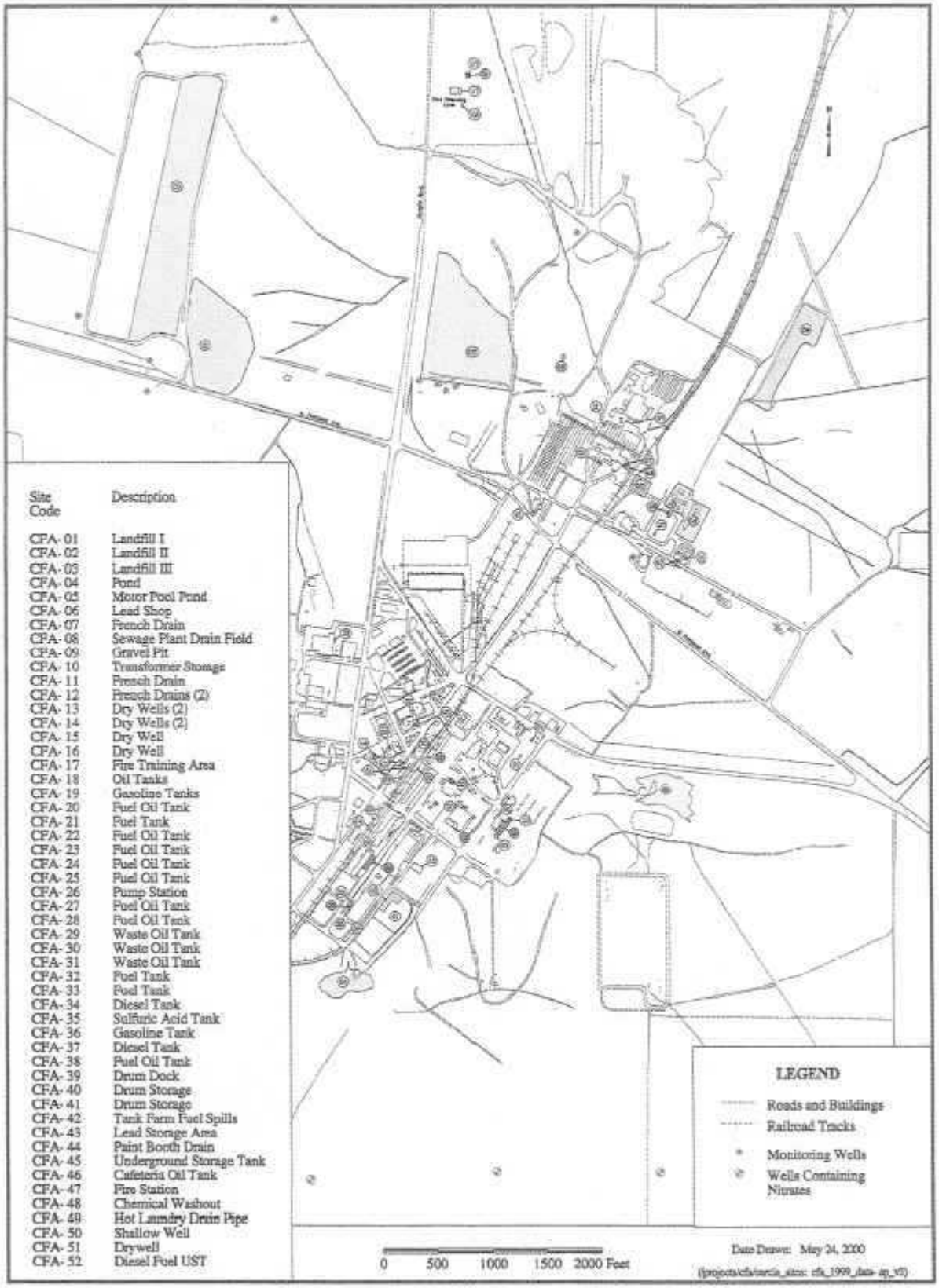

Figure 2-1. Waste Area Group 4 Comprehensive Environmental Response, Compensation, and Liability Act sites.

3. BACKGROUND

This section provides a summary of the physical characteristics of the CFA landfills, a description of the land and resource use, a summary of the contaminants present in various media associated with the landfills, a summary of the initial responses conducted at the landfills, and a summary of the basis for the remedial action conducted at the landfills.

3.1 Physical Characteristics

The CFA landfills are located on the Eastern Snake River Plain in Big Lost River alluvial deposits overlying basalt bedrock. The sediments composing these deposits are primarily sands and gravels and contain very few fine-grained materials. In some places, however, a clay-rich layer (0 to 2.7 m [0 to 9 ft] thick) exists above the bedrock. Depth to basalt at these landfills ranges from 3.0 to 11.2 m (10 to 37 ft). The vadose zone, that portion of the subsurface that extends from the land surface down through the subsurface to the water table, at the CFA landfills is approximately 146 m (480 ft) thick. It is composed of a relatively thin layer of surface sediments, in which the wastes are disposed of, and thick sequences of interfingering basalt flows containing interbedded sediments. As a result of the relatively low annual precipitation, high potential evapotranspiration, and deep water table, vadose zone soils at the landfills tend to be relatively dry during most of the year. The spring snowmelt event provides the greatest source of water available for infiltration into the landfills. The SRPA, one of the largest and most productive groundwater resources in the United States, underlies the CFA landfills. The aquifer is listed as a Class I aquifer, and the EPA has designated it as a sole-source aquifer. The SRPA consists of a series of saturated basalt flows and interlayered pyroclastic and sedimentary materials that underlie the Eastern Snake River Plain. The depth to water at the CFA landfills varies from about 145 m (476 ft) to just over 150 m (495 ft). The direction of groundwater flow in this general vicinity is in a south to southwesterly direction. Additional information pertaining to the CFA landfills can be found in the *Remedial Investigation/Feasibility Study for Operable Unit 4-12: Central Facilities Area Landfills I, II, and III at the Idaho National Engineering Laboratory* (INEL 1995a).

3.1.1 Landfill I

Landfill I occupied a total surface area of approximately 33,400 m^2 (8.25 acres) and consisted of three subunits: the rubble landfill, western waste trench, and northern waste trench. The rubble landfill originated as a gravel quarry that was operated by the U.S. Navy from 1942 to 1949. The quarry was used as a disposal area for Sitewide waste disposal sometime after 1949. Wastes were discarded in the landfill from the 1950s up to 1984. The surface area of the rubble landfill was estimated to be 22,300 m^2 (5.5 acres), and its depth was estimated to be 3.7 to 4.6 m (12 to 15 ft). The rubble landfill was covered with approximately 0.3 to 1.2 m (1 to 5 ft) of soil overlain with a layer of gravel. The surface of the western waste trench was approximately 8,100 m^2 (2 acres) and consisted of smaller waste trenches, each excavated to a size of 2.4 m (8 ft) wide by 3 m (10 ft) deep by 15 m (50 ft) long. Each of the smaller trenches was separated from the other by 4.6 m (15 ft) of undisturbed soil. Filled trenches were covered with 0.3 to 1.5 m (1 to 5 ft) of soil. The western trench is west of the present-day road separating Landfill I and Landfill III and is actually covered by the Landfill III cap. The northern waste trench was identified from aerial photographs and has a surface area of approximately 3,000 m^2 (0.75 acres). Information pertaining to its true dimensions was limited. It was covered with soil and was not discernible at the surface.

3.1.2 Landfill II

Landfill II encompassed approximately 60,700 m^2 (15 acres) and was located in the southwest corner of an abandoned gravel pit. It received waste from September 1970 until it was closed in

September 1982. Depth to basalt at the landfill varied from 4.6 to 11.3 m (15 to 37 ft), based on a seismic refraction survey and a subsurface borehole drilling investigation. The landfill waste profile, however, was estimated to range in depth from 3.7 to 8.5 m (12 to 28 ft), because the pit probably was not excavated beyond the base of the gravel-bearing unit and into the clay material. Hand augering at 60 sampling sites indicated that the original Landfill II soil cover ranged in thickness from 0.1 to 1.0 m (0.33 to 3.17 ft), with an overall mean of 0.47 in (1.5 ft). The landfill surface was gently undulating due to differential settling of the waste and maintained a stand of crested wheatgrass.

3.1.3 Landfill lll

Landfill III consisted of six trenches that covered approximately 48,600 m^2 (12 acres). It opened in October 1982 after Landfill II was closed and operated until December 1984. Depth to the underlying basalt is 3 to 10 m (10 to 33 ft) based on a seismic refraction survey. The landfill waste profile was estimated to be 4 m (13 ft) deep on average. It was common practice to excavate the landfill trenches, leaving a soil layer intact between the wastes and underlying basalt. The original Landfill III soil cover ranged in thickness from 0.3 to 2.4 m (1 to 8 ft) with an overall mean of 0.86 m (2.83 ft), based on augering results. Ground-penetrating radar measurements estimated the average original soil cover thickness to be 0.6 to 0.9 m (2 to 3 ft). The landfill surface was also gently undulating due to differential settling of the waste and maintained a stand of crested wheatgrass.

3.2 Land and Resource Use

The INEEL land area consists of approximately 2,305 km^2 (890 mi^2). Most of this land, approximately 98%, has not been disturbed by Site operations. Land use on the entire INEEL is restricted, and access to the INEEL and WAG 4 is controlled. Though public highways traverse the INEEL, public access beyond the highway right-of-way is not allowed. Access to INEEL facilities requires proper clearance, training, or an escort, and controls to limit exposures. Current and future land uses, as well as a summary of groundwater uses (including classification and basis), are discussed in the following subsections.

3.2.1 Current Land Use

The Bureau of Land Management (BLM) has classified the acreage within the INEEL as industrial and mixed use (DOE-ID 2001a). Typical INEEL land use consists of wildlife management areas, government industrial operations areas, and waste management areas. No residential areas are contained within the INEEL boundaries. As shown in Figure 3-1, large tracts of land are reserved as buffer and safety zones around the boundary of the INEEL, and operations are generally restricted to the central area. Aside from the operational facilities, the remaining land within the core of the Site is largely undeveloped and is used for environmental research, ecological preservation, and sociocultural preservation. Any future construction of new facilities at the INEEL likely will occur within the preferred development corridors.

The buffer consists of 1,295 km^2 (500 mi^2) of grazing land (DOE-ID 2001a) administered by the BLM. Grazing areas at the INEEL support cattle and sheep, especially during dry conditions. Depredation hunts of game animals managed by the Idaho Department of Fish and Game are permitted on the INEEL within the buffer zone during selected years (DOE-ID 2001a). Hunters are allowed access to an area that extends 0.8 km (0.5 mi) inside the INEEL boundary on portions of the northeastern and western borders of the Site.

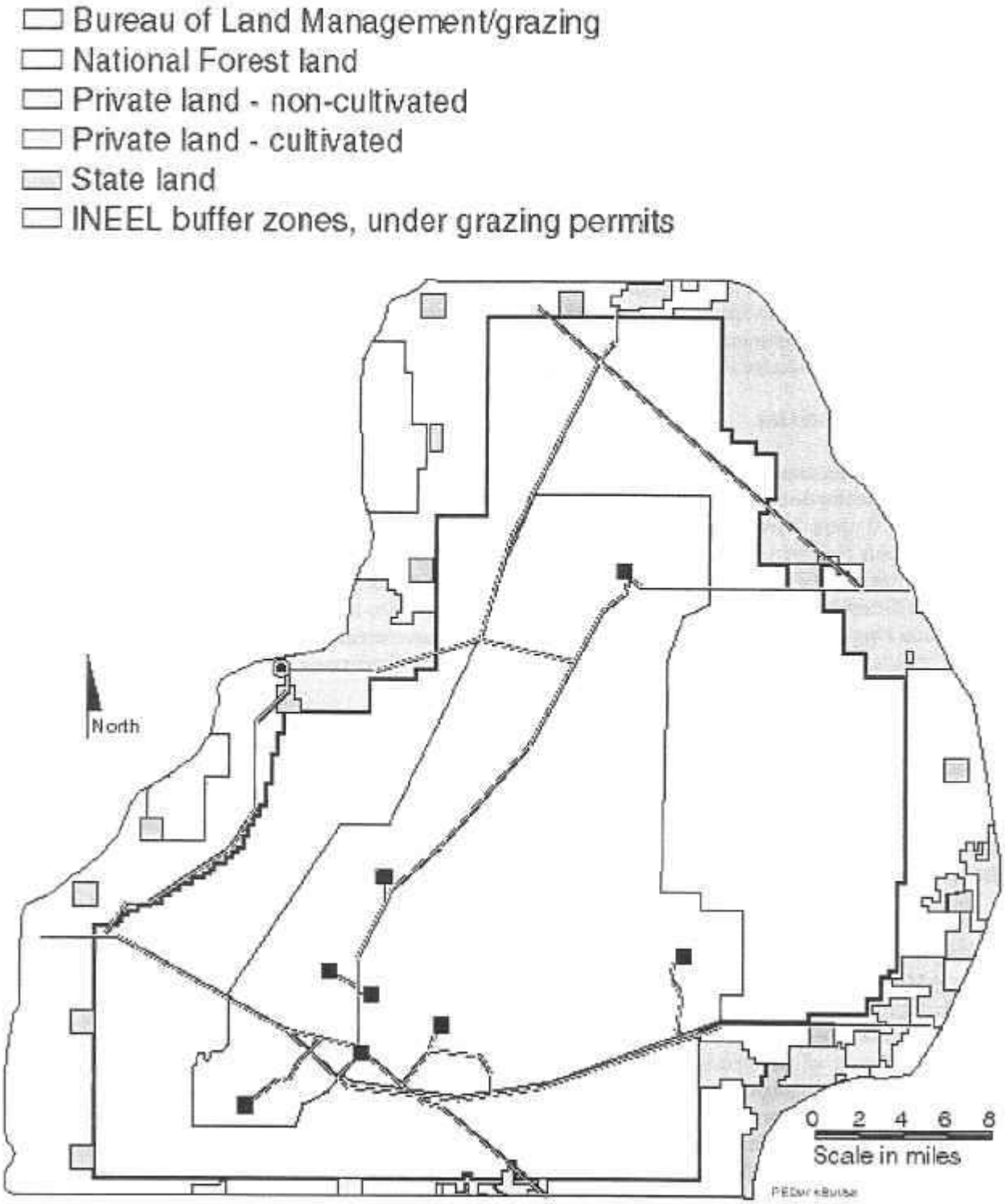

Figure 3-1. Land ownership distribution in the vicinity of the Idaho National Engineering and Environmental Laboratory.

State Highways 22, 28, and 33 cross the northeastern portion of the Site, and U.S. Highways 20 and 26 cross the southern portion (Figure 1-1). One hundred forty-five km (90 mi) of paved highways used by the general public pass through the INEEL (DOE-ID 2001a), and 23 km (14 mi) of Union Pacific Railroad tracks traverse the southern portion of the Site. A government-owned railroad passes from the Union Pacific Railroad through CFA to the Naval Reactors Facility, and a spur runs from the Union Pacific Railroad to the Radioactive Waste Management Complex.

In the counties surrounding the INEEL, approximately 45% of the land is used for agriculture, 45% is open land, and 10% is urban (DOE-ID 2001a). Livestock uses include the production of sheep, cattle, hogs, poultry, and dairy cattle (Bowman et al. 1984). The major crops produced on land surrounding the INEEL include wheat, alfalfa, barley, potatoes, oats, and corn. Sugar beets are grown within about 64 km (40 mi) of the INEEL in the vicinity of Rockford, Idaho, southeast of the INEEL in central Bingham County (Idaho 1996). Private individuals or the U.S. Government owns most of the land surrounding the INEEL. The BLM administers the government land on the INEEL (DOE-ID 2001a).

3.2.2 Future Land Use

Land-use projections in the *INEEL Comprehensive Facility and Land Use Plan* (DOE-ID 2001a) incorporate the assumption that the INEEL will remain under government management and control for at least the next 100 years. However, implementation of this management and control becomes increasingly uncertain over this time period. Regardless of the future use of the land now occupied by the INEEL, the federal government has an obligation to provide adequate institutional controls (i.e., limit access) to areas that pose significant health or safety risks until those risks diminish to acceptable levels. Fulfillment of this obligation hinges on the continued viability of the federal government and on Congress appropriating sufficient funds to maintain the institutional controls for as long as necessary.

A mix of land uses across the INEEL is anticipated to include unrestricted industrial uses, government-controlled industrial uses, unrestricted areas, controlled areas for wildlife management and conservation, and waste management areas. No residential development will be allowed within the INEEL boundaries, and no new major private developments (residential or nonresidential) on public lands are expected in areas adjacent to the Site. Grazing will be allowed to continue in the buffer area (DOE-ID 2001a). In addition, the INEEL is currently a National Environmental Research Park and is expected to remain so for the foreseeable future.

The *INEEL Comprehensive Facility and Land Use Plan* (DOE-ID 2001a) was developed using a stakeholder process that involved a public participation forum, a public comment period, and the INEEL Citizen's Advisory Board. The public participation forum membership included members from the local counties and cities, the Shoshone-Bannock Tribes, the BLM, the DOE, the U.S. Forest Service, the U.S. National Park Service, the Idaho Department of Transportation, Idaho Fish and Game, and eight business, education, and citizen organizations. In addition, the EPA and Idaho Department of Health and Welfare participated in an ex-officio capacity. Following review and comment by the public participation forum, the document underwent a 30-day public comment period and was subsequently submitted to the INEEL Citizen's Advisory Board for review and recommendations. No recommendations for residential use of any portions of the INEEL within at least the next 100 years have been received to date. Projected non-industrial use is limited to grazing and similar activities.

Generally, future land use within the INEEL will remain essentially the same as the current use, which is the same as was in place at the time the baseline risk assessment was performed for the CFA landfills: a research facility within the INEEL boundaries and agriculture and open land surrounding the INEEL. Other potential, but less likely, land use within the INEEL includes agricultural applications and the return of the areas to their natural undeveloped states. The *INEEL Comprehensive Facility and Land*

Use Plan (DOE-ID 2001a) projects that improvements will be made to support performance capabilities of the CFA by upgrading its infrastructure, where needed, and productivity improvements will be implemented. Disposal of old, nonessential facilities will also continue to eliminate safety concerns and reduce surveillance and maintenance costs, although historic preservation and reuse possibilities are considered before facilities enter the demolition process.

3.2.3 Groundwater Uses

Current use of groundwater from the SRPA is for drinking and irrigation. Groundwater is extracted from various production wells around the INEEL, including two located at CFA. Restrictions on groundwater use based on the impacts of WAG 4 operations on the aquifer are not anticipated. A technical assessment of the effects of the CFA landfills on the aquifer is provided in Section 7.

The CFA landfills are situated above the SRPA. The eastern portion of the aquifer was granted sole source status by the EPA on October 7, 1991 (56 FR 50634). The Idaho Ground Water Quality Rule (IDAPA 58.01.11), the Idaho Ground Water Quality Standards (IDAPA 58.01.11.200), and the Idaho Water Quality Standards and Wastewater Treatment Requirements (IDAPA 58.01.02) primarily dictate Idaho water quality standards.

Three categories of protectiveness apply to the aquifer and its associated resources under Idaho regulations: (1) Sensitive Resources, (2) General Resources, and (3) Other Resources. Because no previous action to categorize the SRPA under Idaho regulations has occurred, the aquifer defaults to the "General Resources" category. General Resource aquifers are protected to ensure that groundwater quality is not jeopardized. Idaho's groundwater standards incorporate federal radiation exposure and drinking water standards (10 CFR 20, Appendix B, Table 2; 40 CFR 141 and 143). When the two federal standards are not in agreement, the more restrictive standard applies.

3.3 History of Contamination

Contaminant sources in the CFA landfills can be generally described as solid and liquid nonradioactive materials discarded in the landfills over a period of 40 years. The predominant waste types entering the landfills were construction, office, and cafeteria waste. Review of the waste inventory records indicate that the major types of waste accepted at the landfills included trash sweepings, cafeteria garbage, wood and scrap lumber, masonry concrete, scrap metal, weeds and grass, dirt and gravel, asphalt, and asbestos. To a lesser extent, potentially hazardous wastes were also discarded in the landfills and may have included waste oil, solvents, chemicals, and paint. Landfill waste descriptions were determined from the Industrial Nonradioactive Waste Management Information System, interviews with INEEL personnel, reports, and other information related to waste disposal. Many uncertainties (especially with Landfill I) were associated with the data gathered from these sources, including lost or unreadable records, overestimation and/or underestimation of waste volumes, and inconsistency in actual disposal locations. Although the reliability of the waste descriptions may not have been very high, the waste descriptions did indicate the general categories of waste typically discarded in the landfills.

Solid nonradioactive materials discarded in the CFA landfills were generated by INEEL facilities, including Argonne National Laboratory-West, Auxiliary Reactor Area, CFA, Idaho Nuclear Technology and Engineering Center (formerly known as the Idaho Chemical Processing Plant at the time the landfills were operational), Experimental Breeder Reactor II, Naval Reactors Facility, Special Power Excursion Reactor Test, Test Area North, and Test Reactor Area. The Central Facilities Maintenance Branch of the Site Services Division collected waste material for disposal at the landfills. Demolition and construction materials were discarded in the landfill directly by subcontractors responsible for a given project. Records showed no indication of material segregation within the landfills. To a lesser extent, the disposal of liquid wastes in a sludge form (including oils, solvents, and other chemicals) did occur, usually by spreading

upon the day's collection of solid wastes followed by compaction and covering with at least 0.3 m (1 ft) of natural soil cover.

During operation of CFA Landfills II and III (1970 to 1984), screening procedures were in place to prevent radioactive wastes from being inadvertently deposited in the landfills during their operation. Screening was the responsibility of the generating facility. Before disposal of any waste material in the CFA landfills, the waste was screened by a radiological control technician for radionuclides to determine if the waste material was above radioactive background levels. However, it is acknowledged that up to one shipment per month of low-level radioactive waste may have been inadvertently disposed of to the landfills. Wastes were not screened for radioactivity at the time of disposal on a full-time basis at the INEEL landfills until 1989.

3.4 Previous Response Actions

A Track 2 investigation was conducted at CFA Landfill I in 1992 to collect, evaluate, and report information regarding contamination at the site. The field investigation was summarized in the *Preliminary Scoping Track 2 Summary Report for Operable Unit 4-10* (INEL 1995b) and consisted of two tasks. The first task included the collection of samples from CFA Landfill I that were analyzed for inorganic, volatile organic, semivolatile organic, and radioactive constituents. These analyses were performed to identify and characterize the contamination beneath the landfill at the soil-basalt interface by drilling and sampling the landfill waste and/or soil. The second task included the collection of soil samples for the analysis of geotechnical parameters. This was done to identify and characterize the physical properties of the existing landfill soil cover. A Track 2 risk assessment was performed for occupational and residential scenarios for the following pathways: soil ingestion, inhalation of fugitive dust, and external exposure. Based upon the Track 2 risk assessment performed at the time, no further action was recommended for the site.

In 1995, a remedial investigation was conducted at CFA Landfills I, II, and III. The results of this investigation are summarized in the *Remedial Investigation/Feasibility Study for Operable Unit 4-12: Central Facilities Area Landfills I, II, and III at the Idaho National Engineering Laboratory* (INEL 1995a). Because a Track 2 investigation had been performed previously at the CFA Landfill I, results of the investigation were incorporated into the report, and the remedial investigation concentrated on CFA Landfills II and III. Extensive field investigations and sampling of the groundwater, landfill cover soils, soil gas, and landfill emissions were conducted at these two landfills. In addition, seven boreholes were drilled through the waste to the top of the underlying basalt layer at Landfill II, and soil samples were collected within and below the waste unit.

A baseline risk assessment evaluated the potential adverse health effects to workers and potential future residents under the no-action alternative for the CFA landfills. Contaminants of concern included polyaromatic hydrocarbons detected in the cover soils of Landfill II and beryllium, cadmium, and zinc identified in the groundwater pathway. No contaminants of concern were identified for the air pathway. The potential total risk calculated for incidental ingestion of soil from CFA Landfill II was below the 1×10^{-4} risk for both workers and future residents. Beryllium posed a potential residential risk for the ingestion of groundwater of 2×10^{-4}. While the carcinogenic results indicated that there is concern for potential health effects to future residents exposed to beryllium detected in the downgradient wells, a great deal of uncertainty existed with the results, because beryllium was detected in only three of the downgradient wells and duplicate results at two of the three wells were non-detect for beryllium. The feasibility study recommended that a remedial alternative consisting of uniform containment with native soil cover, institutional controls, and monitoring be implemented at the site due to the heterogeneous nature of the landfill waste, the uncertainty of the waste inventory and disposal records, and the inability to completely characterize the landfills.

4. REMEDIAL ACTION

The remedial action conducted at CFA Landfills I, II, and III is protective of human health and the environment and was performed in compliance with the applicable or appropriate and relevant requirements as established in the ROD (DOE-ID 1995). Based upon cover infiltration monitoring commencing in the spring of 1997 and verbal agreement with the Agencies, it was determined that the 5-year review of the CFA landfills remedial action would take place in the spring of 2002 with submittal of the 5-year review report by the end of April 2002. The review period covers from 1996 when the remedial action began and from 1997 when all landfill monitoring activities commenced through the summer of 2002.

4.1 Remedy Selection

Based upon consideration of the CERCLA requirements, the detailed analysis of alternatives, and public comments, the Agencies selected uniform containment with native soil cover, institutional controls, and monitoring as the most appropriate remedy for the CFA landfills. Containment with a native soil cover is believed to be the best alternative for minimizing public risk and providing long-term protection of the SRPA.

As defined in the ROD (DOE-ID 1995) and established in the OU 4-12 Work Plan (DOE-ID 1996), there are three primary remedial action objectives associated with the CFA landfills. These include the following:

- Prevent direct contact with the landfill contents. This was accomplished by placement of the uniform native soil cover over the landfills and through the implementation of institutional controls including fences, signs, and administrative controls. Maintenance and monitoring of the institutional controls are covered by the *Operations and Maintenance Plan for the Central Facilities Area Landfills I, II, and III Native Soil Cover Project Operable Unit 4-12* (INEL 1997a) as superceded by the *Operations and Maintenance Plan for the Final Selected Remedies and Institutional Controls at Central Facilities Area, Operable Unit 4-13* (DOE-ID 2002a).

- Minimize the potential for erosion and infiltration at the landfill surface. This relied on the use of the HELP model to design a cover that would meet this goal. Requirements for the maintenance of the landfill cover are delineated in the *Operations and Maintenance Plan for the Central Facilities Area Landfills I, II, and III Native Soil Cover Project Operable Unit 4-12* (INEL 1997a) as superceded by the *Operations and Maintenance Plan for the Final Selected Remedies and Institutional Controls at Central Facilities Area, Operable Unit 4-13* (DOE-ID 2002a).

- Ensure that drinking water standards are not violated in the SRPA due to the migration of contaminants from the landfills. This relied on a landfill cover design intended to minimize infiltration as well as implementation of the Post-ROD Monitoring Work Plan (INEL 1997b). Monitoring requirements include measurement of soil moisture, soil gas, groundwater contaminants, and water level measurements to determine groundwater flow direction. Requirements in the *Final Selected Remedies and Institutional Controls at Central Facilities Area, Operable Unit 4-13* (DOE-ID 2002b) cover maintenance of landfill monitoring equipment.

    - The objective of soil moisture monitoring is to determine the landfill covers' effectiveness at minimizing infiltration into the landfill wastes. An action level was to be established for moisture infiltration rate through the landfill covers following the 2-year intensive monitoring period.

- The objective of soil gas monitoring is to provide data to evaluate potential leaching of volatile organic compounds (VOCs) from the buried landfill waste. An action level was to be established for vadose zone gas following the 2-year intensive monitoring period.

- The objective of groundwater monitoring is to provide data to evaluate potential leaching of contaminants to the aquifer, establish a baseline for contaminant concentrations in the aquifer, and monitor groundwater flow direction. The action levels for groundwater contaminant concentrations are based upon EPA-established maximum contaminant levels and risk-based concentrations.

The major components of the remedy included (1) placement of a uniform native soil cover over Landfills I, II, and III; (2) the implementation of institutional controls; and (3) the periodic monitoring of groundwater, infiltration, and/or vadose zone. The remedy is believed to be protective of human health and the environment, complies with the applicable or relevant and appropriate requirements established in the ROD (DOE-ID 1995), and is the most cost-effective of the alternatives evaluated.

As provided in the OU 4-12 Work Plan (DOE-ID 1996), the remedy ensured that a thickness of at least 0.6 m (2 ft) of a combination of existing soil cover and clean, compacted native soils covers the landfills' waste. Routine maintenance of the cover includes placement of soils (as needed) to eliminate low spots that might form due to landfill content subsidence. The cover's long-term stability has been enhanced using natural vegetation consisting of three varieties of wheatgrass (P-27 Siberian wheatgrass, "Ephraim" crested wheatgrass, and "Sodar" streambank wheatgrass) at the cover's surface. In addition to the cover, the remedy included institutional controls to ensure that future activities do not compromise the integrity of the cover (INEL 1997a). Landfill borders have been delineated through the posting of signs warning of the landfills' existence and potentially contaminated soils (INEL 1997a).

4.2 Remedy Implementation

The remedial action for CFA Landfills I, II, and III included placement of a native soil cover, establishment of environmental monitoring, implementation of administrative controls, inspection and maintenance of the cover, and maintenance of institutional controls. The remedial action commenced in 1996 with completion of the installation of the monitoring equipment in April 1997. A new time-domain reflectometer array was installed in 2000 and became operational in October of that year.

The native soil cover consisted of three layers: (1) a general backfill layer that brought the existing grade up to the design slope (rough grade), (2) a compacted low-permeability soil layer, and (3) a topsoil layer that created the final grade and allows for growth of a vegetative cover. To install the cover over each landfill, the landfill was initially grubbed to remove surficial organic material in an effort to minimize void creation due to decomposition. Fill material for all three layers was obtained from Spreading Area "B" at the INEEL and placed over the landfills. The fill material was described as a lean clay with sand. The particle size analysis had 84.1 % of the material passing through a No. 200 sieve (less than 0.075 mm average diameter). Both the general backfill and low-permeability soil layers were compacted to 95% of maximum dry density at 0 to +4 percentage points from optimum moisture content. The general backfill layer was emplaced with a maximum 15-cm (6-in.) compacted lift thickness. The low-permeability soil layer was placed in maximum 20-cm (8-in.) loose lifts to attain a maximum 15-cm (6-in.) compacted lift thickness. The final topsoil layer was emplaced with no compaction. In addition, for Landfill II, a riprap layer was installed at the extreme northeast face of the landfill, rather than revegetating the area, in an effort to prevent erosion due to the steepness of the slope. A detailed description of the remedial action, including the installation of the landfill covers, is provided in the *Remedial Action Report CFA Landfills I, II, and III Native Soil Cover Project Operable Unit 4-12* (DOE-ID 1997).

In accordance with the ROD (DOE-ID 1995), environmental monitoring of the site includes vadose zone, groundwater, and infiltration monitoring. Groundwater monitoring wells were previously installed in the area surrounding the CFA landfills. A total of nine soil gas-sampling points were installed in CFA Landfills II and III prior to the remedial action. These sampling ports range in depth from 3.5 to 9.4 m (11.5 to 31 ft) below land surface (bls). No sampling points were initially located near CFA Landfill I, because the sampling points at Landfills II and III were installed as part of the remedial investigation conducted for OU 4-12 of which Landfill I was not originally a part. As part of the remedial action, five new gas-sampling boreholes were installed (one adjacent to CFA Landfill I and two adjacent to both CFA Landfills II and III). Each borehole was completed with four sampling ports, two above the shallow interbed and two below. In addition to the groundwater and vadose zone monitoring capabilities, a time-domain reflectometry system was installed on Landfills I and II to monitor infiltration. Waveguide probes were installed in groups of four, with the first installed 15 cm (6 in.) above the existing grade, the second at the top of the rough grade material, the third between the first and second lift of low-permeability soil, and the fourth at the top of the low-permeability soil layer, just under the topsoil layer. Infiltration monitoring also includes the logging of the five neutron-probe access tubes (NATs) that were in place before the remedial action.

4.3 Operations and Maintenance

The *Operations and Maintenance Plan for the Central Facilities Area Landfills I, II, and III Native Soil Cover Project Operable Unit 4-12* (INEL 1997a) as superceded by the *Operations and Maintenance Plan for the Final Selected Remedies and Institutional Controls at Central Facilities Area, Operable Unit 4-13* (DOE-ID 2002a) describes the activities and procedures required to maintain the natural soil covers and the related systems and equipment at CFA Landfills I, II, and III. Basic elements of the O&M Plan. (DOE-ID 2002a) include a description of inspection, maintenance, and repair procedures for the vegetative cover, soil cover, rock armor, and monitoring equipment. Operational and sampling procedures for the NATs and time-domain reflectometers are outlined in the *Post Record of Decision Monitoring Work Plan Central Facilities Area Landfills I, II, and III Operable Unit 4-12* (INEL 1997b). The O&M Plan (DOE-ID 2002a) outlines the requirements for the following:

- Inspection and corrective maintenance of the vegetative cover, including inspections for nongrowth areas, sparse growth areas, and weed and shrub encroachment, as well as corrective repair

- Inspection and corrective maintenance of the soil cover— including inspection of erosion areas and ponding caused by subsidence— inspections for animal intrusion, surveying for slope movement and changes in contours, and corrective repair of erosion, animal intrusion, and ponding areas

- Inspection and corrective maintenance of the rock armor, including inspections of the rock-armored slopes and corrective repair

- Inspection and corrective maintenance of NAT installations, including inspections of well components, inspections of the tubes, and corrective repair of problem areas

- Inspection and corrective maintenance of the time-domain reflectometer installations, including inspection of time-domain reflectometer components and corrective repair of problem areas

- Inspection of institutional controls, including fences and postings restricting access to the CFA landfill area by unauthorized personnel.

5. FIVE-YEAR REVIEW PROCESS

5.1 Review Notification

Initially it was thought that DOE-ID would be the lead agency for the 5-year review. Therefore, in accordance with the *Comprehensive Five-Year Review Guidance* (EPA 2001), public notification of the pending 5-year review of the CFA landfill remedial action was provided to the INEEL stakeholders on May 20, 2002. Specific notification was given through the following resources:

- *Arco Advertiser*—Arco, Idaho
- *Idaho State Journal*—Pocatello, Idaho
- *The Idaho Statesman*—Boise, Idaho
- *Idaho Unido*—Pocatello, Idaho
- *Moscow-Pullman Daily News*—Moscow, Idaho/Pullman, Washington
- *The Post Register*—Idaho Falls, Idaho
- *Sho-Ban News*—Fort Hall Reservation
- *The Times News*—Twin Falls, Idaho.

A copy of the public notification is provided in Appendix B. The notification prematurely indicated that the 5-year review was complete and the remedial action had been determined to be protective. A brief description of the selected remedy and a summary of the contamination addressed by that remedy is given. Community input is requested, and a contact name and telephone number are provided so that additional information can be requested.

As of the finalization of this 5-year review document, the EPA has taken responsibility for the 5-year review. This document will be used to support EPA's review instead.

5.2 Review Team Members

The DOE-ID is the lead agency for the 5-year review of the CFA landfills. Team members consist of representatives from that agency and personnel from the operations and maintenance contractor for the INEEL, Bechtel BWXT Idaho, LLC (BBWI). The following individuals are members of the 5-year review team:

- Carol A. Hathaway — DOE-ID WAG 4 Project Manager
- Stephen G. Wilkinson — BBWI WAG 4 Project Manager
- Douglas H. Preussner — BBWI WAG 4 Project Engineer
- Deborah Wiggins-Wagoner — BBWI WAG 4 Technical Task Leader
- Paul V. Hehn — BBWI Staff Scientist

- Richard P. Wells BBWI Advisory Scientist

- Michael S. Roddy BBWI Staff Scientist.

Questions concerning the review or technical content of this report should be addressed to Deborah Wiggins-Wagoner at (208) 526-9989 or E-mail at wigg(@inel.gov.

5.3 Review Schedule

Collection of information and data pertinent to the CFA landfills' 5-year review supporting documentation is an ongoing process and includes the compilation of analytical and inspection reports that have been prepared since the completion of the remedial activity. Preparation of the 5-year review supporting documentation report commenced on January 11, 2002, with the review period expected to culminate with the finalization of the report scheduled for September 2002.

5.4 Document Review

In preparation for and conducting of the CFA landfill 5-year review supporting documentation, the following documents relating to the investigation and remediation of the CFA Landfills I, II, and III were reviewed:

- *Preliminary Scoping Track 2 Summary Report for Operable Unit 4-10* (INEL 1995b)

- *Remedial Investigation/Feasibility Study for Operable Unit 4-12: Central Facilities Area Landfills I, II, and III at the Idaho National Engineering Laboratory* (INEL 1995a)

- *Record of Decision: Declaration for Central Facilities Area Landfills I, II, and III (Operable Unit 4-12), and No Action Sites (Operable Unit 4-03)* (DOE-ID 1995)

- *Remedial Design/Remedial Action Work Plan for Central Facilities Area Landfills I, II, and III Native Soil Cover Project Operable Unit 4-12* (DOE-ID 1996)

- *Remedial Action Report CFA Landfills I, II, and III Native Soil Cover Project Operable Unit 4-12* (DOE-ID 1997)

- *Post Record of Decision Monitoring Work Plan Central Facilities Area Landfills I, II, and III Operable Unit 4-12* (INEL 1997b)

- *Field Sampling Plan for the Post Record of Decision Monitoring CFA Landfills I, II, and III Operable Unit 4-12* (INEL 1997c)

- *Operations and Maintenance Plan for the Central Facilities Area Landfills I, II, and III Native Soil Cover Project Operable Unit 4-12* (INEL 1997a)

- *Operation and Maintenance Plan for the Final Selected Remedies and Institutional Controls at Central Facilities Area, Operable Unit 4-13* (DOE-ID 2002a)

- *Post-Record of Decision Monitoring Report from 1996-1998 at Operable Unit 4-12, Central Facilities Area Landfills I, II, and III (CFA-01, CFA-02, and CFA-03)* (INEEL 2000).

6. DATA REVIEW AND EVALUATION

As previously stated, monitoring data have been obtained from the groundwater wells (see Figure 6-1), gas-sampling boreholes, NATs, and time-domain reflectometer arrays (refer to Figure 6-2 for the locations of the boreholes, NATs, and time-domain reflectometer arrays). The following subsections summarize the results from the monitoring efforts.

6.1 Soil Gas Monitoring

As part of the remedial action, five new soil gas-sampling boreholes were installed in the vicinity of the CFA landfills to monitor for soil gases and contaminants. One borehole was installed adjacent to Landfill I, two adjacent to Landfill II, and two adjacent to Landfill III (one of which is proximal to Landfill I). Each borehole was completed with four soil gas-sampling ports, including two above the shallow interbed and two below it.

The soil gas-sampling ports are designed to sample soil gases from discrete depths. One shallow sampling port was placed within the surficial sediments at a depth of approximately 4 m (13 ft). A second sampling port was placed in basalt at a depth of approximately 11.6 m (38 ft) above the shallow interbed, which is located approximately 12 to 18 m (40 to 60 ft) bls. Two deep sampling ports were placed below the shallow interbed, with perforated sections vertically separated by approximately 9 m (30 ft). The depths of these two ports are approximately 23.8 m (78 ft) and 32.9 m (108 m). The perforated sections of the deep sampling ports were located adjacent to fracture zones in the basalt to place the sampling locations adjacent to the most probable avenue of soil gas migration. Soil gas samples were collected and analyzed for VOCs including methane.

With the exception of 1999 and 2000, soil gas samples were collected twice a year from five soil gas monitoring locations completed near the landfills to monitor soil gas from the four separate depths in the vadose zone at each location. Soil gas sample analytical results from December 1996 through January 2001 (excluding 1999 during which time samples were not collected) are provided in Appendix D. A summary of the soil gas data is provided in Table 6-1 with results presented for each borehole by depth. The soil gas samples are currently scheduled to be collected twice a year. However, as happened in 2000, only one set of soil gas samples was collected. Two sample sets were collected in 2001—in January and July.

As originally discussed and identified in the Post-ROD Monitoring Report from 1996 to 1998 (INEEL 2000), six VOCs have consistently been positively detected in the soil gas samples. These include 1,1,1 -trichloroethane (see Figures 6-3 through 6-6), 1,1-dichloroethane (see Figure 6-7), 1,1-dichloroethene (see Figures 6-8 and 6-9), and trichloroethene (see Figure 6-10), all of which are common solvents or constituents found in solvents used for cleaning mechanical equipment. Dichlorodifluoromethane and trichlorofluoromethane (see Figures 6-11 through 6-13) are freons used in cooling systems. Methane, which is a common by-product of anaerobic degradation of organic wastes, was detected in higher concentrations in 1996, but has now been reduced to low levels in all soil gas samples.

Other cleaning solution chemicals have also been detected occasionally in the soil gas samples. Acetone was detected in samples collected from three of the soil gas sample locations (GSP 1-1, GSP 2-2, and GSP 3-1) between 1996 and 1998. Lower concentrations of acetone have been detected in recent gas samples. Carbon tetrachloride was detected in soil gas samples collected in 1998 from location GSP 2-1 at 23.8 m (78 ft) bls (110 ppbv) and from location GSP 2-1 at 23.8 m (78 ft) bls (1,400 ppbv) in 2000. All other locations were lower in carbon tetrachloride. In addition, several other VOCs were detected in variable concentrations at various gas sample locations between 1997 and 2000. These additional VOCs have included *cis* 1,2-dichloroethene, chloroethane, and tetrachloroethene.

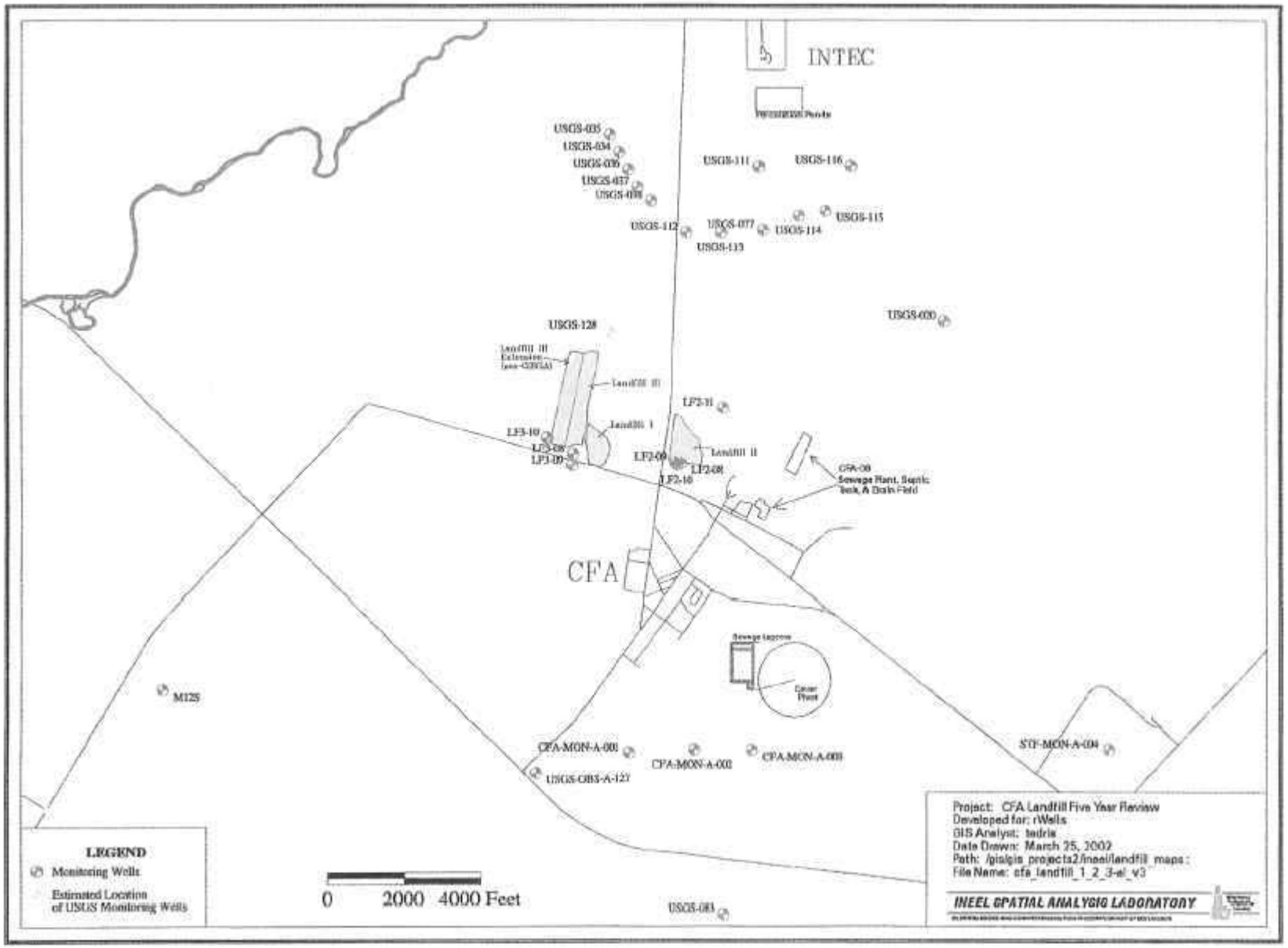

Figure 6-1. Groundwater monitoring wells.

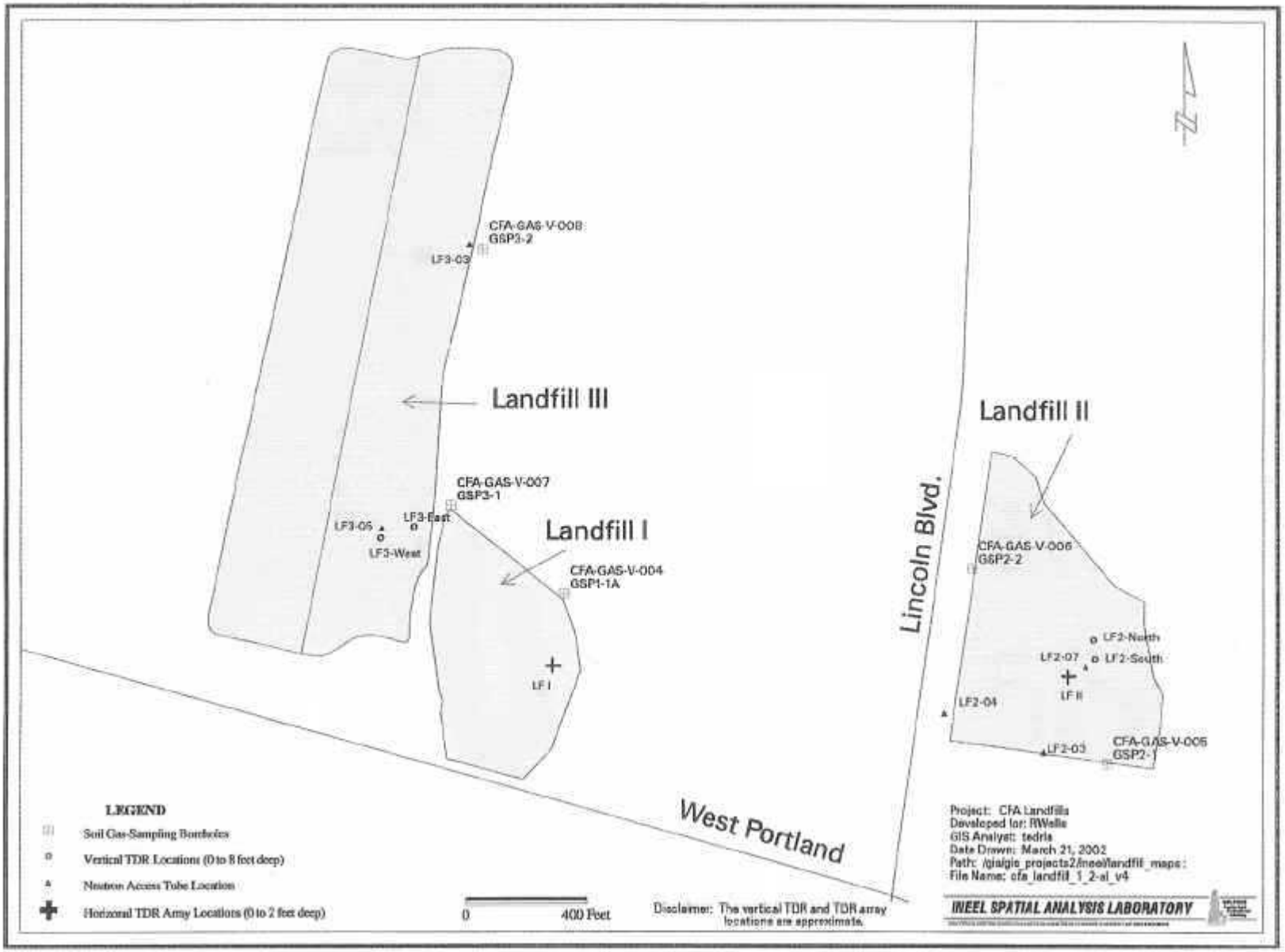

Figure 6-2. Locations of time-domain refelectometer arrays and neutron-probe access tubes.

Table 6-1. Soil gas data summary[a].

	CFA-GAS-V-004											
	12.5 ft			37.5 ft			77.5 ft			107.5 ft		
	Concentration (ppbv)			Concentration (ppbv)			Concentration (ppbv)			Concentration (ppbv)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
1,1,1-Trichloroethane	170	574	1,500	570	2,109	5,400	1,000	4,689	11,000	100	1,101	4,500
1,1,2-Trichloro-1,2,2-trifluoroethane	42	171	300	430	550	690	430	635	980	6.3	45	120
1,1-Dichloroethane	23	66	160	59	163	360	16	134	540	2	7.5	13
1,1-Dichloroethene	48	138	320	150	721	2,400	380	2,098	4,000	39	408	1,600
1,2-Dichloroethane	4	5.65	7.3	4.7	14.94	32	7	23.64	48	9	9	9
1,2-Dichloropropane	2.6	2.8	3	7.6	10.3	13	—	—	—	—	—	—
1,4-Dichlorobenzene	2.5	2.5	2.5	2.8	2.8	2.8	—	—	—	—	—	—
Acetone	14	16	18	210	210	210	24	25.5	27	20	34.5	49
Benzene	—	—	—	22	22	22	—	—	—	1	1	1
Carbon disulfide	7.2	7.2	7.2	—	—	—	—	—	—	—	—	—
Carbon tetrachloride	13	39	64	13	42	70	38	132	320	2	24.3	56
Chlorodifluoromethane	3.4	11.7	20	30	43	56	—	—	—	—	—	—
Chloroethane	3	3	3	3.3	4.15	5	4	4.5	5	—	—	—
Chloroform	8	14	20	2	18	34	3	13.6	25	5	10.5	16
cis-1,2-Dichloroethane	6.1	6.1	6.1	12	12	12	31	31	31	—	—	—
Dichlorodifluoromethane	12	130	380	92	342	820	69	361	600	5	64	220
Methane	369	2,156	4,400	619	4,255	9,600	256	3,982	8,500	439	2,788	5,800
Methylene Chloride	—	—	—	4	4	4	5	5.5	6	2	2	2
n-Pentane	3	3	3	47	63	79	—	—	—	—	—	—
Propene	—	—	—	—	—	—	87	129	170	—	—	—
Tetrachloroethene	13	47	88	18	93	230	5	54	250	3	8	17
Trichloroethene	21	83	180	40	259	1,000	170	773	1,700	18	126	510
Trichlorofluoromethane	43	182	530	190	561	970	150	716	1,200	7	95	360
Vinyl Acetate	—	—	—	8.3	8.3	8.3	—	—	—	—	—	—

a. Based on analytical results from December 1996 through January 2001.

Table 6-1. (continued).

	CFA-GAS-V-005											
	12.5 ft			37.5 ft			77.5 ft			107.5 ft		
	Concentration (ppbv)			Concentration (ppbv)			Concentration (ppbv)			Concentration (ppbv)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
1,1,1-Trichloroethane	3	25.2	65	7	167	840	12	231	1,600	11	150	490
1,1,2-Trichloro-1,2,2-trifluoroethane	9.3	12.1	14	36	120	240	92	123	140	1	117	220
1,1-Dichloroethane	2	4	6	4	57	110	6	26.9	64	9	45	98
1,1 -Dichloroethene	26	26	26	280	280	280	880	880	880	3	49	140
1,2-DC-1,1,2,2-TFA (F114)	4	4	4	15	15	15	12	15	18	—	—	—
1,2-Dichloroethane	—	—	—	7	7	7	—	—	—	8	8	8
2-Hexanone	—	—	—	—	—	—	190	190	190	110	110	110
4-Methyl-2-pentanone	—	—	—	—	—	—	67	67	67	—	—	—
Acetone	11	27.3	58	40	40	40	9	48	120	12	32	64
Carbon disulfide	5.8	5.8	5.8	—	—	—	—	—	—	—	—	—
Carbon tetrachloride	3	19.25	50	18	40	73	4	31.7	110	2	30	73
Chlorodifluoromethane	8	8.1	8.2	39	39	39	74	74	74	55	58	61
Chloroform	2	8	11	14	14	14	2	9.25	13	6	6	6
cis-1,2-Dichloroethene	1	1	1	—	—	—	—	—	—	—	—	—
Dichlorodifluoromethane	35	195	680	2	277	540	120	444	1,700	1	345	760
Hexane	5.7	5.7	5.7	—	—	—	—	—	—	—	—	—
Methane	1,000	1,778	2,300	508	1,736	2,800	1,361	4,367	14,900	2	1,417	3,100
Methylene chloride	10	10	10	—	—	—	—	—	—	—	—	—
n-Pentane	10	10	10	—	—	—	—	—	—	—	—	—
Propene	4.3	5.05	5.8	—	—	—	—	—	—	—	—	—
Tetrachloroethene	7	28.3	59	2	68	130	17	83	250	3	75	150
Toluene	38	38	38	—	—	—	—	—	—	—	—	—
Trichloroethene	4	28.8	64	5	54	130	5	48	220	5	35	67
Trichlorofluoromethane	20	40	90	20	129	360	38	141	340	2	140	330

Table 6-1. (continued).

	CFA-GAS-V-006											
	12.5 ft			37.5 ft			77.5 ft			107.5 ft		
	Concentration (ppbv)			Concentration (ppbv)			Concentration (ppbv)			Concentration (ppbv)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
1,1,1-Trichloroethane	420	947	2,100	210	997	2,100	120	431	650	92	580	14,00
1,1,2-Trichloro-1,2,2-trifluoroethane	150	190	210	300	380	420	330	345	360	88	246	390
1,1-Dichloroethane	420	1,696	3,600	590	7,027	36,000	160	441	1,000	40	430	1,100
1,1-Dichloroethene	22	88	220	23	104	250	6	38	92	10	44	120
1,2-DC-1,1,2,2-TFA (F114)	—	—	—	43	43	43	32	32	32	28	28	28
1,2-Dichlorobenzene	—	—	—	6.8	8.4	10	—	—	—	—	—	—
1,2-Dichloroethane	30	30	30	—	—	—	5	5	5	—	—	—
1,2-Dichloropropane	5	26.1	65	7	27.6	54	3	3	3	3	3	3
2-Butanone	—	—	—	—	—	—	86	86	86	—	—	—
2-Hexanone	26	26	26	—	—	—	—	—	—	—	—	—
Acetone	12	19	26	60	60	60	19	170	470	10	38	75
Acetonitrile	—	—	—	13	13	13	86	86	86	—	—	—
Benzene	3	3.3	4	8	9	10	—	—	—	—	—	—
Carbon tetrachloride	6	20.7	45	7.1	14.0	24	4	242	1,400	2	35.4	77
Chlorobenzene	—	—	—	9	14.5	20	—	—	—	—	—	—
Chlorodifluoromethane	120	120	120	190	190	190	—	—	—	44	97	150
Chloroethane	6.1	28.0	64	15	38	70	4	73	210	20	20	20
Chloroform	5	18.7	43	4.3	18.1	36	3	103	390	12	17	25
Chloromethane	—	—	—	—	—	—	23	23	23	—	—	—
cis-1,2-Dichloroethene	1,100	1,967	2,600	440	1,380	2,200	100	277	450	46	155	230
Dichlorodifluoromethane	100	356	630	50	534	870	160	418	680	190	615	1,200
Dichlorotetrafluoroethane	—	—	—	14	14	14	14	14	14	—	—	—
Methane	651	3,078	6,500	1,249	6,510	20,400	1,502	3,926	7,700	899	5,732	14,400
Methylene chloride	3	7	10	18	56	130	2	2	2	10	10	10
n-Pentane	—	—	—	—	—	—	20	20	20	—	—	—
Tetrachloroethene	22	111	300	64	300	610	34	130	350	19	132	350
trans-l,2-Dichloroethene	2	5.8	10	2	2	2	—	—	—	—	—	—
Trichloroethene	15	117	350	34	171	340	17	134	690	8	85	220
Trichlorofluoromethane	45	183	380	76	448	970	250	662	1,400	180	868	1,700

Table 6-1. (continued).

	CFA-GAS-V-007											
	12.5 ft			37.5 ft			77.5 ft			107.5 ft		
	Concentration (ppbv)			Concentration (ppbv)			Concentration (ppbv)			Concentration (ppbv)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
1,1,1-Trichloroethane	4	726	1,200	960	3,251	8,800	900	5,514	14,000	14	773	3,700
1,1,2-Trichloro-1,2,2-trifluoroethane	230	323	430	1,100	1,233	1,400	62	467	1,000	160	160	160
1,1-Dichloroethane	20	99	160	190	481	740	16	77	170	20	20	20
1,1-Dichloroethene	62	240	400	300	1,001	2,500	450	2,574	6,900	3	290	1,400
1,2-DC-1,1,2,2-TFA (F114)	—	—	—	—	—	—	14	14	14	—	—	—
1,2-Dichloroethane	6	6	6	5.4	14.6	41	4	11.7	24	6	6	6
1,2-Dichloropropane	—	—	—	3	14.5	26	—	—	—	—	—	—
2-Butanone	—	—	—	—	—	—	18	18	18	4.5	4.5	4.5
Acetone	6	15	22	49	64	78	16	24	38	4	95	260
Acetonitrile	4.1	4.1	4.1	9.6	9.6	9.6	14	14	14	—	—	—
Benzene	—	—	—	—	—	—	—	—	—	6	26	46
Carbon disulfide	—	—	—	—	—	—	—	—	—	13	13	13
Carbon tetrachloride	21	54	86	31	31	31	79	79	79	27	53	78
Chlorodifluoromethane	23	23	23	84	84	84	—	—	—	—	—	—
Chloroethane	—	—	—	14	14	14	2	7.0	9.9	—	—	—
Chloroform	—	—	—	6	17.2	38	5.2	13.8	30	7	13	19
cis-1,2-Dichloroethene	—	—	—	42	42	42	—	—	—	—	—	—
Dichlorodifluoromethane	71	190	340	280	796	1,300	63	420	910	4	85	300
Methane	414	2,243	4,100	959	8,015	19,700	1,186	7,247	18,200	413	3,583	8,300
Methylene chloride	3	6.5	10	8	29.8	66	9.5	44	100	1	5.5	10
n-Pentane	—	—	—	—	—	—	26	26	26	—	—	—
Propene	—	—	—	—	—	—	15	15	15	—	—	—
Tetrachloroethene	3	12.5	22	54	214	450	14	18	22	2	11	16
Toluene	—	—	—	—	—	—	32	32	32	—	—	—
trans-l,2-Dichloroethene	—	—	—	3	3	3	—	—	—	—	—	—
Trichloroethene	5.1	46	100	77	277	460	9	55	200	1	36	88
Trichlorofluoromethane	100	268	420	300	1,036	1,900	130	726	1,600	8	121	400

Table 6-1. (continued).

	CFA-GAS-V-008											
	12.5 ft			37.5 ft			77.5 ft			107.5 ft		
	Concentration (ppbv)			Concentration (ppbv)			Concentration (ppbv)			Concentration (ppbv)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
1,1,1-Trichloroethane	12	241	1,100	300	690	1,200	230	1,284	3,100	5	107	290
1,1,2-Trichloro-1,2,2-trifluoroethane	83	133	200	530	653	820	910	973	1,100	440	505	570
1,1-Dichloroethane	12	39	78	85	204	320	19	135	310	10	10	10
1,1-Dichloroethene	7	14.1	27	4	46	120	13	125	260	2	31.75	69
1,2-DC-1,1,2,2-TFA (F114)	—	—	—	—	—	—	—	—	—	45	45	45
2-Butanone	—	—	—	—	—	—	—	—	—	8.9	8.9	8.9
Acetone	19	35.4	61	27	27	27	23	30	42	12	37	64
Benzene	11	11	11	—	—	—	—	—	—	—	—	—
Carbon tetrachloride	3	15.8	40	3	3	3	14	14	14	6	17.6	39
Chlorodifluoromethane	20	20	20	92	92	92	120	120	120	16	16	16
Chloroethene	—	—	—	—	—	—	—	—	—	4.2	4.2	4.2
Chloroform	3	3.3	4	3	8.3	13	6	6	6	8.5	8.5	8.5
Chloromethane							25	25	25	—	—	—
cis-1,2-Dichloroethene	13	18.7	28	55	63	71	69	90	110	—	—	—
Dichlorodifluoromethane	3.8	123	530	150	560	860	140	874	2,200	14	172	380
Dichlorotetrafluoroethane	—	—	—	—	—	—	—	—	—	7.9	7.9	7.9
Hexane	—	—	—	—	—	—	—	—	—	35	35	35
Methane	439	1,928	3,600	594	10,499	23,400	1,319	11,905	35,500	427	3,521	8,000
Methylene chloride	—	—	—	22	22	22	14	34.3	61	4.3	29.2	54
n-Pentane	—	—	—	—	—	—	—	—	—	140	140	140
Propene	—	—	—	—	—	—	—	—	—	5.8	5.8	5.8
Tetrachloroethene	8	45	69	49	116	200	2	9.3	16	9.5	9.5	9.5
Toluene	—	—	—	—	—	—	—	—	—	100	100	100
Trichloroethene	3.9	67	140	57	131	210	14	58	110	3.8	10.6	22
Trichlorofluoromethane	5.8	187	900	280	743	1,400	230	1,356	3,000	12	278	550
Vinyl acetate	—	—	—	—	—	—	—	—	—	3.8	3.8	3.8
Xylene, isomers m&p	—	—	—	—	—	—	—	—	—	7.1	7.1	7.1

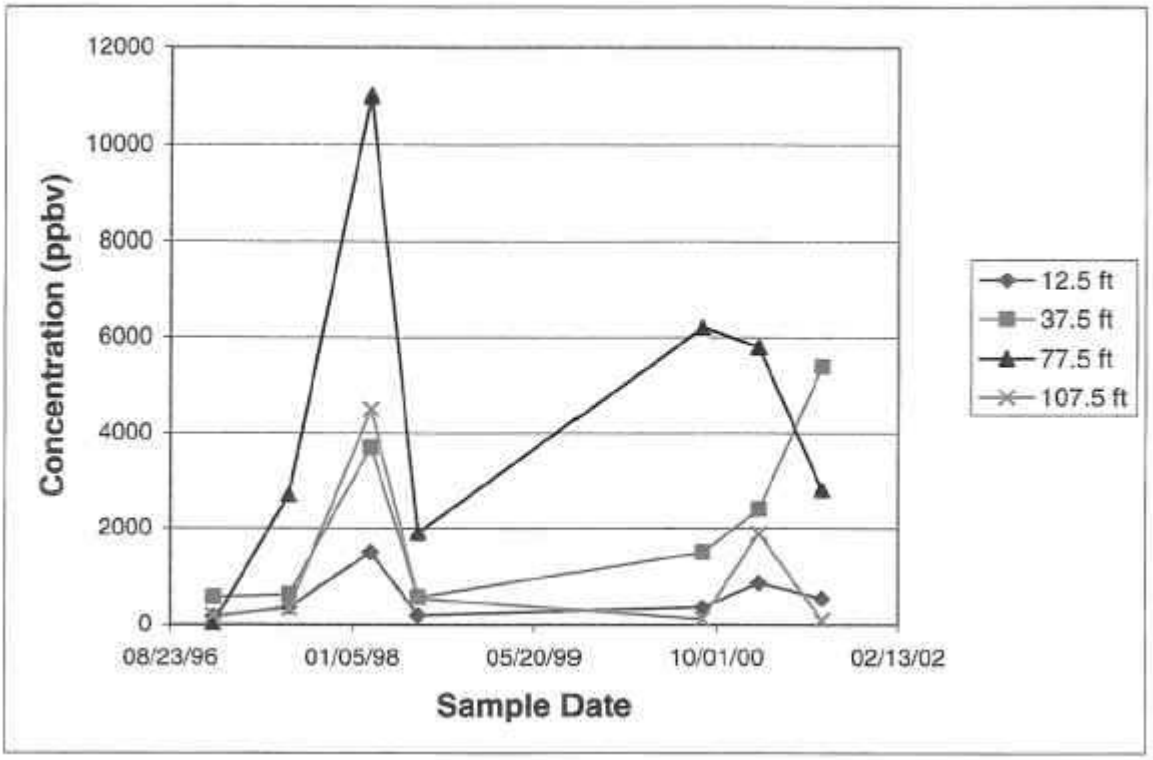

Figure 6-3. 1,1,1-Trichloroethane concentrations in CFA-GAS-V-004.

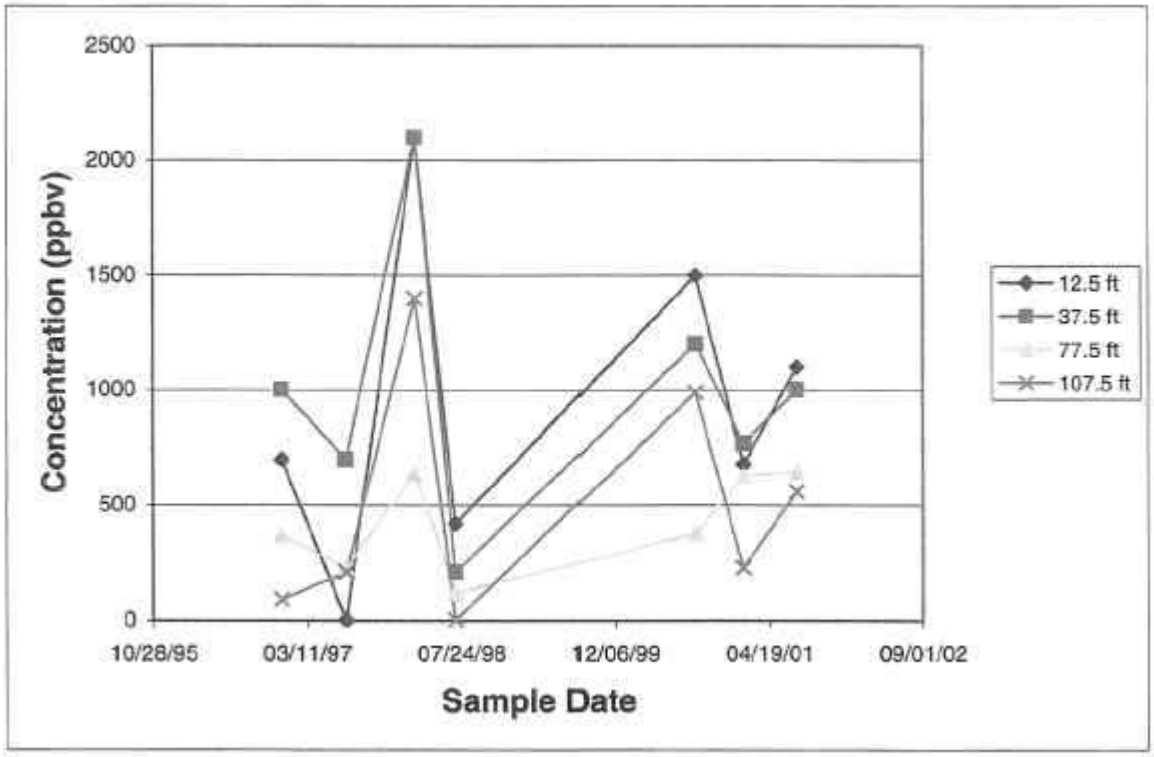

Figure 6-4. 1,1,1-Trichloroethane concentrations in CFA-GAS-V-006.

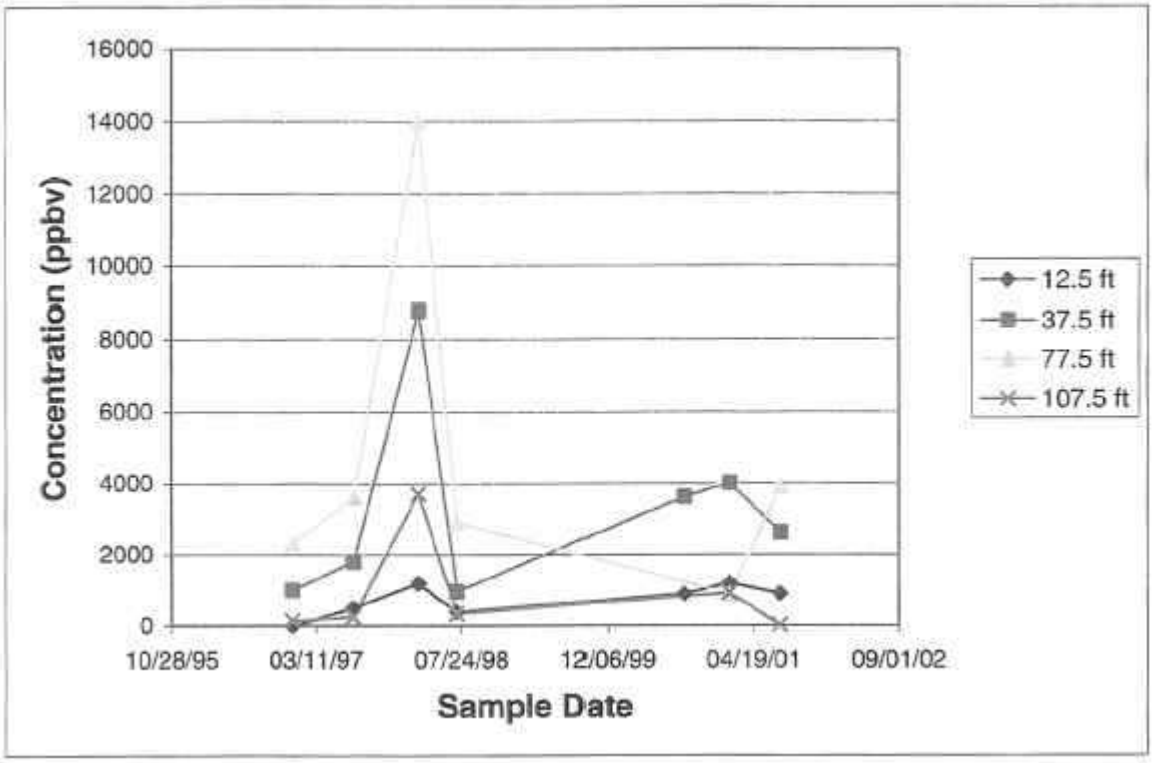

Figure 6-5. 1,1,1-Trichloroethane concentrations in CFA-GAS-V-007.

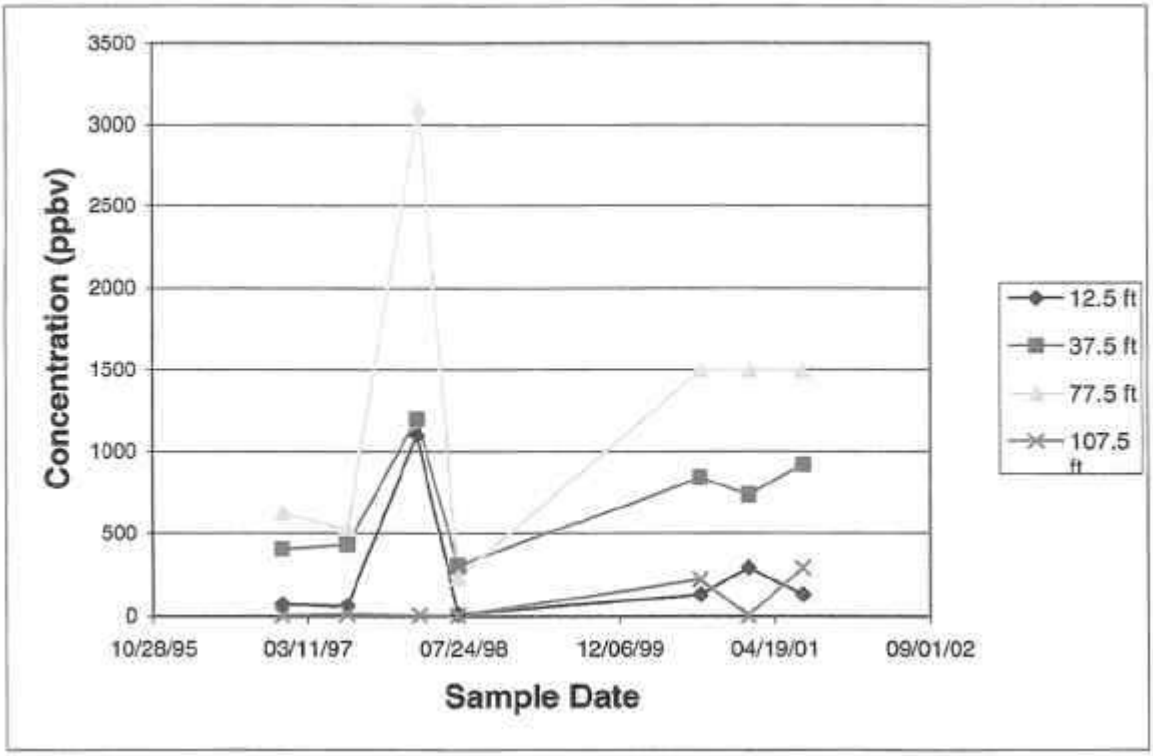

Figure 6-6. 1,1,1-Trichloroethane concentrations in CFA-GAS-V-008.

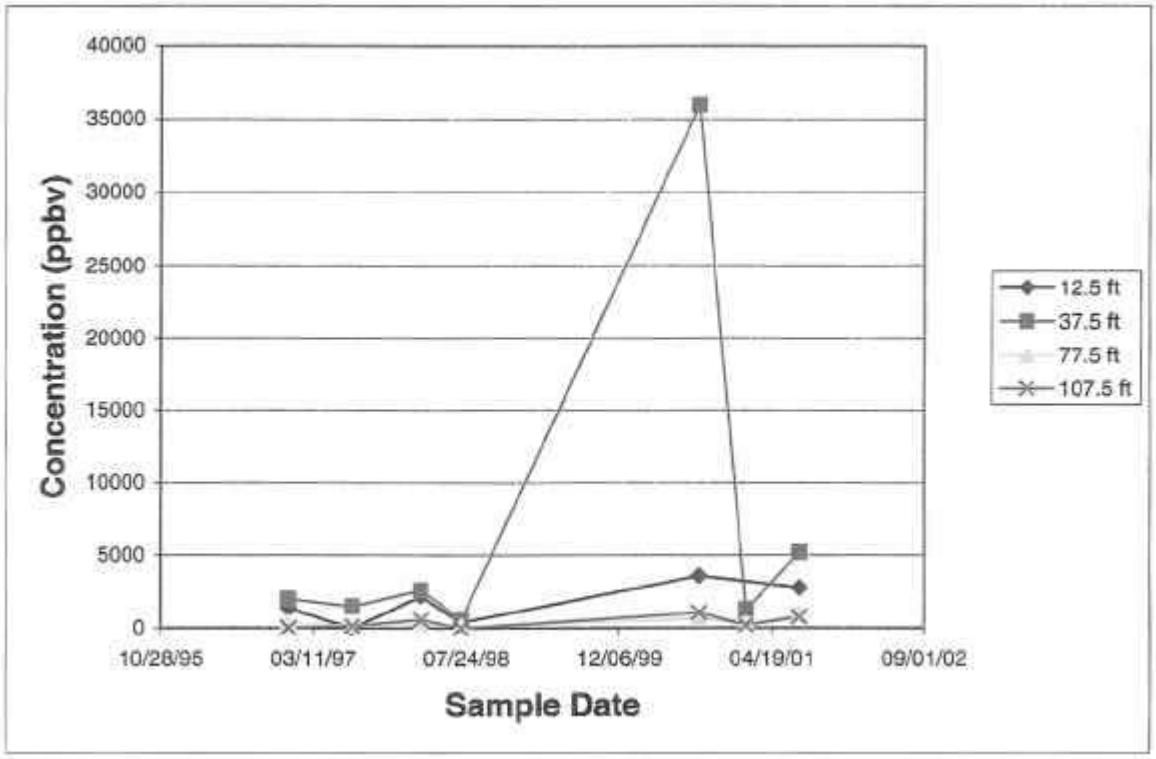

Figure 6-7. 1,1-Dichloroethane concentrations in CFA-GAS-V-006.

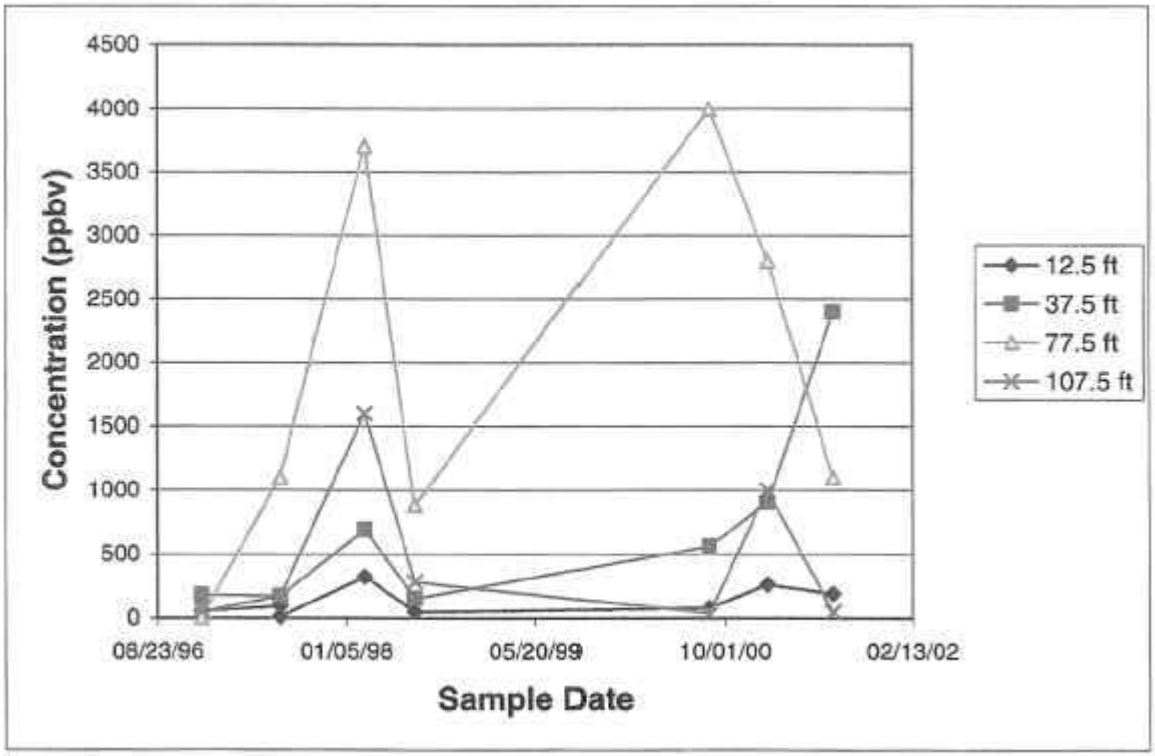

Figure 6-8. 1,1-Dichloroethane concentrations in CFA-GAS-V-004.

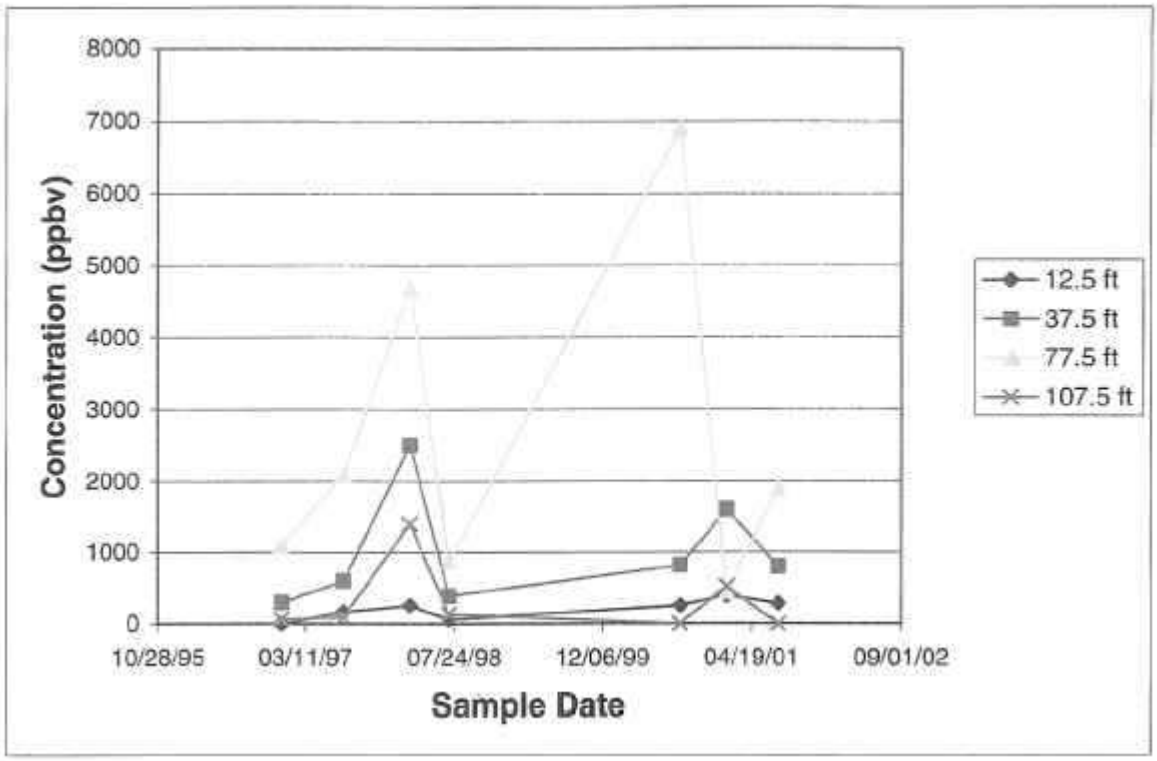

Figure 6-9. 1,1-Dichloroethene concentrations in CFA-GAS-V-007.

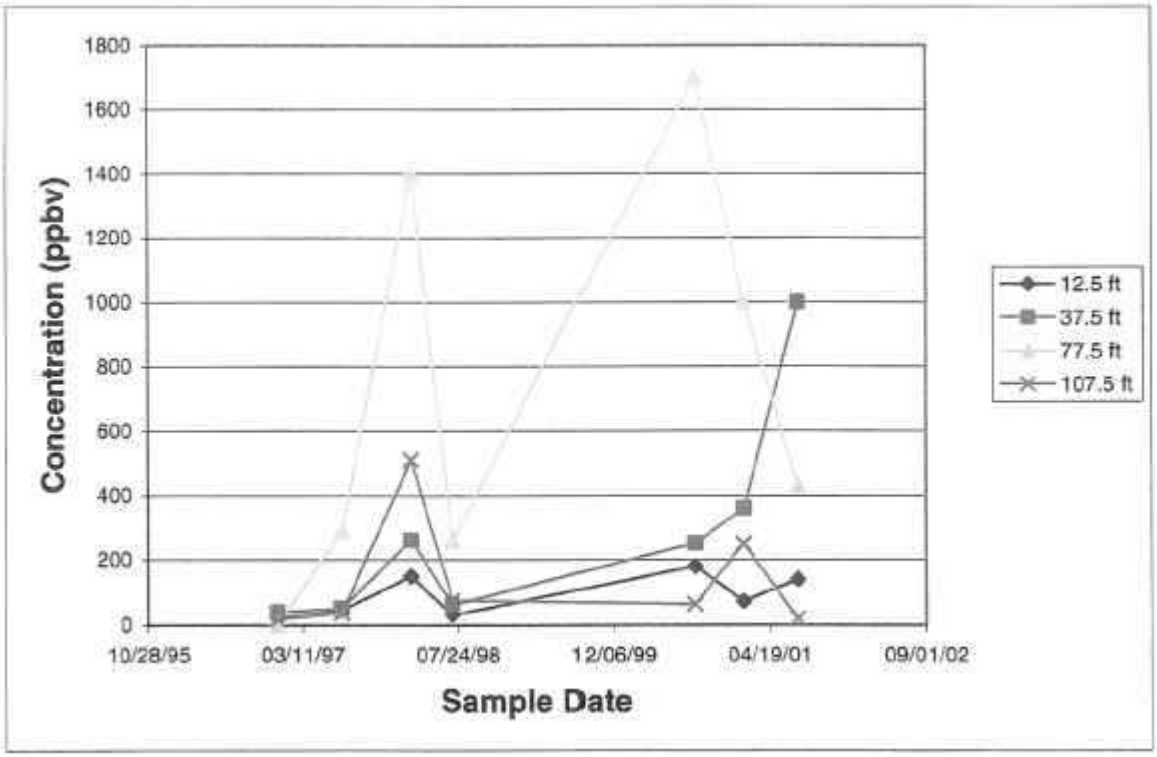

Figure 6-10. Trichloroethene concentrations in CFA-GAS-V-004.

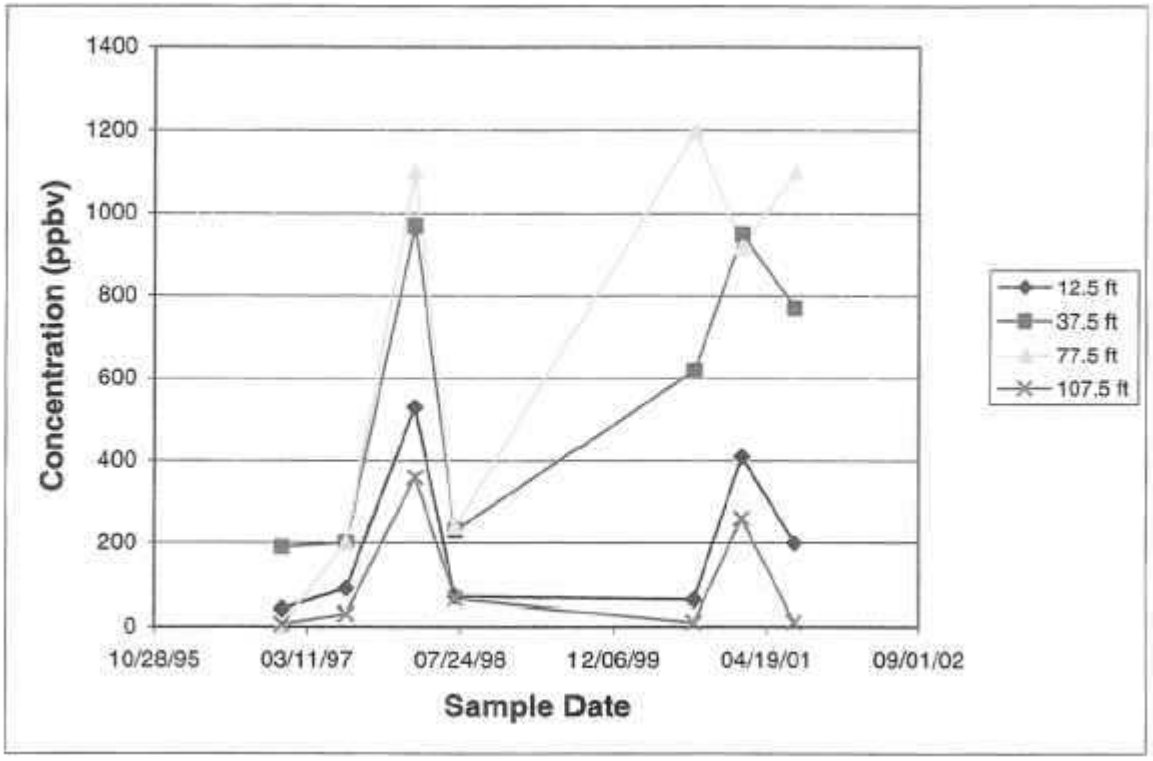

Figure 6-11. Trichlorofluoromethane concentrations in CFA-GAS-V-004.

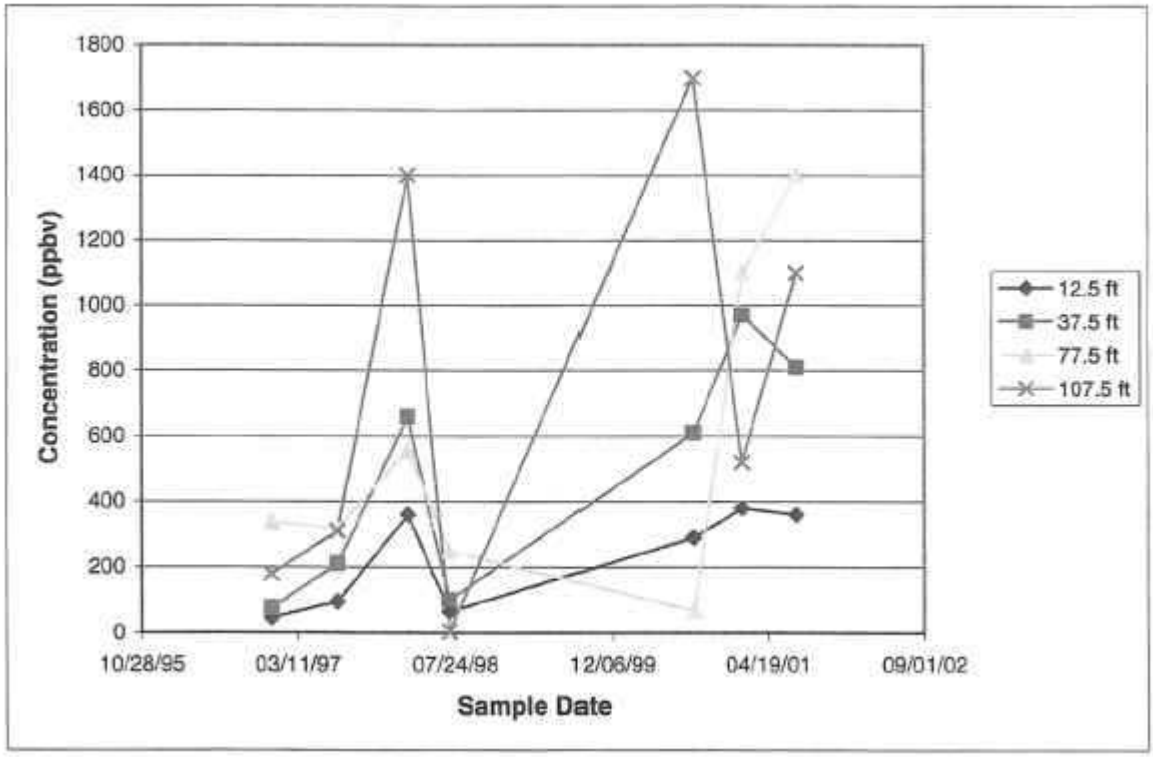

Figure 6-12. Trichlorofluoromethane concentrations in CFA-GAS-V-006.

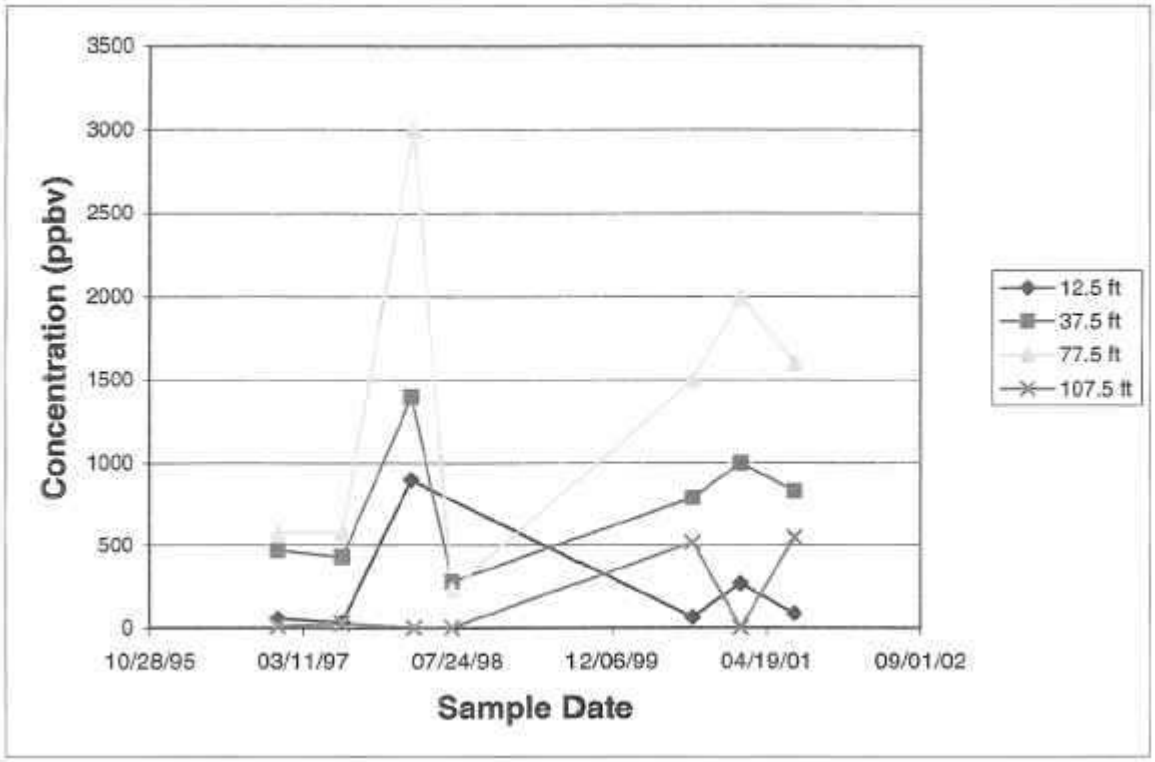

Figure 6-13. Trichlorofluoromethane concentrations in CFA-GAS-V-008.

At two locations, a few VOCs appear to be increasing at depth. At GSP 101, trichloroethene, 1,1,1-trichloroethane, and 1,1-dichloroethene appear to be increasing at 11.4 m (37.5 ft) and trichlorofluoromethane appears to be increasing at 23.6 m (77.5 ft). Trichlorofluoromethane appears to be increasing both at 11.4 m (37.5 ft) and 23.6 m (77.5 ft) in GSP 2-2. The increasing concentrations at depth indicate that some VOCs are migrating deeper into the vadose zone; however, based upon the groundwater monitoring results, there appears to be no impact on groundwater at the present time.

Based on a review of the soil gas sample results, the concentration ranges for all samples collected between December 1996 and July 2001 have varied over time. The VOC concentrations generally increased from 1996 to a peak in 1998. Between 1998 and 2000, the overall concentrations were lower. From 2000 through the most recent sampling event in 2001, the overall VOC concentrations have been increasing to levels similar to, or higher than, those detected in 1998. The causes of the variable ranges in concentrations in the soil gas are unknown.

The soil gas concentrations detected in the soil gas sample locations have shown consistent detections within the sample ports in the middle depths of each location. Generally, the upper soil gas locations at a depth of 3 to 4 m (10 to 13 ft) bls are low in VOC concentrations. The VOC concentrations increase and are the highest at the intermediate sample port depths at approximately 10.7 to 11.6 m (35 to 38 ft) bls and 21.3 to 23.8 m (70 to 78 ft) bls at all soil gas sample locations. The VOC concentrations then generally decrease in samples collected from the lowermost locations at 30.5 to 32.9 m (100 to 108 ft) bls.

According to the Post-ROD Monitoring Report from 1996 to 1998 (INEEL 2000), the middle gas sample ports were installed adjacent to known fracture zones in the basalt. The location of these ports adjacent to these zones may be collecting VOC vapors that may be preferentially vertically and horizontally migrating through the fractures in the basalt. The VOC concentrations are generally detected

in lower concentrations in the lowermost sample ports, since the same basalt fractures are not present at these depths, thus limiting the movement of any VOC vapors at these depths.

Based on the soil gas sample results, it currently appears that either the VOCs are not substantially migrating to the lower depths of 30.5 to 32.9 m (100 to 108 ft) bls or the VOC vapors are being attenuated before reaching these depths. It is possible that VOC vapors could migrate horizontally within interbeds, fractures, or organic rubble zones. Without significant increases in concentrations reaching the lower soil depths, it is unlikely that significant VOCs will migrate to the depths at which they can adversely impact the groundwater. Groundwater underlying the CFA is at an approximate depth of 140 m (460 ft) bls or an additional 107 m (350 ft) below the lowermost soil gas vapor port depth. The VOCs have been detected occasionally in groundwater samples collected from the monitoring wells located downgradient from the CFA landfills, but at concentrations near the method detection limits and well below any regulatory concern. The VOCs will continue to be monitored in the groundwater and would indicate any future vertical migration.

6.2 Groundwater Monitoring

In accordance with the ROD (DOE-ID 1995), groundwater monitoring has been conducted in order to (1) establish a baseline of potential contaminant concentrations in the aquifer against which future data could be compared and (2) to ensure that drinking water standards are not exceeded in the SRPA due to the migration of contaminants from the landfills. Groundwater samples were collected from 11 wells in the vicinity of the CFA landfills. Table 6-2 presents a listing of the wells, as well as the sampling rationale for each. Groundwater Monitoring Well LF 2-10, downgradient from Landfill II, was only to be sampled during the first 2 years of intensive monitoring following the completion of the remedial action. The well was not recommended for long-term monitoring because the top of the screen in the well is located 214.5 m (704 ft) bls, approximately 67 m (220 ft) below the water table, making the well inappropriate for monitoring water quality at the water table, where potential leachate would first enter the aquifer. Groundwater samples were collected and analyzed for VOCs, anions, metals, and alkalinity. In addition, groundwater-level measurements were obtained for the 11 wells being sampled for analysis, as well as 16 other wells located in the vicinity of the CFA landfills (refer to Figure 6-1).

Quarterly sampling commenced in July 1996 and continued every 3 months until April 1998. Between 1999 and 2001, groundwater samples were collected and analyzed from wells in the CFA landfill area during three separate sampling and analysis events, with groundwater samples collected during May/June 1999, September 2000, and October 2001. Currently, groundwater sampling and analysis are done annually in the fall in an effort to consolidate various on-going groundwater-monitoring efforts at the INEEL and in keeping with the previously established norm for the CFA landfill monitoring. Refer to Table 6-3 for a summary of the groundwater monitoring data. The results of the groundwater sample analyses for samples collected between 1996 and 2001 are included in Appendix E.

Groundwater samples have been collected from wells downgradient from the former and current sewage treatment facilities (Wells CFA-MON-A-001, CFA-MON-A-002, and CFA-MON-A-003), wells downgradient from Landfill II (Wells LF 2-08, LF 2-09, and LF 2-10), wells located downgradient from Landfills I and III (Wells LF 3-08, LF 3-09, and LF 3-10), and a well located upgradient from Landfills I and III (Well USGS-085).

Table 6-2. Groundwater monitoring wells and rationale.

Well	Well Completion, m (ft) bls	Sampling Rationale
LF 2-08	Screened, 148–151 (485–495)	Downgradient of Landfill II
LF 2-09	Screened, 143–151 (469.6–497)	Downgradient of Landfill II
LF 2-10	Perforated, 215–218 (704–714) Perforated, 221–224 (725–735) Perforated, 227–230 (745–755) Perforated, 230–233 (755–765)	Downgradient of Landfill II, deep well completion limits usefulness for monitoring leachate migration to water table
LF 2-11	Screened, 148–152 (484–499)	Upgradient of Landfill II
LF 3-08	Screened, 152–155 (500–510)	Downgradient of Landfills I and III
LF 3-09	Screened, 149–152 (490–500)	Downgradient of Landfills I and III
LF 3-10	Screened, 147–153 (481–501)	Adjacent to Landfill III
USGS-85	Open hole, 159–194 (522–637)	Upgradient of Landfills I and III, large open interval limits usefulness for monitoring water table conditions
CFA-MON-A-001	Screened, 149–158 (488–518)	Downgradient of CFA
CFA-MON-A-002	Screened, 149–158 (488–518)	Downgradient of CFA
CFA-MON-A-003	Screened, 149–158 (488–518)	Downgradient of CFA

Based on recommendations proposed in the Post-ROD Monitoring Report (INEEL 2000), Wells LF 2-10 and LF 3-09 were removed from the list of wells sampled beginning with the October 2001 groundwater-sampling event. For LF 3-09, this decision was based on duplications of sampling at other nearby wells (LF 3-08 and LF 3-10). Well LF 2-10 has too deep a screen interval to be an effective monitoring well for the landfills. Also, during the October 2001 sampling event, Well USGS-083 was added to the sampling event as an additional downgradient well for CFA. This well is located approximately 1,220 m (4,000 ft) farther downgradient from Wells CFA-MON-A-002 and CFA-MON-A-003. Well USGS-083 was proposed as an additional monitoring point for nitrates downgradient from the former and current sewage treatment plants. New Well USGS-128 was proposed for sampling during the October 2001 event to replace monitoring and sampling from Wells USGS-085 and USGS-112. However, Well USGS-128 was not completed in time for the groundwater sampling event; therefore, no well upgradient of Landfills I and III was sampled. Figure 6-1 shows the locations of the wells discussed above.

Historic monitoring data had shown that potential contaminants were below the EPA's defined maximum contaminant levels (MCLs) for drinking water with the exception of beryllium, cadmium, and lead. Beryllium had been detected at levels exceeding the MCL of 4 µg/L; however, duplicate samples and subsequent sampling rounds failed to confirm these results. Cadmium was detected in wells located both up and downgradient from the landfills at concentrations above the MCL of 5 µg/L. The distribution of cadmium suggests that the landfills may not be the source of cadmium in the groundwater. Given the uncertainty of the cadmium and beryllium data, the two contaminants were identified as potential contaminants of concern and were quantitatively assessed in the human health risk assessment. Future groundwater concerns, as a result of potential future leaching of the source term to the groundwater, were addressed through modeling and indicated no unacceptable groundwater health risk to potential future residents. Information pertaining to the source term and modeling effort is provided in Appendix E of the *Post-Record of Decision Monitoring Report from 1996-1998 at Operable Unit 4-12, Central Facilities Area Landfills I, II, and III (CFA-01, CFA-02, and CFA-03)* (INEEL 2000) and the *Remedial Investigation/Feasibility Study for Operable Unit 4-12: Central Facilities Area Landfills I, II, and III at the Idaho National Engineering Laboratory* (INEL 1995a).

Table 6-3. Groundwater monitoring data summary.

		CFA-MON-A-001			CFA-MON-A-002			CFA-MON-A-003			LF 2-08		
	Units	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples
Anions													
Chloride	mg/L	25.2	22.2	12/12	57.4	52.9	11/11	45	41.3	11/11	276	153	10/10
Fluoride	mg/L	0.28	0.22	12/12	0.2	0.17	11/11	0.24	0.19	11/11	0.2	0.16	10/10
Nitrate/nitrite	mg-N/L	2.25	1.8	10/11	20.5	17.1	11/12	11	9.5	12/13	4.56	3.9	9/10
Sulfate	mg/L	32.4	21.6	12/12	39	30	11/11	31.5	25.3	11/11	36.9	32.7	10/10
Common Cations													
Calcium	µg/L	36,400	30,436	12/12	62,700	53,944	11/11	45,900	40,470	11/11	73,500	68,910	10/10
Magnesium	µg/L	15,100	12,768	12/12	25,800	22,163	11/11	21,400	18,486	11/11	19,500	18,520	10/10
Potassium	µg/L	3,270	2,502	12/12	3,990	3,393	11/11	3,610	2,849	11/11	6,880	5,030	10/10
Sodium	µg/L	10,300	9,673	11/12	16,300	15,420	10/11	12,100	11,430	10/11	47,700	43,090	10/10
Organic Analytes													
1,1,1-Trichloroethane	µg/L	—	—	0/13	.3	.23	3/12	0.1	0.1	1/13	0.4	0.3	3/10
1,1-Dichloroethene	µg/L	—	—	0/13	—	—	0/12	—	—	0/13	—	—	0/10
1,2,4-Trimethylbenzene	µg/L	—	—	0/13	7	4.2	10/11	—	—	0/13	0.2	0.2	1/10
1,2-Dichloroethane	µg/L	—	—	0/13	0.1	0.1	1/12	—	—	0/13	—	—	0/10
1,3,5-Trimethylbenzene	µg/L	—	—	0/13	4	2.85	9/11	—	—	0/13	—	—	0/10
2-Butanone	µg/L	—	—	0/13	9.9	9.9	1/12	—	—	0/13	—	—	0/10
4-Methyl-2-Pentanone	µg/L	—	—	0/13	2.2	2.2	1/3	—	—	0/13	—	—	0/10
Acetone	µg/L	24	24	1/13	—	—	0/12	—	—	0/13	—	—	0/10
Carbon disulfide	µg/L	—	—	0/13	—	—	0/12	—	—	0/13	—	—	0/10
Carbon tetrachloride	µg/L	—	—	0/13	0.3	0.2	3/12	—	—	0/13	—	—	0/10
Chloroform	µg/L	—	—	0/13	—	—	0/12	—	—	0/13	0.5	0.44	3/10
Ethylbenzene	µg/L	—	—	0/13	0.1	0.1	1/12	—	—	0/13	—	—	0/10
Naphthalene	µg/L	—	—	0/13	—	—	0/12	—	—	0/13	0.3	0.3	1/10

Table 6-3. (continued).

		CFA-MON-A-001			CFA-MON-A-002			CFA-MON-A-003			LF 2-08		
	Units	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples
Tetrachloroethene	µg/L	—	—	0/13	—	—	0/12	—	—	0/13	—	—	0/10
Toluene	µg/L	1.4	1.4	1/13	25	8.5	3/12	8.9	5.9	3/13	0.7	0.45	2/10
Trichloroethene	µg/L	—	—	0/13	0.2	0.15	2/12	—	—	0/13	0.1	0.1	2/10
Xylenes (total)	µg/L	—	—	0/13	1.7	0.76	5/12	—	—	0/13	—	—	0/10
Inorganic Analytes													
Aluminum	µg/L	29.6	20.9	3/12	501	147	5/11	87	54	3/11	83.9	58.5	2/10
Antimony	µg/L	—	—	0/12	—	—	0/11	—	—	0/11	0.4	0.4	1/10
Arsenic	µg/L	3.7	1.6	8/12	4.3	1.6	8/11	1.5	1.2	6/11	3.4	1.4	8/10
Barium	µg/L	39.7	23.6	11/12	52.8	45.8	10/11	44.3	38	10/11	196	158	9/10
Cadmium	µg/L	9.5	2.2	5/12	0.72	0.24	5/11	0.83	0.37	5/11	1.5	0.64	6/10
Chromium	µg/L	86.6	21	9/12	34.9	14.1	11/11	12.2	9.4	8/11	13.2	10.7	4/10
Cobalt	µg/L	—	—	0/12	2.2	2.2	1/11	—	—	0/11	—	—	0/10
Copper	µg/L	5.2	3.6	2/12	5.8	5.4	3/11	5.2	4.1	2/11	45.3	28.5	2/10
Iron	µg/L	6,330	2,574	8/11	79	49.3	6/10	357	126	8/10	242	131	5/9
Lead	µg/L	26.9	10.4	7/12	6.4	2.7	4/11	44.8	20.6	9/11	20.1	6.4	5/10
Manganese	µg/L	149	29.7	12/12	56.2	15.4	10/11	5.5	2.7	4/11	8.9	3.8	4/10
Mercury	µg/L	—	—	0/12	—	—	0/11	—	—	0/11	0.1	0.1	1/10
Nickel	µg/L	6.8	4.2	2/12	25.8	13.9	4/11	2	1.4	2/11	1.6	1.6	1/10
Selenium	µg/L	1.3	0.75	2/12	5.2	3.3	4/11	1.9	1.9	1/11	3.4	2.5	2/10
Thallium	µg/L	6.4	6.4	1/12	—	—	0/11	6.2	6.2	1/11	6.1	6.1	1/10
Vanadium	µg/L	43.1	11.9	6/12	5.9	4.4	4/11	6	4.5	4/11	7	4.7	4/10
Zinc	µg/L	3,530	853	11/12	152	74.8	10/11	1,420	860	10/11	179	47.9	9/10

Table 6-3. (continued).

		CFA-MON-A-001			CFA-MON-A-002			CFA-MON-A-003			LF 2-08		
	Units	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples
Miscellaneous													
Alkalinity	mg/L	107	107	1/2	108	108	1/2	101	101	1/2	136	136	1/1
Bicarbonate alkalinity	mg/L	106	101	5/5	118	108	5/5	110	98	5/5	160	122	5/5
Carbonate alkalinity	mg/L	5	5	5/5	5	5	5/5	5	5	5/5	5	5	5/5
Phenolphthalene alkalinity	mg/L	5	5	5/5	5	5	5/5	5	5	5/5	5	5	5/5
Total alkalinity	mg/L	106	101	6/6	118	107	6/6	110	98	6/6	160	120	6/6
Cyanide	µg/L	—	—	0/1	—	—	0/1	—	—	0/1	—	—	0/1
Gamma Emitters	pCi/L	—	—	0/2	—	—	0/2	—	—	0/2	—	—	0/2
Tritium	pCi/L	426	426	1/1	1,760	1,760	1/1	830	830	1/1	—	—	0/0
Nitrogen in ammonia	mg/L	0.02	0.015	2/2	—	—	2/2	—	—	0/1	—	—	0/1

		LF 2-09			LF 2-10			LF 2-11			LF 3-08		
	Units	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples
Anions													
Chloride	mg/L	133	122	11/11	35.3	29.2	9/9	145	137	9/9	120	108	19/19
Fluoride	mg/L	0.2	0.16	11/11	0.21	0.17	9/9	0.22	0.18	9/9	0.21	0.17	19/19
Nitrate/nitrite	mg-N/L	4.5	3.6	10/11	2.56	1.9	8/9	4.4	3.6	8/9	4.39	3.5	16/18
Sulfate	mg/L	37.5	31.7	11/11	37.4	32.3	9/9	38.3	32.8	9/9	37.8	32	19/19
Common Cations													
Calcium	µg/L	71,100	65,073	11/11	63,700	54,594	9/9	74,000	62,294	9/9	69,000	57,626	20/20
Magnesium	µg/L	19,600	17,300	11/11	18,000	15,442	9/9	20,100	17,073	9/9	19,800	16,232	20/20
Potassium	µg/L	7,420	5,538	11/11	2,640	2,184	8/9	5,120	4,137	9/9	5,430	4,430	20/20
Sodium	µg/L	47,900	43,827	11/11	12,400	11,575	8/9	57,200	47,892	9/9	44,900	37,615	20/20

Table 6-3. (continued).

		LF 2-09			LF 2-10			LF 2-11			LF 3-08		
	Units	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples
Organic Analytes													
1,1,1-Trichloroethane	µg/L	0.4	0.3	3/13	0.3	0.2	2/11	0.4	0.3	3/9	0.4	0.33	6/22
1,1-Dichloroethene	µg/L	–	–	0/13	–	–	0/11	–	–	0/9	0.1	0.1	1/22
1,2,4-Trimethylbenzene	µg/L	–	–	0/13	–	–	0/11	–	–	0/9	–	–	0/22
1,2-Dichloroethane	µg/L	–	–	0/13	–	–	0/11	–	–	0/9	–	–	0/22
1,3,5-Trimethylbenzene	µg/L	–	–	0/13	–	–	0/11	–	–	0/9	–	–	0/22
2-Butanone	µg/L	–	–	0/13	–	–	0/11	–	–	0/9	–	–	0/22
4-Methyl-2-Pentanone	µg/L	–	–	0/13	–	–	0/11	–	–	0/9	–	–	0/22
Acetone	µg/L	–	–	0/13	–	–	0/11	–	–	0/9	70	41	2/22
Carbon disulfide	µg/L	–	–	0/13	–	–	0/11	–	–	0/9	5	5	1/20
Carbon tetrachloride	µg/L	–	–	0/13	–	–	0/11	–	–	0/9	–	–	0/22
Chloroform	µg/L	0.35	0.32	3/13	–	–	0/11	–	–	0/9	–	–	0/22
Ethylbenzene	µg/L	–	–	0/13	–	–	0/11	–	–	0/9	–	–	0/22
Naphthalene	µg/L	0.1	0.1	1/12	–	–	0/11	–	–	0/9	–	–	0/22
Tetrachloroethene	µg/L	1.5	1.5	1/13	–	–	0/11	–	–	0/9	–	–	0/22
Toluene	µg/L	22	5.3	8/13	–	–	0/11	68	23.4	3/9	13	6.6	3/22
Trichloroethene	µg/L	–	–	0/13	–	–	0/11	–	–	0/9	0.1	0.1	1/20
Xylenes (total)	µg/L	–	–	0/13	–	–	0/11	–	–	0/9	–	–	0/22
Inorganic Analytes													
Aluminum	µg/L	186	87.3	3/11	18	18	1/9	70.7	46.1	4/9	187	97	14/20
Antimony	µg/L	–	–	0/11	–	–	0/9	–	–	0/9	–	–	0/20
Arsenic	µg/L	4.7	1.5	8/11	1.7	1.4	7/9	9.6	2.1	8/9	4.8	1.6	15/20
Barium	µg/L	187	173	10/11	94.3	79.1	9/9	199	170	9/9	144	112	18/20
Cadmium	µg/L	7	1.6	5/11	0.35	0.3	2/9	0.36	0.15	3/9	0.45	0.26	7/20

Table 6-3. (continued).

		LF 2-09			LF 2-10			LF 2-11			LF 3-08		
	Units	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples
Chromium	µg/L	50.3	17.8	7/11	14.2	10.1	6/9	23.2	13.4	5/9	28.9	11.1	12/20
Cobalt	µg/L	6.6	6.6	1/11	–	–	0/9	–	–	0/9	–	–	0/20
Copper	µg/L	36.1	19.3	3/11	1.1	1.1	1/9	31.3	31.3	1/9	5.9	3.3	6/20
Iron	µg/L	54,600	7,811	8/10	44.2	21.6	5/8	6,690	2,179	7/9	19,300	1,698	13/18
Lead	µg/L	30.2	7.7	5/11	2	1.2	4/9	10.3	3.3	4/9	13.2	2.8	12/20
Manganese	µg/L	170	29.5	7/11	2.7	1.2	3/9	41.1	18.9	9/9	93.7	10.3	17/20
Mercury	µg/L	–	–	0/11	–	–	0/9	–	–	0/9	3.7	2.2	2/20
Nickel	µg/L	35.3	18.5	2/11	1.1	1.1	1/9	44.7	24.9	8/9	13.7	4.5	4/20
Selenium	µg/L	10.8	5.1	3/11	3	2.4	3/9	3.3	2.6	3/9	2.6	1.5	3/20
Thallium	µg/L	–	–	0/11	–	–	0/9	–	–	0/9	6.3	6.2	2/20
Vanadium	µg/L	5.1	3.7	3/11	8	6	2/9	2.6	2.6	1/9	6.4	2.7	7/20
Zinc	µg/L	770	150	8/11	21.8	11.2	8/9	305	73	9/9	129	83.3	17/20
Miscellaneous													
Alkalinity	mg/L	131	125	2/2				131	131	1/1	134	134	2/2
Bicarbonate alkalinity	mg/L	134	110	5/5	178	159	5/5	132	122	5/5	144	125	8/8
Carbonate alkalinity	mg/L	5	5	5/5	5	5	5/5	5	5	5/5	5	5	8/8
Phenolphthalene alkalinity	mg/L	5	5	5/5	5	5	5/5	5	5	5/5	5	5	8/8
Total alkalinity	mg/L	134	107	6/6	178	161	6/6	133	124	6/6	144	125	10/10
Cyanide	µg/L	–	–	0/1	–	–	0/1	–	–	0/0	–	–	0/2
Gamma Emitters	pCi/L	–	–	0/2	–	–	0/2	–	–	0/2	–	–	0/2
Tritium	pCi/L	9,810	9,810	1/1	–	–	0/0	8,930	8,930	1/1	–	–	0/0
Nitrogen in ammonia	mg/L	–	–	0/1	0.1	0.1	1/1	–	–	0/1	–	–	0/2

Table 6-3. (continued).

		LF 3-09			LF 3-10			USGS-083			USGS-085		
	Units	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples
Anions													
Chloride	mg/L	153	118	8/8	101	92.9	12/12	10.8	10.6	2/2	45.2	37.9	9/9
Fluoride	mg/L	0.22	0.18	8/8	0.21	0.18	12/12	0.196	0.18	2/2	0.21	0.19	9/9
Nitrate/nitrite	mg-N/L	5.42	4.2	7/8	4.07	2.9	11/12	0.642	0.62	2/2	2.31	2	8/9
Sulfate	mg/L	66.5	35.4	8/8	4550	407	12/12	19.5	19.2	2/2	38.2	33.2	9/9
Common Cations													
Calcium	µg/L	80,700	67,863	8/8	67,100	58,868	12/12	29,200	27,650	2/2	60,700	52,831	9/9
Magnesium	µg/L	23,400	19,613	8/8	18,600	15,111	12/12	11,600	10,850	2/2	15,700	13,653	9/9
Potassium	µg/L	4,560	4,340	8/8	4,680	3,659	12/12	2,480	2,380	2/2	3,350	2,619	9/9
Sodium	µg/L	41,100	37,150	8/8	38,600	33,965	12/12	10,100	9,480	2/2	19,200	16,308	9/9
Organic Analytes													
1,1,1-Trichloroethane	µg/L	1	0.65	2/8	0.4	0.27	3/13	–	–	0/3	0.3	0.25	2/9
1,1-Dichloroethene	µg/L	–	–	0/8	–	–	0/13	–	–	0/3	–	–	0/9
1,2,4-Trimethylbenzene	µg/L	–	–	0/8	–	–	0/13	–	–	0/3	–	–	0/9
1,2-Dichloroethane	µg/L	–	–	0/8	–	–	0/13	–	–	0/3	–	–	0/9
1,3,5-Trimethylbenzene	µg/L	–	–	0/8	–	–	0/13	–	–	0/3	–	–	0/9
2-Butanone	µg/L	–	–	0/8	–	–	0/13	–	–	0/3	–	–	0/9
4-Methyl-2-Pentanone	µg/L	–	–	0/8	–	–	0/13	–	–	0/3	–	–	0/9
Acetone	µg/L	–	–	0/8	8.2	8.2	1/13	–	–	0/3	–	–	0/9
Carbon disulfide	µg/L	–	–	0/8	–	–	0/13	–	–	0/3	–	–	0/9
Carbon tetrachloride	µg/L	–	–	0/8	–	–	0/13	–	–	0/3	–	–	0/9
Chloroform	µg/L	–	–	0/8	–	–	0/13	–	–	0/3	–	–	0/9
Ethylbenzene	µg/L	–	–	0/8	–	–	0/13	–	–	0/3	–	–	0/9
Naphthalene	µg/L	–	–	0/8	–	–	0/13	–	–	0/3	–	–	0/9
Tetrachloroethene	µg/L	–	–	0/8	–	–	0/13	–	–	0/3	–	–	0/9

Table 6-3. (continued).

		LF 3-09			LF 3-10			USGS-083			USGS-085		
	Units	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples
Toluene	µg/L	8	8	1/8	17	10.2	3/13	—	—	0/3	0.2	0.2	1/9
Trichloroethene	µg/L	—	—	0/8	—	—	0/13	—	—	0/3	—	—	0/9
Xylenes (total)	µg/L	—	—	0/8	—	—	0/13	—	—	0/3	—	—	0/9
Inorganic Analytes													
Aluminum	µg/L	51.8	51.8	1/8	199	102	4/12	—	—	0/2	13	8.7	2/9
Antimony	µg/L	—	—	0/8	—	—	0/12	—	—	0/2	—	—	0/9
Arsenic	µg/L	1.1	0.98	6/8	5	1.6	7/12	6.3	6.3	1/2	1.9	1.4	7/9
Barium	µg/L	140	128	8/8	143	113	11/12	28.6	28.6	1/2	108	91.3	9/9
Cadmium	µg/L	0.59	0.24	5/8	1	0.29	5/12	—	—	0/2	0.39	0.34	2/9
Chromium	µg/L	105	39.9	8/8	26.8	16.4	12/12	13.9	13.3	2/2	18.3	14.2	9/9
Cobalt	µg/L	0.6	0.6	1/8	—	—	0/12	—	—	0/2	—	—	0/9
Copper	µg/L	13	6.6	3/8	1.1	1.1	1/12	—	—	0/2	1	1	1/9
Iron	µg/L	254	168	7/7	628	342	7/11	—	—	0/2	78	46.5	5/8
Lead	µg/L	3.2	2.4	3/8	18.3	6.5	3/12	—	—	0/2	2.8	1.8	4/9
Manganese	µg/L	21.9	9.9	8/8	64.3	12.2	9/12	6.4	6.4	1/2	4.8	3	6/9
Mercury	µg/L	—	—	0/8	—	—	0/12	—	—	0/2	—	—	0/9
Nickel	µg/L	196	102	8/8	102	45.3	12/12	—	—	0/2	1.2	1.2	1/9
Selenium	µg/L	3.1	2.5	3/8	0.8	0.5	2/12	4.1	4.1	1/2	1.3	1.3	1/9
Thallium	µg/L	—	—	0/8	—	—	0/12	—	—	0/2	—	—	0/9
Vanadium	µg/L	3	3	1/8	1.7	0.86	3/12	9.5	9.2	2/2	4	2.4	2/9
Zinc	µg/L	201	107	8/8	801	239	10/12	257	257	1/2	13	6.4	4/9
Miscellaneous													
Alkalinity	mg/L	—	—	0/0	146	146	1/3	101	100	2/2	—	—	0/0
Bicarbonate alkalinity	mg/L	136	128	4/4	160	141	5/5	—	—	0/0	156	151	5/5
Carbonate alkalinity	mg/L	5	5	4/4	5	5	5/5	—	—	0/0	5	5	5/5

Table 6-3. continued.

		LF 3-09			LF 3-10			USGS-083			USGS-085		
	Units	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples	Max.	Avg.	Detects/ Samples
Phenolphthalene alkalinity	mg/L	5	5	4/4	5	5	5/5	—	—	0/0	5	5	5/5
Total alkalinity	mg/L	136	128	5/5	160	142	6/6	—	—	0/0	156	152	6/6
Cyanide	µg/L	—	—	1/1	—	—	0/1	—	—	0/0	—	—	0/1
Gamma Emitters	pCi/L	—	—	0/2	—	—	0/2	—	—	0/0	—	—	0/2
Tritium	pCi/L	—	—	0/0	7,300	7,115	2/2	—	—	0/1	—	—	0/0
Nitrogen in ammonia	mg/L	—	—	0/1	—	—	0/1	—	—	0/0	—	—	0/1

The iron, lead, and often the zinc concentrations in the groundwater samples collected from several wells as part of the CFA groundwater monitoring and sampling program are anomalous. The higher, anomalous concentrations of iron, lead, and zinc in these wells are a result of rusting carbon-steel casing and corrosion of galvanized riser pipe used in the older groundwater-monitoring wells. This is a common problem identified in wells throughout the INEEL that do not have stainless-steel casing and riser pipes. Figures 6-14 and 6-15 provide a graphical depiction of lead and iron concentrations, respectively, for Well CFA-MON-A-001 where these two analytes have historically posed a particular problem. Figures 6-16 and 6-17 provide a graphical depiction of lead and zinc concentrations, respectively, for Well CFA-MON-A-003. After replacement of the galvanized riser pipe with stainless steel riser pipe in CFA-MON-A-003, the lead concentration decreased below the action level suggesting that the elevated lead and zinc concentrations were the result of galvanic corrosion (see Figure 6-16).

Anomalous levels of nitrate (i.e., levels greater than the 10-mg/L MCL) have been detected in Well CFA-MON-A-002 (concentrations ranging from 16 to 20.5 mg/L) and CFA-MON-A-003 (ranging from 2.22 to 11 mg/L). All other wells detected concentrations of nitrate at less than, or equal to, 4 mg/L. The issue of nitrate in the groundwater will be discussed in further detail in Section 6.2.1.

Table 6-4 provides a comparison of the maximum concentrations for detected analytes versus background and the defined regulatory level. Cadmium concentrations have twice exceeded the EPA's defined MCL of 5 μg/L for drinking water with a maximum concentration of 9.5 μg/L, but cadmium concentrations did not exceed the MCL more than once in the same well. Iron concentrations have exceeded the secondary MCL of 300 μg/L in samples collected from six wells with five wells having recurring detections above this level. Likewise, lead concentrations have exceeded the EPA-defined action level of 15 μg/L in samples collected from six wells with recurrences in two of the six. Aluminum has exceeded the upper end of the secondary MCL of 200 μg/L in one well with a concentration of 501 μg/L. However, this was a single occurrence with all other detections well below the level of the secondary MCL. Similarly, manganese has been detected in two wells, one time each, at concentrations above the secondary MCL of 50 μg/L. Again, these were single detections with all other samples collected from the two wells having concentrations less than 50 μg/L. Following the same logic, chromium has been detected a single time in a sample from one well at a concentration slightly above the MCL of 100 μg/L (the sample result was 105 μg/L), as was mercury with a single detection one time in one well with a concentration of 3.7 μg/L as compared to the MCL of 2.0 μg/L. All other detections have been well below the MCLs for chromium and mercury. Chloride in one sample collected from Well LF 2-08 exceeded the secondary MCL of 250 mg/L on one occasion with a concentration of 276 mg/L. The elevated chloride concentrations in the CFA landfill wells are attributed to upgradient impacts from the Idaho Nuclear Technology and Engineering Center (INTEC), as discussed in Section 6.2.3.

6.2.1 Nitrate in Central Facilities Area Groundwater

Groundwater sample analytical results have shown that between July 1996 and October 2001 nitrate concentrations in wells downgradient from the former and current sewage treatment facilities have been consistent throughout the time period. The downgradient wells include Wells CFA-MON-A-001, CFA-MON-A-002, and CFA-MON-A-003. The nitrate concentrations (as nitrate-nitrogen) have ranged from 1.5 to 2.25 mg/L in Well CFA-MON-A-001, from 16.0 to 20.5 mg/L in Well CFA-MON-A-002, and from 2.22 to 11 mg/L in Well CFA-MON-A-003. This does not include those data that were rejected during the method data validation process for analytical quality control problems. These wells have been monitored and sampled regularly and were of concern since samples from both Wells CFA-MON-A-002 and CFA-MON-A-003 have exceeded or been equal to the EPA's MCL of 10 mg/L (refer to Table 6-4 and Figures 6-18 and 6-19). In contrast to the CFA-MON wells, the CFA landfill wells have nitrate concentrations less than or equal to 4 mg/L.

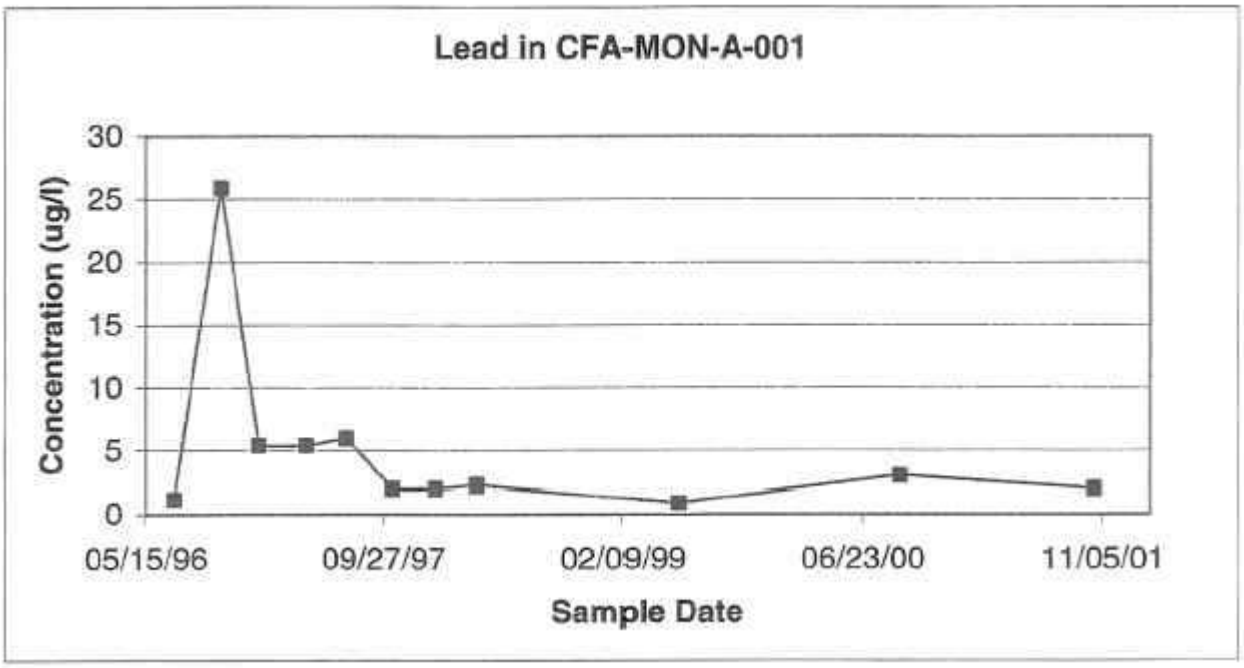

Figure 6-14. Lead concentrations in Well CFA-MON-A-001.

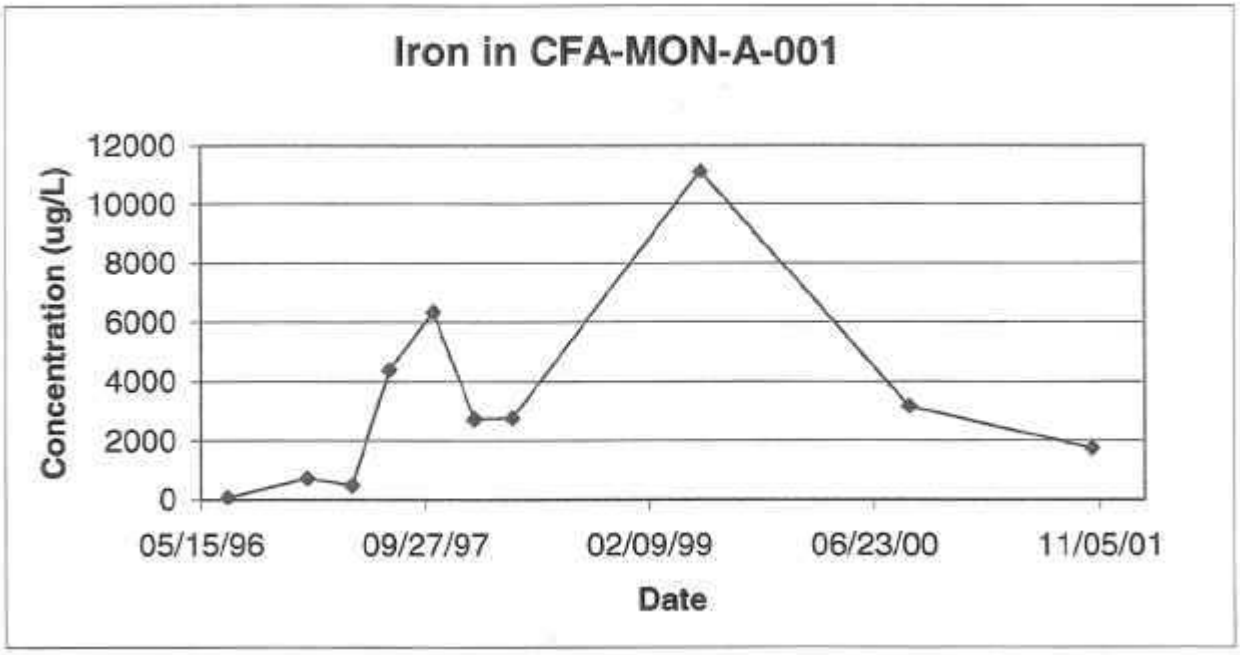

Figure 6-15. Iron concentrations in Well CFA-MON-A-001.

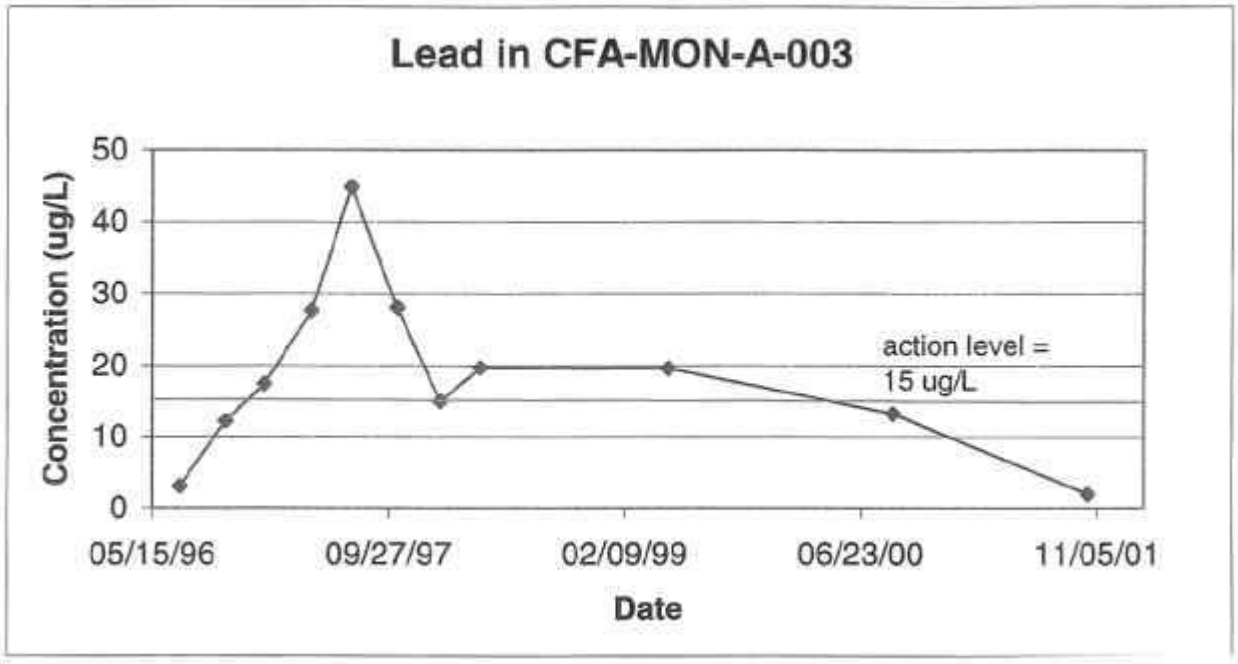

Figure 6-16. Lead concentrations in Well CFA-MON-A-003.

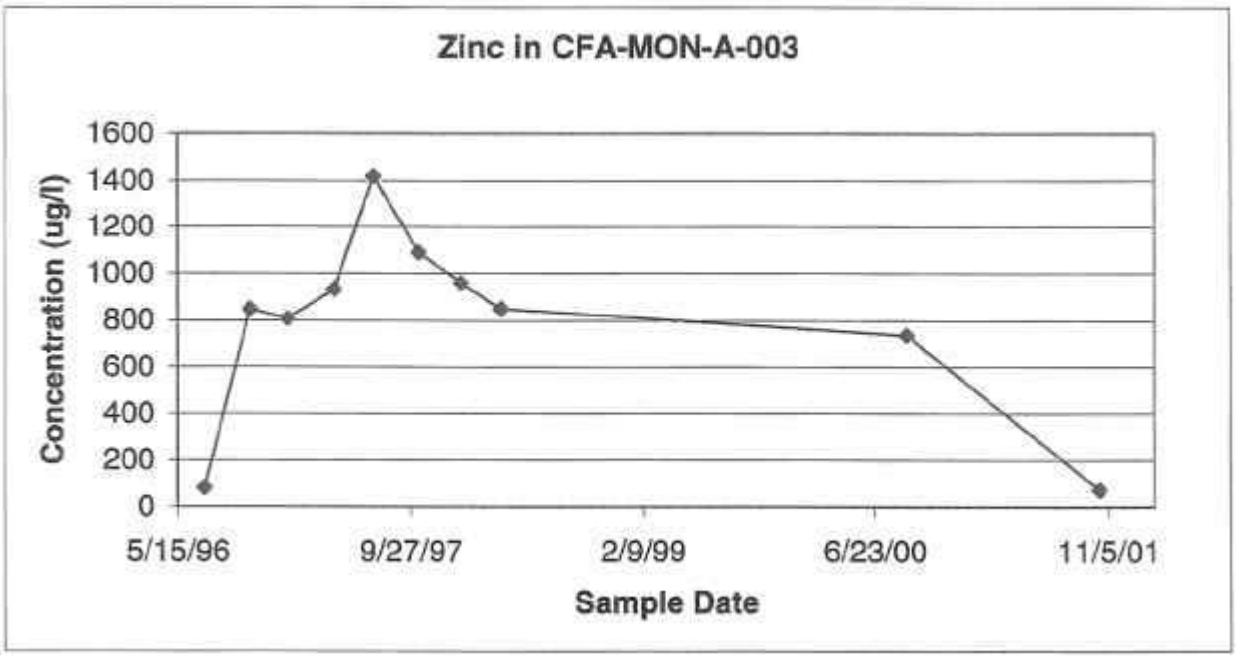

Figure 6-17. Zinc concentrations in Well CFA-MON-A-003.

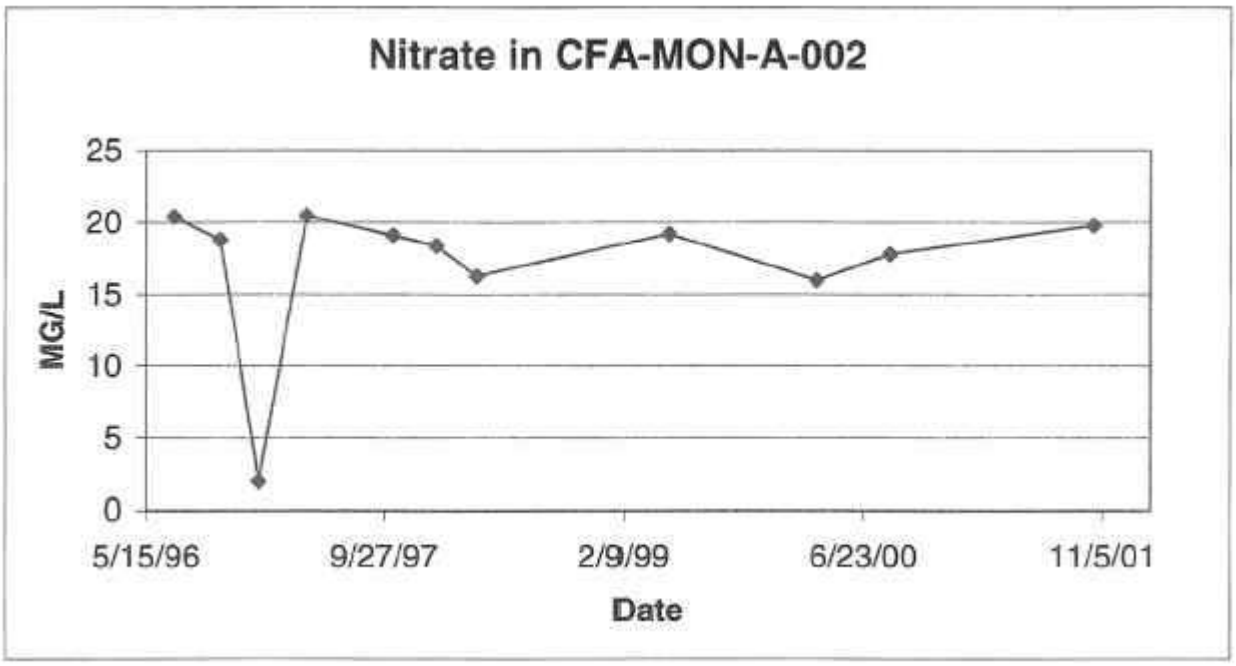

Figure 6-18. Nitrate concentrations in CFA-MON-A-002.

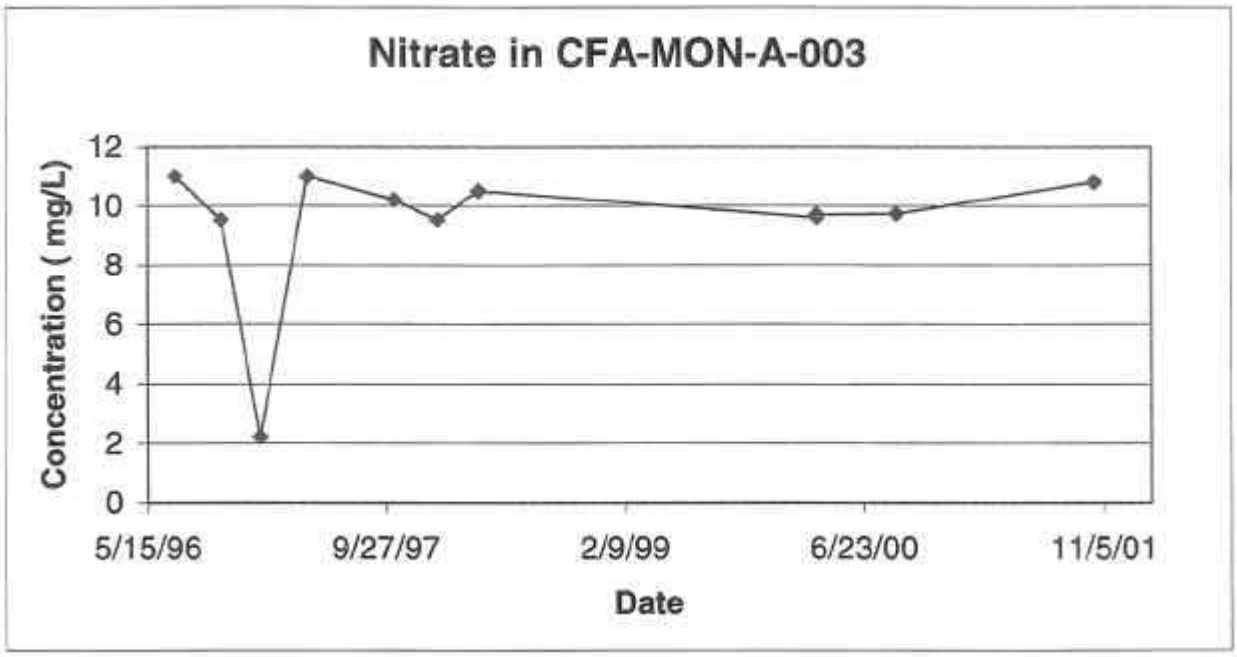

Figure 6-19. Nitrate concentrations in CFA-MON-A-003.

Table 6-4. Background and regulatory levels for detected analytes.

Compound	Units	MDV	MCL or SMCL[a]	LF2-11 Upgradient Well ADV	Background[b]	Detections Above Background	Number of Wells with Detections Above MCL or SMCL	Number of Wells with More Than one Detection Above MCL or SMCL
Anions								
Alkalinity-Bicarbonate	mg/L	146	None	124	*169–174*	No	NA	NA
Chloride	mg/L	276	*250*	137	*16–27*	Yes	1	0
Fluoride	mg/L	0.28	4/2	0.18	*0.3–0.5*	No	0	0
Nitrate/Nitrite	mg-N/L	20.5	10	3.6	1 to 2	Yes	2	2
Sulfate	mg/L	45.5	*250*	32.8	*24–31*	Yes	0	0
Common Cations								
Calcium	µg/L	80,700	None	62,294	*43,000–46,000*	Yes	NA	NA
Magnesium	µg/L	25,800	None	17,073	*15,000*	Yes	NA	NA
Potassium	µg/L	7,420	None	4,137	*3,100–3,500*	Yes	NA	NA
Sodium	µg/L	57,200	None	47,892	*14,000–17,000*	Yes	NA	NA
Organic Analytes								
1,1,1-Trichloroethane	µg/L	1	200	0.3	NA	NA	0	0
1,2-Dichloroethane	µg/L	0.1	5	ND	NA	NA	0	0
1,2,4-Trimethylbenzene	µg/L	7	None	ND	NA	NA	NA	NA
1,3,5-Trimethylbenzene	µg/L	4	None	ND	NA	NA	NA	NA
Carbon Tetrachloride	µg/L	0.3	5	ND	NA	NA	0	0
Chloroform	µg/L	0.5	100	ND	NA	NA	0	0
Ethylbenzene	µg/L	0.1	700	ND	NA	NA	0	0
Naphthalene	µg/L	0.3	None	ND	NA	NA	NA	NA
Toluene	µg/L	22	1000	1.1	NA	NA	0	0
Trichloroethene	µg/L	0.2	5	ND	NA	NA	0	0
Xylene (total)	µg/L	0.7	10,000	ND	NA	NA	0	0

Table 6-4. (continued).

Compound	Units	MDV	MCL or SMCL[a]	LF2-11 Upgradient Well ADV	Background[b]	Detections Above Background	Number of Wells with Detections Above MCL or SMCL	Number of Wells with More Than one Detection Above MCL or SMCL
Inorganic Analytes								
Aluminum	µg/L	501	*50 to 200*	46.1	*10–13*	Yes	1	0
Arsenic	µg/L	9.6	50	2.1	2 to 3	Yes	0	0
Barium	µg/L	199	2,000	170	50 to 70	Yes	0	0
Beryllium	µg/L	ND	4	ND	N	No	0	0
Cadmium	µg/L	9.5	5	0.15	<1	Yes	2	0
Chromium	µg/L	105	100	13.4	2 to 3	Yes	1	0
Copper	µg/L	45.3	*1,300*/ 1,000*	31.3	*<1*	Yes	0	0
Iron	µg/L	54,600	*300*	2,179	*16–25*	Yes	6	5
Lead	µg/L	44.8	15*	3.3	1 to 5	Yes	6	2
Manganese	µg/L	170	*50*	18.9	*7*	Yes	2	0
Mercury	µg/L	3.7	2	ND	N	N	1	0
Nickel	µg/L	196	None	24.9	N	N	NA	NA
Selenium	µg/L	10.8	*50*	2.6	<1	Yes	0	0
Vanadium	µg/L	43.1	None	2.6	N	N	NA	NA
Zinc	µg/L	3,530	*5,000*	73	*10.5–54*	Yes	0	0

*The action level for lead is 15 ug/L.

a. Numbers in italics are for secondary maximum contaminant level (SMCLs).

b. Background is from two sources. Plain numbers are from Knobel, Orr, and Cecil (1992). Italicized numbers are from USGS (1999)—median and mean values.

NA = not applicable

ND =not detected.

N = not determined.

In October 2001, a groundwater sample collected from Well USGS-083, which is located approximately 1,220 m (4,000 ft) farther downgradient from Wells CFA-MON-A-002 and CFA-MON-A-003, has a nitrate concentration of 0.642 mg/L. Because this is the second time that this well has been sampled for nitrate analysis, a trend cannot be established.

A nitrogen isotope study was conducted to identify the source of the nitrate in the CFA monitoring wells (INEEL 2002). Typical $\delta^{15}N$ nitrate values for various sources are as follows (Gellenbeck 1994; Seiler 1996):

- Dairies and feedlots—>15 per mil
- Sewage treatment plants—9 to 14 per mil
- Fertilizers—4 to +4 per mil
- Natural sources such as organics in the subsurface—4 to 9 per mil.

The expected $\delta^{15}N$ value for an anthropogenic source of nitrate is 0 ± 4 per mil, because nitrogen for industrial uses is usually obtained from the atmosphere.

Based on the range of $\delta^{15}N$ values, the nitrate in the CFA monitoring wells is probably derived from sewage effluent. The much lower nitrate concentrations at the CFA landfill wells and the different $\delta^{15}N$ signature of the landfill wells suggest that the landfills are not the source of the nitrate contamination (see Figure F-4 in Appendix F). The nitrogen isotope data for groundwater in the area of CFA indicate that there are two distinct populations or sources of nitrate. The $\delta^{15}N$ values in the CFA landfill and INTEC wells range from 4.66 to 6 per mil and average 5.2 per mil. The $\delta^{15}N$ values for the three CFA monitoring wells and the CFA-1 production well range from 7.6 to 8.4 per mil and average 8 per mil. These data indicate that the nitrate in the CFA monitoring wells and CFA-1 is enriched in the $\delta^{15}N$ isotope relative to the upgradient wells. Although the $\delta^{15}N$ values of 8 per mil in the CFA monitoring wells and CFA-1 are slightly lower than the typical range for $\delta^{15}N$ values of 9 to 14 per mil for sewage treatment plants or septic system sources, two studies have shown similar values for locations downgradient of sewage source areas (Aravena and Wassermaar 1993; Gellenbeck 1994).

6.2.2 Impacts to Central Facilities Area Landfill Wells from Other Facilities

Based on the reported results of groundwater monitoring and sampling performed for WAG 3 Group 5 (Snake River Plain Aquifer) during May and August 2001, the groundwater underlying the CFA landfills has been impacted by former disposal practices at INTEC. The *Annual INTEC Groundwater Monitoring Report for Group 5—Snake River Plain Aquifer (2001)* (DOE-ID 2002c) indicates that I-129 was detected at concentrations at or above the 1-pCi/L MCL in two of the CFA landfill wells (LF 2-08 at 1.04 ± 0.18 pCi/L and LF 3-08 at 1.06 ± 0.19 pCi/L). In addition, I-129 was also detected in samples collected from Wells LF 2-09, LF 2-11, and LF 3-10, at concentrations below the MCL of 0.91 ± 0.16 pCi/L, 0.98 ± 0.17 pCi/L, and 0.85 ± 0.15 pCi/L, respectively. Iodine-129 was also detected in the CFA-1 production well at a concentration of 0.35 ± 0.08 pCi/L.

The WAG 3 Group 5 groundwater sampling also indicated that increasing concentrations of Sr-90 originating from INTEC might also be progressing toward CFA. At the current time, tritium, Tc-99, gross beta, and Sr-90 concentrations do not exceed the MCLs in groundwater underlying CFA. For details of the locations and concentrations of the plumes, refer to the *Annual INTEC Groundwater Monitoring Report for Group 5—Snake River Plain Aquifer (2001)* (DOE-ID 2002c).

The INTEC plumes also provide another indication of groundwater flow directions in addition to the water-level measurements. The migration of chloride from INTEC should define groundwater flow path(s) since chloride acts as a conservative groundwater flow tracer. The shape of the chloride plume is consistent with a southerly groundwater flow direction (see Figure F-3 in Appendix F).

Waste Area Group 3 Group 5 has proposed an ongoing groundwater monitoring and sampling program that will include at least annual groundwater sampling of select radionuclides in some of the CFA wells to track their progress.

6.2.3 Groundwater-Level Evaluation to Assess Monitoring Well Needs at Landfill I

During the review of the data from the first 2 years of intensive monitoring, the Agencies expressed concern that the current groundwater-monitoring wells might not be adequately monitoring the downgradient area of Landfills I and III and that a new monitoring well may need to be installed downgradient. To determine if the downgradient monitoring was adequate, it was agreed that 1 year of monthly groundwater-level measurements would be collected from all available wells surrounding Landfills I and III. Consequently, monthly groundwater-level measurements were collected between October 2000 and September 2001. These measurements were used to determine groundwater flow and to determine whether the current downgradient wells adequately monitored the area downgradient from Landfills I and III. The wells measured included the following:

CFA-MON-A-001	LF 2-11	USGS-036	USGS-112
CFA-MON-A-002	LF 3-08	USGS-037	USGS-113
CFA-MON-003	LF 3-09	USGS-038	USGS-114
LF 2-08	LF 3-10	USGS-077	USGS-115
LF 2-09	USGS-034	USGS-083	USGS-116
LF 2-10	USGS-035	USGS-111	USGS-127

Two of these wells (LF 3-09 and LF 3-10) that are located downgradient from Landfills I and III were not available for measurements because of well repairs or survey issues with the wells during the time of the groundwater-level measurements. The historical groundwater-level measurements are provided in Appendix E, as well as a summary of the maximum, minimum, and average elevations for the historical data and well deviation survey information.

Based on the collected groundwater-level measurements, the groundwater-level elevations were calculated for each monthly measurement event. A groundwater contour map is provided in Appendix F that reflects the groundwater contours for the area surrounding the CFA landfills taking into account the influences of distant wells based on extrapolation between data points. In addition, a map showing the triangulation of groundwater vectors is provided in Appendix F.

Triangulation is the calculation of the plane surface of the aquifer water table formed from the measured water table elevations in three wells. From this surface, the direction and magnitude of the aquifer hydraulic gradient can be determined. The hydraulic gradient, the change in potential energy per distance, is the main driving force that moves groundwater.

Combinations of three wells from the set of CFA aquifer wells were used to produce the groundwater gradient rose diagrams of aquifer hydraulic gradient direction depicted in the figure in Appendix F. For each combination of three wells, four hydraulic gradient calculations were made corresponding to the dates Oct-00, Jan-01, Apr-01, and Jul-01. These calculations are summarized in the

table provided in Appendix F and incorporate the USGS-developed correction factors for wells with known borehole deviation. It should be realized that the USGS correction factors for borehole deviation indicate a certain level of inaccuracy associated with the water levels from these wells and may affect the hydraulic gradient calculation.

These calculations represent a “best estimate” of hydraulic gradient direction in an area of relatively flat water table. The figure shows, for comparison, water table equipotential contour lines prepared from the same water-level data. This figure also shows the location of the aquifer wells used in these calculations.

However, the direction of groundwater movement can only be inferred from the triangulated gradient direction. In a highly fractured, heterogeneous aquifer matrix such as beneath the INEEL, the movement of groundwater can be refracted by the large, contrasting hydraulic properties of fractured and intact basalt and sediment. In addition, choices of wells to make a triangulation can impact the calculated results; combinations that cover a larger area appear to be more consistent with the generally accepted south-southwest regional gradient. As indicated in Section 6.2.2, the shape of the INTEC groundwater plumes also supports a southerly groundwater flow direction.

A review of the waste disposal history of Landfill I and the placement of the LF 3-08 and LF 3-09 monitoring wells at Landfills I and III suggests that the wells are in position to monitor the migration of vapors from the western waste trench at Landfill I (actually located under the southeast corner of the Landfill III cover). The western waste trench was identified as a VOC source area from a shallow soil gas survey conducted at the landfills. The GWSCREEN modeling has shown that Landfill I does not pose a risk to groundwater from metals that may have been disposed of in the landfill. The eastern portion of Landfill I does not appear to be monitored by LF 3-08 and LF 3-09; however, this part of the landfill contains predominantly construction waste. Even so, monitoring should be evaluated without making assumptions about the distribution of contaminants within the landfill due to the uncertainty associated with landfill contents.

6.3 Description of Landfill Moisture Monitoring Systems

A shallow time-domain reflectometer system was installed in 1996 at Landfills I and II to a depth of 0.6 m (2 ft). New deep or vertical time-domain reflectometer systems were installed in the native soil cover at Landfills II and III to a depth of 2.4 m (8 ft) during August and September 2000. Five existing NATs were also used for moisture measurements. Refer to Figure 6-2 for the locations of both the shallow and deep time-domain reflectometer arrays, as well as the NATs. For detailed information pertaining to the landfill soil characteristics, refer to *Shallow Drilling Report for CFA Landfills II and III – FY-1988* (EG&G 1988).

6.3.1 Neutron-Probe Access Tubes

Neutron-probe access tubes (NATs) are one infiltration monitoring system used at the CFA landfills. Five NATs are installed in Landfills II (three tubes) and III (two tubes) ranging in depth from 5.5 to 7 m (18.2 to 23 ft) bls. At Landfill II, one tube is located on the landfill (LF 2-07), with two located adjacent to the landfill (LF 2-03 and LF 2-04). At Landfill III, one tube is on the landfill (LF 3-05) and the second is on the edge of it (LF 3-03). Soil moisture readings were obtained at 0.3-m (1-ft) intervals.

The neutron probe indirectly measures the moisture content of soils. A fast neutron source is lowered into the access tube, where the fast neutrons emitted by the probe are slowed by hydrogen nuclei in the surrounding soil. A detector in the probe counts the slowed or thermalized neutrons, and the counts are correlated to the amount of moisture in the soil. Although the primary source of hydrogen in most soils is water, other materials that contain hydrogen (e.g., plastics and hydrocarbons) can interfere with

the moisture measurement. The accuracy or reproducibility of the neutron-probe measurements is generally ± 3%.

6.3.2 Time-Domain Reflectometry Arrays

The second infiltration monitoring system in place at the CFA landfills comprises time-domain reflectometry arrays.

The time-domain reflectometer data were collected from two systems: (1) a shallow system that collected data at 15-cm (6-in.) intervals to a depth of 0.6 m (2 ft) and (2) a deep system that collects data from the surface to a depth of 2.4 m (8 ft). Because of problems encountered with the shallow time-domain reflectometer systems, monitoring of the shallow arrays was discontinued in 1998. After reviewing and analyzing the existing data in preparation for required review of the first 2 years of intensive monitoring, it was determined that the shallow time-domain reflectometry arrays required replacement with the new system that monitored to a deeper depth. The deep systems were installed in later August and September 2000. Data have been collected from the deep arrays from October 2000 to the present.

The vertical time-domain reflectrometry arrays were installed in a two- or four-step process depending on the insertion depth of the probe. The 0- to 0.6-m (0- to 2-ft) probes were installed by first driving a pilot rod into the ground to create a hole slightly smaller than the time-domain reflectometer probe, then driving the probe into the hole created by the pilot rod. The deeper probes were installed in a four-step process. First, a 10-cm (4-in.) core hole was drilled to within 0.6 m (2 ft) of the target depth of the probe. For example, a 0.6-m (2-ft) deep core hole was drilled for the probe from 0.6 to 1.2 m (2 to 4 ft) in depth. After drilling the borehole to the appropriate depth, the pilot rod was driven into the bottom of the borehole to create a hole for the time-domain reflectometer. The time-domain reflectometer was then driven into the pilot rod hole. The borehole was then backfilled with material removed during the drilling of the borehole and the clay layer was tamped down in place.

The initial shallow time-domain reflectometry arrays were installed in 1996, with monitoring commencing in March of 1997 and continuing into September 1998. An array was not installed in the cover of Landfill III, because modeling results indicated that infiltration through the cover and existing material of Landfill III would be approximately two orders of magnitude less than through Landfill I and one order of magnitude less than through Landfill II (INEL 1996). Based on the greatly reduced infiltration expectations resulting from the shorter precipitation run-off path due to narrower width of the landfill and the modeling results, installation of an array at Landfill III was not considered necessary.

The new deep time-domain reflectometer systems at two locations in Landfills II and III collect data from the surface to a depth of 2.4 m (8 ft) with the data collected at 15-cm (6-in.) intervals. Landfills II and III were selected for installation of the new time-domain reflectometry arrays because the greatest risks for contaminant migration were associated with the wastes disposed of at those landfills. Landfill I received primarily construction debris. The western waste trench, which is associated with Landfill I and received wastes that were periodically ignited using flammable liquids, is actually located under the eastern boundaries of Landfill III. Using this basis, it was determined that a time-domain reflectometry array was not warranted at Landfill I. In addition, the time-domain reflectometry arrays at Landfills II and III were installed in the vicinity of the existing NATs, allowing for a more direct comparison of time-domain reflectometer data to that obtained from the NATs. With the installation of the new time-domain reflectometer systems, monitoring of the original shallow time-domain reflectometer systems was discontinued.

The time-domain reflectometer method determines the water content of soil using a nondestructive technique based on measuring the dielectric constant of the soil using the propagation velocity of a pulse

as it travels along an electromagnetic transmission line (or probe) buried in the soil (Whalley 1993). The travel time of the pulse yields an "apparent" probe length, which is dependent upon the dielectric properties of the medium surrounding the probe. Because free water has a dielectric constant 20 times that of mineral matter, the dielectric constant of the soil is dominated by the contribution from soil water. The volumetric water content of the soil is calculated from the actual and apparent probe lengths.

6.4 Historical Weather Data

The monitoring of precipitation is important because the amount of precipitation is a key factor in determining the amount of infiltration and recharge. Historical precipitation data from the CFA weather station are summarized to put into context the precipitation from the periods that were monitored. Precipitation data for the winter period from November through March are summarized from 1952 to 2001 (refer to Table 6-5). The November through March period is when evapotranspiration is low, and frozen precipitation can build up on the surface. The data show that the average amount of precipitation during this period is 8.33 cm (3.28 in.) with a range of 2.87 to 17.12 cm (1.13 to 6.74 in.). However, the exact timing that frozen precipitation builds up on the surface and the duration of the melting period(s) varies from year to year. The November 1996 through March 1997 period was well above the average precipitation. The weather data indicate that the November 1997 through March 1998 period was slightly above average and that the November 2000 through March 2001 period was well below the average.

6.5 Moisture Monitoring Data Summary

The overall objective of infiltration monitoring at the CFA landfills is to document the effectiveness of the landfill covers for minimizing infiltration into the landfill wastes (INEL 1997b). The moisture content of the soil was monitored using time-domain reflectometer and neutron-probe instruments.

Water that moves into the soil is defined as "infiltration." Water that continues to move downward below the evapotranspiration depth of the soil profile is termed "recharge." Infiltration and recharge are represented by an increase in water storage within a system. In addition to recharge, evapotranspiration is a large contributor to decreasing water content in near-surface soils, moving water upward and out of the soil. The term "drainage" refers to water movement out of a unit thickness of soil or a decrease in soil moisture content, but does not indicate the direction of movement. Drainage is used only to evaluate the evapotranspiration depth (see Appendix G).

The depth to which evapotranspiration is influential depends on the plants and their rooting depths, soil types, and the meteorological conditions that are present. The evapotranspiration depth is assumed to be 0.9 to 1.2 m (3 to 4 ft). For the evapotranspiration depth to be evaluated, enough data are necessary so that yearly variations in moisture content in the upper part of the soil profile can be assessed to determine the evapotranspiration depth for an average year. Based on the historical weather data previously discussed, an average amount of precipitation between November and March is 8.33 cm (3.28 in.). The evapotranspiration depths for the NAT locations will be based on the amount of drainage occurring at 0.3-m (1-ft) increments. The drainage from one layer to the next within the evapotranspiration zone should steadily decrease until the zero flux boundary is reached. The depth at which drainage averaged over the course of a year becomes nearly constant is assumed to be the evapotranspiration depth. The evapotranspiration depth varies over the course of the year and from year to year. The determination of the maximum evapotranspiration depth (late summer time to early fall) should be used to determine the amount of recharge since any water above this depth is subject to removal. Refer to Appendix G for a detailed discussion of the moisture monitoring data obtained since the installation of the new time-domain reflectometer systems. A summary of this information along with previous monitoring is provided in the following subsections.

Table 6-5. Historical precipitation data.

Year		Precipitation	Year		Precipitation	Year		Precipitation
Nov.	March	(in.)	Nov.	March	(in.)	Nov.	March	(in.)
1951	1952	3.11	1968	1969	5.74	1985	1986	5.59
1952	1953	2.14	1969	1970	3.02	1986	1987	1.40
1953	1954	2.26	1970	1971	4.47	1987	1988	1.88
1954	1955	1.93	1971	1972	3.14	1988	1989	3.35
1955	1956	3.68	1972	1973	4.04	1989	1990	1.88
1956	1957	3.52	1973	1974	4.94	1990	1991	1.64
1957	1958	3.51	1974	1975	4.51	1991	1992	1.47
1958	1959	1.83	1975	1976	2.49	1992	1993	4.79
1959	1960	3.83	1976	1977	1.13	1993	1994	1.58
1960	1961	2.06	1977	1978	4.38	1994	1995	4.88
1961	1962	4.63	1978	1979	3.43	1995	1996	3.56
1962	1963	2.98	1979	1980	2.77	1996	1997	4.51
1963	1964	3.00	1980	1981	3.17	1997	1998	3.43
1964	1965	6.74	1981	1982	4.07	1998	1999	4.13
1965	1966	2.62	1982	1983	4.01	1999	2000	2.57
1966	1967	3.11	1983	1984	3.35	2000	2001	1.80
1967	1968	2.08	1984	1985	3.93		Average	3.28

6.5.1 Neutron Probe Monitoring Data Summary

The goal for the neutron probe monitoring at the landfills is to determine the volume of water infiltrating past the evapotranspiration or rooting depth. Water that passes through the evapotranspiration depth may pick up contaminants in the landfill waste and carry them to a depth monitored by the NATs. The volumes for infiltration, drainage, and recharge have been calculated for each NAT location for 1997, 1998, and 2001. Data were not collected from September 1998 to October 2000. Calculated infiltration, recharge, and drainage for the five NATs are summarized in Table 6-6.

6.5.1.1 Infiltration and Recharge Based on Neutron-Probe Monitoring Data. The neutron-probe data for 1997, 1998, and 2001 indicate that recharge varies considerably from year to year. In some years, recharge may be very low or non-existent, as was found in 2001. For 1998, recharge was calculated using calibration equations and a water balance method, as described in Appendix A of the Post-Record of Decision Monitoring Report from 1996–1998 at Operable Unit 4-12, Central Facilities Area Landfills I,II, and III (CFA-01-, CFA-02, and CFA-03) (INEEL 2000). The neutron-probe data from Landfill III in the winter/spring of 1997 suggest that a recharge event took place in January 1997 at Landfill III, although neutron-probe readings were not taken in January 1997 for these NATs to confirm this. Recharge estimates for the spring of 2001 are less than 0.64 cm (0.25 in.) for all locations except LF 2-04 (refer to Table 6-6). The infiltration estimates for the spring of 2001 of 2.34 to 3.61 cm (0.92 to 1.42 in.) are consistent with the measure precipitation at the National Oceanic and Atmospheric Administration (NOAA) weather station of 4.6 cm (1.8. in.).

Table 6-6. Summary of landfill cover neutron-probe access tube monitoring results for 1997, 1998, and 2001.

	Neutron Probe Location				
	LF 2-03 (inches of water)	LF 2-04 (inches of water)	LF 2-07 (inches of water)	LF 3-03 (inches of water)	LF 3-05 (inches of water)
Infiltration and Recharge Estimates					
1997 Winter/Spring					
Recharge	<0.5[a]	<0.5[a]	<0.5[a]	1.03	0.63
Spring 1998 Infiltration Event					
Infiltration	3.23	2.25	3.64	3.21	1.13
Recharge[b]	2.43	1.96	2.27	1.84	0.11
Water Balance of Spring 1998 Infiltration Event					
Infiltration[c]	3.36	3.36	3.36	3.36	3.36
Recharge[b]	2.46	2.57	1.75	2.19	0.16
Spring 2001 Infiltration Event					
Infiltration	0.92	1.42	1.19	1.31	1.07
Recharge[b]	<0.25	0.30	<0.25	<0.25	<0.25
Storage Analysis					
Change in Storage from 8/97 to 8/98					
Total	0.52	0.12	-0.03	-0.45	-1.04
Within Cap	—	—	-0.37	-0.53	-0.41
Within ET Zone	-0.52	-0.12	-0.32	-0.55	-0.60
Below ET Zone	1.04	0.24	0.29	0.10	-0.43
Change in Storage from 10/00 to 9/01					
Total	-0.01	-0.29	-1.00	-0.24	-0.32
Within Cap	—	—	0.01	0.00	-0.07
Within ET Zone	-0.03	-0.16	-0.09	-0.05	-0.17
Below ET Zone	0.02	-0.13	-0.91	-0.19	-0.15

a. Because data from November and December 1996 were not available, a recharge event was not identified.

b. The amount of recharge is estimated to be the increase in moisture content below the evapotranspiration depth (4 ft). The evapotranspiration depth is assumed to be 3 to 4 ft. The evapotranspiration depth can be more reliably determined after 4 years of data are collected.

c. The infiltation was set at 3.36 in. based on the available precipition.

ET = evapotranspiration

6.5.1.2 *Water Storage Analysis Based on Neutron-Probe Monitoring Data.*

Changes in storage refer to changes in soil moisture content over a period of time that represents a full moisture cycle that is typically a 1-year period. Only two 1-year periods are available for analysis, August 1997 to August 1998 and September 2000 to September 2001. Data were not collected between August 1998 and September 2000. The loss of neutron probe monitoring data for October and November of 1997 has been attributed to an equipment malfunction.

Change in storage for two landfill NATs (i.e., LF 2-07 and LF 3-05) for the period of August 1997 to August 1998 indicates that the covers and the entire soil column over the length of the NATs decreased in moisture content. The change in water storage indicates that moisture content decreased within the cap and within the evapotranspiration zone. At LF 3-05, moisture content also decreased below the evapotranspiration depth. In contrast, two NATs (i.e., LF 2-03 and LF 2-04) located near Landfill II show an increase in total storage but decreases in storage within the evapotranspiration zone (refer to Table 6-6). Tube LF 3-03 located on the edge of Landfill III also showed a negative change in total water storage. The negative changes in storage at LF 3-05, and to a lesser extent at LF 2-07, suggest that the covers are reducing the amount of infiltration and continued drainage is drying the soil column compared to pre-cover conditions.

6.5.2 Time-Domain Reflectometer Monitoring Summary

The monitoring of water movement or absence of infiltration through the soil cover and low-permeability layer located 15 to 45 cm (6 to 18 in.) bls is the primary concern of the shallow time-domain reflectometer monitoring. The deep time-domain reflectometer arrays were installed to evaluate infiltration through the cover, evaluate the evapotranspiration depth, and to determine recharge below the evapotranspiration depth.

6.5.2.1 Infiltration and Recharge Through the Soil Cover Based on Time-Domain Reflectometer Data.

Infiltration and recharge calculations for 2001 are based on the amount of infiltration and recharge during the spring, since continuous monitoring of the time-domain reflectometers indicates that this is the only time during the year that significant moisture moved into the soil. Infiltration calculations for the spring of 2001 show that the time-domain reflectometer results are greater than the measured precipitation at the NOAA weather station of 4.6 cm (1.8 in.) (refer to Table 6-7). The discrepancy between measured precipitation at the NOAA weather station and infiltration could be attributed to calibration problems or to physical nonconformities, such as void spaces, next to the probes. However, the data indicated that recharge was minimal, less than 0.64 cm (0.25 in.). The depth of penetration of the wetting front was probably less than 3 ft.

Infiltration and recharge estimates were not made using the shallow time-domain reflectometer systems for 1997 or 1998, because the systems did not have enough vertical coverage for a large infiltration event that occurred in 1998 or to adequately determine the evapotranspiration depth.

6.5.2.2 Water Storage Analyses for the Time-Domain Reflectometer Locations.

Infiltration, drainage, and evapotranspiration affect the amount of water in storage in the soil profile. Changes in storage were estimated for the 2.4-m (8-ft) deep time-domain reflectometers for September 26, 2000, through September 30, 2001, for the systems at Landfill III and November 9, 2000, through September 30, 2001, for those located at Landfill II. Changes in storage for the shallow (0- to 0.6-m [0- to 2-ft]) time-domain reflectometers were determined for the period of April to October 1997 and February to August 1998.

Table 6-7. Summary of landfill cover deep time-domain reflectometer monitoring results for FY 2001.

	Time-Domain Reflectometer Array			
	LF3-East (inches of water)	LF3-West (inches of water)	LF2-North (inches of water)	LF2-South (inches of water)
Spring 2001 Infiltration Event				
Infiltration	2.12	2.85	3.86	NA
Recharge[a]	< 0.25	< 0.25	< 0.25	< 0.25
Change in Storage from 10/00 to 9/01				
Total	0.07	-0.28	0.76	0.33
Within Cap	0.12	-0.09	0.08	-0.35
Within ET Zone	0.36	-0.11	0.40	-0.14
Below ET Zone	-0.21	-0.21	0.37	0.45

a. The amount of recharge is estimated to be the increase in moisture content below the evapotranspiration depth (4 ft). The evapotranspiration depth is assumed to be 3 to 4 ft. The evapotranspiration depth can be more reliably determined after 4 years of data are collected.

The four deep time-domain reflectometers showed little change in storage over the monitoring period for the 0- to 0.6-m (0- to 2-ft) and 0- to 2.4-m (0- to 8-ft) depth intervals for the landfill caps (refer to Table 6-7). Three of the four time-domain reflectometer locations showed a gain in storage for the 0- to 2.4-m (0- to 8-ft) depth interval over the monitoring period. However, gains in moisture content greater than 2.5% occurred at only one interval below 0.9 m (3 ft) in both the north and south time-domain reflectometer arrays at Landfill II. This suggests that any recharge was slight (less than 0.64 cm [0.25 in.]) and that evapotranspiration consumed most to all of the infiltrated water for the spring 2001 snowmelt.

The shallow time-domain reflectometers showed gains in water storage for the 46- to 61-cm (18- to 24-in.) layer in both 1997 and 1998, indicating that water moved through the low-permeability layer and into the 15-cm (6-in.) layer below (refer to Table 6-8). The values for 1998 were greater than those for 1997 because of the snow buildup during 1998. The subsequent decreases in water storage at the 46- to 61-cm (18- to 24-in.) layer after the pulse of snow melt water indicate that water was lost through either recharge or evapotranspiration. Water lost through recharge would have moved deeper into the landfill sediments or waste; whereas water lost through evapotranspiration would have moved upward and out of the system at land surface. Because measurements were only collected to a depth of 0.6 m (2 ft), the ability to differentiate between water loss due to evapotranspiration or to recharge is not possible.

6.5.3 Comparison of Time-Domain Reflectometer and Neutron-Probe Data

The neutron-probe data for LF 3-05 and LF 2-07 and the deep time-domain reflectometer data from Landfills II and III were compared with regard to recharge estimates, depth of wetting front penetration, and infiltration estimates for 2000 and 2001, because these NAT locations and time-domain reflectometers are in the same proximity. The deep (0- to 2.4-m [0- to 8-ft]) time-domain reflectometer data and the neutron-probe monitoring data from both landfills in 2001 suggest that recharge was less than 0.64 cm (0.25 in.) on the landfills and that the wetting front in the spring of 2001 penetrated only about 0.9 m (3 ft). In contrast to the landfill locations, LF 2-04 located off Landfill II showed a wetting

Table 6-8. Changes in water storage within the soil cover: 04/97 to 10/97 and 2/98 to 8/98.

	Change in Storage, 30 to 45 cm (18 to 24 in.) depth			
	1997		1998	
Array	+ΔS (in.)[a]	-ΔS (in.)[a]	+ΔS (in.)[a]	-ΔS (in.)[a]
Landfill I, North	0.12	-0.84	1.56	-1.08
Landfill I, South	0.30	-0.78	0.54	-0.24
Landfill I, East	0.18	-0.60	0.84	-0.42
Landfill I, West	0.30	-0.78	0.48	-0.12
Landfill II, North	0.18	-0.42	0.24	-0.12
Landfill II, South	0.54	-0.43	NA[b]	NA[b]
Landfill II, East	NE[c]	-0.48	1.44	-1.02
Landfill II, West	0.30	-0.72	1.68	-1.38

a. A positive ΔS within the 15-cm (6-in.) layer of soil below the compacted, low-permeability layer indicates water moved through the low-permeability layer.

b. NA = not available. Data were not available for this array.

c. NE = Not estimated. Data variability obscured minor moisture content increase.

front penetration to at least 1.8 m (6 ft), indicating that the landfill covers are reducing infiltration. The primary difference between the deep time-domain reflectometer and neutron probe measurements was that the calculated amount of infiltration using the deep time-domain reflectometers was considerably higher than that determined by the neutron probe and also much greater than the measured precipitation at the CFA NOAA weather station. Part of the overestimation by the time-domain reflectometers could be that the rapid increase in water content in mid-March 2001 is due to both the soil thaw and infiltration. The calibration of the deep time-domain reflectometers needs to be evaluated.

The neutron probe data for LF 2-07 and the shallow (0- to 0.6-m [0- to 2-ft]) time-domain reflectometer data from Landfill II were compared for both 1997 and 1998. In 1997, the time-domain reflectometer data showed increases of 0.91 to 2.74 cm (0.36 to 1.08 in.) at the 0.6-m (2-ft) depth compared to a 1.02-cm (0.40-in.) increase for the 0.6-m (2-ft) depth at LF 2-07 from January to March. In 1998, the time-domain reflectometer indicated changes of 1.21 to 8.53 cm (0.48 to 3.36 in.), as compared to a 1.12-cm (0.44-in.) increase for the neutron-probe data from January to April. The above comparisons suggest that the neutron-probe infiltration estimates tend to be at the low end of the time-domain reflectometer measurement range.

6.5.4 Conclusions

The key events that appear to enhance infiltration are sudden snowmelt and greater-than-average precipitation. The timing of the moisture increases in the landfill soil indicates that winter precipitation and snowmelt account for most of the infiltration at the landfills. The depth of infiltration and amount of recharge are directly related to the amount of precipitation that falls in the winter. Data from 1997, 1998, and 2001 indicate that the landfill covers are reducing the amount of recharge, because recharge is greater at the off-landfill monitoring locations. In drier years with less precipitation (e.g., 2001), the time-domain reflectometer and neutron probe monitoring suggest that the landfill covers should be able to prevent

recharge below the evapotranspiration depth. In 2001, one of the two NAT locations off the landfills had some recharge, but none of the time-domain reflectometer or tube locations on the landfills had recharge.

6.6 Deviations to the Monitoring Work Plan

The following sections discuss the deviations to the work plan for the soil gas monitoring, groundwater monitoring, and moisture monitoring. Also discussed are the recommendations resulting from the review of the first 2 years of intensive monitoring, as provided in the *Post-Record of Decision Monitoring Report from 1996–1998 at Operable Unit 4-12, Central Facilities Area Landfills I, II, and III (CFA-01, CFA-02, and CFA-03)* (INEEL 2000).

6.6.1 Soil Gas Monitoring

For soil gas monitoring, the *Post Record of Decision Monitoring Work Plan Central Facilities Area Landfills I, II, and III Operable Unit 4-12* (INEL 1997b) recommended that the collection of samples for VOC and methane analysis be performed semi-annually for the first 2 years decreasing to an annual basis for years three through five, and a biannual basis for years six through 30. The semi-annual sampling commenced in December 1996 and continued until the fourth round of samples was collected in July 1998. At that time, sampling was temporarily suspended. The Post-ROD Monitoring Report (INEEL 2000) recommended that sampling continue on a semi-annual basis through 2003 to identify any trends. With the release of the Post-ROD Monitoring Report (INEEL 2000) imminent, sampling of the soil gas monitoring ports restarted in August 2000 and has continued on a semi-annual basis since that time.

6.6.2 Groundwater Monitoring

For groundwater monitoring, the *Post Record of Decision Monitoring Work Plan Central Facilities Area Landfills I, II, and III Operable Unit 4-12* (INEL 1997b) required that the collection of groundwater samples be performed on a quarterly basis for the first 2 years decreasing to an annual basis for years three through five, and a biannual basis for years six through 30. Quarterly groundwater monitoring commenced in July 1996 and continued until April 1998 with the collection of the eighth round of samples. Subsequently, samples have been collected on an annual basis with samples collected in May/June 1999, September 2000, and October 2001. Based on recommendations proposed in the Post-ROD Monitoring Report (INEEL 2000), Wells LF 2-10 and LF 3-09 were removed from the list of wells sampled beginning with the October 2001 groundwater-monitoring event. In addition, monitoring of USGS-83 was included in the annual groundwater monitoring effort with USGS-128 being installed to monitor upgradient of Landfills I and III.

Groundwater-level measurements were to be collected monthly for the first year of intensive monitoring decreasing to the same schedule as groundwater monitoring thereafter. As shown in Appendix C of the *Post-Record of Decision Monitoring Report from 1996-1998 at Operable Unit 4-12, Central Facilities Area Landfills I, II, and III (CFA-01, CFA-02, and CFA-03)* (INEEL 2000), water-level measurements were collected on a monthly basis from most wells from the May 1996 timeframe until November 1998. The collection of groundwater-level data in 1999 was sporadic with the monthly collection of water-level measurements resuming in September 2000 and continuing until August 2001 at which time the frequency was decreased to coincide with the annual groundwater monitoring effort. The collection of monthly water-level measurements was done in accordance with the recommendation of the Post-ROD Monitoring Report (INEEL 2000).

6.6.3 Moisture Monitoring

In accordance with the *Post Record of Decision Monitoring Work Plan Central Facilities Area Landfills I, II, and III Operable Unit 4-12* (INEL 1997b), monitoring of the NATs was to be performed on a monthly basis for the first 2 years only. No further monitoring of the NATs was required beyond that point. The time-domain reflectometer arrays monitored moisture infiltration on a continual basis with data from the time-domain reflectometer arrays to be downloaded on a monthly basis for the first 3 months decreasing to a quarterly frequency thereafter.

Data collection from the NATs occurred from December 1996 through August 1998 and October 2000 to the present. As recommended in the Post-ROD Monitoring Report (INEEL 2000), data were collected from the NATs during periods of heavier snowmelt to ensure the viability of the landfill caps. For the time-domain reflectometer arrays, the shallow arrays were monitored from March 1997 through September 1998, and data were collected from the deep arrays from October 2000 to the present. Data were not collected from the time-domain reflectometer arrays from late 1998 until the installation of the deep time-domain reflectometer arrays was completed.

6.7 Landfill Inspections

Formal inspections of the CFA landfills were conducted in 1997, 2000, and 2001. Informal inspections were conducted in 1998 and 1999. The 1997 and 2000 inspection checklists were subsequently transmitted to the Agencies, with the 2001 inspection included in Appendix A to this 5-year review report. In addition, the *FY 2001 Institutional Control Inspection Report for the Central Facilities Area, Operable Unit 4-12* (DOE-ID 2001b) provides and documents the inspection of the ROD-mandated (DOE-ID 1995) institutional controls for the CFA sites under OU 4-13, which includes the CFA landfills.

6.7.1 1997 Inspection Results

The 1997 inspection (Falconer 1997) provided that the predominant impression was that the landfill covers were stable and well vegetated. Two specific areas of concern were identified. First, the eastern edge of Landfill II had an unusually low grass coverage that could not be linked to the application method due to the area running perpendicular to the seeding path. The soil was subsequently analyzed for nutrients and found to have high pH and low organic nutrients. The area was reseeded, and a suitable fertilizer was selected and applied. Second, the toes at Landfill III were poorly vegetated with desirable grasses and highly vegetated with undesirable weeds. The area was reworked to promote vegetative growth.

A check survey to evaluate weathering and subsidence was also performed as part of the 1997 inspection (Falconer 1997). The check survey indicated a uniform settling of the landfills of approximately 2.5 cm (1 in.). This was attributed to the 15-cm (6-in.) topsoil layer not being compacted when placed and the subsequent natural compaction associated with a full season of weather. No specific areas of subsidence or excessive erosion were noted. The aquifer wells, soil gas wells, and NATs were inspected when sampled quarterly, as a minimum, and were functioning properly. No significant concerns were identified with the landfill covers, rock armor, or monitoring equipment.

It is documented that a mid-year inspection of the vegetative growth at Landfills I and III was performed as part of the facility stormwater plan inspection in July of 1997, but no detailed results are available.

6.7.2 1998 Inspection Results

The previous WAG 4 program manager indicated that inspections were performed in 1998, but documentation cannot be found in the company-maintained files. The aquifer and soil gas wells and NATs were inspected when sampled.

6.7.3 1999 Inspection Results

Monthly inspections of vegetative growth at Landfills I and III were performed as part of the facility stormwater plan inspections. No anomalies were noted, but in the 2000 inspection, it was noted that a herbicide was applied in 1999. The aquifer wells were inspected when sampled.

6.7.4 2000 Inspection Results

The 2000 inspection (Smith 2000) noted non-uniform growth of vegetation and the encroachment of Canadian thistle at all three landfills. Evidence of animal intrusion around the perimeters of the landfills was found. Because the intrusion appeared to be in the perimeter and not into the waste, no corrective action was taken. At Landfill II, there were some areas of erosion on the downward side of the soil cover, with erosion on the southeast end and long eastside of Landfill III. The condition of the time-domain reflectometer arrays at Landfills I and II was acceptable. It was noted that the locks to the NATs at all three landfills had been cut and there was rusting of the covers to the tubes. The locks were subsequently replaced. The institutional controls were deemed to be adequate. The results of the topographical survey indicated very little major subsidence in the height of the caps, with the exception of the erosion previously discussed. New time-domain reflectometers were installed in 2000.

A midyear inspection of vegetative growth at Landfills I and III was performed as part of the facility stormwater plan inspection in June of 2000. During this inspection, it was noted that noxious weeds required removal and eroded side slopes of the east portion of Landfill III needed to be repaired and reseeded. The aquifer and soil gas wells and NATs were also inspected when sampled and were determined to be functioning properly.

6.7.5 2001 Inspection Results

The 2001 inspection noted differing growth of vegetation on the covers. At Landfill I, the vegetation was well established, while Landfill II had some areas with sparse growth and Landfill III had even more sparsely vegetated areas. The topographical survey showed minimal subsidence in the landfill covers, with a maximum shift of 0.073 m (0.24 ft) found at one location on Landfill I between the survey conducted in 1997 and the survey done in 2001. The average change in the survey results for Landfills I, II, and III are 0.034 m (0.11 ft), 0.015 m (0.05 ft), and 0.009 m (0.03 ft), respectively. The condition of the time-domain reflectometer arrays at all three landfills was acceptable, as were the NATs. The institutional controls were deemed adequate, as discussed in the following section. Results of the 2001 inspection, including a detailed inspection of the various wellheads, are provided in Appendix A.

A midyear inspection of vegetative growth at the landfills was performed as part of the facility stormwater plan inspection in June of 2001. During this inspection, dead noxious weed stalks were observed with no evidence of new thistle growth. It was noted that a herbicide had been applied in 1999 and Canadian thistle had been removed by hand in 2000. The side slopes showed some soil disturbance from burrowing animals and animal trails. It was also noted that the density of the vegetation of the side slopes had not reached the density of the flatter portions of the landfill, but it was effective in reducing erosion. Reseeding of the side slopes had not taken place, but was planned for the fall of 2001.

The aquifer and soil gas wells and NATs were inspected when sampled and were determined to be functioning properly.

6.7.6 Fiscal Year 2001 Institutional Control Inspection Report

The WAG 4 institutional controls, as required by the Final Comprehensive ROD (DOE-ID 2000b), were inspected in Fiscal Year (FY) 2001 to ensure that they were being maintained as required. The description of the institutional controls for the CFA landfills, as provided in the Final Comprehensive ROD (DOE-ID 2000b), is as follows:

"Maintain land use controls and re-evaluate at the five-year review."

The site-specific institutional control requirements in the comprehensive ROD (DOE-ID 2000b) include visible access restrictions (warning signs and permanent markers), control of activities (drilling or excavating and drilling of residential drinking water wells), and publication of surveyed boundaries and descriptions of controls in the *INEEL Comprehensive Facility and Land Use Plan* (DOE-ID 2001a). Signage is established in accordance with technical interpretation EA-TI-021, "Posting Warning Signs at CERCLA Sites" (INEEL 2001).

All three landfills had permanent markers (brass caps) and institutional control signs. Other signs posted around the landfill on the barbwire fence state "CFA Landfill Keep Out." The landfills were fenced with a gate and had posted CERCLA signs listing the contaminants of concern, access requirements, and a telephone number to call before entering the site. Access to the site required entrance through the main INEEL gate, which is controlled by Site Security. Institutional control information was submitted for inclusion in the *INEEL Comprehensive Facility and Land Use Plan* (DOE-ID 2001a). This plan can be accessed on the World Wide Web at http://mceris.inel.gov/plan/cflup/html/wags.html.

6.7.7 Site Inspections Conclusions

Site inspections, including inspection of institutional controls and inspections of the landfill caps, monitoring equipment, etc., have been conducted at the CFA Landfills I, II, and III. Vegetative growth has been monitored on a semi-annual basis. As noted in the 1997 inspection report, some areas of Landfills II and III demonstrated poor results, requiring attention to promote vegetative growth. Photographs from the June 25, 2001, inspection that show the progress of the reseeding effort are provided in Appendix C. Current vegetative growth is adequate based on O&M Plan requirements (DOE-ID 2002a).

The soil covers for the three landfills were inspected to identify any areas that had been adversely affected by erosion or subsidence. The rock armoring on the north end of Landfill II has been inspected, as discussed in Section 6.7. No major subsidence issues with the covers or concerns with the rock armor have been noted.

The NATs, gas-sampling boreholes, and groundwater monitoring wells are inspected when sampled. The time-domain reflectometry array data are downloaded remotely, with the arrays visually inspected on a quarterly basis to ensure that they are operating properly. Maintenance has been performed as needed and all monitors are currently working properly.

A more aggressive approach to weed control and revegetation has been implemented at the INEEL. A centralized organization is now responsible for these activities and performs annual INEEL Sitewide inspections for noxious weeds and vegetative growth. Within that organization's purview is the responsibility for weed control and revegetation of sites (where needed).

7. TECHNICAL ASSESSMENT

The information provided in this technical assessment is an update of previously compiled data on the monitoring of the CFA landfills. The initial compilation, review, and evaluation of the monitoring efforts included data collected between 1996 and 1998. This was documented in the *Post-Record of Decision Monitoring Report from 1996–1998 of Operable Unit 4-12, Central Facilities Area Landfills I, II, and III (CFA-01, CFA-02, and CFA-03)* (INEEL 2000). Refer to that document for information pertaining to the monitoring and sampling results collected and evaluated between 1996 and 1998.

This assessment compiles, reviews, and evaluates the monitoring data collected in support of the CFA landfills' remedial action, including the results of groundwater samples collected during October 2001. The data that are included in this assessment were collected as part of the monitoring program originally established in the *Post Record of Decision Monitoring Work Plan Central Facilities Area Landfills I, II, and III Operable Unit 4-12* (INEL 1997b). The data included in this assessment are derived from the following:

- Infiltration monitoring to monitor and evaluate water infiltration into the soil covers placed over the waste in the landfills. The monitoring is designed to determine if the landfill covers are operating properly and reducing the infiltration of water into and through the landfills.

- Soil gas monitoring to monitor and evaluate potential soil gas concentrations below and adjacent to the landfills. The source of the soil gas is composed of materials placed in the landfills.

- Groundwater monitoring to monitor and evaluate whether contaminants from the landfills are impacting the SRPA. The FSP for the post-ROD monitoring (INEL 1997c) also provides for the monitoring and evaluation of potential impacts from the previous and current sewage treatment facilities.

The information contained in this assessment is divided into sections that address the information, evaluations, and conclusions based on the results of each of the three monitoring phases described above.

In addition to the monitoring, this technical assessment includes a discussion, data, and a recommended course of action pertaining to two issues raised by the Agencies. These two issues are described below:

1. Agency concerns about the continuing detections of nitrate in the CFA-MON-A-002 and CFA-MON-A-003 groundwater monitoring wells. These wells are downgradient from the previous and current sewage treatment facilities.

2. Discussions with the Agencies as to whether an additional well is necessary to adequately monitor the SRPA downgradient from Landfills I and III.

Issues, recommendations, and follow-up actions associated with the three monitoring phases and the two issues mentioned above are addressed in Sections 8 and 9.

7.1 Responses to U.S. Environmental Protection Agency Technical Assessment Questions

The following sections provide responses to the three technical assessment questions, as provided in the *Comprehensive Five-Year Review Guidance* (EPA 2001). These questions provide a framework for

organizing and evaluating data and information and ensure that all relevant issues are considered when determining the protectiveness of the remedy.

7.1.1 Is the Remedy Functioning as Intended per the Decision Documents?

The landfill covers were intended to prevent water from percolating through the landfills and carrying contaminants from the landfills toward the aquifer below. The soil gas monitoring locations and the groundwater-monitoring wells were designed to determine if impacts from the landfills were affecting the SRPA.

Based on the review of the available data presented herein, all of the remedies appear to be functioning as intended. The caps placed over Landfills I, II, and III appear to be working as designed. In 1998, recharge occurred at least to the 6.7-m (22-ft) depth of the NATs. To note, vegetation had not had a chance to become established on the landfill covers by that time. Since the vegetation has grown on the landfill caps and the caps have firmed, there has been very little infiltration of moisture to any depths in the landfills. The most recent landfill cap monitoring data from the NATs and the time-domain reflectometers have shown that in the spring of 2001 the wetting front penetrated only about 0.9 m (3 ft) into the landfill cover. Measurements off of, but near, the landfill covers had a wetting front that penetrated to at least 1.8 m (6 ft) bls.

Based on the data from the soil gas sampling, the system is adequately monitoring soil gas vapors that may be emanating from the landfills. It is premature to determine whether the groundwater data demonstrate that the groundwater-monitoring network is adequately monitoring the downgradient groundwater wells for potential impacts to groundwater from the landfills. Further analysis of the available data and groundwater flow is required before a final determination can be made. Additional data may be required to support such a determination. No contaminants have been detected in the lower soil gas-monitoring ports or in the groundwater that would indicate that contaminants from the landfills are reaching the SRPA.

Institutional controls (i.e., fencing and signage) placed around the landfills to limit access to the landfills have been effective so that only authorized persons are now entering the landfill areas. Inspections of the fencing and signage confirm that all institutional controls are in place and have remained so since they were originally constructed.

7.1.2 Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of the Remedy Still Valid?

The remedial action objectives for the CFA landfills include minimizing the potential for erosion and infiltration at the landfills' surfaces, ensuring that drinking water standards are not exceeded in the SRPA due to the migration of contaminants from the landfills, and preventing direct contact with the landfill contents.

Based on the review of the landfill infiltration monitoring results presented in this report, the objective of minimizing the potential for erosion and infiltration at the surface of the landfills appears to be working as designed. The groundwater monitoring results have also shown that concentrations of nitrates that exceed the EPA maximum contaminant levels for drinking water are not attributed to leaching of contaminants from the landfills (refer to Section 6.2). As stated in Section 7.1.1, additional review is required before a final determination can be made as to the possible impacts of contaminants potentially originating from the CFA landfills on the groundwater. Based on the review of the technical assessment data provided, the original assumptions, cleanup levels, and remedial action objectives used at the time of the remedy are still valid.

7.1.3 Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

In compiling and reviewing the landfill, soil gas, and groundwater monitoring data, no new information has come to light that would call into question the protectiveness of the remedy. While the overall protectiveness is not in question, several issues should continue to be monitored until the next 5-year review to ensure that the protectiveness does not change. The issues include (1) the impact of nitrate on the groundwater downgradient from the former and current CFA sewage treatment facilities and (2) current increases in soil gas concentrations at intermediate-depth soil gas sampling ports. These two issues are discussed in the technical summary and are also addressed in Sections 8 and 9.

8. ISSUES

The following are the substantive findings and issues from the current technical assessment:

1. Additional groundwater level data and moisture infiltration data are needed before it can be concluded that all remedies completed for the CFA landfills have been operating adequately and as designed.

2. Except for nitrate in groundwater from monitoring wells downgradient from the former and current sewage treatment facilities, no significant issues have arisen from the groundwater sample analytical results. The nitrate concentrations were below the MCLs in samples collected from USGS-083 located downgradient from the CFA monitoring wells. However, nitrates have been detected in the CFA-MON-A-002 and CFA-MON-A-003 monitoring wells at concentrations equal to or above the MCL of 10 mg/L. The source of the nitrates in these wells is uncertain.

3. During the past 5 years, groundwater samples have been analyzed for alkalinity and anions (including nitrate, chloride, fluoride, and sulfate). Based on review of the analytical results, no anomalous concentrations have been detected in samples for alkalinity, chloride, fluoride, or sulfate. The detected chloride concentrations are elevated above what would normally be expected; however, this is attributed to upgradient impacts from INTEC.

4. Higher concentrations of iron and zinc were detected in some wells, but these higher concentrations appear to be related to the disintegration of carbon-steel casing and galvanized riser pipes used to complete these wells (refer to Section 6.2). The iron and zinc concentrations in the wells are attributed to the galvanic corrosion of the well components.

5. While soil gas vapor samples from soil gas sample ports near and in the landfills have variable concentrations, the highest concentrations of VOCs are detected in the intermediate sample port depths of 9.1 to 11.6 m (30 to 38 ft) bls and 21.3 to 23.8 m (70 to 78 ft) bls near known fractures in the basalt. Lower soil gas VOC concentrations have been detected in samples from the lowermost gas sample ports at depths of 30.5 to 32.9 m (100 to 108 ft) bls. No concentrations of VOCs have been detected in the groundwater samples collected from groundwater monitoring wells located downgradient from the landfills, but not all detected VOCs in the gas vapor are also analyzed for in the groundwater (e.g., freon).

6. Mostly spurious near-detection-level concentrations of organics have been observed only in CFA-MON–A-002. This should continue to be checked for any increases in future groundwater monitoring.

7. Based on the available results of the NAT and time-domain reflectometer moisture monitoring in the landfills, it appears that there has not been detectable infiltration of moisture in the landfills after 1998. This is based upon limited data and below-normal precipitation years. In 2001, the wetting front only penetrated about 0.9 m (3 ft) into the landfills.

8. Because of potentially highly deviated wells, after collecting 1 year of monthly groundwater-level measurements from wells located near the landfills, it is still uncertain whether the groundwater flow direction from Landfills I and III is in a southerly to southwesterly direction. Therefore, additional evaluation of the data, as described herein, is necessary before a determination can be made as to whether the monitoring network is adequate to ensure that the remedial action is protective of human health and the environment.

9. Current reporting requirements for the monitoring results include the following:

   a. Quality-assured soil gas vapor and groundwater monitoring data will be submitted no later than 120 days from the completion of sampling.

   b. Non-quality-assured data (i.e., groundwater elevations, NAT and TDR data) will be submitted with the quality-assured data.

   c. An annual monitoring report will be submitted.

9. CENTRAL FACILITIES AREA LANDFILLS FIVE-YEAR REVIEW RECOMMENDATIONS

The determination as to whether the remedial action implemented for the CFA landfills is protective of human health and the environment will be deferred until additional assessment of landfill moisture data and groundwater level data can be performed, as included in the recommendations below. Recommendations to maintain protectiveness while looking at reasonable approaches to reducing the life-cycle costs for the CFA landfill monitoring effort are also discussed in the following sections. To summarize, the recommendations are as follows:

- Continue the yearly inspections of the institutional controls.
- Continue soil gas sampling on an annual basis.
- Continue groundwater monitoring on an annual basis and change it from October to September.
- Continue to monitor USGS-083 and LF3-09.
- Continue monthly moisture monitoring through September of 2003. Based upon the monitoring results and modeling showing that the caps are minimizing precipitation infiltration into the landfills, a decision to discontinue moisture monitoring or perform an “artificial rain” infiltration test will be made prior to September 2003. The written results of the moisture infiltration modeling will be included in the FY 2003 monitoring report.
- Perform digital gyroscopic deviation surveys on suspect highly deviated wells. Re-do groundwater contour maps using this information.
- Defer the decision as to whether an additional well is required to monitor groundwater underlying the CFA landfills until new groundwater contour maps are derived.
- Monitor detectable vapor analytes (VOCs) in the groundwater.
- Re-evaluate the source of nitrates in the groundwater using the new groundwater contour maps.

Furthermore, it is recommended that the following changes be made to the reporting requirements:

- The non-quality-assured data (i.e., groundwater elevations, NAT and TDR data) will be submitted as part of the annual monitoring report that will be submitted. In addition to this routine data, the FY 2002 report will include the nitrate source re-evaluation and new groundwater contour maps based on corrected well deviations.
- The timing and requirements for the reporting of quality-assured soil gas vapor and groundwater monitoring data are per the schedule in Figure 9-1.
- Contact the Agencies if future operation, maintenance, and monitoring activities cannot be performed as scheduled.

A summary of the frequency and timing of all monitoring and reporting is included in Figure 9-1.

Figure 9-1 CFA Landfills Monitoring Schedule

Activity	Schedule for CY2002 Month 1	2	3	4	5	6	7	8	9	10	11	12	Schedule for CY 2003 Month 1	2	3	4	5	6	7	8	9
Infiltration Monitoring																					
NPAT Logging	XX	XX	XX	XX	X	X	X	X	X	X	X	X	XX	XX	XX	XX	X	X	X	X	X
TDR Logging Data Download	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Soil Vapor Monitoring																					
VOC and Methane Sample Collection					X																X
Groundwater Monitoring																					
Water Level Measurements										X											X
Groundwater Sampling										X											X
Reporting and Review																					
Data Submission to Agencies									X					X							
Monitoring Report															X						

CFA Landfills Monitoring Schedule

Activity	Schedule for CY2004 Month 1	2	3	4	5	6	7	8	9	10	11	12	Schedule for CY 2005 Month 1	2	3	4	5	6	7	8	9
Infiltration Monitoring																					
NPAT Logging																					
TDR Logging Data Download																					
Soil Vapor Monitoring																					
VOC and Methane Sample Collection									X												X
Groundwater Monitoring																					
Water Level Measurements									X												X
Groundwater Sampling									X												X
Reporting and Review																					
Data Submission to Agencies	x												X								
Monitoring Report			X												X						

Figure 9-1. Central Facilities Area monitoring schedule.

Activity	CFA Landfills Monitoring Schedule[1]											
	Schedule for CY2006											
	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Infiltration Monitoring												
NPAT Logging												
TDR Logging Data Download												
Soil Vapor Monitoring												
VOC and Methane Sample Collection									X			
Groundwater Monitoring												
Water Level Measurements									X			
Groundwater Sampling									X			
Reporting and Review												
Data Submission to Agencies	x											
Monitoring Report[2]												
5 year review report			X									

1. Schedule will continue the same as CY2005 in subsequent years unless negotiated otherwise with the Agencies.

2. Monitoring Report will be included in the CY2006 5 year review report. Monitoring Report will also be included in any subsequent 5 year review report.

Figure 9-1. (continued).

Finally, it is recommended that the Post-ROD Monitoring Work Plan (INEL 1997b), the Operations and Maintenance Plan (DOE-ID 2002a), and the Field Sampling Plan for the post-ROD monitoring (INEL 1997c) be updated to incorporate revised INEEL procedures and requirements and to include recommendations agreed to in this report.

9.1 Institutional Controls

It is recommended that the yearly inspection of the institutional controls be continued. An annual report on the results of this inspection and any corrective actions taken to maintain these controls will be submitted to the Agencies per the OU 4-13 Operations and Maintenance Plan (DOE-ID 2002a).

9.2 Soil Gas Monitoring

In the original Post-ROD Monitoring Work Plan (INEL 1997b), it was proposed that after the first 2 years of semi-annual sampling, soil gas sampling would then be reduced to an annual basis. After the first 2 years of soil gas sample collection, it was determined that more data were needed to adequately provide trends of soil gas data results. Consequently, soil gas samples were collected on a semi-annual basis in 1998 and 2001. It now appears that sufficient data have been collected to look at current and future trends in soil gas sample results. Therefore, it is recommended that the soil gas sampling be reduced to an annual event as originally proposed in the monitoring plan. Furthermore, sampling should be completed in early fall (i.e., September timeframe) in order to observe maximum vapor levels and to facilitate sample collection rather than attempting to collect these data during the winter months. Maximum vapor levels would be observed in the fall since there is less moisture infiltration that would interfere. This will also allow for better access to the collection ports and improved working conditions, leading to the collection of more accurate soil gas samples.

The Post-ROD Monitoring Work Plan (INEL 1997b) provided that an action level for VOCs in the vadose zone would be established. The receptor that is to be protected from impacts from VOCs is the SRPA for which compliance will be monitored through the analysis of groundwater samples. Monitoring of the soil gas for VOCs is recommended until concentrations demonstrate a significant downward trend. Because the landfill covers mitigate the primary carrier for VOCs to move through the vadose zone to the SRPA (i.e., infiltration), there does not exist a need to establish an action level for soil gas contaminants in the vadose zone. Monitoring of the groundwater will continue to ensure compliance with the drinking water MCLs.

9.3 Groundwater Monitoring

The groundwater monitoring and sampling events associated with the landfills and the downgradient monitoring and sampling of groundwater for nitrates from the former and current sewage treatment facilities should be continued on an annual basis. With the various changes discussed in Section 6.2, future groundwater depth-to-water measurements and sampling events will include 11 wells that will be sampled on an annual basis. The wells proposed for these future events include the following:

LF 2-08	*LF 2-09	*LF 2-11	*LF 3-08	*LF3-09
*LF3-10	*CFA-MON-A-001	*CFA-MON-A-002	*CFA-MON-A-003	USGS-083
*USGS-128				

The current groundwater monitoring plan for WAG 4 provides for the continued annual sampling of groundwater downgradient from the CFA former and current sewage treatment facility. It is recommended that Well USGS-083 continue to be included in this regular sampling event to provide better information on the nitrate level in the groundwater downgradient from CFA. It is also recommended that LF3-09 continue to be included in this regular sampling event to provide better information on contaminants in groundwater downgradient of Landfills I and III at least until the groundwater contours, as discussed below, are re-evaluated.

Detectable analytes in the vapor should also be analyzed in the groundwater. These include 2-chloroethylvinylether, acetonitrile, dichlorodifluoromethane (Freon-12), methane, and trichlorofluoromethane (Freon-11).

In addition to the depth-to-water measurements and sampling that will be collected as part of the groundwater monitoring conducted at the wells listed above, the following wells will also be measured for depth-to-water but not sampled during the annual groundwater monitoring and sampling:

STF-MON-A-004	*LF 2-10	*USGS-020	USGS-034	USGS-035
USGS-036	USGS-037	USGS-038	USGS-077	*USGS-111
*USGS-112	*USGS-113	*USGS-114	*USGS-115	USGS-116
USGS-127	M12S	*USGS-085[a]		

a. To be included starting in 2003.

The depth-to-water measurements from these additional wells will provide a broader basis of groundwater-level elevations for the area around CFA from which more complete groundwater contour maps can be constructed. Digital gyroscopic surveys will be performed on 16 wells in 2002 (indicated by an asterisk in the above tables) and one well in 2003 in order to more accurately determine their deviations. Based on the gyroscopic survey results correcting the well deviations, subsequent annual monitoring reports will include the new groundwater contour map prepared from the corrected depth-to-water measurements collected during the CFA landfill-sampling event.

It must also be noted that the long-term sitewide groundwater monitoring program portion of Long-Term Stewardship has also targeted groundwater sampling from Wells CFA-MON-A-001, CFA-MON-A-002, CFA-MON-A-003, and USGS-083 as part of that project's groundwater monitoring program. The long-term sitewide groundwater-monitoring program is scheduled to sample sitewide wells for the next 95 years; so monitoring for the downgradient wells from the CFA sewage treatment facilities will be ongoing for many years. It is recommended that this groundwater monitoring continue until such time as the nitrate levels in the groundwater are consistently below the MCL, and it is agreed upon with the Agencies during a 5-year review that the monitoring effort can cease. No other remedial action, other than continued monitoring, is currently proposed for dealing with the nitrate in the groundwater.

The source of nitrate contamination in the groundwater will be re-evaluated using corrected water contour maps and recently available source information. This re-evaluation will be included in the annual CFA landfill monitoring report.

9.3.1 Groundwater-Level Evaluation to Assess Monitoring Well Needs at Landfill I

Although two downgradient wells of Landfill I and III are now being monitored, further evaluation of the need for another downgradient monitoring well will be deferred until the groundwater contour maps are redone as indicated in the previous section.

9.4 Central Facilities Area Landfill Moisture Monitoring

Based on the results of the CFA landfill moisture monitoring using the NAT, shallow time-domain reflectometer, and deeper time-domain reflectometer data, the covers appear to be limiting movement of water into and through the landfills. The one limiting factor to this conclusion is that a "normal" amount of precipitation has not occurred at the landfills since the deeper time-domain reflectometers were installed in 2000. Ideally, monitoring data would be collected during a normal or above-normal precipitation year where "normal" is defined as an average amount of precipitation based upon historical data. The November to June time period is the most likely time to have an infiltration event, because winter precipitation can build up and melt suddenly, causing a large influx of water. In addition, evapotranspiration is low until early May.

The precipitation in 2000 and 2001 has been below normal. It could take many years to obtain sufficient moisture infiltration information. The landfill caps limit infiltration by the way they are designed to promote water run-off and inhibit infiltration. Standing water that was observed before placement of the caps is no longer observed and the compacted soil in the cap inhibits the rapid movement of moisture downward. Therefore, it is recommended that the landfill moisture monitoring program be continued through the summer of 2003 to evaluate the results and effectiveness of the landfill covers through the end of the winter/spring snowmelt and infiltration event for this year and next. Continuous time-domain reflectometer and monthly (except bimonthly as needed during snowmelt) neutron probe monitoring (NAT) of the landfills would continue through September 2003 to allow for the evaluation of recharge below the evapotranspiration depth. In addition, the calibration of the new deeper time-domain reflectometer arrays would be evaluated in the spring of 2003 to assess the quality of the data being obtained. The moisture infiltration monitoring data from before and after the cover was installed would be modeled and compared. A decision on whether to continue moisture infiltration monitoring or to perform an "artificial rain" infiltration test to simulate normal precipitation on the landfills would be made prior to September 2003. The written results of the moisture infiltration modeling would be included in the FY 2003 monitoring report that would be transmitted to the Agencies in March 2004.

After the decision is made to stop infiltration monitoring, the NAT and time-domain reflectometer sample locations will be properly abandoned and removed. As long as the landfill covers remain intact, additional moisture infiltration monitoring should not be necessary.

10. REMEDY PROTECTIVENESS

Based upon a review of the available monitoring data and inspection reports, a protectiveness determination will be deferred until all the recommendations in the previous section are implemented and reported in an annual monitoring report. The Agencies may concur at that time that the remedy for the CFA Landfills I, II, and III is expected to be protective of human health and the environment and that exposure pathways that could result in an unacceptable risk are being controlled.

11. FIVE-YEAR REVIEW SCHEDULE

In accordance with the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300), a review of the selected remedy will be conducted no less than every 5 years for sites where contamination above risk-based concentrations is left in place. The 5-year reviews will continue to evaluate the remedy to determine if it remains protective of human health and the environment. The 5-year reviews will be conducted for those remediated sites with institutional controls at least until 2095 (i.e., until the 100-year institutional control period expires) or until it is determined during a 5-year review that controls and reviews are no longer necessary. As such, the next 5-year review will be conducted in 2006 based on the OU 4-13 remedial action start date of June 2001 in conjunction with all other WAG 4 sites that are subject to 5-year reviews. Reviews will continue to be conducted every 5 years thereafter until 2095 or until such time as they are determined to no longer be necessary and discontinued with concurrence of the Agencies. This review date may be moved up to accommodate an INEEL-wide programmatic review of institutional controls if agreed upon by the Agencies.

In accordance with the ROD (DOE-ID 1995), institutional controls have been established at the CFA landfills. These controls include administrative (e.g., written notification of the remedial action in the *INEEL Comprehensive Facility and Land Use Plan* [DOE-ID 2001a]) and physical (e.g., fencing with the landfill borders delineated through the posting of signs) controls. The landfills will be subject to 5-year reviews with restrictions remaining until 2095 or until determined to be unnecessary during the 5-year review cycles. The CFA landfills, which were remediated under the OU 4-12 ROD (DOE-ID 1995), were rolled in under the OU 4-13 Comprehensive ROD (DOE-ID 2000b), which consolidates and addresses all of the sites within WAG 4. As provided in the O&M Plan (INEL 1997a), operations and maintenance of the institutional controls include, but are not limited to, the following:

- Inspection and corrective maintenance of the vegetative cover
- Inspection and corrective maintenance of the soil cover
- Inspection and corrective maintenance of the rock armoring
- Inspection and corrective maintenance of the NAT installations so long as monitoring continues
- Inspection and corrective maintenance of the time-domain reflectometer installations so long as monitoring continues
- Inspection of institutional controls.

In addition, continued environmental monitoring will be performed as outlined in the *Post Record of Decision Monitoring Work Plan Central Facilities Area Landfills I, II, and III Operable Unit 4-12* (INEL 1997b) and the *Field Sampling Plan for the Post Record of Decision Monitoring Central Facilities Area Landfills I, II, and III Operable Unit 4-12* (INEL 1997c). These documents define the requirements for performing the routine infiltration, vadose zone, and groundwater monitoring as required by the ROD (DOE-ID 1995). Specific monitoring requirements include the following:

- Monitoring of the time-domain reflectometer arrays and NATs for moisture infiltration
- Monitoring of the gas-sampling boreholes for contamination in the vadose zone
- Monitoring of the groundwater wells for contamination in the SRPA.

12. REFERENCES

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42 USC 103, Subchapter I, Section 9621, *United States Code*, Title 42, "The Public Health and Welfare," Chapter 103, "Comprehensive Environmental Response, Compensation, and Liability," Subchapter I, "Hazardous Substances Releases, Liability, Compensation," Section 9621, "Cleanup Standards."

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Appendix A

2001 CFA Landfills Inspection

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AS REQUIRED BY OU 4-12 OPERATING AND MAINTENANCE PLAN

Periodic Inspection of CFA Landfill Native Soil Covers

Inspection at Landfill I ☒ Landfill II ☐ Landfill III

INSPECTION ACTIVITY	INSPECTOR SIGNATURE	INSPECTOR DATE	STATUS		COMMENTS/RECOMMENDED REPAIR
			SAT	UNSAT	
VEGETATIVE COVER					
1. Inspect for nongrowth areas.	D Wilgoma	10/17/01	✓		
2. Inspect for sparse growth areas.	D Wilgoma	10/17/01	✓		Vegetation lush
3. Inspect for weed encroachment.	D Wilgoma	10/17/01	✓		
SOIL COVER					
1. Inspect for erosion areas.	D Wilgoma	10/17/01	✓		
2. Inspect for subsidence areas or slope movement.	D Wilgoma	10/17/01	✓		See topo survey
3. Inspect for animal intrusion.	D Wilgoma	10/17/01	✓		None on top
ROCK ARMOR					
1. Inspect to verify a minimum of 30.5 cm (12 in.) of rock armor.					NA
TIME DOMAIN REFLECTOMETER					
1. Inspect equipment cabinet to verify it is sealed.	D Wilgoma	10/17/01	✓		These TDRs were inspected quarterly this last year per Carol Grigson.
2. Inspect interior for unusual dirt or debris.	D Wilgoma	10/17/01	✓		
3. Inspect the exterior and interior of the weather box for deterioration and presence of moisture or water.	D Wilgoma	10/17/01	✓		
4. Inspect the solar collector barrel for condition/function.	D Wilgoma	10/17/01	✓		
5. Inspect and verify presence of guard post and TDR.	D Wilgoma	10/17/01	✓		

SAT = Satisfactory
UNSAT = Unsatisfactory

INSPECTION ACTIVITY	INSPECTOR SIGNATURE	INSPECTOR DATE	STATUS		COMMENTS/RECOMMENDED REPAIR
			SAT	UNSAT	
AQUIFER/SOIL GAS WELLS AND NEUTRON ACCESS PROBES TUBES (NPAT)					Recent inspections and repairs were done by groundwater monitoring personnel. See attached results
1. Inspect for integrity.	D. Wagoner	10/17/01	✓		
2. Inspect for cleanliness.	D. Wagoner	10/17/01	✓		
3. Inspect operating condition of lock, rust on cover, well casing damage.	D. Wagoner	10/17/01	✓		NPAT locks replaced, corrosion only but solid
4. Inspect guard posts around well cover to ensure they are stable	D. Wagoner	10/17/01	✓		
INSTITUTIONAL CONTROLS					See IC Inspection Report
1. Document fences/barriers restrict access.	D. Wagoner	10/17/01	✓		
2. Document signs/barriers identifying they are in place.	D. Wagoner	10/17/01	✓		

Name of Inspector Deborah Wagoner

Qualification/Title Engineer/Tech Lead

Approved [signature] 1/28/02

Signature Date

INEEL M&O Contractor WAG 4 Remediation Program Manager

Photographs: ☒ Taken ☐ Not Taken

See IC Inspection Report DOE/ID-10973

Periodic Inspection of CFA Landfill Native Soil Covers

Inspection at Landfill I ☐ Landfill II ☒ Landfill III ☐

INSPECTION ACTIVITY	INSPECTOR SIGNATURE	INSPECTOR DATE	STATUS		COMMENTS/RECOMMENDED REPAIR
			SAT	UNSAT	
VEGETATIVE COVER					
1. Inspect for nongrowth areas.	D Wagoner	10/17/01	✓		None greater than 10'x10'
2. Inspect for sparse growth areas.	D Wagoner	10/17/01	✓		Better than Landfill III
3. Inspect for weed encroachment.	D Wagoner	10/17/01	✓		
SOIL COVER					
1. Inspect for erosion areas.	D Wagoner	10/17/01	✓		
2. Inspect for subsidence areas or slope movement.	D Wagoner	10/17/01	✓		See topo survey
3. Inspect for animal intrusion.	D Wagoner	10/17/01	✓		None on top
ROCK ARMOR					(More dense survey points taken this year)
1. Inspect to verify a minimum of 30.5 cm (12 in.) of rock armor.	D Wagoner	10/17/01	✓		See topo survey
TIME DOMAIN REFLECTOMETER					Must TDRs not be unchecked more frequently than quarterly to check out the new system near pump house.
1. Inspect equipment cabinet to verify it is sealed.	D Wagoner	10/17/01	✓		
2. Inspect interior for unusual dirt or debris.	D Wagoner	10/17/01	✓		
3. Inspect the exterior and interior of the weather box for deterioration and presence of moisture or water.	D Wagoner	10/17/01	✓		
4. Inspect the solar collector barrel for condition/function.	D Wagoner	10/17/01	✓		
5. Inspect and verify presence of guard posts and TDR.	D Wagoner	10/17/01	✓		Place guard posts around new reflectometers to protect them. Completed in 12/01. (DW 1/9/02)

SAT = Satisfactory
UNSAT = Unsatisfactory

INSPECTION ACTIVITY	INSPECTOR SIGNATURE	INSPECTOR DATE	STATUS		COMMENTS/RECOMMENDED REPAIR
			SAT	UNSAT	
AQUIFER/SOIL GAS WELLS AND NEUTRON ACCESS PROBES TUBES (NPAT)					
1. Inspect for integrity.	D. Wagoner	10/17/01	✓		Recent inspections and repairs were done by groundwater personnel. See attached results
2. Inspect for cleanliness.	D. Wagoner	10/17/01	✓		
3. Inspect operating condition of lock, rust on cover, well casing damage.	D. Wagoner	10/17/01	✓		Locks securely checked and replaced
4. Inspect guard posts around well cover to ensure they are stable.	D. Wagoner	10/17/01	✓		
INSTITUTIONAL CONTROLS					
1. Document fences/barriers restrict access.	D. Wagoner	10/17/01	✓		See IC Inspection Report DOE/ID-10973
2. Document signs/barriers identifying they are in place.	D. Wagoner	10/17/01	✓		

Name of Inspector D. Wagoner

Qualification/Title Engineer / WAG 4 Task Lead

Photographs: ☑ Taken ☐ Not Taken

See IC inspection Report. DOE/ID-10973

Approved ... Signature

INEEL M&O Contractor WAG 4 Remediation Program Manager

1/28/02
Date

AS REQUIRED BY OU 4-12 OPERATING AND MAINTENANCE PLAN

Periodic Inspection of CFA Landfill Native Soil Covers

Inspection at Landfill I Landfill II ☐ Landfill III ☒

INSPECTION ACTIVITY	INSPECTOR SIGNATURE	INSPECTOR DATE	STATUS		COMMENTS/RECOMMENDED REPAIR
			SAT	UNSAT	
VEGETATIVE COVER					
1. Inspect for nongrowth areas.	D Wagoner	10/17/01	✓		Only nongrowth areas greater than 10 ft x 10 ft are on the road leading to TDR's
2. Inspect for sparse growth areas.	D Wagoner	10/17/01	✓		Growth is sparser than other landfills
3. Inspect for weed encroachment.	D Wagoner	10/17/01	✓		
SOIL COVER					
1. Inspect for erosion areas.	D Wagoner	10/17/01	✓		Nothing
2. Inspect for subsidence areas or slope movement.	D Wagoner	10/17/01	✓		Nothing visually - see survey results
3. Inspect for animal intrusion	D Wagoner	10/17/01	✓		No animals, intrusion on top
ROCK ARMOR					
1. Inspect to verify a minimum of 30.5 cm (12 in.) of rock armor.					NA
TIME DOMAIN REFLECTOMETER					
1. Inspect equipment cabinet to verify it is sealed.	D Wagoner	10/17/01	✓		These TDRs have been checked more frequently than quarterly with checklists and ok - new pair system per Cowlington.
2. Inspect interior for unusual dirt or debris.	D Wagoner	10/17/01	✓		ok - new
3. Inspect the exterior and interior of the weather box for deterioration and presence of moisture or water.	D Wagoner	10/17/01	✓		ok - new
4. Inspect the solar collector barrel for condition/function.	D Wagoner	10/17/01	✓		ok - new
5. Inspect and verify presence of guard post and TDR.	D Wagoner	10/17/01			Construction crews only - contrib have sealed guard posts

Completed in 12/01. (DWW 1/9/02)

SAT = Satisfactory
UNSAT = Unsatisfactory

INSPECTION ACTIVITY	INSPECTOR SIGNATURE	INSPECTOR DATE	STATUS		COMMENTS/RECOMMENDED REPAIR
			SAT	UNSAT	
AQUIFER/SOIL GAS WELLS AND NEUTRON ACCESS PROBES TUBES (NPAT) 1. Inspect for integrity.			✓		Recent inspections and repairs under the groundwater monitoring personnel. Fine See attached results
2. Inspect for cleanliness.			✓		Fine
3. Inspect operating condition of lock, rust on cover, well casing damage.			✓		NPAT locks are replaced, cover is rusty but good
4. Inspect guard posts around well cover to ensure they are stable.			✓		guard posts stable
INSTITUTIONAL CONTROLS 1. Document fences/barriers restrict access.			✓		No breaks in fence, locks intact – See IC Inspection Report
2. Document signs/barriers identifying they are in place.			✓		Keepout signs & IC signs in good shape

Name of Inspector Deborah Wagoner

Qualification/Title Engineer/WAG 4 Task Lead

Approved _____ 1/28/07
Signature Date
INEEL M&O Contractor WAG 4 Remediation Program Manager

Photographs: ☒ Taken ☐ Not Taken
See IC Inspection Report
DCC/ID 10973

'sfactory
Unsatisfactory

SURVEY COMPARISON FOR CFA LANDFILLS
LANDFILL I

t #	Northing	Easting	1997	2000	2001	Description	Delta from 1997 to 2001
2	10099.98	10100.03	4944.75	4944.90	4944.86	LF-1 FINISH GRADE	0.11
3	10100.01	10200.00	4944.06	4944.16	4944.14	LF-1 FINISH GRADE	0.08
4	10099.99	10299.98	4944.05	4944.12	4944.12	LF-1 FINISH GRADE	0.07
5	10099.98	10400.06	4944.02	4944.14	4944.10	LF-1 FINISH GRADE	0.08
6	10200.00	10499.97	4944.26	4944.35	4944.33	LF-1 FINISH GRADE	0.07
7	10200.00	10400.02	4943.36	4943.55	4943.54	LF-1 FINISH GRADE	0.18
8	10200.00	10300.04	4943.86	4944.00	4944.00	LF-1 FINISH GRADE	0.14
9	10200.00	10200.02	4943.97	4944.08	4944.07	LF-1 FINISH GRADE	0.10
10	10200.00	10100.05	4944.72	4944.85	4944.80	LF-1 FINISH GRADE	0.08
11	10300.03	10100.08	4944.75	4944.80	4944.78	LF-1 FINISH GRADE	0.03
12	10300.02	10200.11	4943.82	4943.96	4944.02	LF-1 FINISH GRADE	0.20
13	10300.01	10300.07	4943.14	4943.28	4943.26	LF-1 FINISH GRADE	0.12
14	10300.01	10400.07	4942.60	4942.86	4942.84	LF-1 FINISH GRADE	0.24
15	10300.02	10500.02	4943.36	4943.43	4943.45	LF-1 FINISH GRADE	0.09
16	10400.01	10500.03	4942.44	4942.55	4942.56	LF-1 FINISH GRADE	0.12
17	10400.02	10400.00	4942.86	4942.85	4942.90	LF-1 FINISH GRADE	0.04
18	10399.98	10299.95	4943.26	4943.31	4943.30	LF-1 FINISH GRADE	0.04
19	10400.00	10200.00	4943.89	4943.97	4943.96	LF-1 FINISH GRADE	0.07
20	10400.01	10100.03	4944.80	4944.94	4944.92	LF-1 FINISH GRADE	0.12
21	10399.98	9999.97	4945.03	4945.19	4945.22	LF-1 FINISH GRADE	0.19
22	10500.02	10000.02	4944.72	4944.89	4944.90	LF-1 FINISH GRADE	0.18
23	10500.02	10100.02	4944.54	4944.70	4944.72	LF-1 FINISH GRADE	0.18
24	10500.01	10200.02	4944.03	4944.10	4944.10	LF-1 FINISH GRADE	0.07
25	10499.94	10299.92	4943.12	4943.22	4943.22	LF-1 FINISH GRADE	0.10
26	10500.78	10401.56	4943.12	4943.08	4943.10	TOP OF CONCRETE	-0.02
27	10499.97	10499.95	4942.14	4942.21	4942.21	LF-1 FINISH GRADE	0.07
28	10599.97	10399.97	4942.60	4942.68	4942.72	LF-1 FINISH GRADE	0.12
29	10599.96	10299.95	4943.15	4943.21	4943.22	LF-1 FINISH GRADE	0.07
30	10599.97	10199.98	4943.49	4943.65	4943.61	LF-1 FINISH GRADE	0.12
31	10600.04	10100.03	4943.72	4943.92	4943.90	LF-1 FINISH GRADE	0.18
32	10599.94	9999.97	4944.00	4944.17	4944.15	LF-1 FINISH GRADE	0.15
33	10600.02	9900.01	4943.22	4943.38	4943.41	LF-1 FINISH GRADE	0.19
34	10699.97	9899.99	4944.11	4944.23	4944.19	LF-1 FINISH GRADE	0.08
35	10700.00	9999.99	4943.14	4943.29	4943.29	LF-1 FINISH GRADE	0.15
36	10700.04	10100.02	4942.97	4942.92	4942.90	LF-1 FINISH GRADE	-0.07
37	10699.95	10199.96	4942.44	4942.54	4942.54	LF-1 FINISH GRADE	0.10
38	10700.00	10299.98	4942.47	4942.60	4942.59	LF-1 FINISH GRADE	0.12
39	10699.99	10400.02	4941.92	4942.03	4942.04	LF-1 FINISH GRADE	0.12
40	10799.99	10299.99	4942.21	4942.31	4942.30	LF-1 FINISH GRADE	0.09
41	10800.00	10199.99	4942.38	4942.50	4942.50	LF-1 FINISH GRADE	0.12
42	10800.02	10100.02	4942.88	4943.04	4943.01	LF-1 FINISH GRADE	0.13
43	10800.00	10000.00	4943.33	4943.43	4943.43	LF-1 FINISH GRADE	0.10
44	10800.06	9900.01	4943.86	4943.99	4943.97	LF-1 FINISH GRADE	0.11
45	10900.04	9900.01	4943.50	4943.65	4943.64	LF-1 FINISH GRADE	0.14
46	10899.98	9999.99	4943.16	4943.21	4943.20	LF-1 FINISH GRADE	0.04

Maximum	0.02	← .24
Minimum	-0.07	← ~.02
Average	0.11	
St Dev	0.06	

SURVEY COMPARISON FOR CFA LANDFILLS
LANDFILL II

	Northing	Easting	1997	2000	2001	Description	Delta from 1997 to 2001
2	10100.02	13299.84	4936.64	4936.61	4936.61	LF-2 FINISH GRADE	-0.03
3	10100.00	13400.03	4936.15	4936.22	4936.17	LF-2 FINISH GRADE	0.02
4	10100.01	13499.96	4935.94	4936.02	4935.99	LF-2 FINISH GRADE	0.05
5	10099.99	13600.03	4935.63	4935.67	4935.67	LF-2 FINISH GRADE	0.04
6	10100.00	13699.99	4935.35	4935.43	4935.41	LF-2 FINISH GRADE	0.06
7	10099.99	13800.03	4935.40	4935.43	4935.38	LF-2 FINISH GRADE	-0.02
8	10099.97	13900.04	4935.59	4935.64	4935.63	LF-2 FINISH GRADE	0.04
9	10100.03	13999.98	4934.48	4934.57	4934.56	LF-2 FINISH GRADE	0.08
10	10199.99	14000.00	4933.84	4933.91	4933.91	LF-2 FINISH GRADE	0.07
11	10199.99	13900.01	4934.83	4934.89	4934.83	LF-2 FINISH GRADE	0.00
12	10200.03	13799.96	4934.84	4934.95	4934.89	LF-2 FINISH GRADE	0.05
13	10200.01	13699.98	4934.92	4934.92	4934.87	LF-2 FINISH GRADE	-0.05
14	10199.99	13600.03	4935.14	4935.20	4935.13	LF-2 FINISH GRADE	-0.01
15	10200.00	13499.99	4935.60	4935.67	4935.65	LF-2 FINISH GRADE	0.05
16	10200.02	13399.94	4935.87	4935.94	4935.89	LF-2 FINISH GRADE	0.02
17	10199.97	13300.03	4936.19	4936.26	4936.24	LF-2 FINISH GRADE	0.05
18	10200.00	13199.99	4936.69	4936.79	4936.76	LF-2 FINISH GRADE	0.07
19	10300.01	13199.99	4936.95	4936.93	4936.93	LF-2 FINISH GRADE	-0.02
20	10300.01	13299.97	4935.58	4935.57	4935.53	LF-2 FINISH GRADE	-0.05
21	10299.98	13400.03	4935.01	4935.08	4935.04	LF-2 FINISH GRADE	0.03
22	10301.44	13497.38	4934.96	4934.99	4934.89	LF-2 FINISH GRADE	-0.07
23	10299.98	13600.02	4935.08	4935.18	4935.15	LF-2 FINISH GRADE	0.07
24	10299.98	13700.03	4934.45	4934.53	4934.48	LF-2 FINISH GRADE	0.03
25	10299.94	13800.05	4934.01	4934.01	4934.08	LF-2 FINISH GRADE	0.07
26	10299.93	13900.04	4931.11	4931.22	4931.17	LF-2 FINISH GRADE	0.06
27	10400.03	13799.98	4933.41	4933.51	4933.48	LF-2 FINISH GRADE	0.07
28	10400.01	13699.98	4934.18	4934.18	4934.17	LF-2 FINISH GRADE	-0.01
29	10399.95	13600.06	4934.24	4934.31	4934.29	LF-2 FINISH GRADE	0.05
30	10399.97	13600.01	4934.24	4934.49	4934.46	LF-2 FINISH GRADE	0.22
31	10400.04	13499.93	4934.40	4934.49	4934.46	LF-2 FINISH GRADE	0.06
32	10400.10	13399.81	4934.80	4934.90	4934.88	LF-2 FINISH GRADE	0.08
33	10400.04	13299.94	4935.24	4935.30	4935.28	LF-2 FINISH GRADE	0.04
34	10400.02	13199.95	4936.97	4937.01	4936.98	LF-2 FINISH GRADE	0.01
35	10500.00	13200.01	4937.01	4937.05	4937.10	LF-2 FINISH GRADE	0.09
36	10500.03	13299.95	4935.35	4935.51	4935.54	LF-2 FINISH GRADE	0.19
37	10499.98	13400.03	4934.33	4934.43	4934.43	LF-2 FINISH GRADE	0.10
38	10499.95	13500.05	4934.02	4934.26	4934.23	LF-2 FINISH GRADE	0.21
39	10499.98	13600.01	4934.16	4934.24	4934.26	LF-2 FINISH GRADE	0.10
40	10500.02	13699.99	4933.48	4933.62	4933.61	LF-2 FINISH GRADE	0.13
41	10500.02	13799.98	4932.50	4932.62	4932.62	LF-2 FINISH GRADE	0.12
42	10599.99	13800.00	4926.46	4926.58	4926.55	LF-2 FINISH GRADE	0.09
43	10600.05	13699.97	4931.34	4931.39	4931.38	LF-2 FINISH GRADE	0.04
44	10600.01	13599.99	4933.11	4933.18	4933.17	LF-2 FINISH GRADE	0.06
45	10599.98	13500.02	4933.70	4933.84	4933.82	LF-2 FINISH GRADE	0.12
46	10599.99	13399.99	4934.10	4934.08	4934.10	LF-2 FINISH GRADE	0.00
47	10600.05	13299.95	4934.60	4934.71	4934.70	LF-2 FINISH GRADE	0.10
48	10600.00	13199.99	4936.81	4936.91	4936.89	LF-2 FINISH GRADE	0.08
49	10700.00	13200.00	4938.49	4938.57	4938.53	LF-2 FINISH GRADE	0.04
50	10700.04	13299.96	4935.88	4936.06	4935.96	LF-2 FINISH GRADE	0.08
51	10699.99	13399.98	4933.77	4933.82	4933.75	LF-2 FINISH GRADE	-0.02
52	10699.93	13500.06	4932.02	4932.21	4932.11	LF-2 FINISH GRADE	0.09
53	10700.02	13599.99	4928.11	4928.24	4928.17	LF-2 FINISH GRADE	0.06
54	10700.03	13700.08	4922.00	4922.03	4922.02	LF-2 FINISH GRADE	0.02
55	10799.84	13500.12	4923.69	4923.91	4923.91	LF-2 FINISH GRADE	0.22
58	10800.12	13399.89	4929.94	4930.13	4930.14	LF-2 FINISH GRADE	0.20
57	10799.99	13300.04	4933.42	4933.55	4933.51	LF-2 FINISH GRADE	0.09
58	10800.01	13200.01	4936.45	4936.56	4936.57	LF-2 FINISH GRADE	0.12
59	10900.04	13199.97	4934.49	4934.57	4934.47	LF-2 FINISH GRADE	-0.02
60	10900.05	13299.96	4928.73	4928.76	4928.74	LF-2 FINISH GRADE	0.01
61	10999.96	13300.04	4929.22	4929.16	4929.13	LF-2 FINISH GRADE	-0.09
62	11000.02	13200.00	4933.95	4934.06	4934.03	LF-2 FINISH GRADE	0.08
63	11100.09	13200.02	4932.30	4932.09	4931.98	LF-2 FINISH GRADE	-0.32
64	11099.95	13300.01	4926.08	4926.21	4926.09	LF-2 FINISH GRADE	0.01

Maximum	0.22
Minimum	-0.32
Average	0.05
St Dev	0.08

SURVEY COMPARISON FOR CFA LANDFILLS
LANDFILL III

SURVEY COMPARISON FOR CFA LANDFILLS
LANDFILL III

Point #	Norlhing	Easting	1997	2000	2001	Description	Delta from 1997 to 2001
2	10300.03	9699.97	4945.68	4945.73	4945.72	LF-S FINISH GRADE	0.04
3	10299.99	9600.03	4946.02	4946.08	4946.08	LF-3 FINISH GRADE	0 06
4	10400 02	9599.97	4946.19	4946.17	4946.14	LF-3 FINISH GRADE	-0.05
5	10399.98	9700.02	4945.61	4945.71	4945.70	LF-3 FINISH GRADE	0.09
6	10399.97	9800 00	4944.50	4944.52	4944.52	LF-3 FINISH GRADE	0 02
7	10500.04	9800.00	4945.19	4945.27	4945.27	LF-3 FINISH GRADE	0.08
8	10499 99	9700.00	4945.57	4945.75	4945.70	LF-3 FINISH GRADE	0 13
9	10499.93	9600.05	4946.16	4946.20	4946.14	LF-3 FINISH GRADE	-0.02
10	10600.05	9599.98	4946.11	4946.15	4946.15	LF-3 FINISH GRADE	0.04
11	10599.95	9700.01	4945.58	4945.60	4945.56	LF-3 FINISH GRADE	-0.02
12	10600.01	9800.00	4945.14	4945.20	4945 24	LF-3 FINISH GRADE	0.10
13	10699.95	9800.00	4945.04	4945.02	4945.08	LF-3 FINISH GRADE	0.04
14	10700.06	9699.98	4945.66	4945.70	4945.72	LF-3 FINISH GRADE	0.06
15	10700.06	9599.98	4946.08	4946.16	4946.15	LF-3 FINISH GRADE	0.07
16	10699.98	9500.00	no data	4944.79	4944.77	LF-3 FINISH GRADE	-0.02 [a]
17	10800.01	9500.01	no data	4946.38	4946.41	LF-3 FINISH GRADE	0.03 [a]
18	10799.94	9600.02	4946.05	4946.10	4946.12	LF-3 FINISH GRADE	0.07
19	10800.07	9699.99	4945.21	4945.31	4945.34	LF-3 FINISH GRADE	0.13
20	10799.91	9800 01	4944.90	4945.01	4945.03	LF-3 FINISH GRADE	0.13
21	10899.98	9800.01	4944.87	4944.94	4944.94	LF-3 FINISH GRADE	0.07
22	10900.06	9699.99	4945.40	4945.41	4945.45	LF-3 FINISH GRADE	0.05
23	10899.97	9600.02	4945.84	4945.86	4945.87	LF-3 FINISH GRADE	0.03
24	10899.95	9500.03	4946.47	4946.37	4946.56	LF-3 FINISH GRADE	0.09
25	10999.97	9500.01	4946.13	4946.17	4946.20	LF-3 FINISH GRADE	0.07
26	10999.93	9600.03	4946.01	4945.93	4945.98	LF-3 FINISH GRADE	-0.03
27	11000.02	9700.00	4945.00	4945.07	4945.08	LF-3 FINISH GRADE	0.08
28	11000.06	9799.97	4944.42	4944.52	4944.56	LF-3 FINISH GRADE	0.14
29	11100.04	9700.00	4944.03	4944.09	4944.11	LF-3 FINISH GRADE	0.08
30	11099.98	9600.00	4945.58	4945.62	4945.68	LF-3 FINISH GRADE	0.10
31	11100.01	9500.02	4946.00	4945.96	4946.03	LF-3 FINISH GRADE	0.03
32	11200.01	9500.00	4945.82	4945.79	4945.85	LF-3 FINISH GRADE	0.03
33	11200.04	9599.99	4945.31	4945.35	4945.35	LF-3 FINISH GRADE	0.04
34	11199.97	9700.01	4942.58	4942.71	4942.71	LF-3 FINISH GRADE	0.13
35	11299.97	9600.02	4944.57	4944.64	4944.65	LF-3 FINISH GRADE	0.08
36	11299.99	9499.99	4945.27	4945.35	4945.38	LF-3 FINISH GRADE	0.11
37	11399.99	9500.01	4944.90	4944.97	4944.97	LF-3 FINISH GRADE	0.07
38	11399.95	9600.01	4944.38	4944.49	4944.41	LF-3 FINISH GRADE	0.03
39	11500.04	9600.01	4944.17	4944.26	4944.17	LF-3 FINISH GRADE	0.00
40	11500.06	9500.00	4944.54	4944.56	4944.58	LF-3 FINISH GRADE	0.04
41	11600.00	9500.00	4944.62	4944.57	4944.52	LF-3 FINISH GRADE	-0.10
42	11600.06	9599.99	4943.87	4943.97	4943.91	LF-3 FINISH GRADE	0.04
43	11700.02	9600.02	4943.60	4943.67	4943.57	LF-3 FINISH GRADE	-0.03
44	11699.98	9500.00	4944.27	4944.28	4944.19	LF-3 FINISH GRADE	-0.08
45	11799.95	9500.01	4944.05	4944.07	4943.97	LF-3 FINISH GRADE	-0.08
46	11800.04	9600.24	4943.37	4943.25	4943.27	LF-3 FINISH GRADE	-0.10
47	11900.00	9600.02	4943.46	4943.28	4943.33	LF-3 FINISH GRADE	-0.13
48	11899.96	9500.02	4943.92	4943.86	4943.93	LF-3 FINISH GRADE	0.01
49	12000.06	9500.04	4943.78	4943.69	4943.67	LF-3 FINISH GRADE	-0.11
50	11999.99	9599.98	4943.28	4943.08	4943.13	LF-3 FINISH GRADE	-0.15
51	12100.01	9600.02	4943.03	4942.74	4842.90	LF-3 FINISH GRADE	-0.13
52	12100.00	9499.99	4943.66	4943.39	4943.60	LF-3 FINISH GRADE	-0.06
53	12200.03	9500.00	4943.38	4943.45	4943.51	LF-3 FINISH GRADE	0.13
54	12200.04	9600.01	4942.72	4942.81	4942.83	LF-3 FINISH GRADE	0.11
55	12300.00	9600.00	4942.58	4942.60	4942.63	LF-3 FINISH GRADE	0.05
56	12299.96	9500.00	4943.43	4943.57	4943.51	LF-3 FINISH GRADE	0.08
57	12400.02	9500.00	4943.08	4943.02	4943.02	LF-3 FINISH GRADE	-0.06
58	12399.97	9599.99	4942.08	4942.17	4942.17	LF-3 FINISH GRADE	0.09
59	12499.94	9599.99	4941.85	4941.87	4941.88	LF-3 FINISH GRADE	0.03
60	12500.00	9500.00	4943.21	4943.25	4943.20	LF-3 FINISH GRADE	-0.01
61	12600.04	9400.01	4944.48	4944.58	4944.54	LF-3 FINISH GRADE	0.06
62	12599.91	9499.95	4943.38	4943.50	4943.50	LF-3 FINISH GRADE	0.12
63	12600.09	9600.03	4942.04	4942.22	4942.14	LF-3 FINISH GRADE	0.10
						Maximum	0.14
						Minimum	-0.15
						Average	0.03
						St Dev	0.07

a. Delta from 2000 to 2001

07/16/01

Well Name	Well ID	Status	Alias	Date Inspected	ments	Owner	Lock	Key Numb
CFA	CFA	CFA	CFA	CFA	CFA	CFA	CI	CFA
CFA-1	93	Active	CFA-1	3-May-01	inside pumphouse	U.S. Navy	NA	
CFA-2	94	Active	CFA-2	3-May-01	Inside pumphouse	NF	NA	
CFA DISPOSAL WELL	95			3-May-01	no surface trace	U.S. DOE	NA	
COREHOLE 2A	97			31-May-01	American 5100 lock	[redacted]	American	5100
DH-1B	147			6-Jun-01	USGS controlled?? American lock 20	[redacted]	American	20
DH-2A	148			6-Jun-01	USGS controlled, Master lock 2640	[redacted]	Master	2640
INEL-1	186			25-May-01		[redacted]	American	5100
LF2-01	189	Active	LF2-01	30-May-01		NF	American	5100
LF2-02	190	Active	LF2-02	30-May-01		NF	American	5100
LF2-03	191	Active	LF2-03	30-May-01		NF	American	5100
LF2-04	192	Active	LF2-04	30-May-01		NF	American	5100
LF2-05	193	Active	LF2-05	30-May-01		NF	American	5100
LF2-06	194	Active	LF2-06	30-May-01		NF	American	5100
LF2-07	195	Active	LF2-07	30-May-01		NF	American	5100
LF2-08	196	Active	LF2-08	30-May-01		NF	American	5100
LF2-09	197	Active	LF2-09	30-May-01		NF	American	5100
LF2-10	198	Active	LF2-10	30-May-01		[redacted]	American	5100
LF2-11	199	Active	LF2-11	30-May-01		NF	American	5100
LF3-01	200	Active	LF3-01	31-May-01		NF	American	5100
LF3-02	201	Active	LF3-02	31-May-01		NF	American	5100
LF3-03	202	Active	LF3-03	31-May-01		NF	American	5100
LF3-04	203	Active	LF3-04	31-May-01		NF	American	5100
LF3-05	204	Active	LF3-05	31-May-01		NF	American	5100
LF3-06	205	Active	LF3-06	31-May-01		NF	American	5100
LF3-07	206	Active	LF3-07	30-May-01		NF	American	5100
LF3-08	207	Active	LF3-08	30-May-01		NF	American	5100
SITE 06	274				Not visited (USGS Admin control)	[redacted]		
SITE-14	276				Not visited (USGS Admin control)	[redacted]		
SITE-17	278			25-May-01	USGS lock replaced with American 5100???	[redacted]	American	5100
CFA-633	633	Abandoned	CFA-633	3-May-01	No surface trace, trench drain	NF	NA	
CFA-640-E	634					NF		
CFA-664-A	635	Abandoned	CFA 664 A	3-May-01	No surface trace, trench drain	NF	NA	
CFA-664-B	636	Abandoned	CFA 664 B	3-May-01	No surface trace, trench drain	NF	NA	
CFA-664-C	637	Abandoned	CFA 664 C	3-May-01	No surface trace, trench drain	NF	NA	
CFA-666-A	638	Abandoned	CFA 666 A	3-May-01	No surface trace, trench drain	NF	NA	
CFA-666-B	639	Abandoned	CFA 666 B	3-May-01	No surface trace, trench drain	NF	NA	
CFA-674	640	Abandoned	CFA 674	3-May-01	No surface trace, trench drain	NF	NA	
CFA-682	641					NF		
CFA-690-A	642	Abandoned	CFA 690 A	3-May-01	No surface trace, trench drain	NF	NA	
CFA-690-B	643	Abandoned	CFA 690 B	3-May-01	No surface trace, trench drain	NF	NA	
EBR1-WP	644			19-Jul-10	Can not access area behind building	NF	NA	
LF3-11A	721	Abandoned	LF3-11A	31-May-01	3.5 in PVC well cs w/unlockable cap	NF	NA	
LF3-11	722	Active	LF3-11	31-May-01	Welded shut	DOE	NA	
LF2-12	724	Active	LF2-12	30-May-01	Not lockable, well head incomplete, can not be capped	DOE	American	5100

CFA	CFA	CFA	CFA	CFA	CFA	CFA	CF	CFA
LF2-12A	725	Perm. Abandoned	LF2-12A	30-May-01	doned, 1 ft concrete aband. Pad	NF	NA	
LF3-09	726	Active	LF3-09		Currently being maintained	[illegible]		
LF3-10	727	Active	LF3-10	30-May-01	Needs wellhead completion, surface casing needs fixed	[illegible]	American	5100
CFA-641	670	Abandoned	CFA 641	3-May-01	No surface trace, french drain	NF	NA	
CFA-654	671	Abandoned	CFA 654	3-May-01	No surface trace, french drain	NF	NA	
CFA-IDHW-37	881	Active		10-May-01	No surface trace, french drain	NF	NA	
CFA-MON-A-001	1077	Active		3-May-01		DOE	American	5100
CFA-MON-A-002	1078	Active		7-May-01		Westinghouse	American	5100
CFA-MON-A-003	1089	Active		7-May-01		DOE	American	5100
CFA-SCI-V-009	1139					NF		
CFA-NF-V-009	1156			7-May-01		nf	American	5100
CFA-NF-V-011	1157			7-May-01	Abandoned, only concrete pad remains	DOE		
CFA-GAS-V-004	1254	Active	GSP1-1A	3-May-01		NF	American	5100
CFA-GAS-V-005	1255	Active	GSP2-1	2-May-01		NF	American	5100
CFA-GAS-V-006	1256	Active	GSP2-2	3-May-01		NF	American	5100
CFA-GAS-V-007	1257	Active	GSP3-1	3-May-01		NF	American	5100
CFA-GAS-V-008	1258	Active	GSP3-2	3-May-01		NF	American	5100

Scanned

Well Inspection Checklist

Well ID: 93	Well Name: CFA-1
Date of Inspection: 5/3/01	Purpose of inspection (check one)
Location/Directions to the well:	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc			Easting: 343282
If yes, describe how, where, and what it says:			Northing: 4823978
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present			
If yes is it securely attached to the casing			5
How is it attached (circle one)	Welded	Bolted	
Describe the condition of the cap			
Can well be accessed without unlocking, and if so, how (ie unbolt the cap)			

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure			Is an electrical plug present		
Identify the condition of the lock			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present			Was the well photographed		
If yes, are post painted yellow			What camera was used		
If yes, how many (circle one)	1 2 3 4 5		Which smart card are the photos on	1 2 3	
Is at least one post removable			List the photograph numbers		
Describe the condition of the posts					

Materials	Yes	No	More materials	Yes	No
Is a water access line present			Is a discharge line present		
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked			**Surface Pad**	**Yes**	**No**
If yes, how			Is a concrete pad present		
Stick up	**Inches**		If yes, describe the condition		
Stick up of surface casing above concrete pad					
Stick up of well casing stick up above the pad			**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad			Is a survey (brass) marker present		
Stick up of water discharge pipe above the pad			If yes, what is recorded		

Describe the general condition of the well

Additional comments/Other hazards at the well: CFA-1 appears to be inside a brick guardhouse next to the railroad tracks near Dynatrol Employee area. It is not accessible.

Checklist prepared by (print): R Garcia		Checklist reviewed by (print): Wendell Jolley	
Signature: [signature]	Date: 5/3/01	Signature: Wendell Jolley	Date: 5/3/01

Scanned

Well Inspection Checklist

Well ID: 94	Well Name: CFA-2		
Date of Inspection: 5/5/01		Purpose of inspection (check one)	
Location/Directions to the well:			Institutional control
		✓	Routine maintenance
			Nonroutine maintenance
			Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc			Easting: 342913
If yes, describe how, where, and what it says:			Northing: 4821373
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present			3
If yes is it securely attached to the casing			
How is it attached (circle one)	Welded	Bolted	
Describe the condition of the cap			
Can well be accessed without unlocking, and if so, how (ie unbolt the cap)			

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure			Is an electrical plug present		
Identify the condition of the lock			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present			Was the well photographed		
If yes, are post painted yellow			What camera was used		
If yes, how many (circle one) 1 2 3 4 5			Which smart card are the photos on 1 2 3		
Is at least one post removable			List the photograph numbers		
Describe the condition of the posts					

Materials	Yes	No	More materials	Yes	No
Is a water access line present			Is a discharge line present		
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked			**Surface Pad**	**Yes**	**No**
If yes, how			Is a concrete pad present		
Stick up	**Inches**		If yes, describe the condition		
Stick up of surface casing above concrete pad					
Stick up of well casing stick up above the pad			**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad			Is a survey (brass) marker present		
Stick up of water discharge pipe above the pad			If yes, what is recorded		
Describe the general condition of the well					
Additional comments/Other hazards at the well	well appears to be in an inaccessible pumphouse				

Checklist prepared by (print): R. Garcia		Checklist reviewed by (print): Wendell Jolley	
Signature: [illegible]	Date: 5/10/01	Signature: [illegible]	Date: 5/11/01

Scanned

Well Inspection Checklist

Well ID: 94	Well Name: CFA-2		
Date of Inspection: 5/5/01		Purpose of inspection (check one)	
Location/Directions to the well:			Institutional control
		✓	Routine maintenance
			Nonroutine maintenance
			Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc			Easting: 342,913
If yes, describe how, where, and what it says:			Northing: 4821373
			Projection: UTM
			Datum: WGS 84
Locking well cap	Yes	No	GPS grade: Recreational
Is cap or wellhead box present			
If yes is it securely attached to the casing			3
How is it attached (circle one)	Welded	Bolted	
Describe the condition of the cap			
Can well be accessed without unlocking, and if so, how (ie unbolt the cap)			

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure			Is an electrical plug present		
Identify the condition of the lock			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present			Was the well photographed		
If yes, are post painted yellow			What camera was used		
If yes, how many (circle one) 1 2 3 4 5			Which smart card are the photos on 1 2 3		
Is at least one post removable			List the photograph numbers		
Describe the condition of the posts					

Materials	Yes	No	More materials	Yes	No
Is a water access line present			Is a discharge line present		
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	Yes	No			
Is the water level measuring point marked			Surface Pad	Yes	No
If yes, how			Is a concrete pad present		
Stick up	Inches		If yes, describe the condition		
Stick up of surface casing above concrete pad					
Stick up of well casing stick up above the pad			Survey	Yes	No
Stick up of water access pipe above the pad			Is a survey (brass) marker present		
Stick up of water discharge pipe above the pad			If yes, what is recorded		

Describe the general condition of the well

Additional comments/Other hazards at the well well appears to be in an inaccessible purgehouse

Checklist prepared by (print): R. Garcia		Checklist reviewed by (print): Wendell Jolley	
Signature: [illegible]	Date: 5/10/01	Signature: [illegible]	Date: 5/11/01

Well ID: 189

Well Name:LF2-01

Date:May 30, 2001

File Name:CFA\189 may 30 01.jpg

Well Inspection Checklist

Well ID: 190	Well Name: LF2-02
Date of Inspection: 5/30/01	Purpose of inspection (check one)
Location/Directions to the well: N from N CFA [illegible]	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc	✓		Easting: 342912
If yes, describe how, where, and what it says: metal tag on			Northing: 4322425
the well cap LF2-2			Projection: UTM
N. 6830402 & E. 29 40 18.6 Elev 4937.1			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	(Bolted)	
Describe the condition of the cap U good			
Can well be accessed without unlocking, and if so, how (ie unbolt the cap) no			

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present	✓	
Identify the condition of the lock good			What type of plug is present (volts, amps)		
Identify the type (make) of lock, and the lock number			multi. port. outlet		
M. LCC 5100					
Protective Posts	**Yes**	**No**	**Photographs**	**Yes**	**No**
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used Canon		
If yes, how many (circle one) 1 2 (3) 4 5			Which smart card are the photos on (1) 2 3		
Is at least one post removable	✓		List the photograph numbers		
Describe the condition of the posts good			abl looking N.		

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present		✓
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked	✓		**Surface Pad**	**Yes**	**No**
If yes, how MP "y" N2 side AL CAP			Is a concrete pad present	✓	
Stick up	Inches		If yes, describe the condition 2ft sq		
Stick up of surface casing above concrete pad	1ft 4in		U. good condition		
Stick up of well casing stick up above the pad	—		**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad	—		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	—		If yes, what is recorded LF2-02		

Describe the general condition of the well v. good condition 10.5" steel surface casing w/ multiple electrical cables stored inside

Additional comments/Other hazards at the well

Checklist prepared by (print) [illegible]		Checklist reviewed by (print) Wendell Jolley	
Signature: [illegible]	Date: 5/30/01	Signature: [illegible]	Date: 6/6/01

Well ID: 190

Well Name:LF2-02

Date:May 30, 2001

File Name:CFA\190 may 30 01.jpg

Well Inspection Checklist

Well ID: 191	Well Name: LF2-03
Date of Inspection: 5/20/01	Purpose of Inspection (check one)
Location/Directions to the well: ~10' W LF2-1	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc		✓	Easting: 343 087
If yes, describe how, where, and what it says:			Northing: 4822 379
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	Bolted	
Describe the condition of the cap good			

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) yes - well has hole that's been cut

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present		✓
Identify the condition of the lock NEW			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number NEW Am Lock 3100					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used Canon		
If yes, how many (circle one) 1 2 (3) 4 5			Which smart card are the photos on (1) 2 3		
Is at least one post removable	✓		List the photograph numbers		
Describe the condition of the posts good			# 11 [illegible]		

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present		✓
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked		✓	**Surface Pad**	**Yes**	**No**
If yes, how			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition 2 lift cracks		
Stick up of surface casing above concrete pad	—				
Stick up of well casing stick up above the pad	1 ft 1 in		**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad	—		Is a survey (brass) marker present		✓
Stick up of water discharge pipe above the pad	—		If yes, what is recorded		

Describe the general condition of the well good PZ well ? / Has bent ?

Additional comments/Other hazards at the well

Checklist prepared by (print) G.W. Stanley		Checklist reviewed by (print) Wendell Jolly	
Signature: [signature]	Date: 5/20/01	Signature: [signature]	Date: 6/6/01

Well ID: 191

Well Name:LF2-03

Date:May 30, 2001

File Name:CFA\191 may 30 01.jpg

Well Inspection Checklist

Well ID: 192	Well Name: LF2-04
Date of Inspection: 5/20/01	Purpose of Inspection (check one)
Location/Directions to the well: ~ 1/4 N CEA location	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc		✓	Easting: 342 911
If yes, describe how, where, and what it says:			Northing: 4822 432
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	Bolted	
Describe the condition of the cap	V. good but cut		

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) Yes Lock has been cut

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present		✓
Identify the condition of the lock	N/A		What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number	N/A				
Mil. Lock 3100					
Protective Posts	**Yes**	**No**	**Photographs**	**Yes**	**No**
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used	Sony	
If yes, how many (circle one)	1 2 (3) 4 5		Which smart card are the photos on	(1) 2 3	
Is at least one post removable	✓		List the photograph numbers		
Describe the condition of the posts	Good		# 5 looking west		

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present		✓
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked		✓	**Surface Pad**	**Yes**	**No**
If yes, how			Is a concrete pad present		
Stick up	**Inches**		If yes, describe the condition		
Stick up of surface casing above concrete pad	—				
Stick up of well casing stick up above the pad	10 in		**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad			Is a survey (brass) marker present		
Stick up of water discharge pipe above the pad			If yes, what is recorded		

Describe the general condition of the well V. good 1 1/2 in well casing (2 inch)

Additional comments/Other hazards at the well

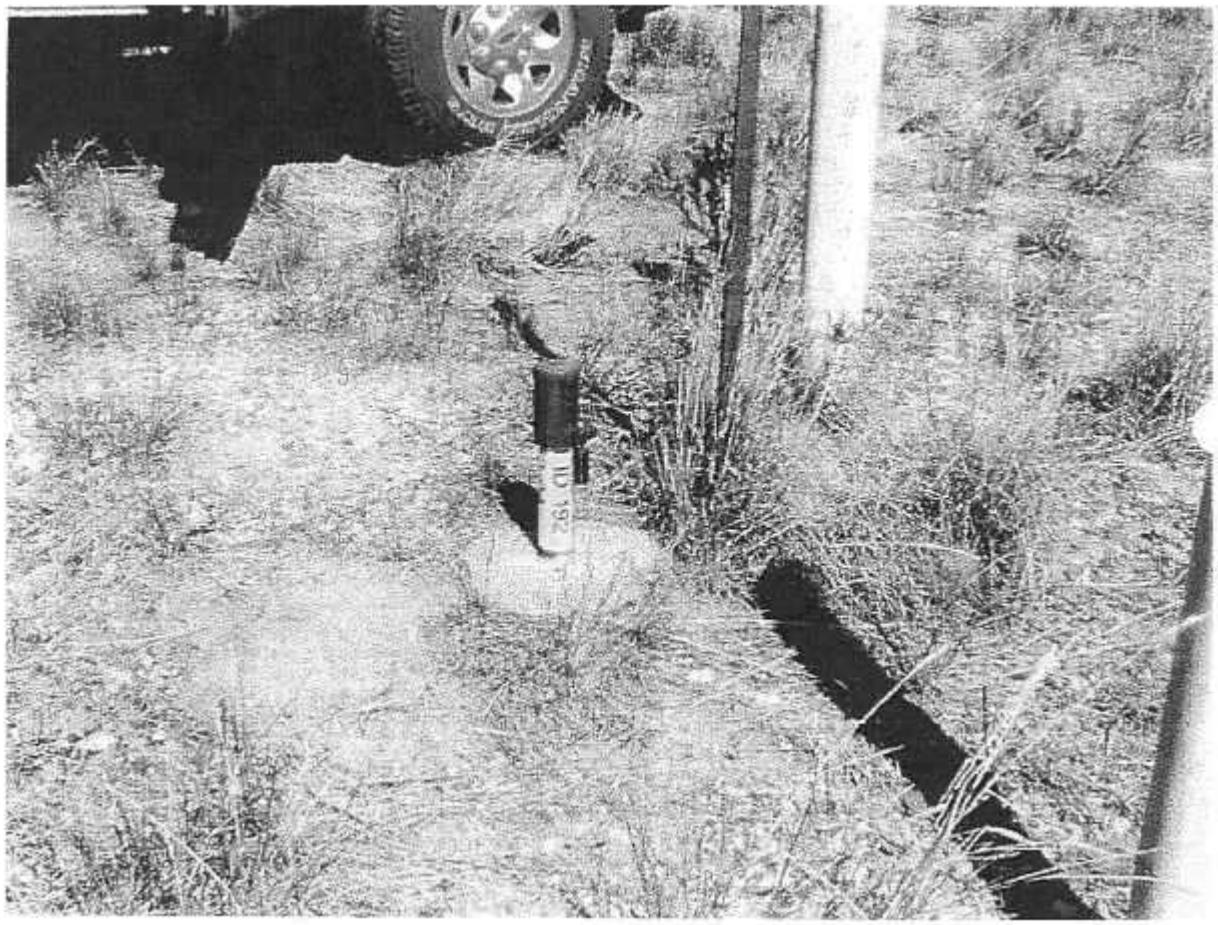
Checklist prepared by (print) G.W. Smalley		Checklist reviewed by (print) Valerie J. Jolley	
Signature: [illegible]	Date: 5/20/01	Signature: [illegible]	Date: 6/8/01

Well ID: 192

Well Name:LF2-04

Date:May 30, 2001

File Name:CFA\192 may 30 01.jpg



Well Inspection Checklist

Well ID: 193 | Well Name: LF2-05

Date of Inspection: 9/20/01

Location/Directions to the well: Landfill #2 (center)

Purpose of inspection (check one):
- Institutional control
- ✓ Routine maintenance
- Nonroutine maintenance
- Other

Identification	Yes	No
Is well identified, marked with a tag etc	✓	
If yes, describe how, where, and what it says: metal tag in the well head cap (rusty cap)		

GPS Coordinates
Easting: 343 088
Northing: 4822 485
Projection: UTM
Datum: WGS 84
GPS grade: Recreational

Locking well cap	Yes	No
Is cap or wellhead box present	✓	
If yes is it securely attached to the casing	✓	
How is it attached (circle one)	Welded	(Bolted)

Describe the condition of the cap v. good LF2-5
N. 683235.5 GEL 4929.8
E. 294589.2

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) no

Locks	Yes	No
Is the well locked upon departure	✓	
Identify the condition of the lock rsw		
Identify the type (mfgr) of lock, and the lock number YSM Master Lock 5100		

Electrical	Yes	No
Is an electrical plug present		
What type of plug is present (volts, amps)		

Protective Posts	Yes	No
Are protective posts present	✓	
If yes, are post painted yellow	Partially	
If yes, how many (circle one)	1 2 (3) 4 5	
Is at least one post removable	✓	
Describe the condition of the posts v. good		

Photographs	Yes	No
Was the well photographed	✓	
What camera was used	C3000	
Which smart card are the photos on	1 2 3	
List the photograph numbers		
LF2 looking N		

Materials	Yes	No
Is a water access line present		✓
If yes, what diameter is it		
If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it		

More materials	Yes	No
Is a discharge line present		✓
If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it 3/4" SS NAT.		

Measuring point	Yes	No
Is the water level measuring point marked		✓
If yes, how		
Stick up	Inches	
Stick up of surface casing above concrete pad	2 ft 7 in	
Stick up of well casing stick up above the pad		
Stick up of water access pipe above the pad		
Stick up of water discharge pipe above the pad		

Surface Pad	Yes	No
Is a concrete pad present	✓	
If yes, describe the condition v. good		
YH circle		

Survey	Yes	No
Is a survey (brass) marker present	✓	
If yes, what is recorded LF2-5 NAD 27 N 683237.37 E 294593.46 El 4931.04		

Describe the general condition of the well
3/4" SS tube inside 10" steel
Outside casing

Additional comments/Other hazards at the well

Checklist prepared by (print) [illegible] | Signature: [illegible] | Date: 9/20/01

Checklist reviewed by (print) Wendell Jolley | Signature: Wendell Jolley | Date: 10/10/01

Well ID: 193

Well Name:LF2-05

Date:May 30, 2001

File Name:CFA\193 may 30 01.jpg

Well Inspection Checklist

Well ID: 194 | Well Name: LF2-06

Date of Inspection: 5/30/01

Location/Directions to the well: Landfill #2 w/ Kenton

Purpose of inspection (check one):
- Institutional control
- ✓ Routine maintenance
- Nonroutine maintenance
- Other

Identification	Yes	No
Is well identified, marked with a tag etc	✓	
If yes, describe how, where, and what it says: metal tag in AL well cap LF2-06 LAPL4931.2 N. 693221.5 E 294323.0		

Locking well cap	Yes	No
Is cap or wellhead box present	✓	
If yes Is it securely attached to the casing	✓	
How is it attached (circle one)	Welded	Bolted

GPS Coordinates
- Easting: 343 008
- Northing: 4822 510
- Projection: UTM
- Datum: WGS 84
- GPS grade: Recreational

Describe the condition of the cap: good 10¾" AL well cap

Can well be accessed without unlocking, and if so, how (ie unbolt the cap): NO

Locks	Yes	No
Is the well locked upon departure	✓	
Identify the condition of the lock: new		
Identify the type (mfgr) of lock, and the lock number: Master Lock 6100		

Electrical	Yes	No
Is an electrical plug present		✓
What type of plug is present (volts, amps)		

Protective Posts	Yes	No
Are protective posts present	✓	
If yes, are post painted yellow	✓	
If yes, how many (circle one) 1 2 3 4 5		
Is at least one post removable	✓	
Describe the condition of the posts: good		

Photographs	Yes	No
Was the well photographed	✓	
What camera was used: Lumix		
Which smart card are the photos on: 1 2 3		
List the photograph numbers: #14 looking E.		

Materials	Yes	No
Is a water access line present		✓
If yes, what diameter is it		
If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it		

More materials	Yes	No
Is a discharge line present		✓
If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it		

Measuring point	Yes	No
Is the water level measuring point marked		✓
If yes, how		
Stick up	inches	
Stick up of surface casing above concrete pad	—	
Stick up of well casing stick up above the pad	4/ft 3/4	
Stick up of water access pipe above the pad	—	
Stick up of water discharge pipe above the pad	—	

Surface Pad	Yes	No
Is a concrete pad present	✓	
If yes, describe the condition: 5 ft circle		

Survey	Yes	No
Is a survey (brass) marker present	✓	
If yes, what is recorded: LAPL 4931.2 N 693221.21 E 294323.3		

Describe the general condition of the well: Excellent condition 10" steel surface casing

Additional comments/Other hazards at the well:

Checklist prepared by (print): G.V. Stuckey | Signature: [signature] | Date: 5/30/01

Checklist reviewed by (print): Wendell Jolley | Signature: [signature] | Date: 6/6/01

Well ID: 194

Well Name:LF2-06

Date:May 30, 2001

File Name:CFA\194 may 30 01.jpg

Well Inspection Checklist

Well ID: 195	Well Name: 42-07
Date of Inspection: 5/22/01	Purpose of Inspection (check one)
Location/Directions to the well: N 7' N of 2-05 Landfill well #2	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No
Is well identified, marked with a pig etc		✓
If yes, describe how, where, and what it says:		

GPS Coordinates	
Easting:	743 087
Northing:	4822 [illegible]
Projection:	UTM
Datum:	WGS 84
GPS grade:	Recreational

Locking well cap	Yes	No
Is cap or wellhead box present	✓	
If yes is it securely attached to the casing	✓	
How is it attached (circle one)	Welded	Bolted
Describe the condition of the cap	✓ good	

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) Yes lockbrand cut

Locks	Yes	No
Is the well locked upon departure	✓	
Identify the condition of the lock	new	
Identify the type (mfgr) of lock, and the lock number	Master #1000	

Electrical	Yes	No
Is an electrical plug present		✓
What type of plug is present (volts, amps)		

Protective Posts	Yes	No
Are protective posts present	✓	
If yes, are post painted yellow	✓	
If yes, how many (circle one)	1 2 (3) 4 5	
Is at least one post removable	✓	
Describe the condition of the posts	good	

Photographs	Yes	No
Was the well photographed	✓	
What camera was used	digital	
Which smart card are the photos on	1 2 3	
List the photograph numbers	#12 back SW	

Materials	Yes	No
Is a water access line present		✓
If yes, what diameter is it		
If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it		

More materials	Yes	No
Is a discharge line present		✓
If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it		

Measuring point	Yes	No
Is the water level measuring point marked		✓
If yes, how		

Surface Pad	Yes	No
Is a concrete pad present		✓
If yes, describe the condition		

Stick up	Inches
Stick up of surface casing above concrete pad	—
Stick up of well casing stick up above the pad	2 ft 2 in
Stick up of water access pipe above the pad	—
Stick up of water discharge pipe above the pad	—

Survey	Yes	No
Is a survey (brass) marker present		✓
If yes, what is recorded		

Describe the general condition of the well good 1½ steel casing

Additional comments/Other hazards at the well

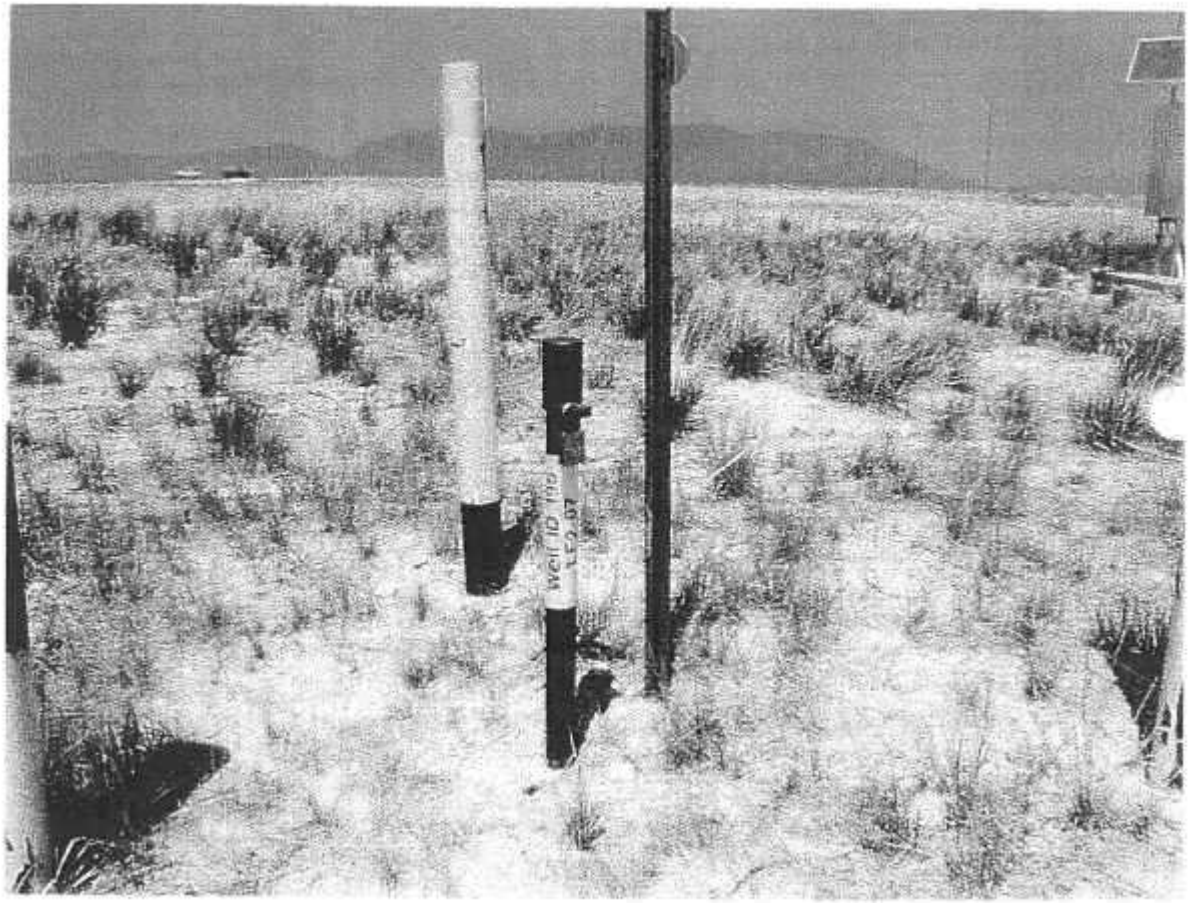
Checklist prepared by (print) G.W. Shrock	Checklist reviewed by (print) Wendell Jolley
Signature: [illegible] Date: 5/22/01	Signature: Wendell Jolley Date: 6/16/01

Well ID: 195

Well Name:LF2-07

Date:May 30, 2001

File Name:CFA\195 may 30 01.jpg



Well Inspection Checklist

Well ID: 196	Well Name: LF2-8
Date of Inspection: 6/20/01	Purpose of Inspection (check one)
Location/Directions to the well: ~ 1/4 mi. E. CFA Junction	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc	✓		Easting: 343016
If yes, describe how, where, and what it says: Well name painted on protective post			Northing: 4822375
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	Bolted	
Describe the condition of the cap	U. good Alt. 1ft. wellhead box		
Can well be accessed without unlocking, and if so, how (ie unbolt the cap)	No		

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present	✓	
Identify the condition of the lock	N/A		What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number	N/A Am. Lock 5100		30A 250V 4 prong 1p		
Protective Posts	**Yes**	**No**	**Photographs**	**Yes**	**No**
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used	C2000 E	
If yes, how many (circle one)	1 2 3 4 5		Which smart card are the photos on	1 2 3	
Is at least one post removable		✓	List the photograph numbers		
Describe the condition of the posts	Good		48 looking NW 49 " "		

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present	✓	
If yes, what diameter is it			If yes, what diameter	1/4	
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked	✓		**Surface Pad**	**Yes**	**No**
If yes, how "X" Pside discharge line			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition	3ft x U. good	
Stick up of surface casing above concrete pad	—				
Stick up of well casing stick up above the pad	1ft 4"		**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad			Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	1ft 8"		If yes, what is recorded	LF2-08	

Describe the general condition of the well: good 6" steel well casing

Additional comments/Other hazards at the well:

Checklist prepared by (print): G.W. Shuler		Checklist reviewed by (print): Wendell Jolley	
Signature: [signature]	Date: 5/24/01	Signature: [signature]	Date: 6/6/01

Well ID: 196

Well Name:LF2-08

Date:May 30, 2001

File Name:CFA\196 may 30 01.jpg

Well ID: 196

Well Name:LF2-08

Date:May 30, 2001

File Name:CFA\196 may 30 01 open box.jpg

Well Inspection Checklist

Well ID: 197	Well Name: LF2-09
Date of Inspection: 5/30/01	Purpose of inspection (check one)
Location/Directions to the well: ~ 1/4 mi CFA junction	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc	✓		Easting: 342 962
If yes, describe how, where, and what it says: well name painted on protective post			Northing: 4822 387
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	Bolted	
Describe the condition of the cap	V. good AL wellhead box (LF box)		
Can well be accessed without unlocking, and if so, how (ie unbolt the cap)	NO		

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present	✓	
Identify the condition of the lock	new		What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number	KEY for LOCK 5140		30 250 4 prong 2 1P		
Protective Posts	**Yes**	**No**	**Photographs**	**Yes**	**No**
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used	Canon	
If yes, how many (circle one)	1 2 (3) 4 5		Which smart card are the photos on	(1) 2 3	
Is at least one post removable		✓	List the photograph numbers		
Describe the condition of the posts	V. good		#3 looking S #4 looking E		

Materials	Yes	No	More materials	Yes	No
Is a water access line present	✓		Is a discharge line present	✓	
If yes, what diameter is it	1 1/4		If yes, what diameter	1 1/4"	
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked			**Surface Pad**	**Yes**	**No**
If yes, how			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition	V. good 3 ft	
Stick up of surface casing above concrete pad	1 ft 3 in				
Stick up of well casing stick up above the pad			**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad	1 ft 5 in		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	1 ft 5 in		If yes, what is recorded	LF2 09	

Describe the general condition of the well: good steel 4" well aug. 09

Additional comments/Other hazards at the well:

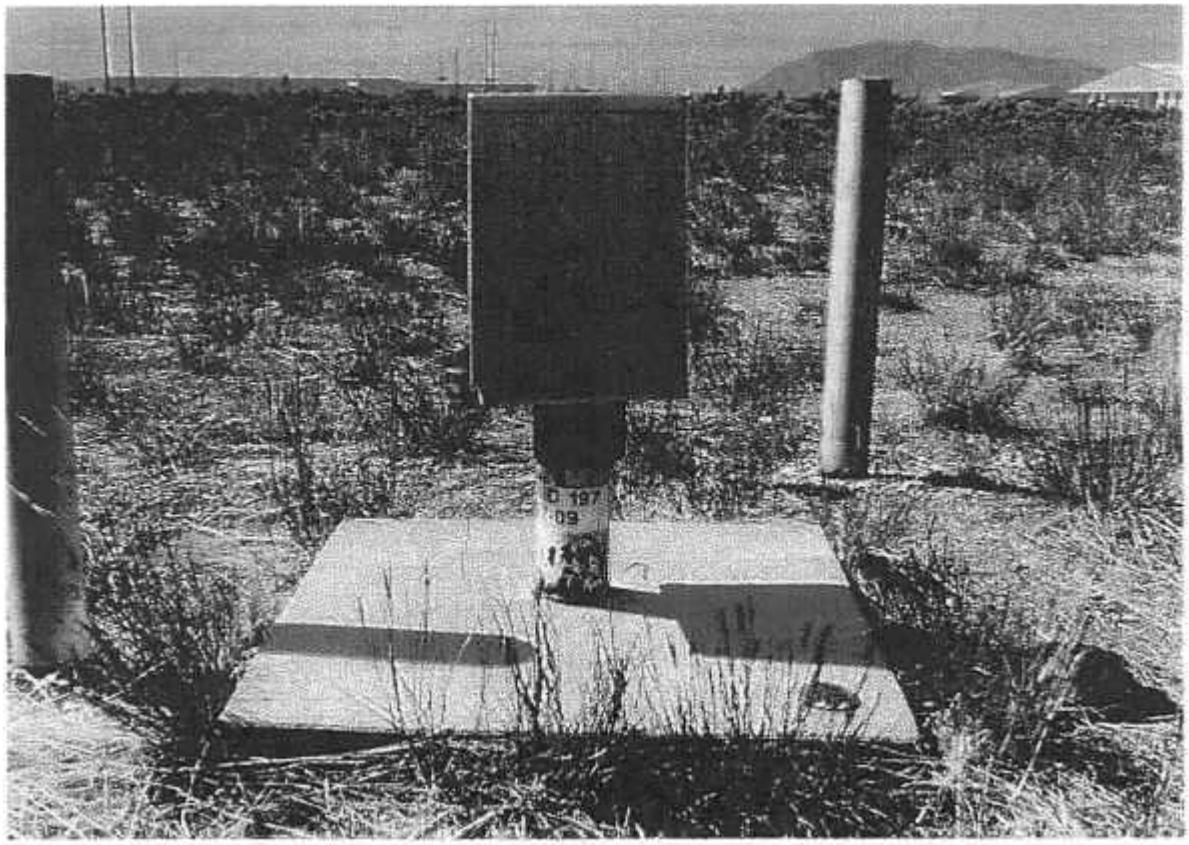
Checklist prepared by (print) G.W. Shaffer		Checklist reviewed by (print) Intentell Jolley	
Signature: [signature]	Date: 5/30/01	Signature: [signature]	Date: 10/10/01

Well ID: 197

Well Name:LF2-09

Date:May 30, 2001

File Name:CFA\197 may 30 01.jpg

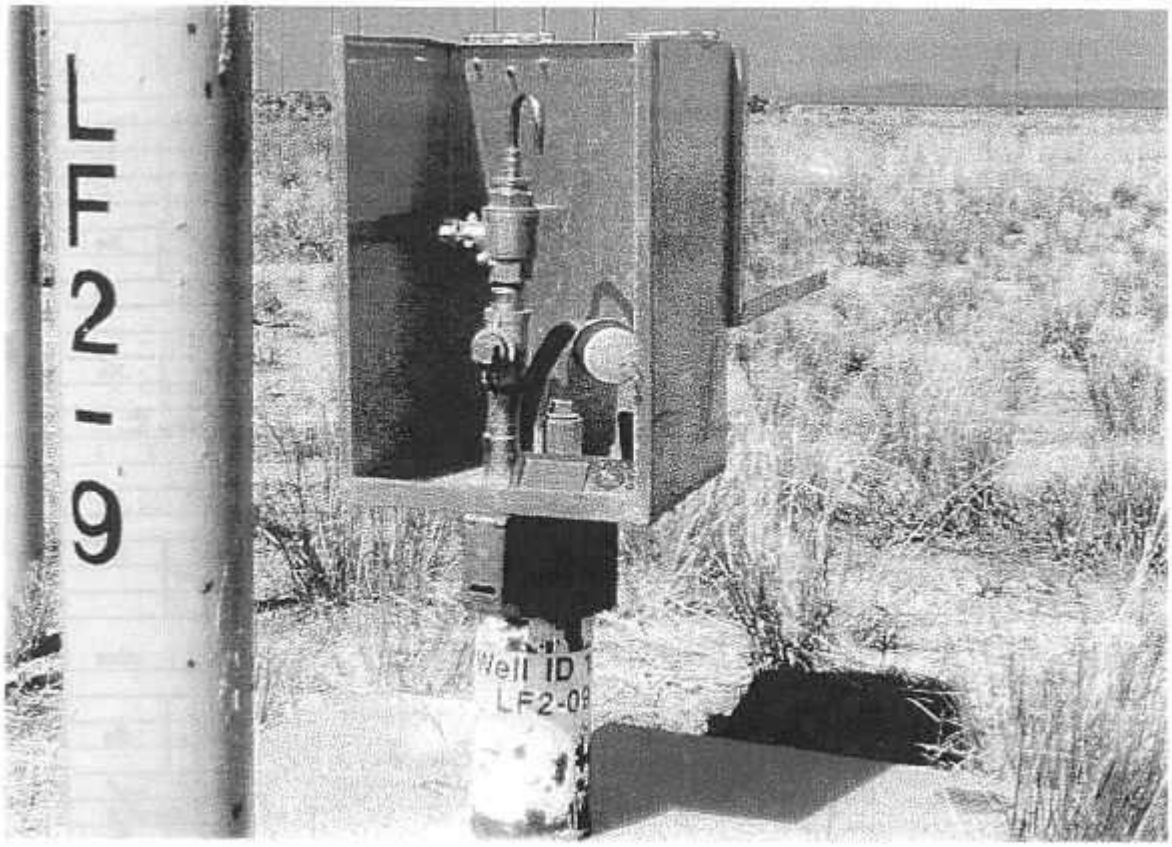


Well ID: 197

Well Name:LF2-09

Date:May 30, 2001

File Name:CFA\197 may 30 01 open box.jpg



Well Inspection Checklist

Well ID: 198	Well Name: LF2-10
Date of Inspection: 5/30/01	Purpose of Inspection (check one)
Location/Directions to the well: [illegible]	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc		✓	Easting: 342 998
If yes, describe how, where, and what it says:			Northing: 4822 303
			Projection: UTM
			Datum: WGS 84
Locking well cap	Yes	No	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	Bolted	
Describe the condition of the cap good AL wellhead box			
Can well be accessed without unlocking, and if so, how (ie unbolt the cap) no			

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present	✓	
Identify the condition of the lock NZW			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number KSW Ann LCK 5100			30 230 4 prong		

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used	Canon	
If yes, how many (circle one)	1 2 (3) 4 5		Which smart card are the photos on	(1) 2 3	
Is at least one post removable	✓		List the photograph numbers		
Describe the condition of the posts good			#6 Looking N #7 " W		

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present	✓	
If yes, what diameter is it			If yes, what diameter 1/4		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel (galvanized steel) PVC other		
If other, what is it			If other, what is it		
Measuring point	Yes	No			
Is the water level measuring point marked		✓	**Surface Pad**	Yes	No
If yes, how			Is a concrete pad present	✓	
Stick up	Inches		If yes, describe the condition 3 ft w/ 4 all the way through + cracks		
Stick up of surface casing above concrete pad	—				
Stick up of well casing stick up above the pad	1 ft 1in		**Survey**	Yes	No
Stick up of water access pipe above the pad			Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	1 ft 9in		If yes, what is recorded LF2-10		

Describe the general condition of the well good

Additional comments/Other hazards at the well

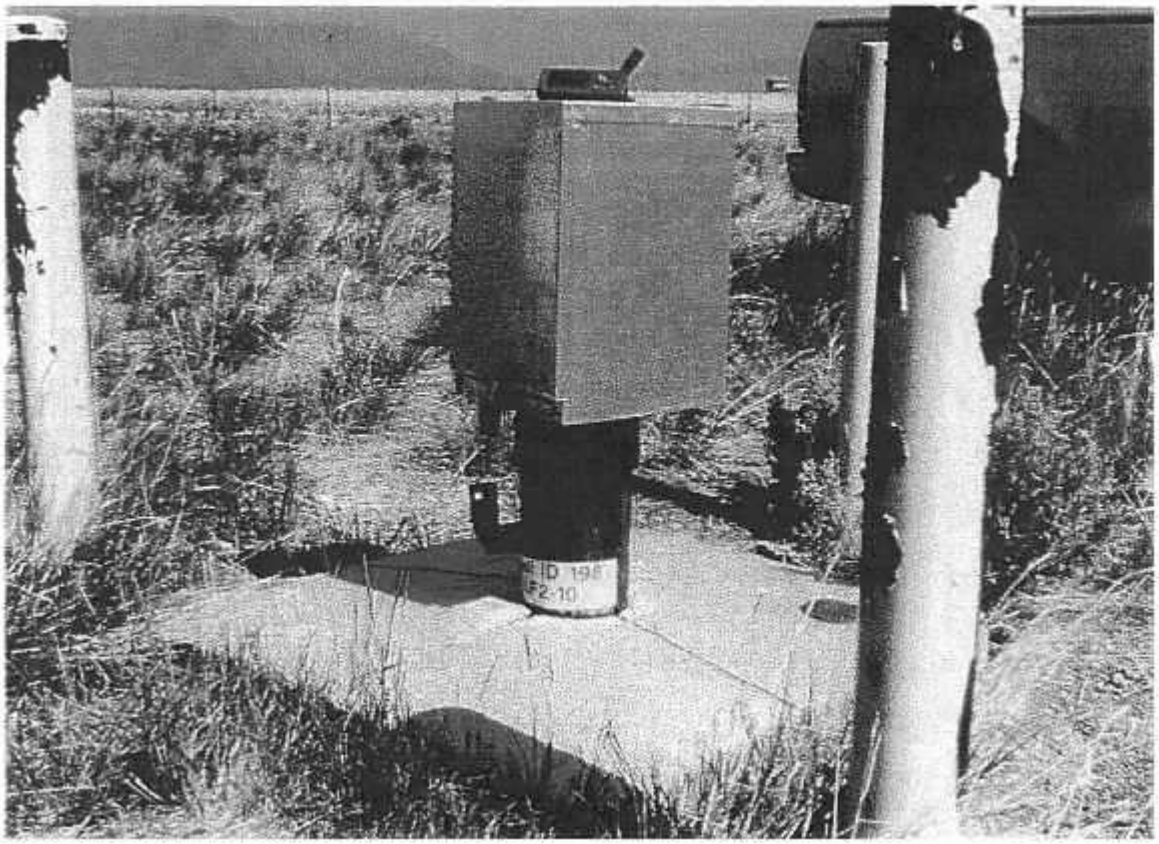
Checklist prepared by (print) G. Wagner	Checklist reviewed by (print) Wanda Jones
Signature: [illegible] Date: 5/30/01	Signature: [illegible] Date: 6/6/01

Well ID: 198

Well Name:LF2-10

Date:May 30, 2001

File Name:CFA\198 may 30 01.jpg



Well ID: 198

Well Name:LF2-10

Date:May 30, 2001

File Name:CFA\198 may 30 01 open box.jpg

Well Inspection Checklist

Well ID: 199	Well Name: LF 2-11
Date of Inspection: 5/2014	Purpose of inspection (check one)
Location/Directions to the well: N end Landfill #2	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc	✓		Easting: 342 357
If yes, describe how, where, and what it says: well name painted on protective post			Northing: 4822 799
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	Bolted	

Describe the condition of the cap: is in good condition after redrilling; replacing protecting the wellhead box to steel well casing

Can well be accessed without unlocking, and if so, how (ie unbolt the cap): no

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present	✓	
Identify the condition of the lock: new			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number: new Master Lock 5100			30A 230V 1φ		

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used: Canon		
If yes, how many (circle one)	1 2 (3) 4 5		Which smart card are the photos on	(1) 2 3	
Is at least one post removable		✓	List the photograph numbers		
Describe the condition of the posts: good			#15 looking S; #16 looking S; #17 looking S		

Materials	Yes	No	More materials	Yes	No
Is a water access line present	✓		Is a discharge line present	✓	
If yes, what diameter is it: 1¼"			If yes, what diameter: 1¼"		
If yes, what material type (circle one): stainless steel, galvanized steel, PVC, other			If yes, what material type (circle one): stainless steel, galvanized steel, PVC, other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked		✓	**Surface Pad**	**Yes**	**No**
If yes, how			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition: good 3ft		
Stick up of surface casing above concrete pad	14 ½"				
Stick up of well casing stick up above the pad	—		**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad	14 ½"		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	20 3"		If yes, what is recorded: LF 2-11		

Describe the general condition of the well: good 4" steel well/surface casing

Additional comments/Other hazards at the well

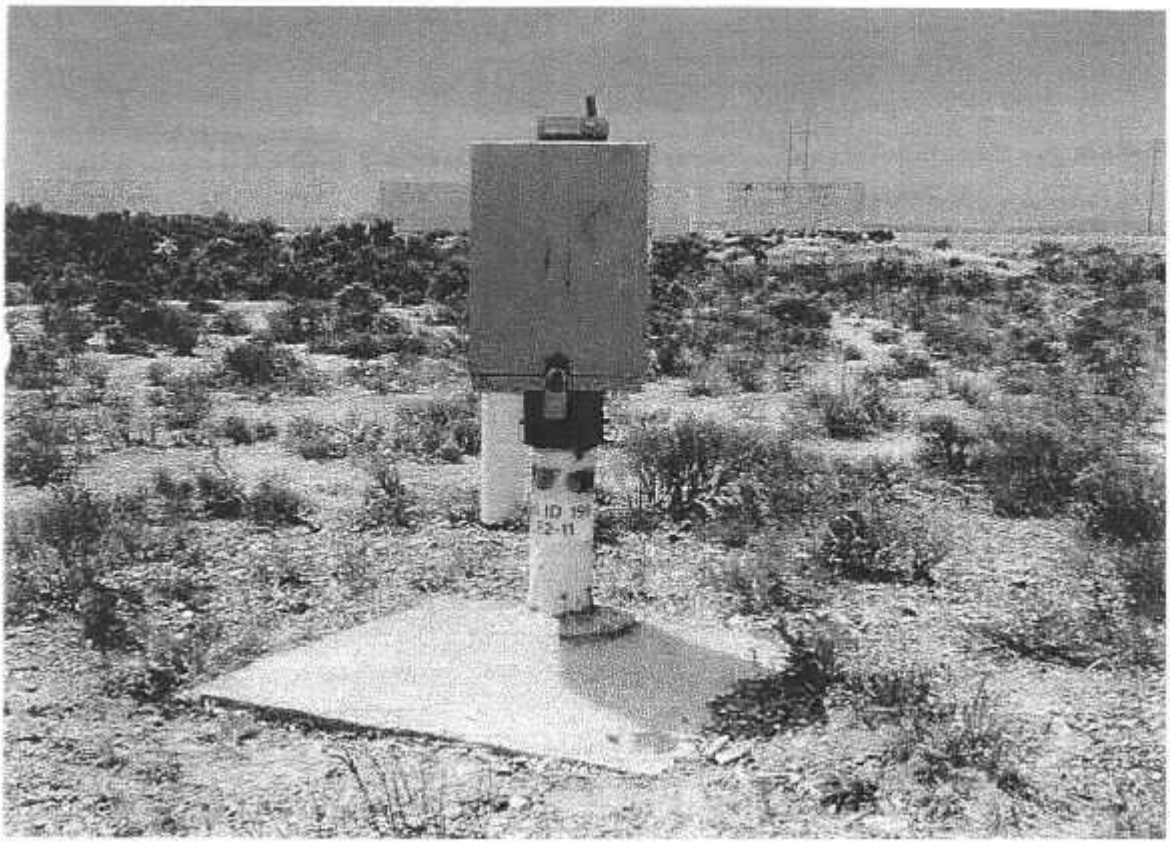
Checklist prepared by (print): G.L. Stanley	Checklist reviewed by (print): Wendell Jolley
Signature: [signature] Date: 5/30/14	Signature: [signature] Date: 6/6/14

Well ID: 199

Well Name:LF2-11

Date:May 30, 2001

File Name:CFA\199 may 30 01.jpg

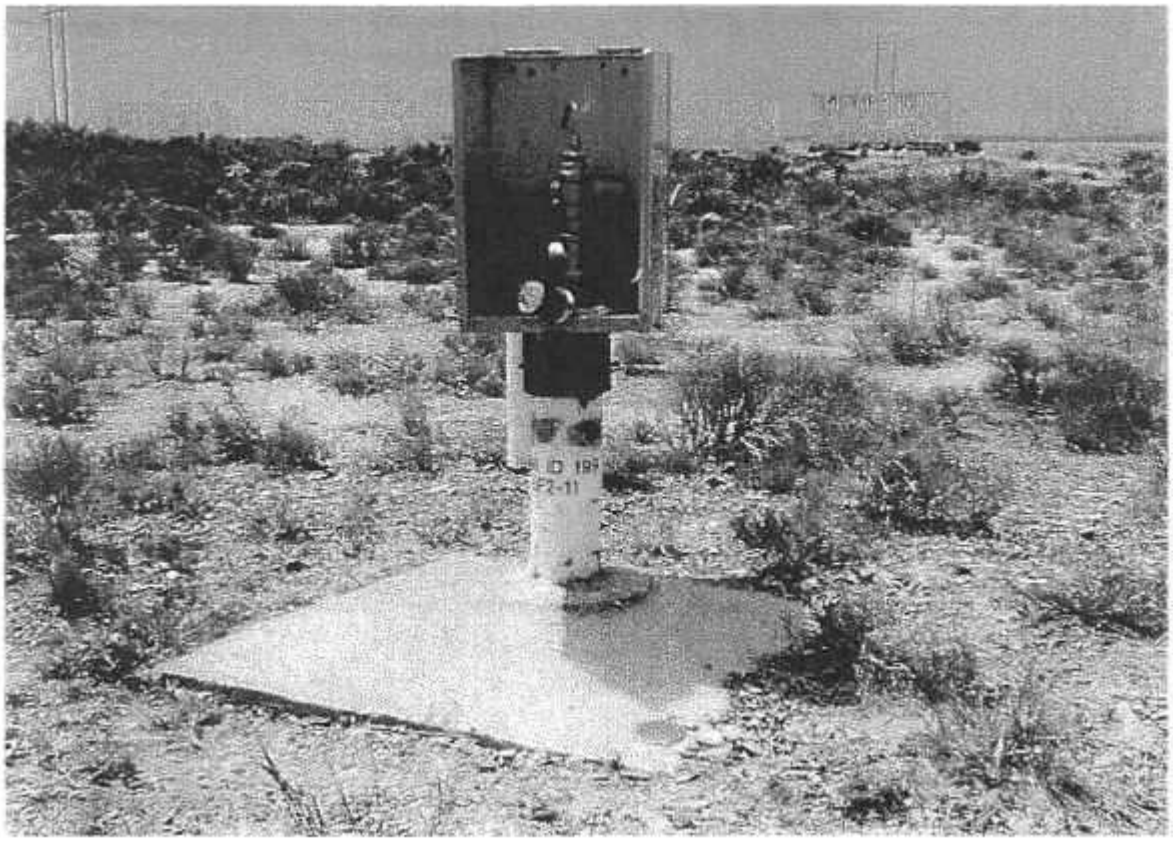


Well ID: 199

Well Name:LF2-11

Date:May 30, 2001

File Name:CFA\199 may 30 01 open box.jpg

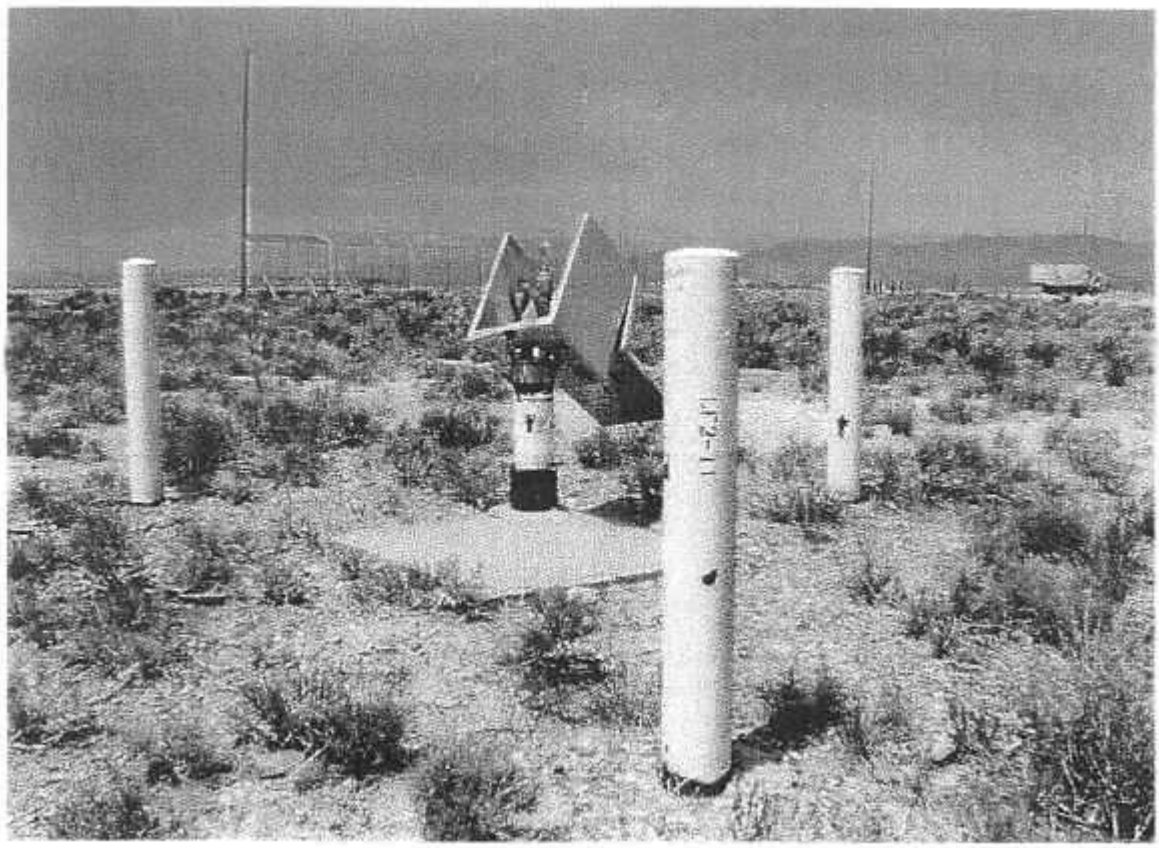


Well ID: 199

Well Name:LF2-11

Date:May 30, 2001

File Name:CFA\199 may 30 01 pre repair.jpg



Well Inspection Checklist

Well ID: 724	Well Name: LF 2-12
Date of Inspection: 5/30/01	Purpose of inspection (check one)
Location/Directions to the well: N ¼ of CEA Junction	institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc	✓		Easting: 342 912
If yes, describe how, where, and what it says: well name painted on protective post			Northing: 4822 390
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present		✓	
If yes is it securely attached to the casing			
How is it attached (circle one)	Welded	Bolted	
Describe the condition of the cap			

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) yes

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure		✓	Is an electrical plug present		✓
Identify the condition of the lock			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used C2000Z		
If yes, how many (circle one) 1 (2) 3 4 5			Which smart card are the photos on (1) 2 3		
Is at least one post removable		✓	List the photograph numbers		
Describe the condition of the posts Good except only 2 - one side upward			#2 looking S		

Materials	Yes	No	More materials	Yes	No
Is a water access line present	✓		Is a discharge line present		✓
If yes, what diameter is it 1¼ S			If yes, what diameter		
If yes, what material type (circle one) stainless steel (galvanized steel) PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it ¾" SS vapor port 35 ft		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked		✓	**Surface Pad**	**Yes**	**No**
If yes, how			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition good		
Stick up of surface casing above concrete pad	1 ft		3 ft		
Stick up of well casing stick up above the pad	—		**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad	4 ft 4 in		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	—		If yes, what is recorded LF 2-12		

Describe the general condition of the well in need of security completion — in need of well head completion / access road cut & leveled

Additional comments/Other hazards at the well

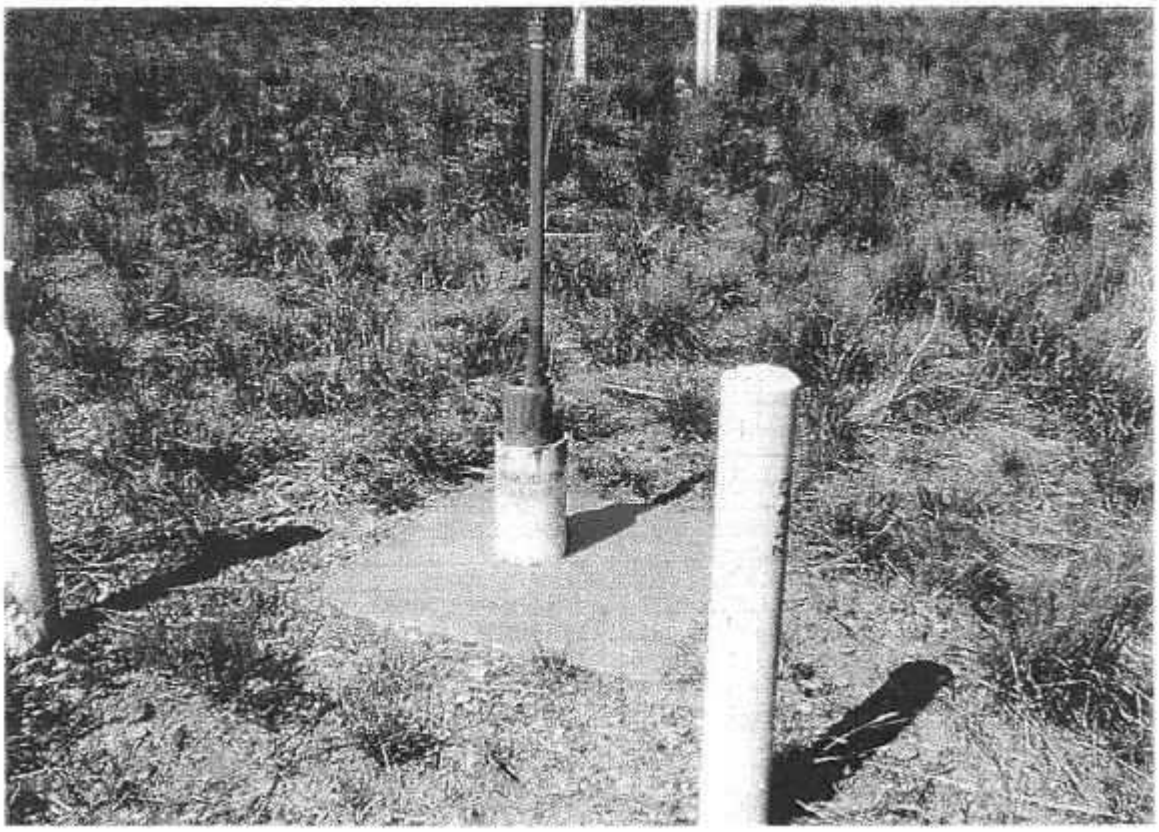
Checklist prepared by (print) G.W. Studley	Checklist reviewed by (print) [illegible]
Signature: [illegible] Date: 5/30/01	Signature: [illegible] Date: 6/6/01

Well ID: 724

Well Name:LF2-12

Date:May 30, 2001

File Name:CFA\724 may 30 01.jpg



Well Inspection Checklist

Well ID: 200	Well Name: LF3-01
Date of Inspection: 5/31/01	Purpose of inspection (check one)
Location/Directions to the well: Land Fill #3	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc	✓		Easting: 342 345
If yes, describe how, where, and what it says: metal tag w AL well head CAP LF3-1 N. 68 5239.2 E. 292119.4 Elev 4936.6			Northing: 4823138
			Projection: UTM
			Datum: WGS 84
Locking well cap	Yes	No	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	Bolted	
Describe the condition of the cap good			

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) NO

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present		✓
Identify the condition of the lock NEW			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number KEY AM LOCK 5100					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used Olympus		
If yes, how many (circle one) 1 2 (3) 4 5			Which smart card are the photos on 1 2 3		
Is at least one post removable			List the photograph numbers		
Describe the condition of the posts good w/ reflectors EX leaning N					

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present		✓
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	Yes	No	3/4" SS. pipe		
Is the water level measuring point marked	✓		Surface Pad	Yes	No
If yes, how "x" N2 side of AL ring			Is a concrete pad present	✓	
Stick up	Inches		If yes, describe the condition 4 ft circle		
Stick up of surface casing above concrete pad	35 in		in good condition		
Stick up of well casing stick up above the pad	—		Survey	Yes	No
Stick up of water access pipe above the pad	—		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	—		If yes, what is recorded NAD 27 LF3-01 N. 685241.62 E 292123.72 El 4938.75 1997		

Describe the general condition of the well 29" s.u. pipe 3/4" SS tube inside excellent 12" steel surface casing

Additional comments/Other hazards at the well

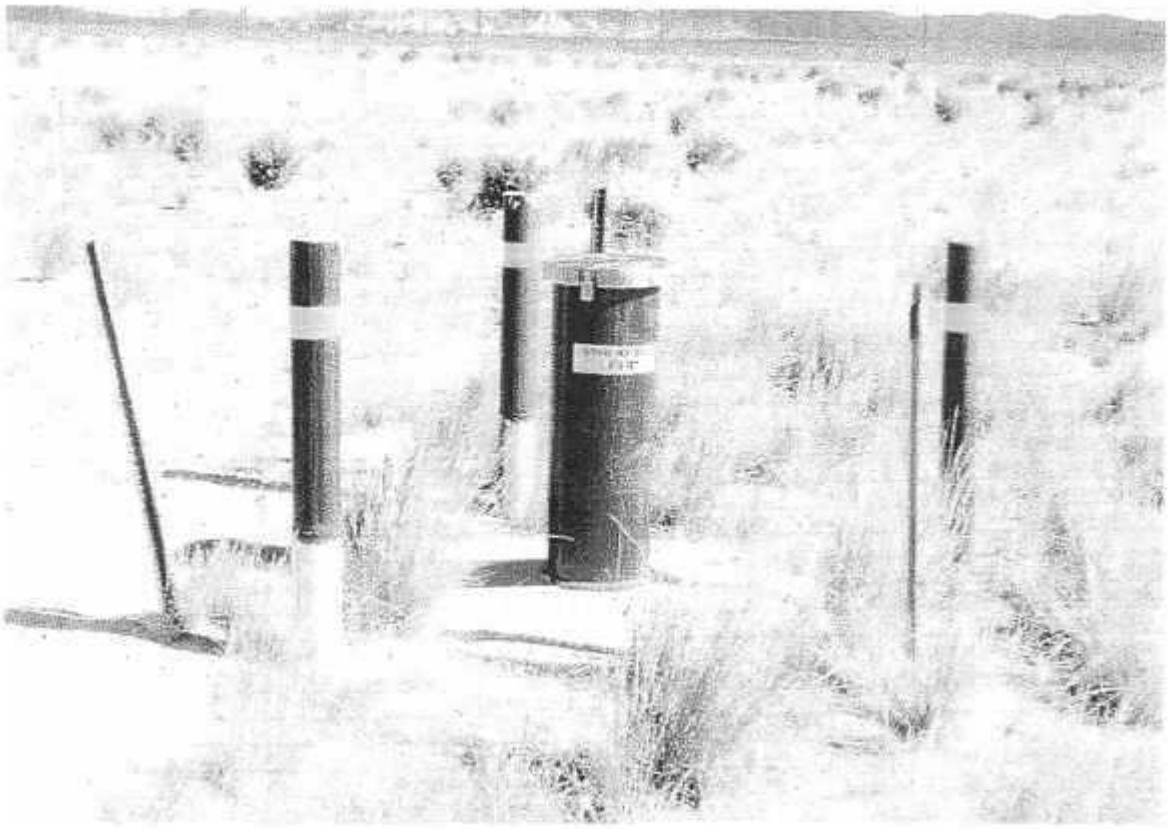
Checklist prepared by (print) G.W. Shaw	Checklist reviewed by (print) Wendell Jolley
Signature: [signature] Date: 5/31/01	Signature: Wendell Jolley Date: 6/6/01

Well ID: 200

Well Name:LF3-01

Date:May 31, 2001

File Name:CFA\200 may 31 01.jpg



Well Inspection Checklist

Well ID: 201	Well Name: LF3-02
Date of Inspection: 5/31/01	Purpose of inspection (check one)
Location/Directions to the well: Landfill #3	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc	✓		Easting: 342 319
If yes, describe how, where, and what it says: metal tag on AL well head cap LF3-2			Northing: 9823 017
			Projection: UTM
N. 684951.7 E 292017.4 GEL 4938.5			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	Bolted	

Describe the condition of the cap 10¾" AL well head cap/ring — really 12" ring

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) NO

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present		✓
Identify the condition of the lock New			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number XEN Atm. Lck 5100					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used C2000Z		
If yes, how many (circle one) 1 2 3 4 (5)			Which smart card are the photos on 1 2 3		
Is at least one post removable	✓		List the photograph numbers #2 Looking N		
Describe the condition of the posts Fencepost w/ extension / Protect. post need repainting					

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present		✓
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**	3/4" ES NAT. ?		
Is the water level measuring point marked	✓		**Surface Pad**	**Yes**	**No**
If yes, how MP "X" on NW side AL cap/ring			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition		
Stick up of surface casing above concrete pad	32 IN		good 4 ft circle		
Stick up of well casing stick up above the pad	—		**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad	—		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	—		If yes, what is recorded NAD 27 LF3-02		

Describe the general condition of the well NAT. 28" inside 0.900 12" steel surface casing

N 684954.27
E 292044.04
EL 4939.60
1997

Additional comments/Other hazards at the well

Checklist prepared by (print) A.L. Bradley		Checklist reviewed by (print) Jolenda L. Jolley	
Signature: [illegible]	Date: 5/31/01	Signature: [illegible]	Date: 6/6/01

Well ID: 201

Well Name:LF3-02

Date:May 31, 2001

File Name:CFA\201 may 31 01.jpg

Well Inspection Checklist

Well ID: 202	Well Name: LF3-03	
Date of Inspection:		Purpose of inspection (check one)
Location/Directions to the well: ~ 7' from LF3-#2		Institutional control
		✓ Routine maintenance
		Nonroutine maintenance
		Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc	✓		Easting: 342 318
If yes, describe how, where, and what it says:			Northing: 4923 016
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	Bolted	

Describe the condition of the cap 2 1/2" steel cap over 1 1/2" steel well casing

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) yes Lock previously cut & left in place

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure			Is an electrical plug present		✓
Identify the condition of the lock			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used	Canon	
If yes, how many (circle one) 1 2 (3) 4 5			Which smart card are the photos on (3) 2 3		
Is at least one post removable	✓		List the photograph numbers		
Describe the condition of the posts good			#3 Looking N		

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present		✓
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked	✓		**Surface Pad**	**Yes**	**No**
If yes, how "x" N			Is a concrete pad present		✓
Stick up	**Inches**		If yes, describe the condition		
Stick up of surface casing above concrete pad					
Stick up of well casing stick up above the pad	24" ALS		**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad			Is a survey (brass) marker present		✓
Stick up of water discharge pipe above the pad			If yes, what is recorded		

Describe the general condition of the well good 1 1/2" steel casing

Additional comments/Other hazards at the well

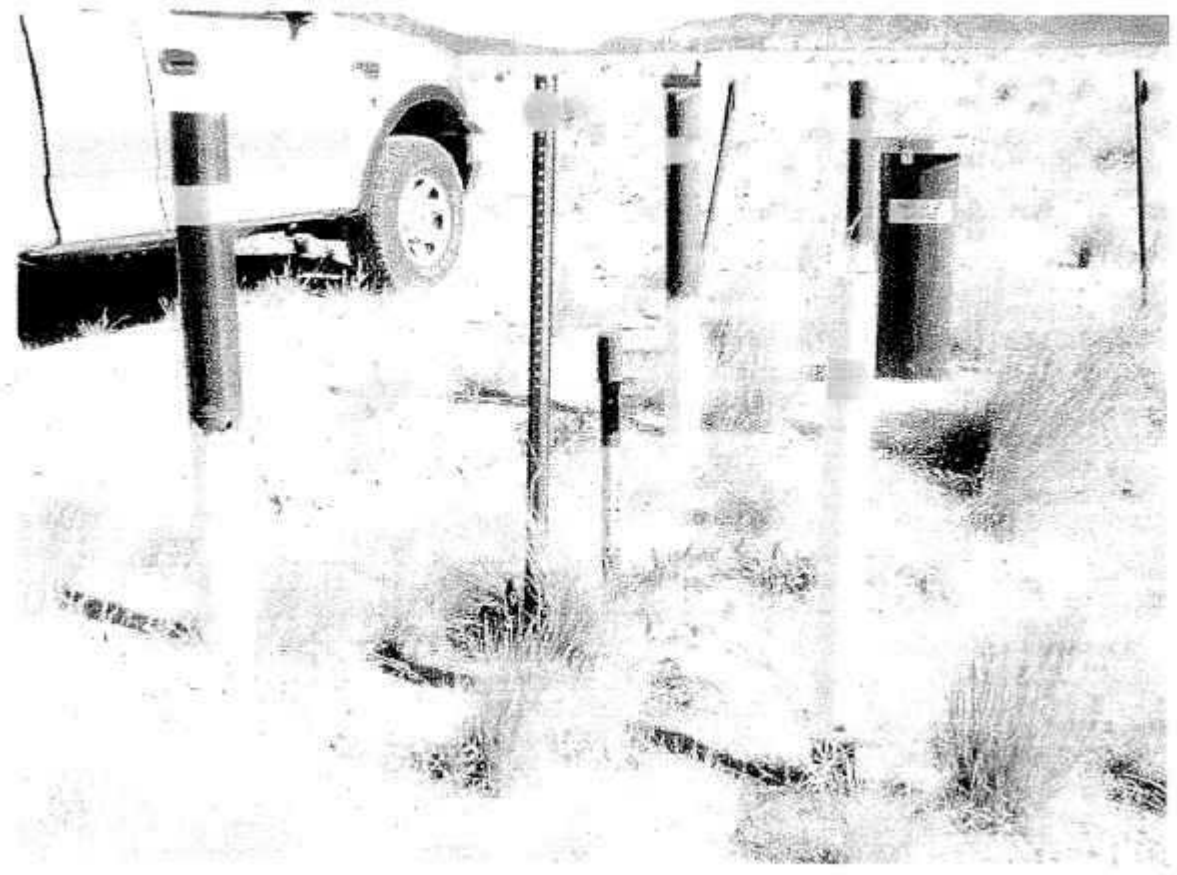
Checklist prepared by (print) G.W. Spurlock		Checklist reviewed by (print) Glendell Jolley	
Signature: [signature]	Date: 9/4/01	Signature: [signature]	Date: 10/10/01

Well ID: 202

Well Name:LF3-03

Date:May 31, 2001

File Name:CFA\202 may 31 01.jpg



Well Inspection Checklist

Well ID: 203	Well Name: LF3-04
Date of Inspection: 5/21/01	Purpose of inspection (check one)
Location/Directions to the well: LANDFILL #3	Institutional control
	Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc	✓		Easting: 342 255
If yes, describe how, where, and what it says: metal TAG 1"			Northing: 4822 847
AL 1074 well cap LF3-4			Projection: UTM
N 6843863 E 2918337.7 6Z-4940.1			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	Bolted	

Describe the condition of the cap N. good 1074 AL Lock. well cap & ring

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) NO

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present		✓
Identify the condition of the lock NEW			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number KEY					
Ace Lock 5100					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used Canon		
If yes, how many (circle one) 1 2 3 4 5 6			Which smart card are the photos on 1 2 3		
Is at least one post removable	✓		List the photograph numbers		

Describe the condition of the posts three Lewis post #1 Looking N. w/ reflectors / 3 protect weld on pad

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present		✓
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**	3/8" SS N.A.T.		
Is the water level measuring point marked	✓		**Surface Pad**	**Yes**	**No**
If yes, how MP "X" N. side AL cap/Ring			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition 4 ft circle		
Stick up of surface casing above concrete pad	23 in		good condition		
Stick up of well casing stick up above the pad	—		**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad	—		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	—		If yes, what is recorded WID 27 LF3-04		

Describe the general condition of the well S.W. 34 55 22w inside protect 18" steel surface casing N. 6847288.80 E 2918343.46 EL 4940.84 1997

Additional comments/Other hazards at the well

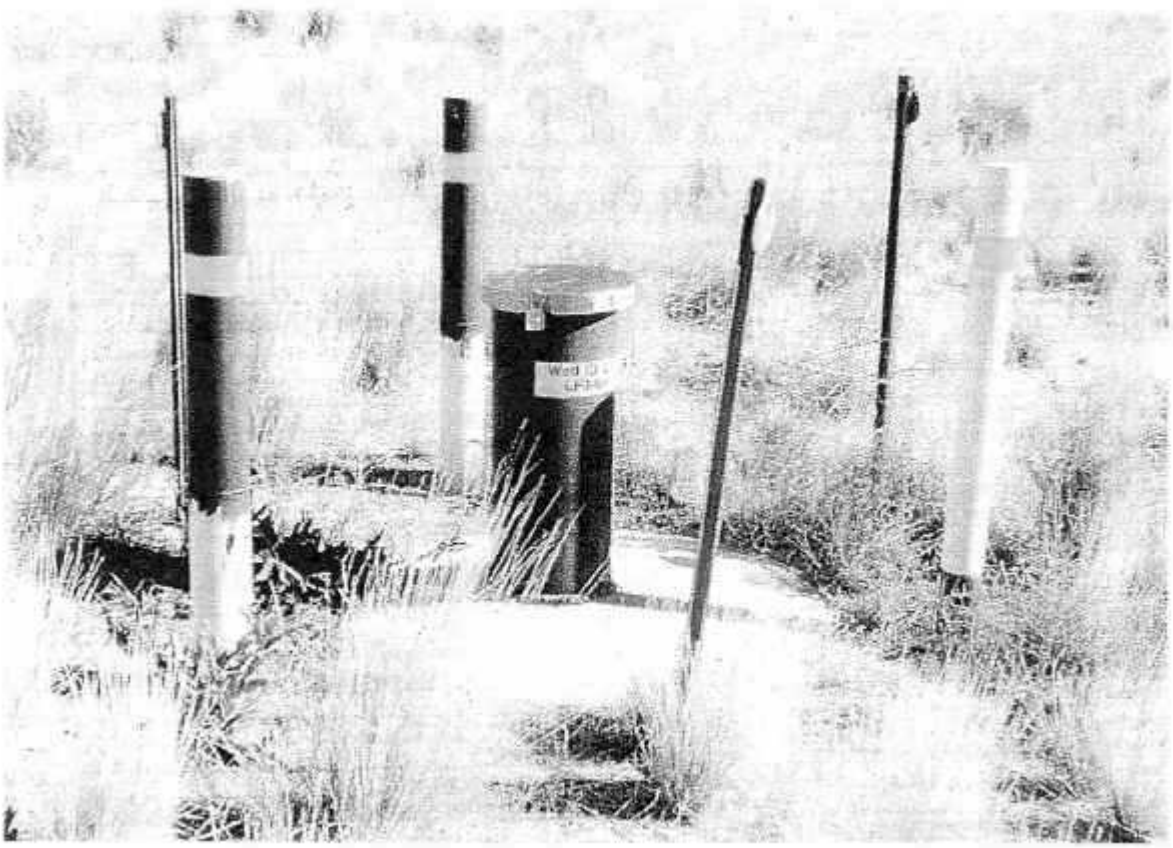
Checklist prepared by (print) G.W. Smalley	Checklist reviewed by (print) Wendell Foley
Signature: [illegible] Date: 5/31/01	Signature: [illegible] Date: 6/6/01

Well ID: 203

Well Name:LF3-04

Date:May 31, 2001

File Name:CFA\203 may 31 01.jpg



Well ID: 204	Well Name: LF 2-05
Date of Inspection: 5/31/01	Purpose of inspection (check one)
Location/Directions to the well: [illegible]	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No
Is well identified, marked with a tag etc		✓
If yes, describe how, where, and what it says:		

GPS Coordinates	
Easting:	3422 01
Northing:	4822 691
Projection:	UTM
Datum:	WGS 84
GPS grade:	Recreational

Locking well cap	Yes	No
Is cap or wellhead box present	✓	
If yes is it securely attached to the casing	✓	
How is it attached (circle one)	Welded	Bolted
Describe the condition of the cap	good	

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) yes Lock cut but left in place

Locks	Yes	No
Is the well locked upon departure	✓	
Identify the condition of the lock	USW	
Identify the type (mfgr) of lock, and the lock number	XSW Art LK 3100	

Electrical	Yes	No
Is an electrical plug present		✓
What type of plug is present (volts, amps)		

Protective Posts	Yes	No
Are protective posts present	✓	
If yes, are post painted yellow	✓	
If yes, how many (circle one)	1 2 (3) 4 5	
Is at least one post removable	✓	
Describe the condition of the posts	good	

Photographs	Yes	No
Was the well photographed	✓	
What camera was used	Leica	
Which smart card are the photos on	(1) 2 3	
List the photograph numbers	#24 Looking NW	

Materials	Yes	No
Is a water access line present		✓
If yes, what diameter is it		
If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it		

More materials	Yes	No
Is a discharge line present		✓
If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it		

Measuring point	Yes	No
Is the water level measuring point marked		✓
If yes, how		

Surface Pad	Yes	No
Is a concrete pad present		✓
If yes, describe the condition		

Stick up	Inches
Stick up of surface casing above concrete pad	—
Stick up of well casing stick up above the pad	16 10 in
Stick up of water access pipe above the pad	—
Stick up of water discharge pipe above the pad	—

Survey	Yes	No
Is a survey (brass) marker present		✓
If yes, what is recorded		

Describe the general condition of the well

good 1/2 steel PL well

Additional comments/Other hazards at the well

Checklist prepared by (print) [illegible]	Checklist reviewed by (print) Wanda Jolley
Signature: [illegible] Date: 5/31/01	Signature: [illegible] Date: 6/1/01

Well ID: 204

Well Name:LF3-05

Date:May 31, 2001

File Name:CFA\204 may 31 01.jpg

Well Inspection Checklist

Well ID: 205	**Well Name:** LF3-06		
Date of Inspection: 5/30/01		**Purpose of inspection (check one)**	
Location/Directions to the well: Loop 64 # 2			Institutional control
		✓	Routine maintenance
			Nonroutine maintenance
			Other

Identification	**Yes**	**No**	**GPS Coordinates**
Is well identified, marked with a tag etc	✓		Easting: 342203
If yes, describe how, where, and what it says: metal tag in			Northing: 4822 672
At well cap LF3-06 N. 483845.4			Projection: UTM
Elev 4941.6 E 291475.3			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	Bolted	

Describe the condition of the cap excellent

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) NO

Locks	**Yes**	**No**	**Electrical**	**Yes**	**No**
Is the well locked upon departure	✓		Is an electrical plug present		✓
Identify the condition of the lock NEW			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number NEW					
Am. Lock 5100					

Protective Posts	**Yes**	**No**	**Photographs**	**Yes**	**No**
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used	Canon	
If yes, how many (circle one) 1 2 (3) 4 5			Which smart card are the photos on	1 2 3	
Is at least one post removable	✓		List the photograph numbers		
Describe the condition of the posts good			# 23 Looking N		

Materials	**Yes**	**No**	**More materials**	**Yes**	**No**
Is a water access line present		✓	Is a discharge line present		✓
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it 3/8" SS NAT.		

Measuring point	**Yes**	**No**			
Is the water level measuring point marked	✓		**Surface Pad**	**Yes**	**No**
If yes, how MP "X" on N. Side Casing Ring			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition good Level		
Stick up of surface casing above concrete pad	24 7/8				
Stick up of well casing stick up above the pad			**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad			Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad			If yes, what is recorded NAD 27 N. 483807.77 E. 291681.05 Elev 4942.71 1994		

Describe the general condition of the well

Additional comments/Other hazards at the well good steel 18" well/surface casing

Checklist prepared by (print) S.W. Stanley		Checklist reviewed by (print) Wendell Jolley	
Signature: [illegible]	Date: 5/30/01	Signature: [illegible]	Date: 10/10/01

Well ID: 205

Well Name:LF3-06

Date:May 31, 2001

File Name:CFA\205 may 31 01.jpg

Well Inspection Checklist

Well ID: 206	Well Name: LF3-7
Date of Inspection: 5/30/01	Purpose of inspection (check one)
Location/Directions to the well: [illegible]	Institutional control
	Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates	
Is well identified, marked with a tag etc	✓		Easting:	242 176
If yes, describe how, where, and what it says: well identified on protective post - metal tag in AL cap N 68 374.7 E 29 574.7 GB-0941-3			Northing:	4822 562
			Projection:	UTM
			Datum:	WGS 84
Locking well cap	**Yes**	**No**	GPS grade:	Recreational
Is cap or wellhead box present				
If yes is it securely attached to the casing	✓			
How is it attached (circle one)	Welded	(Bolted)		

Describe the condition of the cap ✓ good AL 10¾" lockable well cap

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) No

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present		✓
Identify the condition of the lock	N/A		What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number	N/A				
Master Lock 5100					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used	[illegible]	
If yes, how many (circle one) 1 2 (3) 4 5			Which smart card are the photos on 0 2 3		
Is at least one post removable	✓		List the photograph numbers		
Describe the condition of the posts	good		22 22 looking N.		

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present		✓
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it ¾" 22 NAT/ [illegible]		

Measuring point	Yes	No			
Is the water level measuring point marked		✓	Surface Pad	Yes	No
If yes, how			Is a concrete pad present	✓	
Stick up	Inches		If yes, describe the condition	4 ft [illegible]	
Stick up of surface casing above concrete pad	2 ft 8 in				
Stick up of well casing stick up above the pad	—		Survey	Yes	No
Stick up of water access pipe above the pad	—		Is a survey (brass) marker present		
Stick up of water discharge pipe above the pad	—		If yes, what is recorded	LF3-07	NAD27
			N. 683 444.16		
Describe the general condition of the well			E 2916 00.47		
2 ft 5 in looking good condition el 4942.82					
N 24 7 in PVC well casing (1" Steel Surface casing)					

Additional comments/Other hazards at the well

Checklist prepared by (print) GW-Stuckey		Checklist reviewed by (print) [illegible]	
Signature: [illegible]	Date: 5/30/01	Signature: [illegible]	Date: 6/6/01

Well ID: 206

Well Name:LF3-07

Date:May 30, 2001

File Name:CFA\206 may 30 01.jpg

Well Inspection Checklist

Well ID: 207	Well Name: LF3-08
Date of Inspection: 5/30/11	Purpose of inspection (check one)
Location/Directions to the well: Rw CFA gate w S. side Landfill #3	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc	✓		Easting: 342 158
If yes, describe how, where, and what it says: well name painted on protective post			Northing: 7822 458
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	Bolted	
Describe the condition of the cap: excellent condition			
Can well be accessed without unlocking, and if so, how (ie unbolt the cap): no			

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present	✓	
Identify the condition of the lock: new			What type of plug is present (volts, amps): 30A 250V 1Φ		
Identify the type (mfgr) of lock, and the lock number: xsw Am. Lock 5100					
Protective Posts	**Yes**	**No**	**Photographs**	**Yes**	**No**
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used: Canon		
If yes, how many (circle one): 1 2 3 4 5			Which smart card are the photos on: 1 2 3		
Is at least one post removable		✓	List the photograph numbers: #18 looking N; #19 looking NW		
Describe the condition of the posts: good					
Materials	**Yes**	**No**	**More materials**	**Yes**	**No**
Is a water access line present	✓		Is a discharge line present	✓	
If yes, what diameter is it: 1¼"			If yes, what diameter: 1¼"		
If yes, what material type (circle one): stainless steel galvanized steel PVC other			If yes, what material type (circle one): stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked	✓		**Surface Pad**	**Yes**	**No**
If yes, how: "X" on N side coupler			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition: 2 ft²		
Stick up of surface casing above concrete pad	1 ft 3 in				
Stick up of well casing stick up above the pad			**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad	1 ft 7 in		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	1 ft 7 in		If yes, what is recorded: LF3-8		

Describe the general condition of the well: good steel 4" casing

Additional comments/Other hazards at the well:

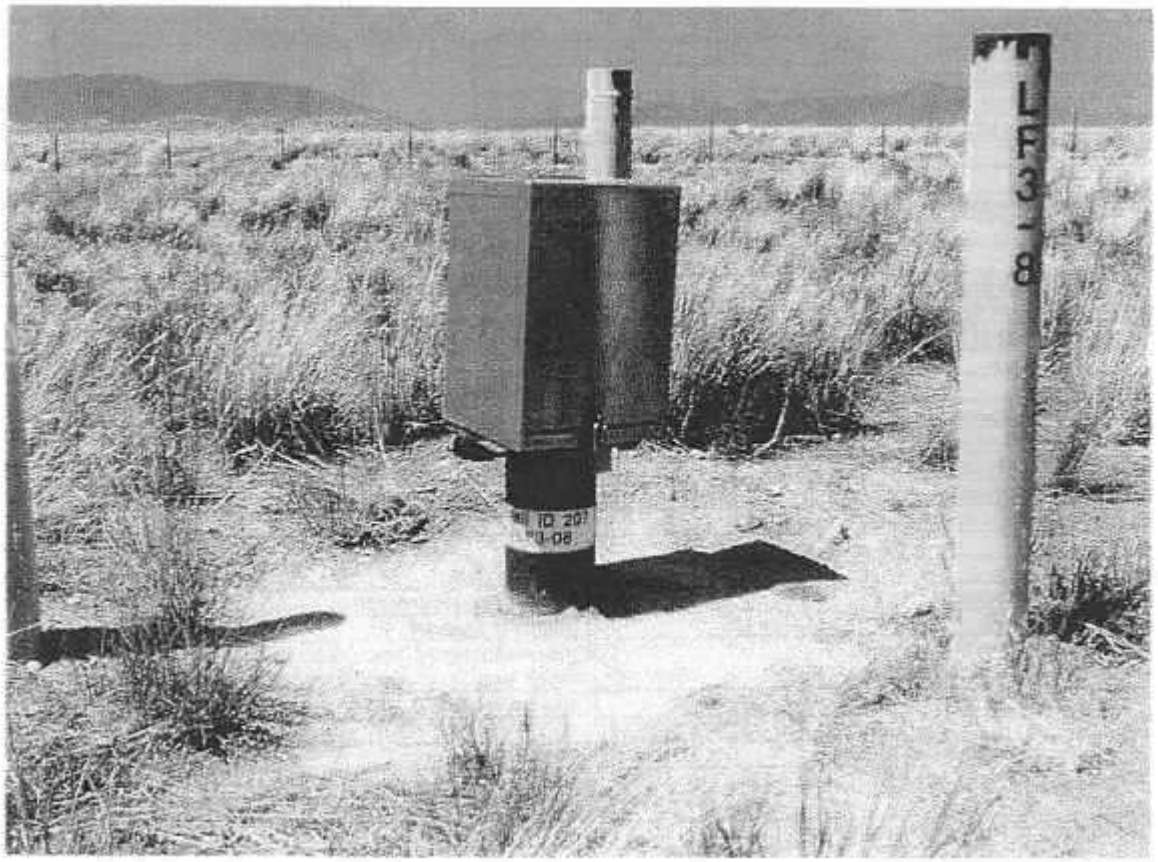
Checklist prepared by (print): Gus Sylvey	Checklist reviewed by (print): Wendell Jolley
Signature: [signature] Date: 6/30/11	Signature: [signature] Date: 6/30/11

Well ID: 207

Well Name:LF3-08

Date:May 30, 2001

File Name:CFA\207 may 30 01.jpg



Well ID: 207

Well Name:LF3-08

Date:May 30, 2001

File Name:CFA\207 may 30 01 open box.jpg

Well Inspection Checklist

Well ID: 727	Well Name: LF 3-10
Date of Inspection: 3/20/01	Purpose of Inspection (check one)
Location/Directions to the well: SW corner LF06 #7	Institutional control
N & W of fence junction	Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc	✓		Easting: 341958
If yes, describe how, where, and what it says: well name painted on protective post			Northing: 4822589
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	Bolted	

Describe the condition of the cap good - rest in wellhead box

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) no

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present	✓	
Identify the condition of the lock NEW			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number KEW Abus Lock 5100			30A 250 L9		

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used Canon		
If yes, how many (circle one) 1 2 3 4 5			Which smart card are the photos on 1 2 3		
Is at least one post removable		✓	List the photograph numbers		
Describe the condition of the posts good Surfaces #20 looking S2					
Two/one side painted #21 looking S2					

Materials	Yes	No	More materials	Yes	No
Is a water access line present	✓		Is a discharge line present	✓	
If yes, what diameter is it 1 1/4			If yes, what diameter 1 1/4		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		

Measuring point	Yes	No			
Is the water level measuring point marked		✓	Surface Pad	Yes	No
If yes, how			Is a concrete pad present		✓
Stick up	Inches		If yes, describe the condition		
Stick up of surface casing above concrete pad	—				
Stick up of well casing stick up above the pad	2ft 4in AGS		Survey	Yes	No
Stick up of water access pipe above the pad	2ft 7in AGS		Is a survey (brass) marker present		✓
Stick up of water discharge pipe above the pad	2ft 7in AGS		If yes, what is recorded		

Describe the general condition of the well well need protective surface casing well needs surface pad - Access OK well needs RE surveying

Additional comments/Other hazards at the well

Checklist prepared by (print) G.W. Studley		Checklist reviewed by (print) J. Wendell	
Signature: [signature]	Date: 5/30/01	Signature: [signature]	Date: 6/6/01

Well ID: 727

Well Name:LF3-10

Date:May 30, 2001

File Name:CFA\727 may 30 01.jpg

Well ID: 727

Well Name:LF3-10

Date:May 30, 2001

File Name:CFA\727 may 30 01 open box.jpg

Well Inspection Checklist

Well ID: 722	Well Name: LF3-11
Date of Inspection:	Purpose of inspection (check one)
Location/Directions to the well: N/W of Landfill #3	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc	✓		Easting: 342 520
If yes, describe how, where, and what it says: Well name			Northing: 4823 407
Painted on protective post / Brass survey			Projection: UTM
marker in cement pad			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present		✓	
If yes is it securely attached to the casing			
How is it attached (circle one)	Welded	Bolted	
Describe the condition of the cap			

Can well be accessed without unlocking, and if so, how (ie unbolt the cap)

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure		✓	Is an electrical plug present		✓
Identify the condition of the lock			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow	✓		What camera was used	C2000Z	
If yes, how many (circle one) 1 2 3 4 5			Which smart card are the photos on 1 2 3		
Is at least one post removable		✓	List the photograph numbers		
Describe the condition of the posts good			#6 looking W		

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present		✓
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked		✓	**Surface Pad**	**Yes**	**No**
If yes, how			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition		
Stick up of surface casing above concrete pad	1.5 in		3 ft 5 in		
Stick up of well casing stick up above the pad	—		**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad	—		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	—		If yes, what is recorded LF3-11		

Describe the general condition of the well well / surface casing 7" has been cut off @ pad & welded shut w/ steel plate

Additional comments/Other hazards at the well

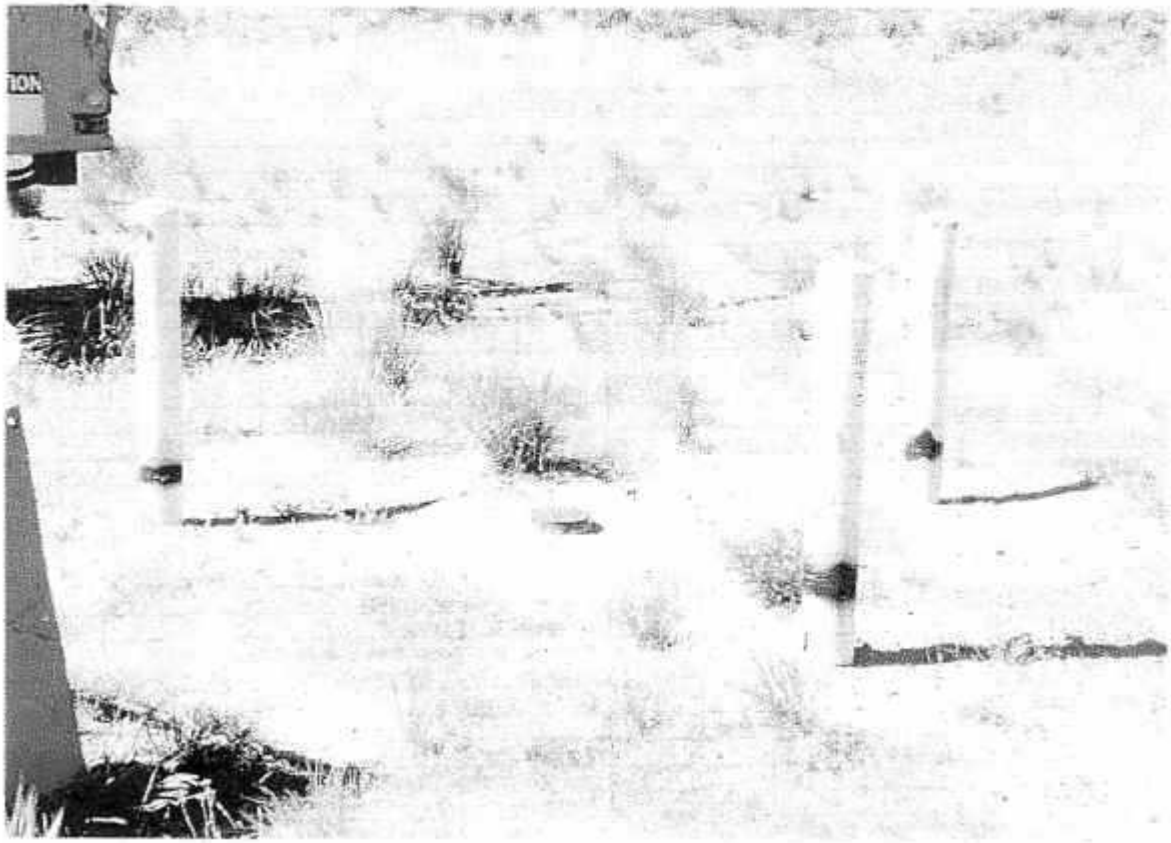
Checklist prepared by (print) Jesse Sharley		Checklist reviewed by (print) Wendell Jolley	
Signature: [illegible]	Date: 9/24/01	Signature: Wendell Jolley	Date: 6/6/02

Well ID: 722

Well Name:LF3-11

Date:May 31, 2001

File Name:CFA\722 may 31 01.jpg



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Well Inspection Checklist

Well ID: 1077	Well Name: CFA-MON-A-001
Date of Inspection: 5/13/01	Purpose of inspection (check one)
Location/Directions to the well:	Institutional control
1/4 mi S of CFA on dirt road	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc		✓	Easting: 342570
If yes, describe how, where, and what it says:			Northing: 4820137
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	(Bolted)	
Describe the condition of the cap Good			

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) No Yes 5/13/01 remove bolts on casing

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present	✓	
Identify the condition of the lock Nice			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number American Lock GEE			Male 4 prong 30amp, 600volt		

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present		✓	Was the well photographed	✓	
If yes, are post painted yellow		✓	What camera was used Coopet		
If yes, how many (circle one) 1 2 3 4 5			Which smart card are the photos on (1) 2 3		
Is at least one post removable			List the photograph numbers 12, 13, 14		
Describe the condition of the posts —			12 to east 13 to east 14 to east		

Materials	Yes	No	More materials	Yes	No
Is a water access line present	✓		Is a discharge line present	✓	
If yes, what diameter is it 1¼ in ID			If yes, what diameter 1½ in		
If yes, what material type (circle one) stainless steel (galvanized steel) PVC other			If yes, what material type (circle one) stainless steel (galvanized steel) PVC other		
If other, what is it			If other, what is it		

Measuring point	Yes	No			
Is the water level measuring point marked		✓	**Surface Pad**	Yes	No
If yes, how			Is a concrete pad present	✓	
Stick up	Inches		If yes, describe the condition Good		
Stick up of surface casing above concrete pad	1 ft 8½ in				
Stick up of well casing stick up above the pad	1 ft 11 in		Survey	Yes	No
Stick up of water access pipe above the pad	2 ft 1¾ in		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	2 ft 1¾ in		If yes, what is recorded CFA-MON-A-001		

Describe the general condition of the well Good

Additional comments/Other hazards at the well

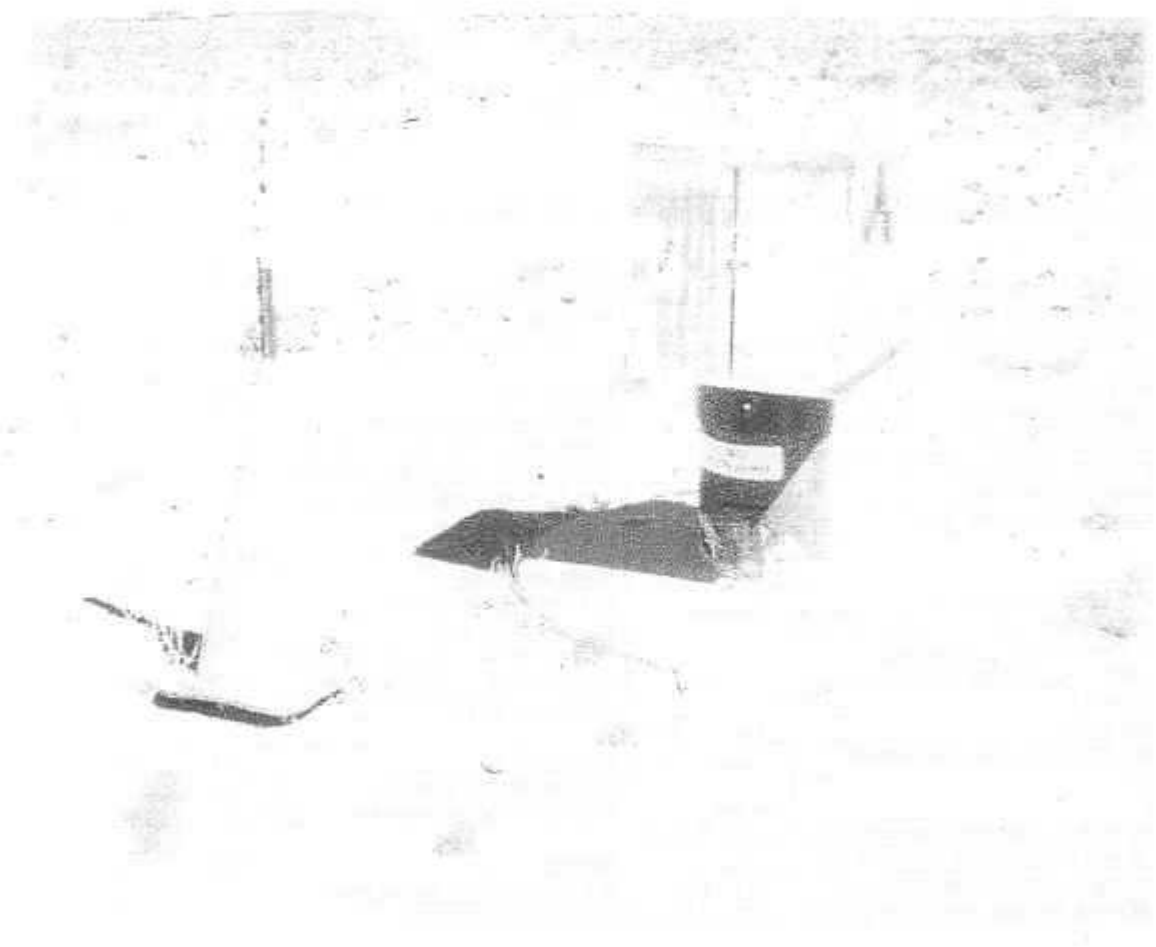
Checklist prepared by (print) D. Garcia		Checklist reviewed by (print) Wendell Jolley	
Signature: [signature]	Date: 5/13/01	Signature: Wendell Jolley	Date: 5/31/01

Well ID: 1077

Well Name:CFA-MON-A-001

Date:May 3, 2001

File Name:CFA\1077 may 3 01 closed box.jpg

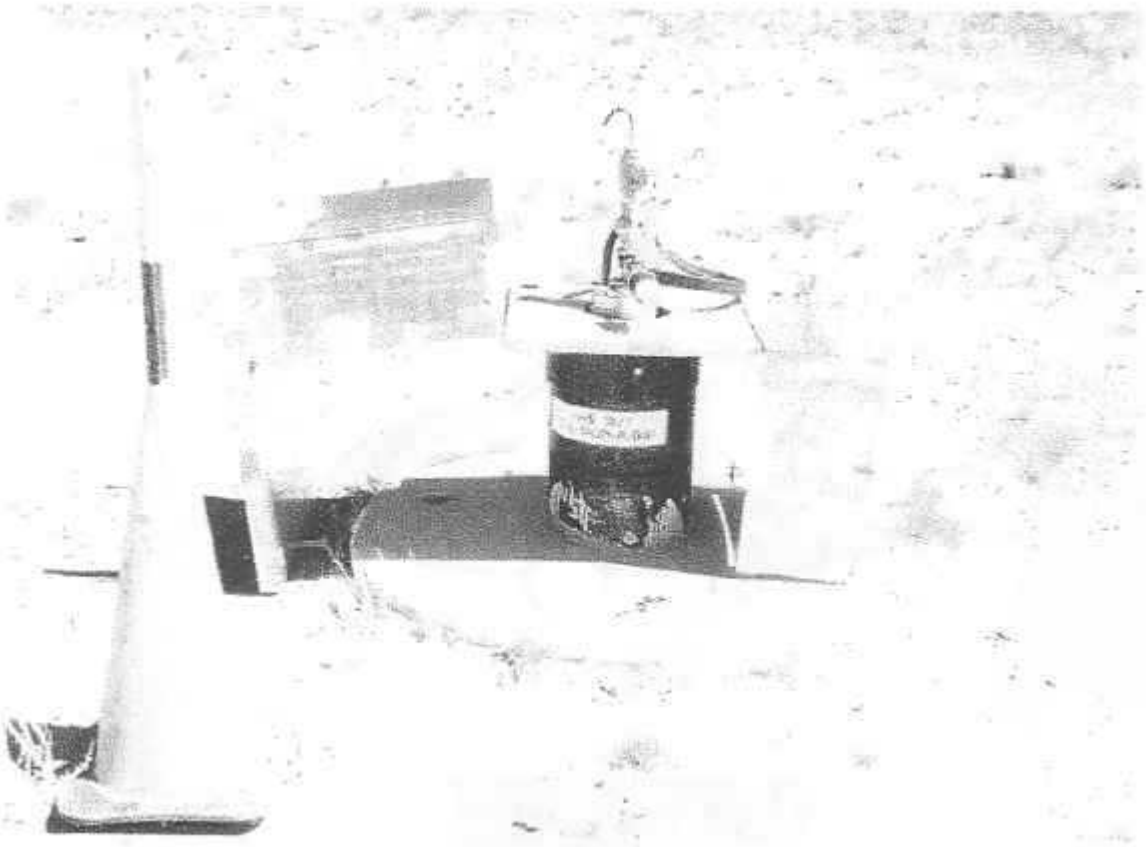


Well ID: 1077

Well Name:CFA-MON-A-001

Date:May 3, 2001

File Name:CFA\1077 may 3 01 open box.jpg

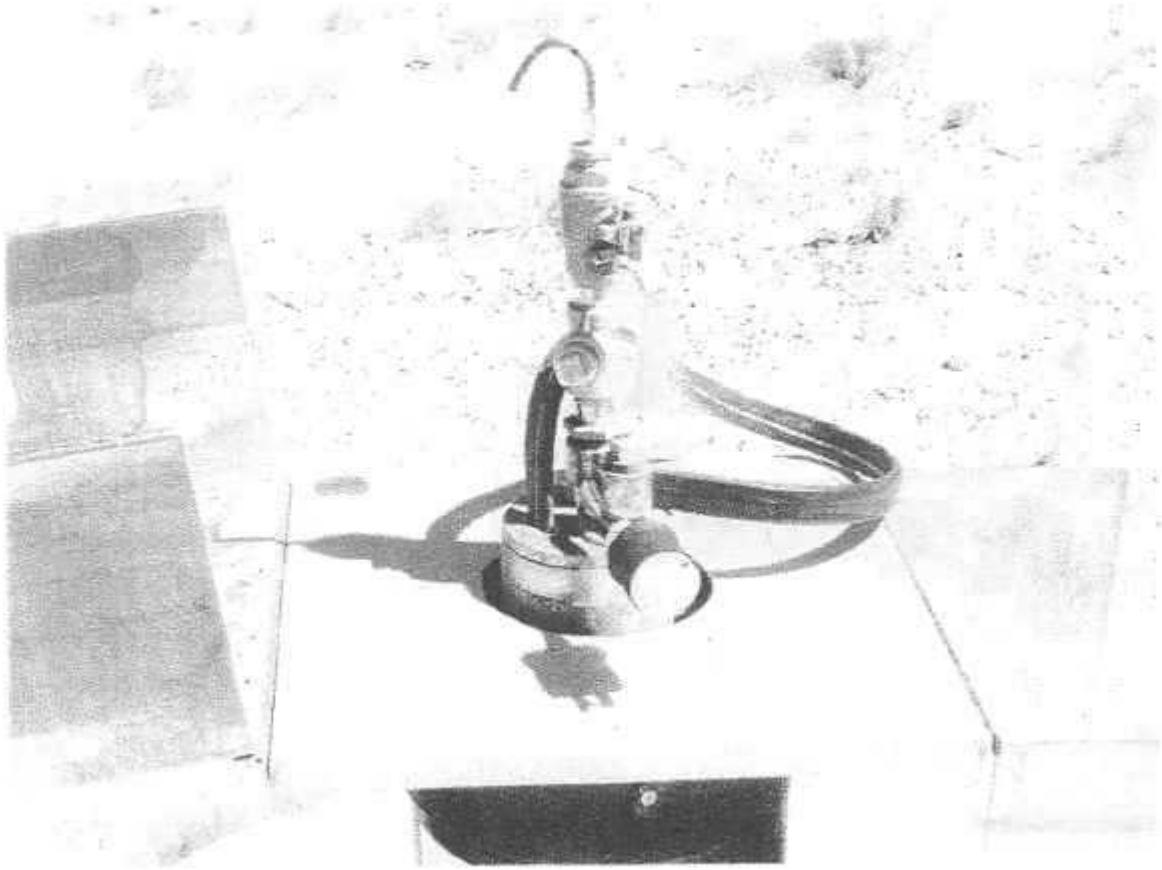


Well ID: 1077

Well Name:CFA-MON-A-001

Date:May 3, 2001

File Name:CFA\1077 may 3 01 plug.jpg



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Well Inspection Checklist

Well ID: 1078	Well Name: CFA-MW-4-002
Date of Inspection: 05-07-01	Purpose of inspection (check one)
Location/Directions to the well: Mi 7 yrs. 5. CFA distrib.	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No
Is well identified, marked with a tag etc		✓
If yes, describe how, where, and what it says:		

GPS Coordinates
Easting: 3430[illegible]71
Northing: 4820149
Projection: UTM
Datum: WGS 84
GPS grade: Recreational

Locking well cap	Yes	No
Is cap or wellhead box present	✓	
If yes is it securely attached to the casing	✓	
How is it attached (circle one)	Welded	Bolted ✓

Describe the condition of the cap excellent condition

Can well be accessed without unlocking, and if so, how (to unbolt the cap) Yes by unbolting hex bolts

Locks	Yes	No
Is the well locked upon departure	✓	
Identify the condition of the lock new		
Identify the type (mfgr) of lock, and the lock number American Lock 922		

Electrical	Yes	No
Is an electrical plug present	✓	
What type of plug is present (volts, amps) 4-prong 30 amp 125/250 Volts		

Protective Posts	Yes	No
Are protective posts present		✓
If yes, are post painted yellow		
If yes, how many (circle one) 1 2 3 4 5		
Is at least one post removable		
Describe the condition of the posts		

Photographs	Yes	No
Was the well photographed	✓	
What camera was used Canon		
Which smart card are the photos on 1 2 3		
List the photograph numbers (3)(2)-15-16-19		

Materials	Yes	No
Is a water access line present	✓	
If yes, what diameter is it 1.25" copper		
If yes, what material type (circle one) stainless steel ✓ galvanized steel PVC other		
If other, what is it		

More materials	Yes	No
Is a discharge line present	✓	
If yes, what diameter 1.25"		
If yes, what material type (circle one) stainless steel ✓ galvanized steel PVC other		
If other, what is it		

Measuring point	Yes	No
Is the water level measuring point marked	✓	
If yes, how x N. side casing		

	Inches
Stick up 1' 11"	
Stick up of surface casing above concrete pad	1' 7"
Stick up of well casing stick up above the pad	1' 9"
Stick up of water access pipe above the pad	1' 11"
Stick up of water discharge pipe above the pad	1' 11"

Surface Pad	Yes	No
Is a concrete pad present	✓	
If yes, describe the condition cracked in 3 places		

Survey	Yes	No
Is a survey (brass) marker present	✓	
If yes, what is recorded CFA-MW-4-002 ENEL 1995		

Describe the general condition of the well good condition

Additional comments/Other hazards at the well

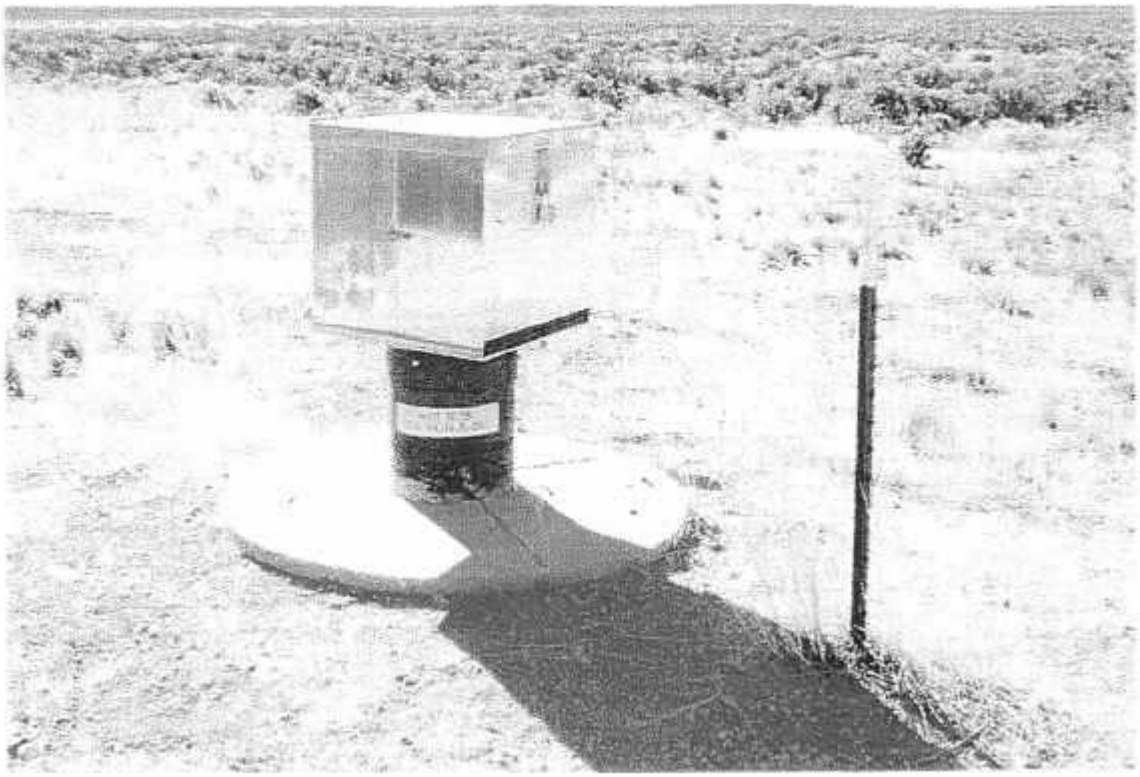
Checklist prepared by (print) G. W. Studley	Checklist reviewed by (print) Wendell Jolley
Signature: G.W. Studley	Signature: Wendell Jolley
Date: 05/07/01	Date: 5/9/01

Well ID: 1078

Well Name:CFA-MON-A-002

Date:May 7, 2001

File Name:CFA\1078 may 7 01.jpg

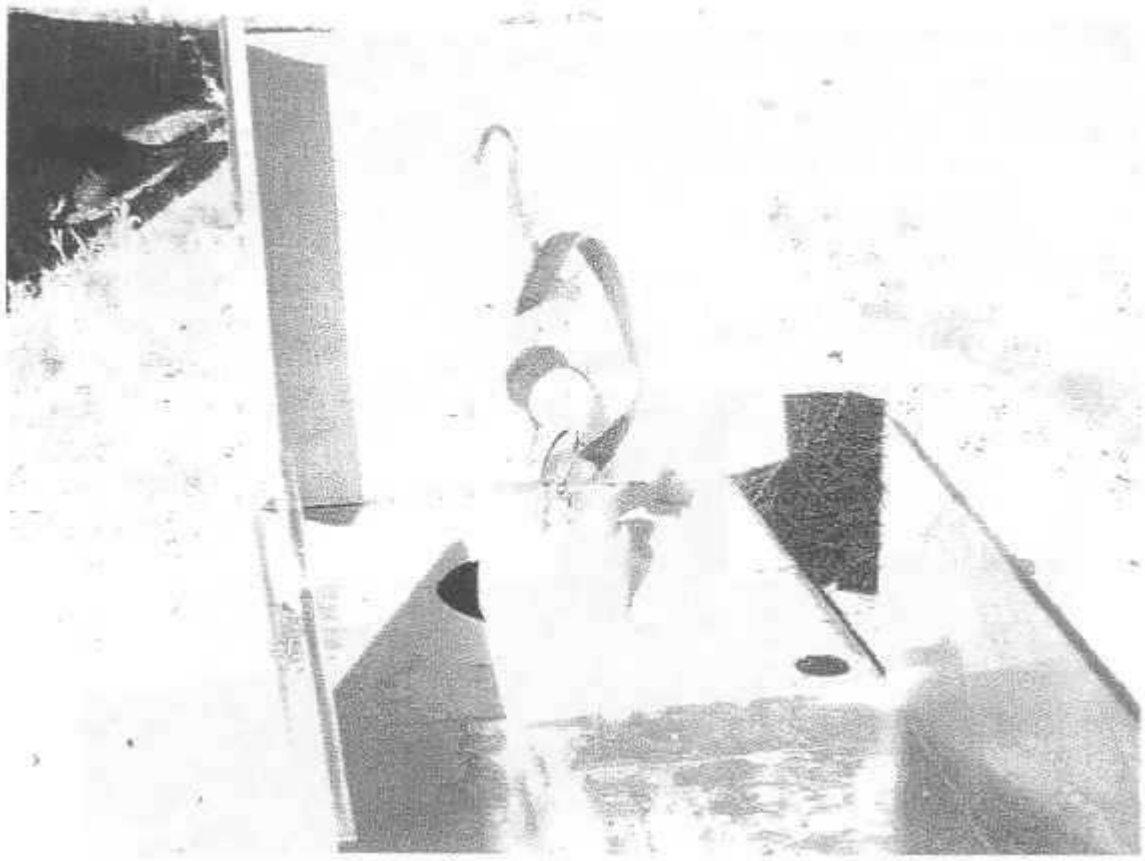


Well ID: 1078

Well Name:CFA-MON-A-002

Date:May 7, 2001

File Name:CFA\1078 may 7 01 plug.jpg



Well ID: 1078

Well Name:CFA-MON-A-002

Date:May 7, 2001

File Name:CFA\1078 may 7 01 open box.jpg

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Well Inspection Checklist

Well ID: 1089	Well Name: CFA-MW-A-003
Date of Inspection: 05-07-01	Purpose of Inspection (check one)
Location/Directions to the well: ~ 3/4 mi. SE CFA on dirt Rd.	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc		✓	Easting: 343547
If yes, describe how, where, and what it says:			Northing: 4820143
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	(Bolted)	

Describe the condition of the cap excellent

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) Yes unbolt hex bolts

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present	✓	
Identify the condition of the lock new			What type of plug is present (volts, amps) 4 prong 30A 125/250 volts		
Identify the type (mfgr) of lock, and the lock number American Lock 825					
Protective Posts	**Yes**	**No**	**Photographs**	**Yes**	**No**
Are protective posts present		✓	Was the well photographed	✓	
If yes, are post painted yellow			What camera was used CE 8002		
If yes, how many (circle one) 1 2 3 4 5			Which smart card are the photos on (1) 2 3		
Is at least one post removable			List the photograph numbers (2) 17-18		
Describe the condition of the posts					

Materials	Yes	No	More materials	Yes	No
Is a water access line present	✓		Is a discharge line present	✓	
If yes, what diameter is it	1.25"		If yes, what diameter	1.25"	
If yes, what material type (circle one) stainless steel (galvanized steel) PVC other			If yes, what material type (circle one) stainless steel (galvanized steel) PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked		✓	**Surface Pad**	**Yes**	**No**
If yes, how			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition good		
Stick up of surface casing above concrete pad	1' 3"				
Stick up of well casing stick up above the pad	1' 5"		**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad	1' 10"		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	1' 7"		If yes, what is recorded CFA-MW-A-003 INEL 1995		

Describe the general condition of the well v. good

Additional comments/Other hazards at the well

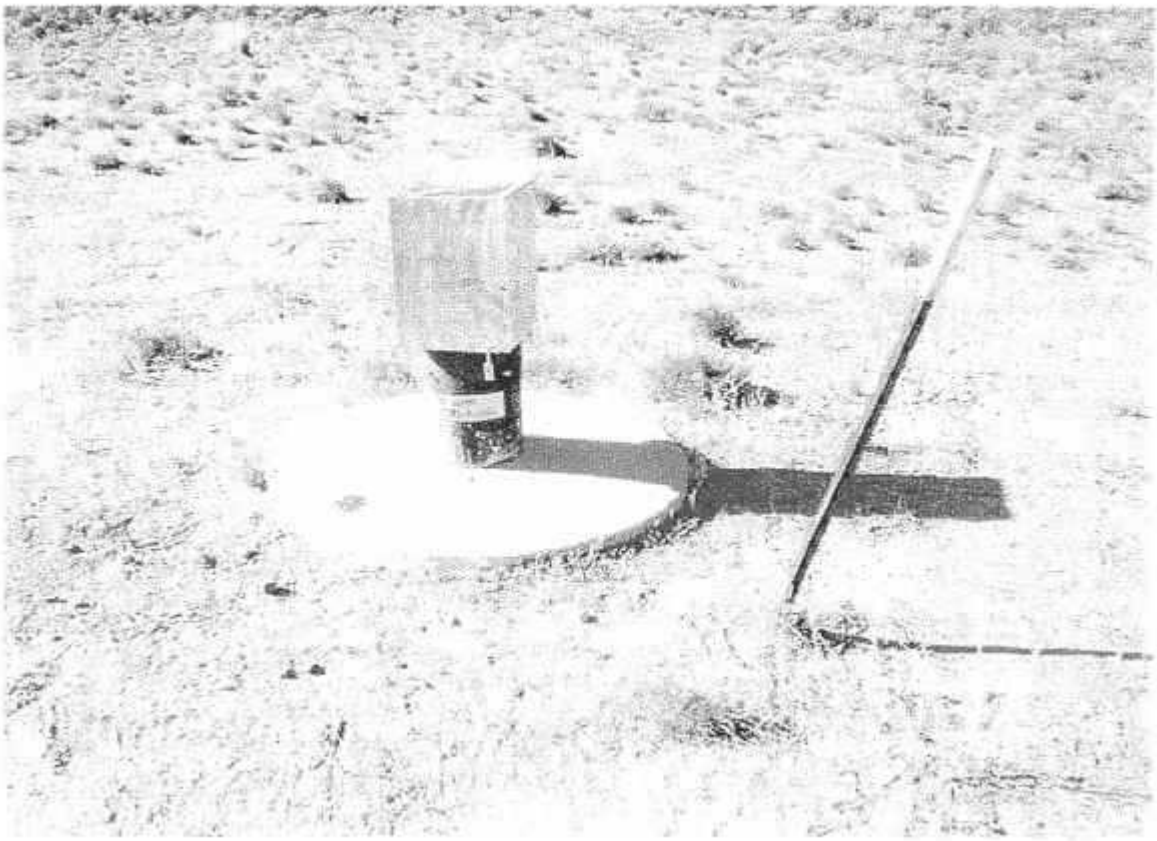
Checklist prepared by (print) R.W. Stanley	Checklist reviewed by (print) Wendell Jolley
Signature: [signature] Date: 06/08/01	Signature: [signature] Date: 5/9/01

Well ID: 1089

Well Name:CFA-MON-A-003

Date:May 7, 2001

File Name:CFA\1089 may 7 01.jpg

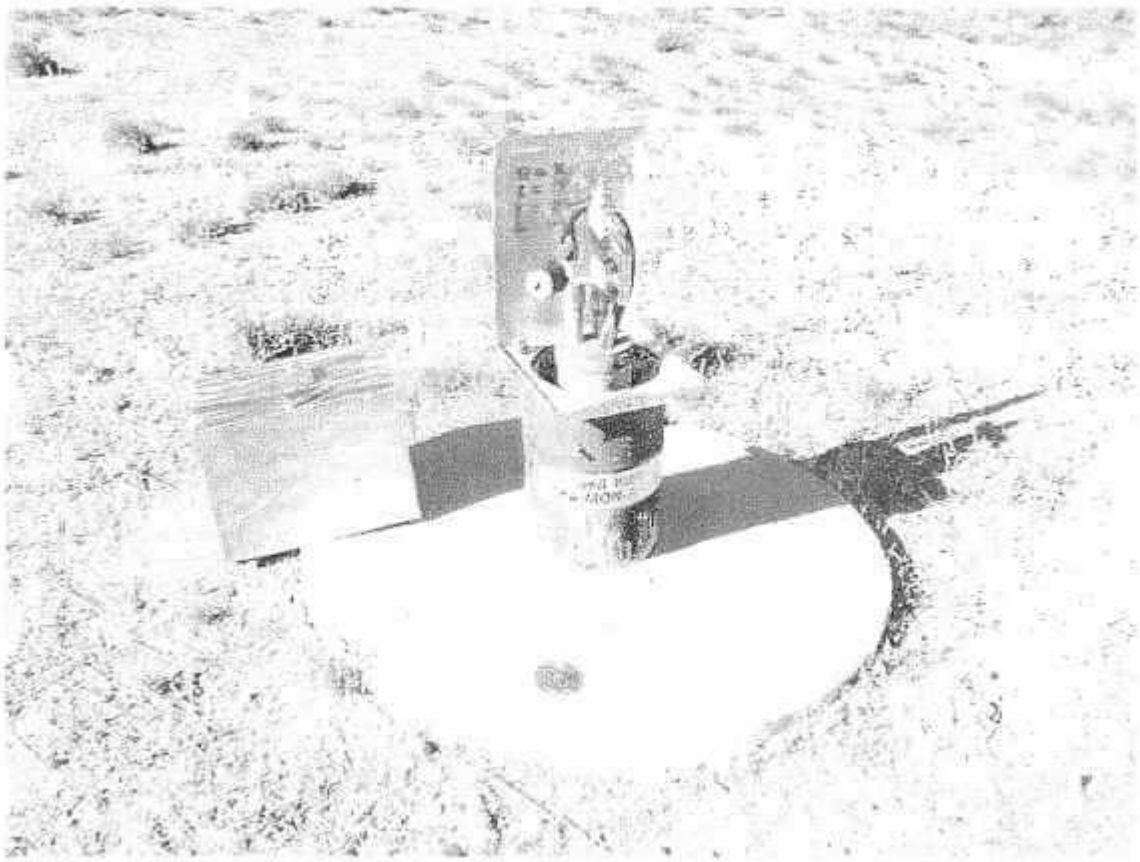


Well ID: 1089

Well Name:CFA-MON-A-003

Date:May 7, 2001

File Name:CFA\1089 may 7 01 open box.jpg



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Well Inspection Checklist

Well ID: 1254	Well Name: GFA-GBS-V-004
Date of Inspection: 5/3/01	Purpose of inspection (check one)
Location/Directions to the well:	Institutional control
Yuma N of Portland Ave east of Landfill 1,	✓ Routine maintenance
1 yard W of major intersection of Portland-Lincoln	Nonroutine maintenance
no track road.	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc		✓	Easting: 342433
If yes, describe how, where, and what it says: —			Northing: 4827580
GSP-1001			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	(Bolted)	

Describe the condition of the cap Good

Existing lock (old lock) was cut

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) No

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present		✓
Identify the condition of the lock New			What type of plug is present (volts, amps) —		
Identify the type (mfgr) of lock, and the lock number					
American Lock QEC					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed		
If yes, are post painted yellow		✓	What camera was used		
If yes, how many (circle one)	1 2 (3) 4 5		Which insert card are the photos on	(1) 2 3	
Is at least one post removable	✓		List the photograph numbers 7		
Describe the condition of the posts Good			Photo taken looking NW		

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present		✓
If yes, what diameter is it —			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it —			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked	✓		**Surface Pad**	**Yes**	**No**
If yes, how Mk "X" on N. side			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition Good		
Stick up of surface casing above concrete pad	2.5 inches				
Stick up of well casing stick up above the pad	24 inches		**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad	–		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	–		If yes, what is recorded GSP1-01		

NAD27 coordinates

Describe the general condition of the well

Good

Nor 683536.22

Eas 293418.02

Elev 4937.35

3" Metal casing, flat – 4 inner steel inside protector.

Additional comments/Other hazards at the well

Old lock was cut upon arrival WJ 5/7/01

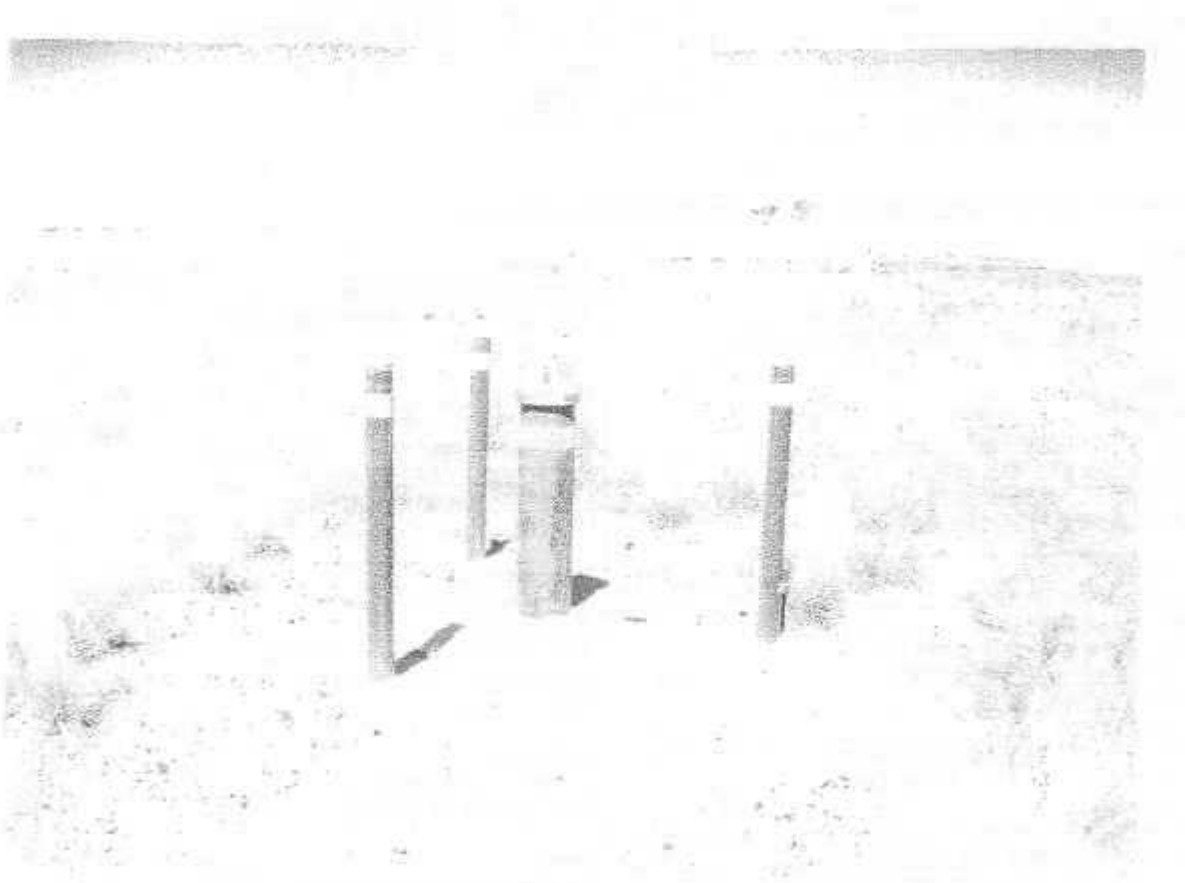
Checklist prepared by (print) R Garcia		Checklist reviewed by (print) Wendell Jolley	
Signature: [signature]	Date: 5/3/01	Signature: [signature]	Date: 5/7/01

Well ID: 1254

Well Name: CFA-GAS-V-004

Date: May 3, 2001

File Name:CFA\1254 may 3 01.jpg



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Well Inspection Checklist

Well ID: 1255	Well Name: CFA - GAS-V-005
Date of Inspection: 5/2/01	Purpose of inspection (check one)
Location/Directions to the well: 0.1 mi. N of Portland/Lincoln intersection, 0.25 mi. E down dirt road on south side of fence	Institutional control
	✓ Routine maintenance
	Nonroutine maintenance
	Other

Identification	Yes	No
Is well identified, marked with a tag etc		✓
If yes, describe how, where, and what it says:		

GPS Coordinates
Easting: 343116
Northing: 4822361
Projection: UTM
Datum: WGS 84
GPS grade: Recreational

Locking well cap	Yes	No
Is cap or wellhead box present	✓	
If yes is it securely attached to the casing	✓	
How is it attached (circle one)	Welded	Bolted

Describe the condition of the cap Good

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) No

Locks	Yes	No
Is the well locked upon departure	✓	
Identify the condition of the lock New		
Identify the type (mfgr) of lock, and the lock number American Lock 0656		

Electrical	Yes	No
Is an electrical plug present		✓
What type of plug is present (volts, amps)		

Protective Posts	Yes	No
Are protective posts present	✓	
If yes, are post painted yellow		✓
If yes, how many (circle one)	1 2 (3) 4 5	
Is at least one post removable	✓	
Describe the condition of the posts Good		

Photographs	Yes	No
Was the well photographed	✓	
What camera was used C2000		
Which smart card are the photos on (1) 2 3		
List the photograph numbers 10		
Photo looking East		

Materials	Yes	No
Is a water access line present	✓	
If yes, what diameter is it		
If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it		

More materials	Yes	No
Is a discharge line present		✓
If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it		

Measuring point	Yes	No
Is the water level measuring point marked	✓	
If yes, how "X" on N. side (M.P.)		

Surface Pad	Yes	No
Is a concrete pad present	✓	
If yes, describe the condition Good		

Stick up	Inches
Stick up of surface casing above concrete pad	2 ft 8 in
Stick up of well casing stick up above the pad	22 in
Stick up of water access pipe above the pad	—
Stick up of water discharge pipe above the pad	—

Survey	Yes	No
Is a survey (brass) marker present	✓	
If yes, what is recorded		

GSP2-01
N9027
Northing 682849.49
Easting 294688.85
Elev 4930.63

Describe the general condition of the well Good
[N gas (vapor) parts on 2" steel]
Exterior pipe weld protect casing

Additional comments/Other hazards at the well

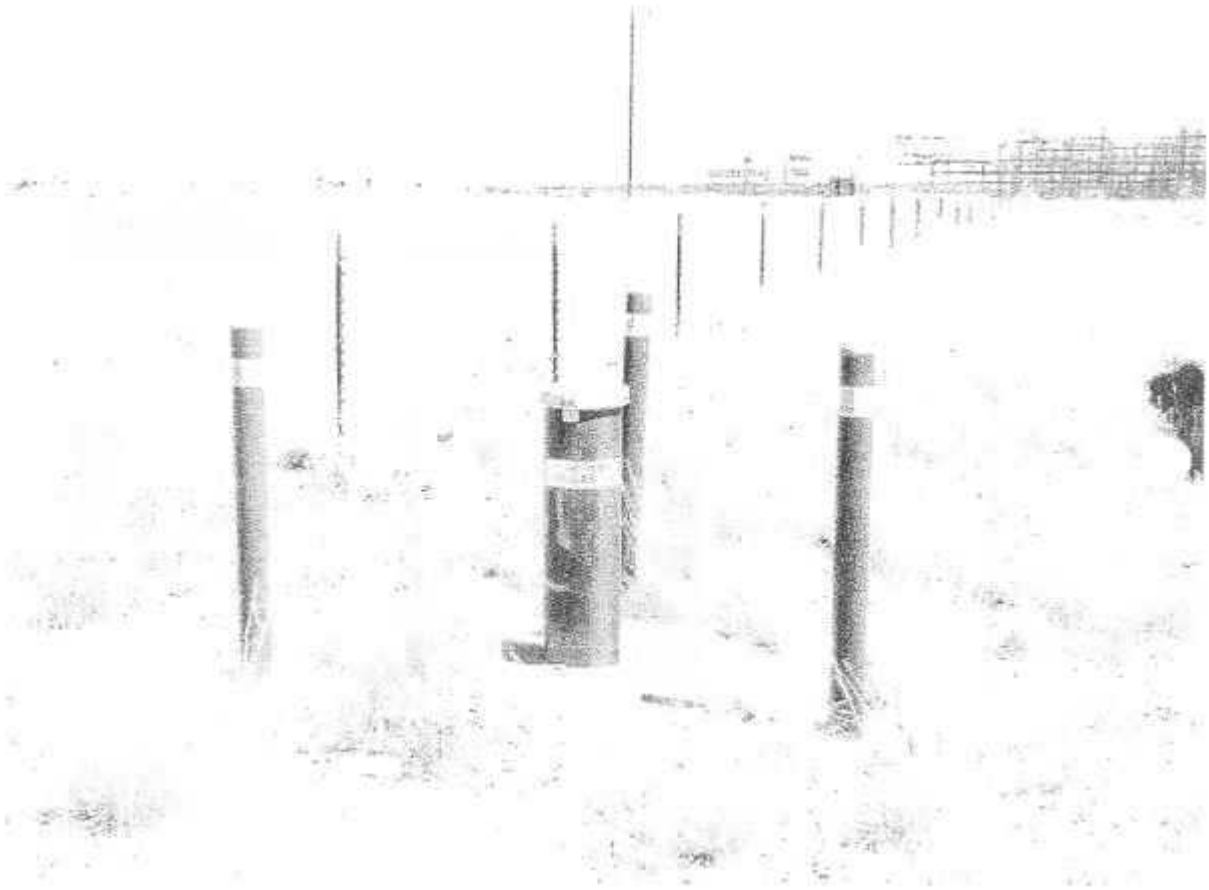
Checklist prepared by (print) R Garcia	Checklist reviewed by (print) Wendell Jolley
Signature: [signature] Date: 5/2/01	Signature: [signature] Date: 5/2/01

Well ID: 1255

Well Name: CFA-GAS-V-005

Date of Photo: May 2, 2001

File: ...\CFA\1255 May 2 01.jpg

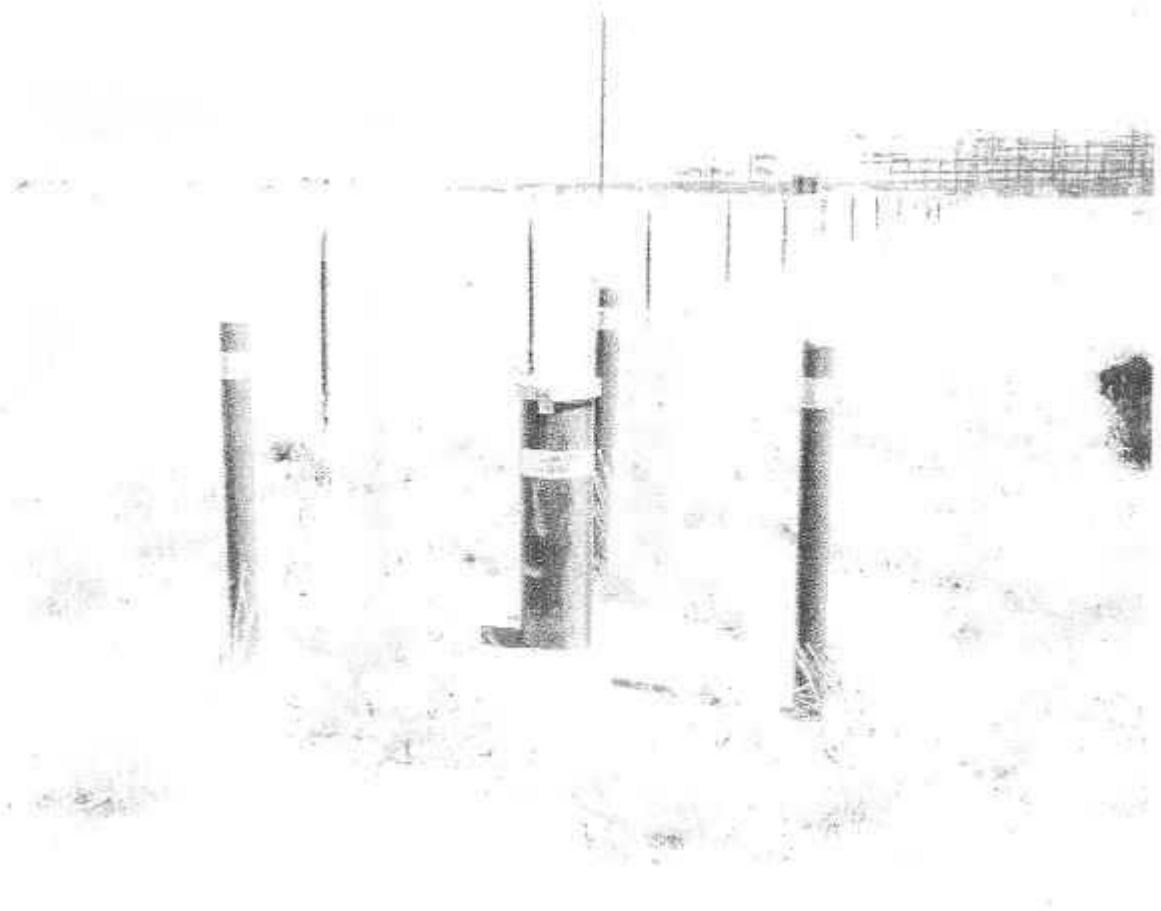


Well ID: 1255

Well Name: CFA-GAS-V-005

Date: May 3, 2001

File Name:CFA\1255 may 3 01.jpg



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Well Inspection Checklist

Well ID: 1256	Well Name: CFA-GRS-V-006
Date of Inspection: 5/3/01	Purpose of Inspection (check one)
Location/Directions to the well:	Institutional control
0.3 mi N on Lincoln from Portland/Lincoln	✓ Routine maintenance
intersection. Well is on E side of road	Nonroutine maintenance
	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc		✓	Easting: 342948
If yes, describe how, where, and what it says:			Northing: 4827604
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	(Bolted)	

Describe the condition of the cap Good

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) No

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present		✓
Identify the condition of the lock New			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number					
American Lock QEE					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow		✓	What camera was used C2000z		
If yes, how many (circle one)	1 2 (3) 4 5		Which smart card are the photos on	(1) 2 3	
Is at least one post removable	✓		List the photograph numbers 11		
Describe the condition of the posts Good			Photo taken to 9		

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present		✓
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		

Measuring point	Yes	No			
Is the water level measuring point marked	✓		Surface Pad	Yes	No
If yes, how "X" on Grade (M.P.)			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition Good		
Stick up of surface casing above concrete pad	3 ft 1 in				
Stick up of well casing stick up above the pad	— 2 in		Survey	Yes	No
Stick up of water access pipe above the pad	—		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	—		If yes, what is recorded		
			GSP2-02		

Describe the general condition of the well Good — Northing 683639.07
4 vapor ports inside protective casing. — Easting 294128.07
attached to 2" carbon (metal) pipe — Elev. 4937.51

Additional comments/Other hazards at the well

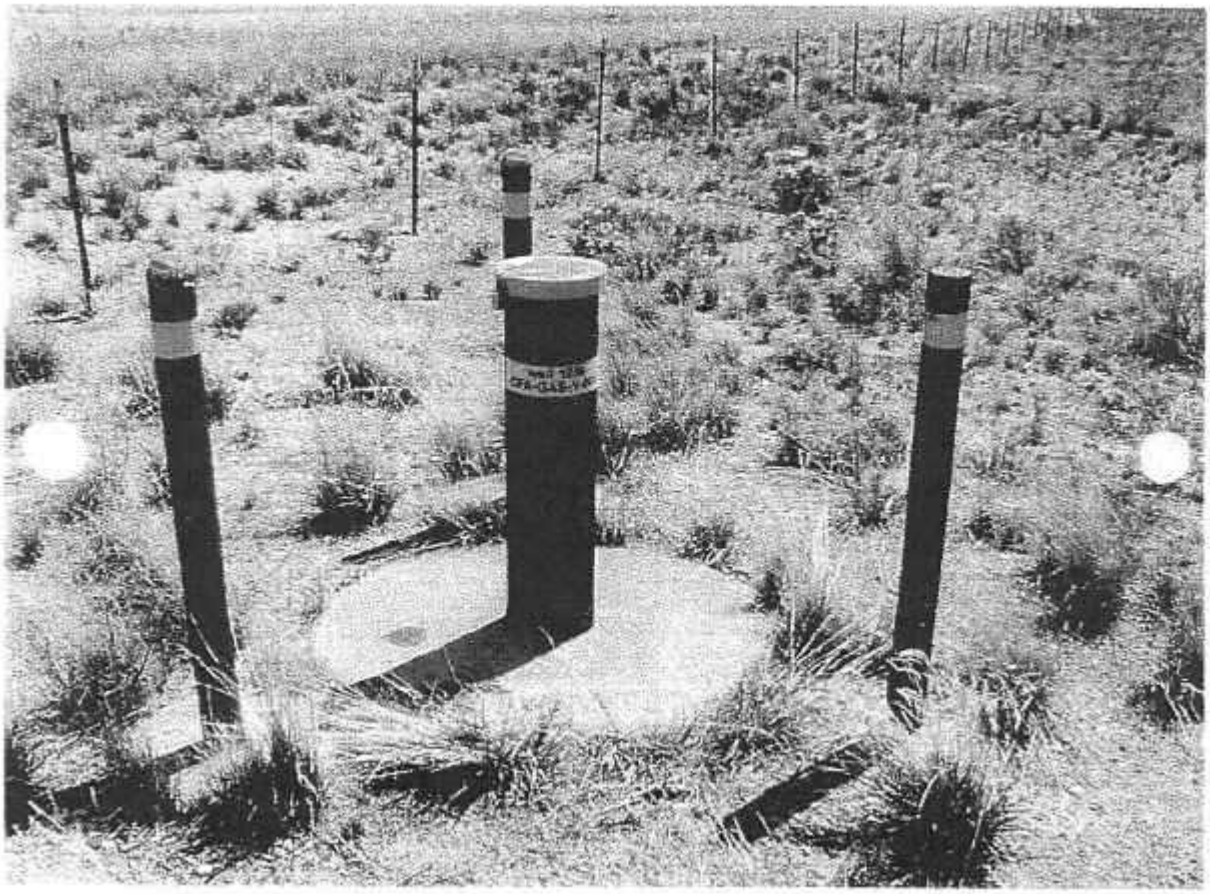
Checklist prepared by (print) JR Garcia		Checklist reviewed by (print) Wendell Jolley	
Signature: [signature]	Date: 5/2/01	Signature: Wendell B Jolley	Date: 5/7/01

Well ID: 1256

Well Name: CFA-GAS-V-006

Date of Photo: May 3, 2001

File: ...\CFA\1256 May 3 01.jpg

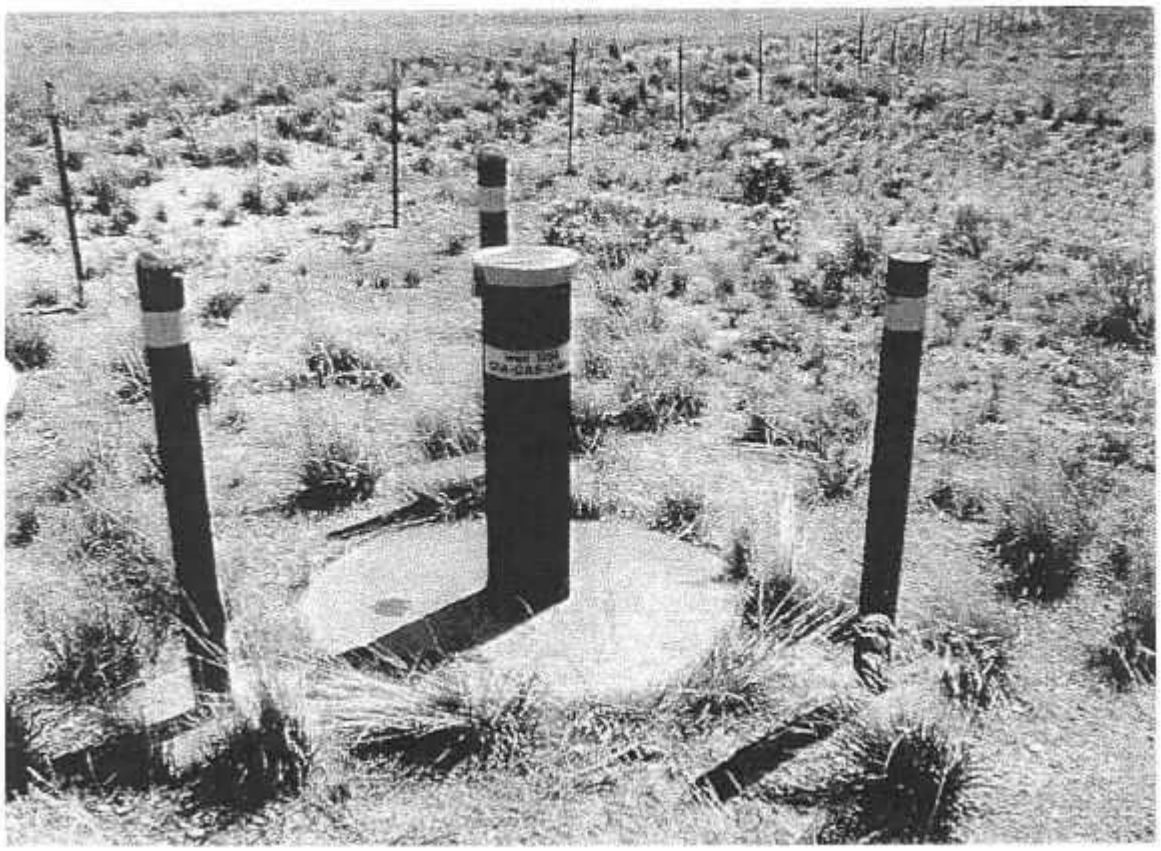


Well ID: 1256

Well Name: CFA-GAS-V-006

Date: May 3, 2001

File Name:CFA\1256 may 3 01.jpg



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Well Inspection Checklist

Well ID: 1257	Well Name: CFA-GAS-V-007
Date of Inspection: 5/3/01	Purpose of Inspection (check one)
Location/Directions to the well:	Institutional control
1/4 mi down road between landfill #1/4	✓ Routine maintenance
landfill #3	Nonroutine maintenance
	Other

Identification	Yes	No
Is well identified, marked with a tag etc		✓
If yes, describe how, where, and what it says:		

GPS Coordinates	
Easting:	342189
Northing:	4822692
Projection:	UTM
Datum:	WGS 84
GPS grade:	Recreational

Locking well cap	Yes	No
Is cap or wellhead box present	✓	
If yes is it securely attached to the casing	✓	
How is it attached (circle one)	Welded	(Bolted)
Describe the condition of the cap: Good		

Can well be accessed without unlocking, and if so, how (to unbolt the cap): No

Locks	Yes	No
Is the well locked upon departure	✓	
Identify the condition of the lock: New		
Identify the type (mfgr) of lock, and the lock number: American Lock 0FE		

Electrical	Yes	No
Is an electrical plug present		✓
What type of plug is present (volts, amps)		

Protective Posts	Yes	No
Are protective posts present	✓	
If yes, are post painted yellow		✓
If yes, how many (circle one)	1 2 (3) 4 5	
Is at least one post removable	✓	
Describe the condition of the posts: Good		

Photographs	Yes	No
Was the well photographed	✓	
What camera was used: C 8000		
Which smart card are the photos on: (1) 2 3		
List the photograph numbers: 8		
Photo to 8		

Materials	Yes	No
Is a water access line present		✓
If yes, what diameter is it		
If yes, what material type (circle one): stainless steel, galvanized steel, PVC, other		
If other, what is it		

More materials	Yes	No
Is a discharge line present		✓
If yes, what diameter		
If yes, what material type (circle one): stainless steel, galvanized steel, PVC, other		
If other, what is it		

Measuring point	Yes	No
Is the water level measuring point marked	✓	
If yes, how "X" on side (N,R)		

Surface Pad	Yes	No
Is a concrete pad present	✓	
If yes, describe the condition: Good		

Stick up	Inches
Stick up of surface casing above concrete pad	3 ft 2½ in
Stick up of well casing stick up above the pad	~ 26 in
Stick up of water access pipe above the pad	—
Stick up of water discharge pipe above the pad	—

Survey	Yes	No
Is a survey (brass) marker present	✓	
If yes, what is recorded: GSP3-01		
NAD27 coordinates		
Northing 693893.79		
Easting 39,968.15		
Elev 4939.04		

Describe the general condition of the well: Good
4 wooden posts on 2" metal conduit pipe

Additional comments/Other hazards at the well:
Old lock was cut upon arrival. WJ 5/7/01

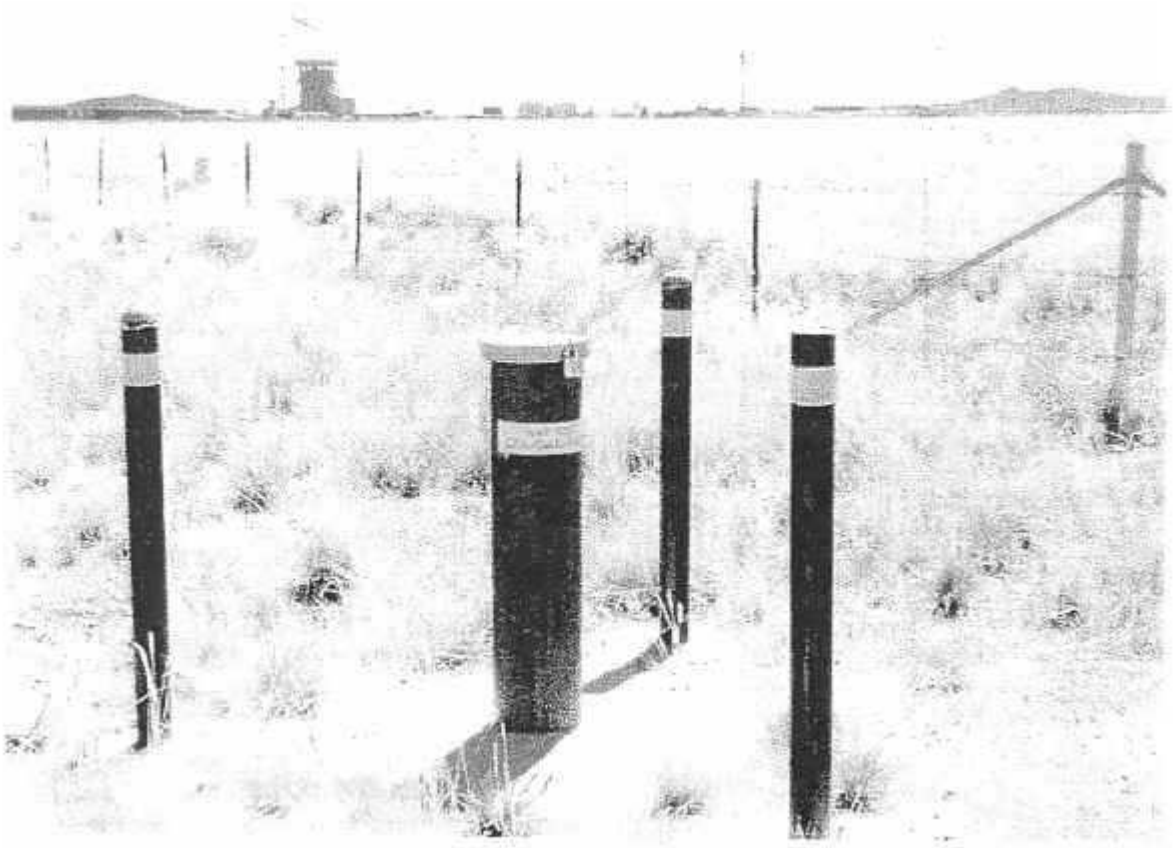
Checklist prepared by (print): R Garcia	Checklist reviewed by (print): Wendell Jolley
Signature: [signature] Date: 5/3/01	Signature: [signature] Date: 5/7/01

Well ID: 1257

Well Name: CFA-GAS-V-007

Date: May 3, 2001

File Name:CFA\1257 may 3 01.jpg



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Well Inspection Checklist

Well ID: 1258	Well Name: CEA-GMS-V-008
Date of Inspection: 5/3/01	Purpose of inspection (check one)
Location/Directions to the well:	Institutional control
1/4 w down Portland from Lincoln/Portland intersection,	✓ Routine maintenance
ya Near dirt road after fence Vent,	Nonroutine maintenance
well in on E side of road	Other

Identification	Yes	No	GPS Coordinates
Is well identified, marked with a tag etc		✓	Easting: 342335
If yes, describe how, where, and what it says:			Northing: 482.3005
			Projection: UTM
			Datum: WGS 84
Locking well cap	**Yes**	**No**	GPS grade: Recreational
Is cap or wellhead box present	✓		
If yes is it securely attached to the casing	✓		
How is it attached (circle one)	Welded	(Bolted)	

Describe the condition of the cap Good

Can well be accessed without unlocking, and if so, how (ie unbolt the cap) No

Locks	Yes	No	Electrical	Yes	No
Is the well locked upon departure	✓		Is an electrical plug present		✓
Identify the condition of the lock Good			What type of plug is present (volts, amps)		
Identify the type (mfgr) of lock, and the lock number Master Lock #66					

Protective Posts	Yes	No	Photographs	Yes	No
Are protective posts present	✓		Was the well photographed	✓	
If yes, are post painted yellow		✓	What camera was used CE0003		
If yes, how many (circle one)	1 2 (3) 4 5		Which smart card are the photos on	(1) 2 3	
Is at least one post removable	✓		List the photograph numbers 9		
Describe the condition of the posts Good			Photo to E		

Materials	Yes	No	More materials	Yes	No
Is a water access line present		✓	Is a discharge line present		✓
If yes, what diameter is it			If yes, what diameter		
If yes, what material type (circle one) stainless steel galvanized steel PVC other			If yes, what material type (circle one) stainless steel galvanized steel PVC other		
If other, what is it			If other, what is it		
Measuring point	**Yes**	**No**			
Is the water level measuring point marked	✓		**Surface Pad**	**Yes**	**No**
If yes, how MP. "X" outside (N)			Is a concrete pad present	✓	
Stick up	**Inches**		If yes, describe the condition Good pad		
Stick up of surface casing above concrete pad	3 ft 2 in				
Stick up of well casing stick up above the pad	— Very		**Survey**	**Yes**	**No**
Stick up of water access pipe above the pad	—		Is a survey (brass) marker present	✓	
Stick up of water discharge pipe above the pad	—		If yes, what is recorded		

GSP3-02-
NORTHING 684927.13
EASTING 392096.75
ELEV 4937.42

Describe the general condition of the well excellent
4 upper parts of 3" metal access pipe
inside painted, such. casing

Additional comments/Other hazards at the well

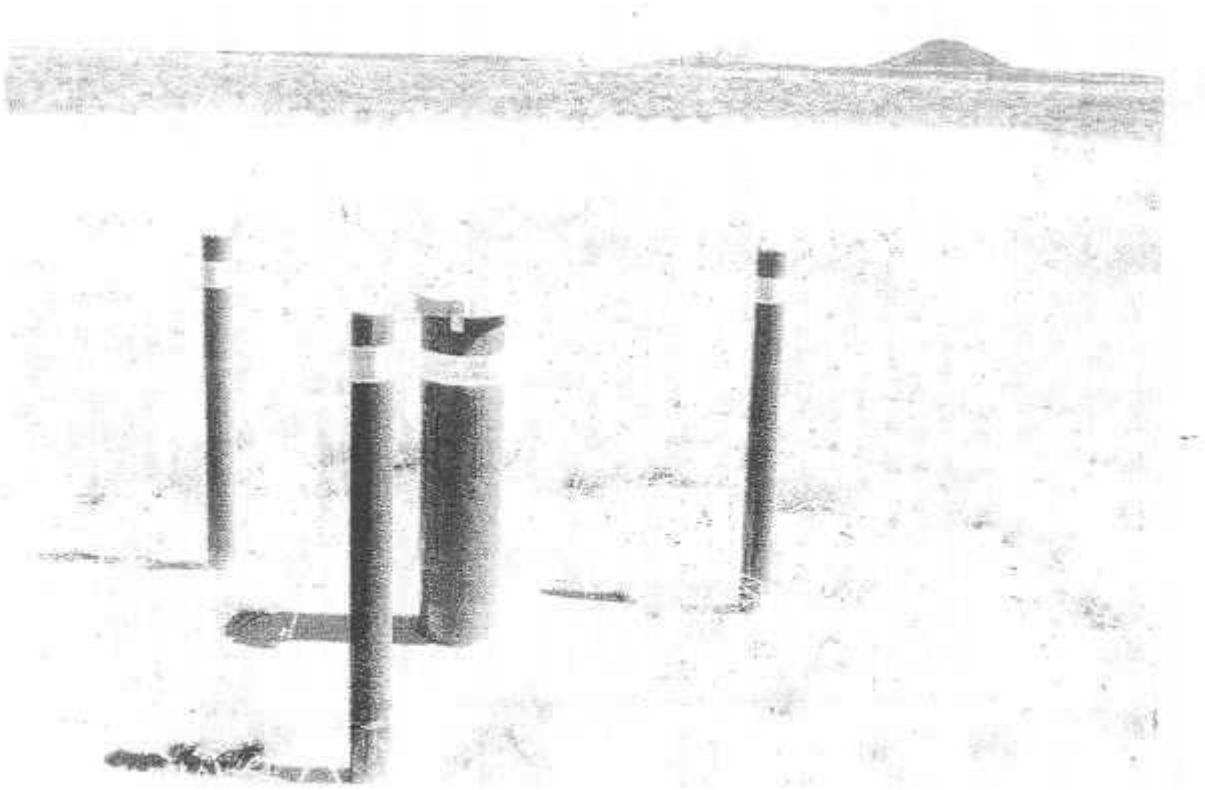
Checklist prepared by (print) K. Garcia		Checklist reviewed by (print) Wendell Taylor	
Signature: [signature]	Date: 5/3/01	Signature: [signature]	Date: 5/7/01

Well ID: 1258

Well Name: CFA-GAS-V-008

Date: May 3, 2001

File Name:CFA\1258 may 3 01.jpg



STORM WATER COMPREHENSIVE SITE COMPLIANCE EVALUATION AT LANDFILLS I, III, AND III EXTENSION		Evaluated by: S. H. McCormick, D. L. Roberts, D. R. Braun Date: July 14 and 21, 1989
Facilities were inspected for evidence of, or the potential for, pollutants exposed to storm water. Observations and required actions are noted.		
AREA, BUILDING, ACTIVITY, ETC.	**OBSERVATIONS**	**REQUIRED ACTIONS**
Soil stabilization-Landfill III (except east portion) and Landfill III Extension	Uniform perennial vegetation is required for temporary or permanent cover. Some areas of inadequate soil stabilization were identified July 1988. The plan was to be implemented by March 29, 1989. No efforts were underway to improve vegetation. A consultation was conducted with ecologists from the Environmental Science and Research Foundation June 1989.	Prepare seedbed and seed ditches, topsoil stockpile, and berms by November 1, 1989 (P. M. Wraught).
Soil Stabilization-Landfill I and Landfill III east portion	Noxious weeds were observed (Canada thistle, musk thistle). Noxious weed control measures were not implemented in 1998 or 1999 to date. Vegetation is improving on the sideslopes of the east portion of Landfill III. Some erosion was observed.	Implement noxious weed control measures before weeds bloom each srping (S. H. McCormick).
Offsite tracking	Gravel effectively controls offsite tracking of soil.	No additional action required.
Preventive maintenance	Equipment used at the landfill is routinely maintained, with the exception of the crane.	No additional action required.
Inspections-Landfill III (except east portion) and Landfill III Extenstion	Inspections have been required since January 1989. Weekly inspections have been performed since June 21, 1989.	Ensure weekly inspections are performed (D. L. Roberts, P. M. Wraught).
Inspections-Landfill I and Landfill III east portion	Monthly inspections have been performed since January 1999 as required.	No additional action required.
Storm Water Team	Team roster is being updated to include Compliance Field Support personnel.	No additional action required.
Storm Water Training	Training is being revised (D. R. Braun).	No additional action required.

STORM WATER COMPREHENSIVE SITE COMPLIANCE EVALUATION AT LANDFILLS I, III, AND III EXTENSION	Evaluated by: S. H. McCormick, D. L. Roberts, D. R. Braun Date: July 14 & 21, 1999

Prepared by: _____ Date: 8/24/99
Name: S. H. McCormick
Title: Manager, Waste Area Group 4
Representing: Lockheed Martin Idaho Technologies Company

Prepared by: _____ Date: 8-11-99
Name: D. R. Braun
Title: INEEL Storm Water Coordinator
Representing: Lockheed Martin Idaho Technologies Company

Prepared by: _____ Date: 8-12-99
Name: D. L. Roberts
Title: Landfills III and Extension Storm Water Coordinator
Representing: Lockheed Martin Idaho Technologies Company

Reviewed by: _____ Date: 8-24-99
Name: D. K. Jorgensen
Title: Manager, Buried Waste and Landfill Restoration
Representing: Lockheed Martin Idaho Technologies Company

Reviewed by: _____ Date: 8/24/99
Name: C. R. Chelsul
Title: ESH&Q Manager, Environmental Restoration
Representing: Lockheed Martin Idaho Technologies Company

Reviewed by: _____ Date: 8-17-99
Name: M. C. Tiernan
Title: Manager, Waste Reduction Operations Complex
Representing: Lockheed Martin Idaho Technologies Company

Reviewed by: _____
Name: T. L. Carlson
Title: ES&H Manager, Waste Reduction Operations Complex
Representing: Lockheed Martin Idaho Technologies Company

CERTIFICATION STATEMENT

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based upon my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: _____ Date: 8/26/99
Name: H. T. Conner, Jr.
Title: Executive Vice President for Operations and Chief Operating Officer
Representing: Lockheed Martin Idaho Technologies Company

Signature: _____ Date: 9/14/99
Name: R. C. Cullison
Title: Environmental Programs and Settlement Agreement Manager
Representing: U.S. Department of Energy-Idaho Operations Office

STORM WATER COMPREHENSIVE SITE COMPLIANCE EVALUATION AT LANDFILLS I, III, AND III EXTENSION	Evaluated by: D. L. Roberts, D. L. Braun, D. E. Snyder Date: April 5, 2000

Reviewed by: Joseph A. Lanto Date: 5/8/2000
Name: J. A. Lanto
Title: Landfill I and III Extension Storm Water Coordinator
Representing: Bechtel BWXT Idaho, LLC

Prepared by: DL Braun Date: 5-3-00
Name: D. R. Braun
Title: INEEL Storm Water Coordinator
Representing: Bechtel BWXT Idaho, LLC

Reviewed by: Dean L. Roberts Date: 5-9-00
Name: D. L. Roberts
Title: Landfills III and Extension Storm Water Coordinator
Representing: Bechtel BWXT Idaho, LLC

Reviewed by: H. D. Williams Date: 5/10/00
Name: H. D. Williams
Title: Manager, Waste Area Group 4
Representing: Bechtel BWXT Idaho, LLC

Reviewed by: C. R. Chebul Date: 5/11/00
Name: C. R. Chebul
Title: ESH&QA Manager, Environmental Restoration
Representing: Bechtel BWXT Idaho, LLC

Reviewed by: M. C. Tiernan Date: 5-15-00
Name: M. C. Tiernan
Title: Site Area Director, Waste Reduction Operations Complex
Representing: Bechtel BWXT Idaho, LLC

Reviewed by: Timothy L. Carlson Date: 5-15-00
Name: T. L. Carlson
Title: ESH&QA Manager, Waste Reduction Operations Complex
Representing: Bechtel BWXT Idaho, LLC

CERTIFICATION STATEMENT

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based upon my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: R. S. Watkins Date: 5-23-00
Name: R. S. Watkins
Title: ESH&QA General Manager
Representing: Bechtel BWXT Idaho, LLC

Signature: Terry L. Parkins Date: 10/26/00
Name: ~~R. C. Collison~~ T.L. Parkins
Title: Environmental Technical Support Division Acting Director
Representing: U.S. Department of Energy Idaho Operations Office

STORM WATER COMPREHENSIVE SITE COMPLIANCE EVALUATION AT LANDFILLS I, III, AND III EXTENSION		Evaluated by: D. L. Roberts, D. R. Braun, D. E. Snyder Date: April 5, 2000
Facilities were inspected for evidence of, or the potential for, pollutants exposed to storm water. Observations and required actions are noted.		
AREA, BUILDING, ACTIVITY, ETC.	**OBSERVATIONS**	**REQUIRED ACTIONS**
Inspections- Landfill III (except east portion) and Landfill III Extension	Inspections have been performed as required.	No additional action required.
Inspections- Landfill I and Landfill III east portion	Monthly Inspections were performed from January 1999 through September 1999, then quarterly inspections were performed because it was realized that the landfills should be categorized as inactive.	No additional action required.
Storm Water Team	Team roster Is being updated.	No additions action required.
Storm Water Training	Appropriate personnel completed the training (Course 000TRN68).	No additional action required.

STORM WATER COMPREHENSIVE SITE COMPLIANCE EVALUATION AT LANDFILLS I, III, AND III EXTENSION		Evaluated by: D. L. Roberts, D. R. Braun, D. E. Snyder Date: April 5, 2000
Facilities were inspected for evidence of, or the potential for, pollutants exposed to storm water. Observations and required actions are noted.		
AREA, BUILDING, ACTIVITY, ETC.	**OBSERVATIONS**	**REQUIRED ACTIONS**
Grounds	Little windblown litter observed on west side. Otherwise housekeeping generally effective. Windblown litter Is being pickup daily.	No additional action required.
Records	Records are maintained of disposed material.	No additional action required.
Map	The map Is being updated (remove culvert near road).	No additional action required.
Soil stabilization-Landfill III (except east portion) and Landfill III Extension	Uniform perennial vegetation is required for temporary or permanent cover. Some areas of inadequate soil stabilization were identified July 1998. The 1999 evaluation required seeding of ditches, topsoil stockpile, and berms. Ditches were seeded in November 1999, but growth was not yet evident (due to cold weather). The topsoil stockpile and berms were not seeded.	Establish perennial vegetation on topsoil stockpile as soon as practicable (ICARE DR 12292). Control weeds on gravel berms (P. M. Wraught).
Soil Stabilization-Landfill I and Landfill III east portion	Noxious weeds were observed (Canada thistle, musk thistle). Noxious weed control measures apparently were not implemented since 1997. Sideslopes of the east portion of Landfill III showed some erosion.	Implement noxious weed control measures as soon as practicable (ICARE DR 10414). Repair and seed eroded areas (H. D. Williams).
Offsite tracking	Gravel effectively controls offsite tracking of soil.	No additional action required.
Preventive maintenance	Equipment used at the landfill is routinely maintained, with the exception of the crane, which still needs repair.	Complete repair as soon as possible using good spill prevention techniques (M. R. Carroll).

STORM WATER COMPREHENSIVE SITE COMPLIANCE EVALUATION AT LANDFILLS I, III, AND III EXTENSION		Evaluated by: D. L. Roberts, D. R. Braun, D. E. Snyder Date: April 5, 2000
Facilities were inspected for evidence of, or the potential for, pollutants exposed to storm water. Observations and required actions are noted.		
AREA, BUILDING, ACTIVITY, ETC.	**OBSERVATIONS**	**REQUIRED ACTIONS**
Asbestos waste disposal trench	Empty boxes, wood chips, cranes, and containers of asbestos waste were observed.	No additional action required.
Spill prevention	One crane was in need of repair; it has been in the landfill with a drip pan since the previous evaluation. The storm water plan states that equipment is not fueled or maintained at the landfill. Repair progress is documented in weekly inspection reports.	No additional action required (see preventive maintenance).
Non-storm water discharges	There are no nonstorm water discharges, including leachate. The 1999 review of the Liquid Effluent inventory was completed June 1999 and the 2000 review Is scheduled to be completed June 2000.	No additional action required.
Monitoring point	The monitoring point end collection basins were dry.	No additional action required.
Spills and leaks	No significant spills or leaks have occurred.	No additional action required.
Spill response equipment	The hazardous material response team has spill response equipment at CFA.	No additional action required.
Storm water management	Basins and ditches were In good condition and effective. The parallel ditches along part of the perimeter were reconfigured into a single ditch with flatter side slopes to facilitate seedbed preparation and seeding. There have been no discharges of storm water from the collection basins or ditches.	No additional action required.

STORM WATER COMPREHENSIVE SITE COMPLIANCE EVALUATION AT LANDFILLS I, III, AND III EXTENSION	Evaluated by: D. L. Roberts, E. D. Walker, P. M. Wraught, M. A. Pinzel, R. L. Skinner, C. J. Duncan, T. J. Safford, R. D. Blew, and C. J. Craiglow Date: April 10, 16, and 17, 24, 26,2001

Reviewed by: _____ Date: 6-1-01
Name: C. A Craiglow
Title: Landfill I and III Eastside Storm Water Coordinator
Representing: Bechtel BWXT Idaho, LLC

Prepared by: _____ Date: 6/1/01
Name: E. D. Walker
Title: INEEL Industrial Storm Water Coordinator
Representing: Bechtel BWXT Idaho, LLC

Reviewed by: _____ Date: 6-5-01
Name: D. L. Roberts
Title: Landfills III and Extension Storm Water Coordinator
Representing: Bechtel BWXT Idaho, LLC

Reviewed by: _____ Date: 6/4/01
Name: S. G. Wilkinson
Title: Manager, Waste Area Group 4
Representing: Bechtel BWXT Idaho, LLC

Reviewed by: _____ Date: 6/5/01
Name: C. R. Chellel
Title: ESH&QA Manager, Environmental Restoration
Representing: Bechtel BWXT Idaho, LLC

Reviewed by: _____ Date: 6-5-01
Name: M. C. Tierney
Title: Site Area Director, Waste Reduction Operations Complex
Representing: Bechtel BWXT Idaho, LLC

Reviewed by: _____ Date: 6/5/01
Name: T. L. Carlson
Title: ESH&QA Manager, Waste Reduction Operations Complex
Representing: Bechtel BWXT Idaho, LLC

CERTIFICATION STATEMENT

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based upon my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: _____ Date: 6/6/01
Name: R. S. Wilkins
Title: Vice President, Environmental Safety Health and Quality Assurance
Representing: Bechtel BWXT Idaho, LLC

Signature: _____ Date: 6/27/01
Name: T. L. Perkins
Title: Director, Environmental Technical Support Division
Representing: U.S. Department of Energy Idaho Operations Office

STORM WATER COMPREHENSIVE SITE COMPLIANCE EVALUATION AT LANDFILLS I, III, AND III EXTENSION		Evaluated by: D. L. Roberts, E. D. Walker, P. M. Wraught, M. A. Pinzel, R. L. Skinner, C. J. Duncan, T. J. Safford, R. D. Blew, and C. J. Craiglow Date: April 10, 16, and 17, 24, 26,2001
Facilities were inspected for evidence of, or the potential for, pollutants exposed to storm water. Observations and required actions are noted.		
AREA, BUILDING, ACTIVITY, ETC.	**OBSERVATIONS**	**REQUIRED ACTIONS**
Asbestos waste disposal trench	Empty boxes, wood chips, and containers of asbestos waste were observed.	No additional action required.
Spill prevention	A crane in need of repair, discussed in the April 5, 2000 evaluation report was removed from Landfill III extension on September 27, 2000. The storm water plan states that equipment is not fueled or maintained at the landfill. No subcontractor equipment disposes of material in Landfill III Extension (Asbestos Landfill) and therefore, has no potential for leak from their equipment. Landfill equipment is 1991 or newer which minimizes, the potential for leeks.	No additional action required.
Non-storm water discharges	There are no nonstorm water discharges, including leachate. Weekly and quarterly inspections verify this. The 2000 review of the Liquid Effluent Inventory completed June 2000, is additional verification that there are no nonstorm water discharges	No additional action required.
Monitoring point	The monitoring point (CFA-MP-4/1) and collection basins were dry. No liquid was present in the	It is recommended that the area be observed during the next snowmelt to observe flow.

STORM WATER COMPREHENSIVE SITE COMPLIANCE EVALUATION AT LANDFILLS I, III, AND III EXTENSION		Evaluated by: D. L. Roberts, E. D. Walker, P. M. Wraught, M. A. Pinzel, R. L. Skinner, C. J. Duncan, T. J. Safford, R. D. Blew, and C. J. Craiglow Date: April 10, 16, and 17, 24, 26,2001
Facilities were inspected for evidence of, or the potential for, pollutants exposed to storm water. Observations and required actions are noted.		
AREA, BUILDING, ACTIVITY, ETC.	**OBSERVATIONS**	**REQUIRED ACTIONS**
	sampler. There have been no discharges from the landfills to the northeast tributary channel since storm water monitoring was instituted. If there is a discharge in the event of overflow from the middle storm water collection basin on the east side, It is not readily observable that the overflow would discharge to the northeast tributary channel and monitoring point (CFA-MP-4/1) in the channel. There is no record of discharge from the retention basins.	patterns and determine the most appropriate monitoring point. (Environmental Monitoring and Facility Storm Water Coordinators) No additional action required.
Spills and leaks	No significant spills or leaks have occurred since the April 5, 2000 evaluation.	No additional action required.
Spill response equipment	The hazardous material response team has spill response equipment at CFA. In addition spill pillows in drip pans are available at the CFA landfill mechanics office.	No additional action required.
Storm water management	Basins and ditches were in good condition and effective. Culverts to the collection basins on the east side of Landfill IIII are not blocked and are in good repair. The culvert on the southwest comer of Landfill III Extension was blocked. As reported in the 2000 evaluation, the parallel	The blocked culvert should be cleared. The blocked culvert was partially cleared of sand and gravel on April 16 and was completely cleared on April 24, 2001. No additional action required.

STORM WATER COMPREHENSIVE SITE COMPLIANCE EVALUATION AT LANDFILLS I, III, AND III EXTENSION		Evaluated by: D. L. Roberts, E. D. Walker, P. M. Wraught, M. A. Pinzel, R. L. Skinner, C. J. Duncan, T. J. Safford, R. D. Blew, and C. J. Craiglow Date: April 10, 16, and 17, 24, 26,2001
Facilities were inspected for evidence of, or the potential for, pollutants exposed to storm water. Observations and required actions are noted.		
AREA, BUILDING, ACTIVITY, ETC.	**OBSERVATIONS**	**REQUIRED ACTIONS**
	ditches along part of the perimeter were reconfigured into a single ditch with flatter side slopes to facilitate seedbed preparation and seeding. There have been no discharges of storm water from the collection basins or ditches.	
Grounds	No windblown litter was observed. Windblown litter is being picked up daily. Housekeeping is effective.	No additional action required.
Records	Records are maintained of disposed material.	No additional action required.
Map	The map is being updated.	Revise the map. Revision of the map was completed on 4/19/01. No additional action required.
Soil stabilization- Landfill Ill Extension	Uniform perennial vegetation is required for temporary or permanent cover. It was reported that weeds on the berms and soil stockpile were removed or buried and the berms and the soil stockpile were seeded on 5/17/2000. The Stoller plant ecologist indicated it was too early to expect germination. Vehicle tracks were noted on the soil stockpile.	It Is recommended that signs or other measures be utilized to prevent traffic on the seeded area of the soil stockpile. Signs were placed on the north and south ends of the soil stockpile the week of 4/17/01. The signs read “Newly Seeded Area Keep Off”. No additional action required.

STORM WATER COMPREHENSIVE SITE COMPLIANCE EVALUATION AT LANDFILLS I, III, AND III EXTENSION		Evaluated by: D. L. Roberts, E. D. Walker, P. M. Wraught, M. A. Pinzel, R. L. Skinner, C. J. Duncan, T. J. Safford, R. D. Blew, and C. J. Craiglow Date: April 10, 16, and 17, 24, 26,2001
Facilities were inspected for evidence of, or the potential for, pollutants exposed to storm water. Observations and required actions are noted.		
AREA, BUILDING, ACTIVITY, ETC.	**OBSERVATIONS**	**REQUIRED ACTIONS**
	Ditches were seeded In November 1999, and new growth was evident during the 2001 evaluation. The Stoller plant ecologist indicated it is still too early to determine the likelihood of success, and the ditches should he watched over the next few years to determine if the native species planted can become established or if competition from cheatrgrass is too strong.	
Soil Stabilization – old asbestos landfill on the north end of Landfill III Extension	The area has temporary cover of predominantly sand and gravel. Annual maintenance is ongoing to fill areas that subside. There was very little vegetation and some Indian Rice grass and Kochia were present. The Stoller plant ecologist indicated that the gravely cover will not likely support Cheat grass. It was reported that weeds will be continue to be controlled by periodic blading as part of the maintenance activities for this area	No additional action required.
Soil Stabilization-Landfill I and Landfill III east portion	Dead noxious weed stalks were observed (Canada thistle, musk thistle), but there was no evidence of new thistle growth during the 2001 evaluation. Weeds were treated with a herbicide in 1999 and hand removal of Canada thistle was	No additional action required.

STORM WATER COMPREHENSIVE SITE COMPLIANCE EVALUATION AT LANDFILLS I, III, AND III EXTENSION		Evaluated by: D. L. Roberts, E. D. Walker, P. M. Wraught, M. A. Pinzel, R. L. Skinner, C. J. Duncan, T. J. Safford, R. D. Blew, and C. J. Craiglow Date: April 10, 16, and 17, 24, 26,2001
Facilities were inspected for evidence of, or the potential for, pollutants exposed to storm water. Observations and required actions are noted.		
AREA, BUILDING, ACTIVITY, ETC.	**OBSERVATIONS**	**REQUIRED ACTIONS**
	conducted in the summer of 2000. It may be too early to evaluate if eradication of noxious weeds has been fully achieved. It was reported that if noxious weeds are observed during ongoing Inspections and maintenance, a herbicide will be used to control the weeds. Side slopes of Landfill I and III showed some soil disturbance from burrowing animals and animal trails. While the density of vegetation of the side slopes has not reached the density of the flatter portions of the landfill, vegetation present appears to be effective in reducing erosion. It was reported that re-seeding will take place in low vegetation density areas this fall as part of an ongoing maintenance program for the landfills.	It Is recommended that a plant ecologist be utilized to provide guidance for the ongoing landfill cap re-vegetation and maintenance program at Landfill I and III. (Environmental Restoration project manager)
Offsite tracking	Gravel effectively controls offsite tracking of soil.	No additional action required.
Preventive maintenance	Equipment used at the landfill is routinely maintained.	No additional action required
Inspections- Landfill III (except east portion) and Landfill III Extension	Inspections have been performed as required.	No additional action required.

STORM WATER COMPREHENSIVE SITE COMPLIANCE EVALUATION AT LANDFILLS I, III, AND III EXTENSION		Evaluated by: D. L. Roberts, E. D. Walker, P. M. Wraught, M. A. Pinzel, R. L. Skinner, C. J. Duncan, T. J. Safford, R. D. Blew, and C. J. Craiglow Date: April 10, 16, and 17, 24, 26,2001
Facilities were inspected for evidence of, or the potential for, pollutants exposed to storm water. Observations and required actions are noted.		
AREA, BUILDING, ACTIVITY, ETC.	**OBSERVATIONS**	**REQUIRED ACTIONS**
Inspections- Landfill I and Landfill III east portion	Monthly inspections were performed as required since the 2000 evaluation.	No additional action required.
Storm Water Team	Team roster is being updated.	No additional action required.
Storm Water Training	Appropriate personnel completed the training (Course 000TRN68). In addition, tailgate training was presented by the CFA Landfill storm water pollution prevention team leader to equipment operators.	No additional action required.

Appendix B

Public Notification Announcement

Idaho National Engineering and Environmental Laboratory
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DOE News Release
FOR IMMEDIATE RELEASE
May 20, 2002

NEWS MEDIA CONTACTS:
Stacey Francis (208) 526-0075; syf@inel.gov

INEEL completes five-year review of landfills remediation project

The soil caps placed over Central Facilities Area industrial landfills at the Department of Energy's Idaho National Engineering and Environmental Laboratory to protect people and the environment are working as intended. The five-year review of the remedial action was performed as required by the Environmental Protection Agency.

The INEEL has completed a five-year review of the Central Facilities Area Landfills I, II, and III remediation project and detailed its findings in a recent report that is available to the public. Citizens may request copies of the report or project briefings by calling the INEEL Community Relations Office at (208) 526-4700 or the INEEL's toll-free number at (800) 708-2680.

DOE, the U.S. Environmental Protection Agency and state of Idaho signed a Record of Decision in 1995 for the industrial waste landfills, which the agencies agreed required clean up actions to protect human health and the environment. The remedy included the installation of a native soil cover over each landfill to reduce infiltration of surface water, implementing administrative controls (such as fencing or regulations) to prevent access and environmental monitoring to ensure effectiveness of the remedy.

Construction of the landfill caps was completed in 1997, along with the installation of equipment designed to monitor moisture in the landfills, soil gas and groundwater beneath the site.

Nitrate levels in the groundwater near the landfills remain above the EPA maximum contaminant level of 10 milligrams per liter for community drinking water systems, but below the 20 mg/L concentration allowable for noncommunity water systems. Nitrate concentrations will continue to be monitored annually and re-evaluated at the next five-year review scheduled for 2007. Yearly inspections of institutional controls and annual soil gas surveys will continue.

With a combined area of more than 35 acres, the Central Facilities Area Landfills were used as early as the 1950s and as recently as 1993 to dispose of construction, office and cafeteria waste from the INEEL. To a lesser extent, some hazardous materials, such as solvents, waste oils, paints and chemicals were also disposed of in the landfills.

Detailed information is available in the Administrative Record file for Operable Unit 4-12. The Administrative Record is located at the DOE Reading Room of the INEEL Technical Library, 1776 Science Center Drive, Idaho Falls. Copies can be found at Albertsons Library on the Boise State University campus and the University of Idaho Library in Moscow. The Administrative Record can be accessed on the Internet at http://ar.inel.gov/home.html.

The INEEL is a science-based, applied engineering national laboratory dedicated to supporting the DOE's missions in environment, energy, science and national security. The INEEL is operated for the DOE by Bechtel BWXT Idaho, LLC.

--INEEL--

02-045

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Appendix C

CFA Landfills I, II, and III Photographic Log

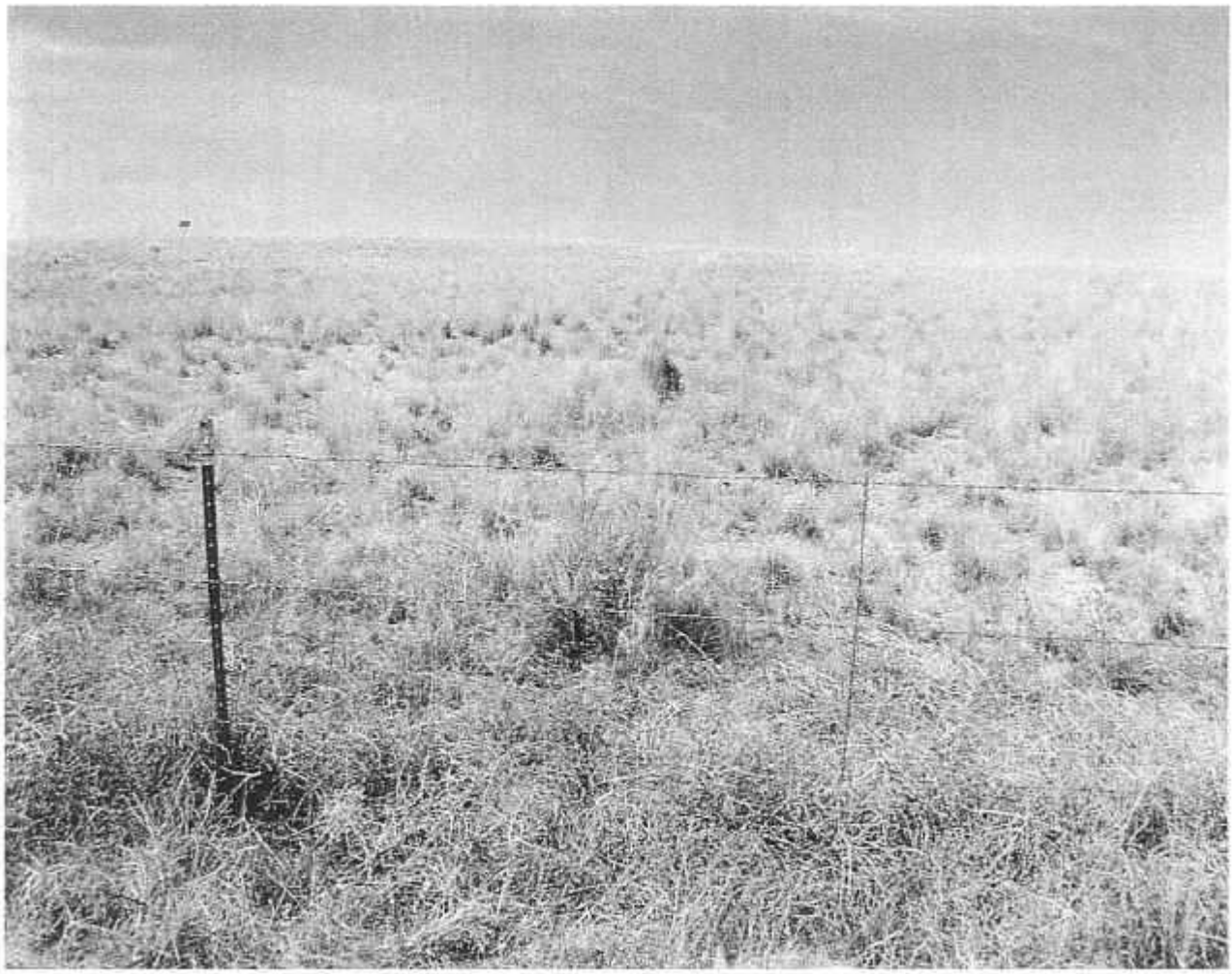


Figure C-1. Sagebrush intrusion on eastside of Landfill II.

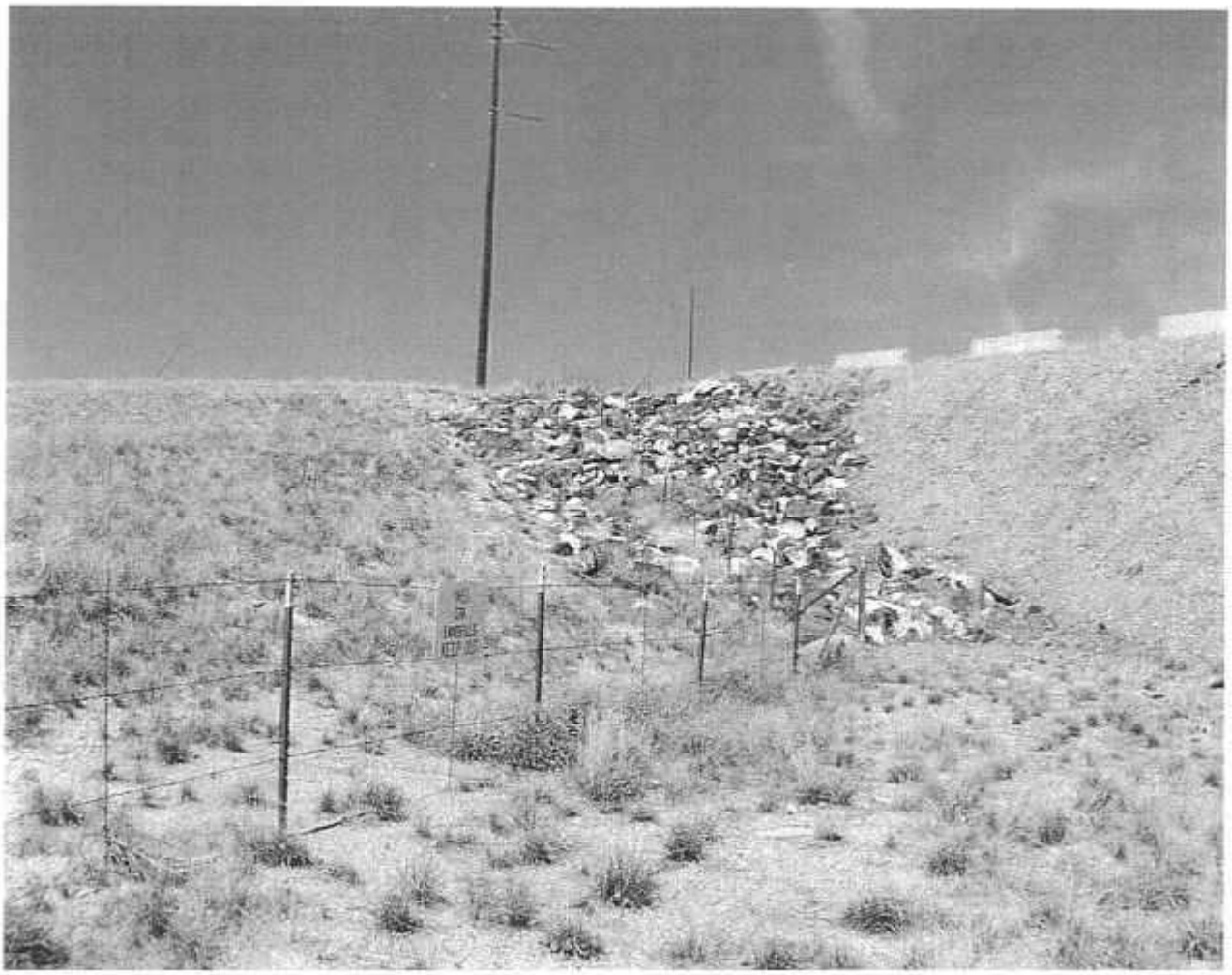


Figure C-2. Rock armor at north end of Landfill II.

Figure C-3. Rill on the northeast slope of Landfill II.

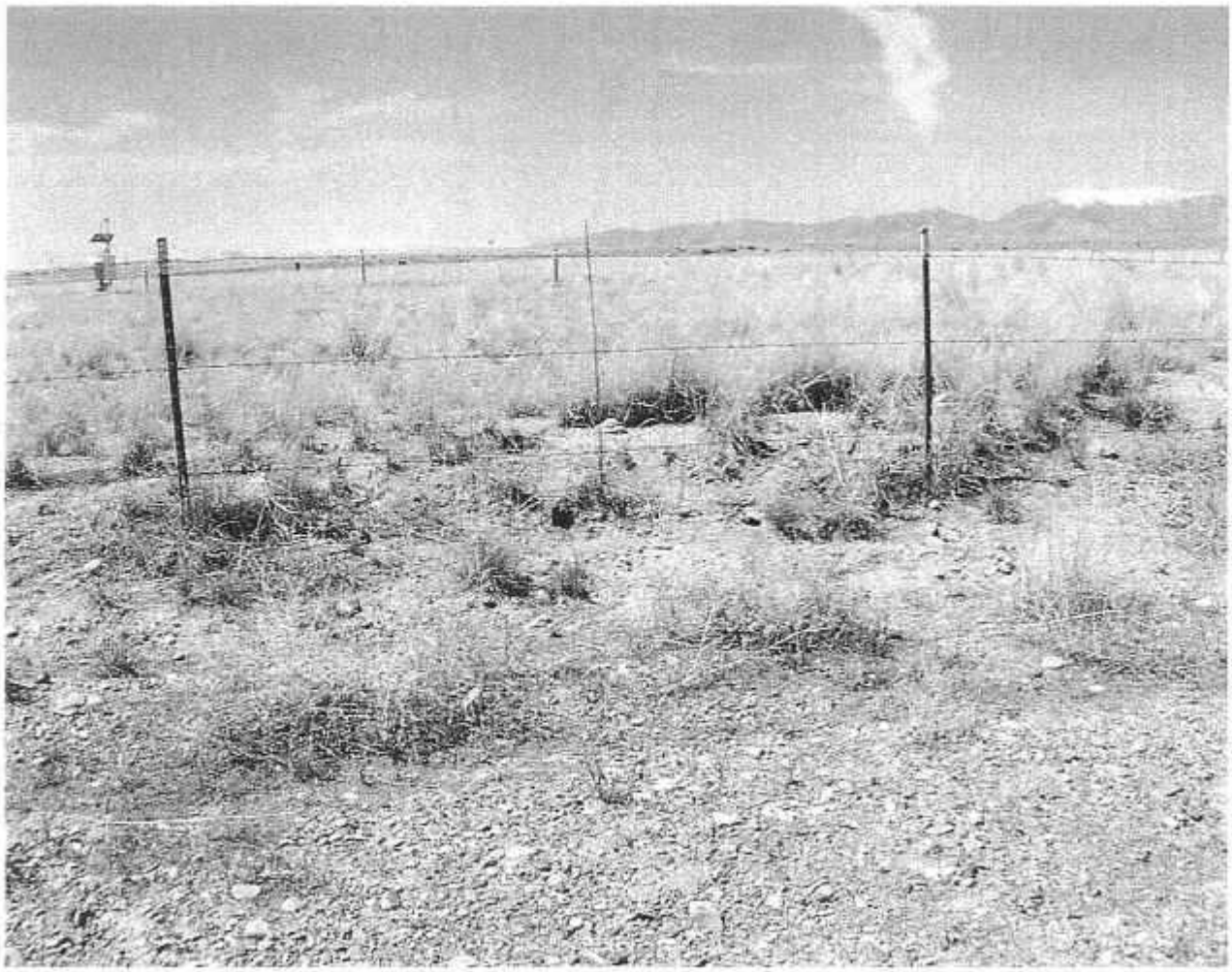


Figure C-4. Animal burrows along the eastside of Landfill III.

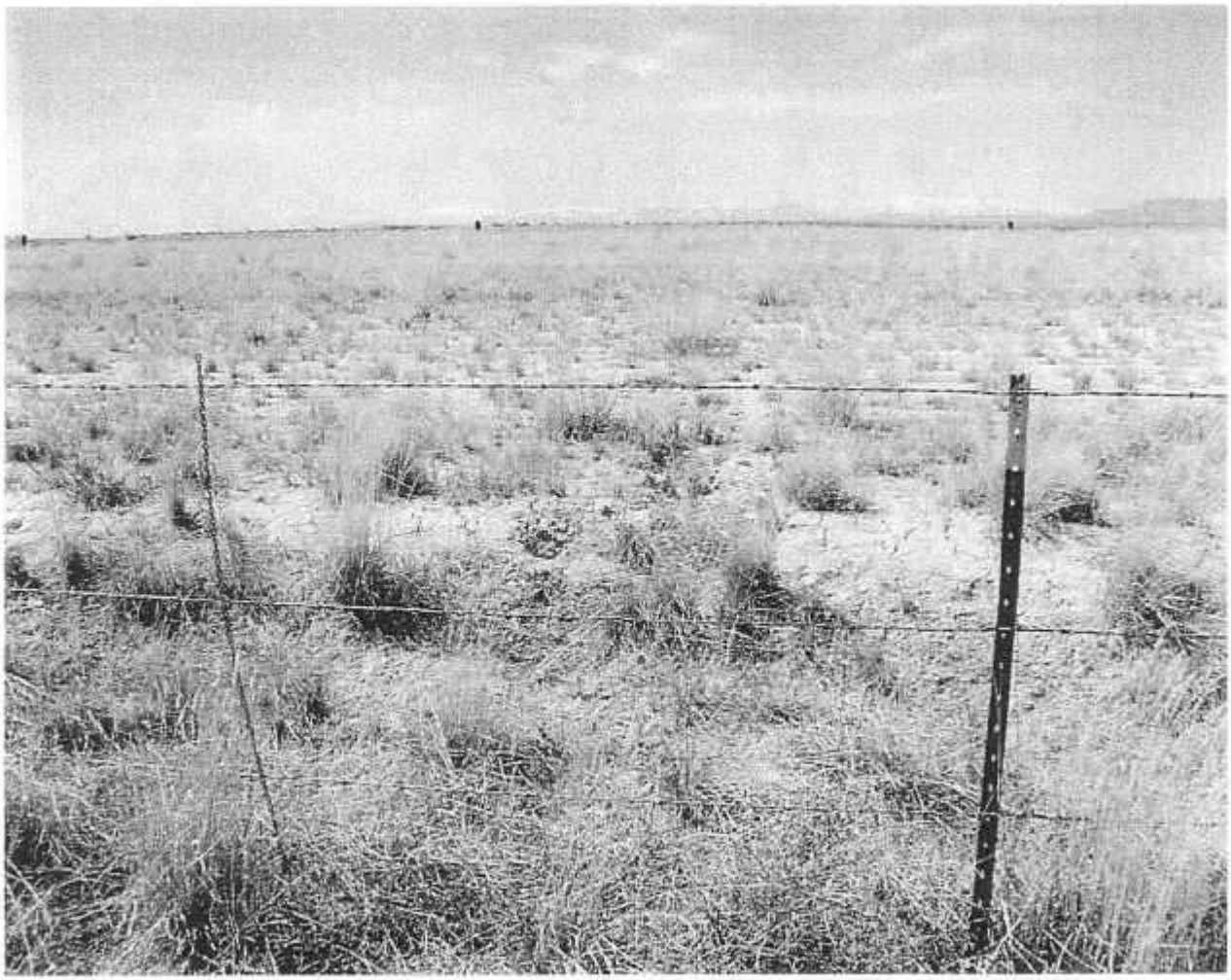


Figure C-5. Rill on eastside of Landfill III between Boreholes LF 3-03 and LF 3-05.

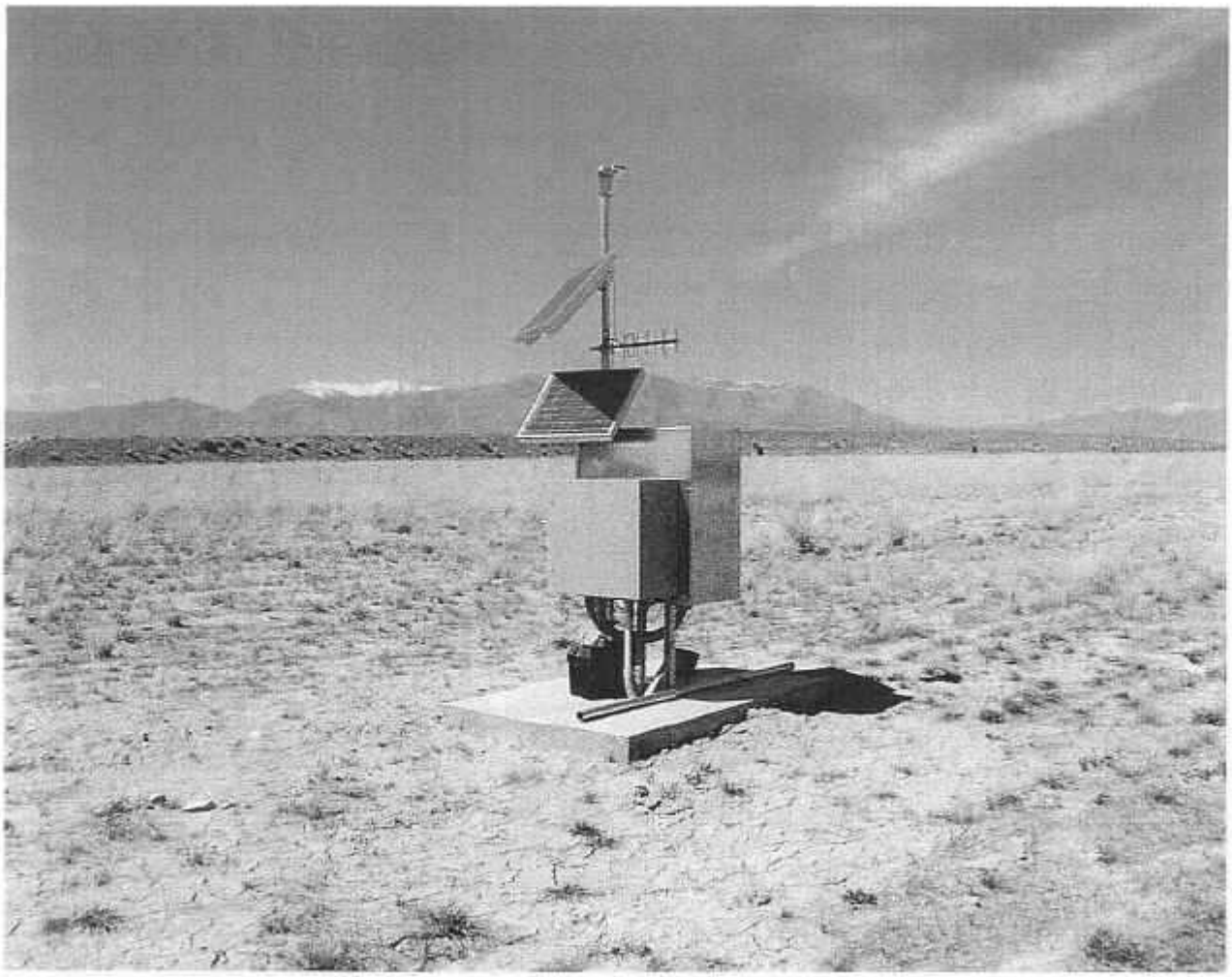


Figure C-6. Time-domain reflectometer on Landfill III before solar panel was repositioned.

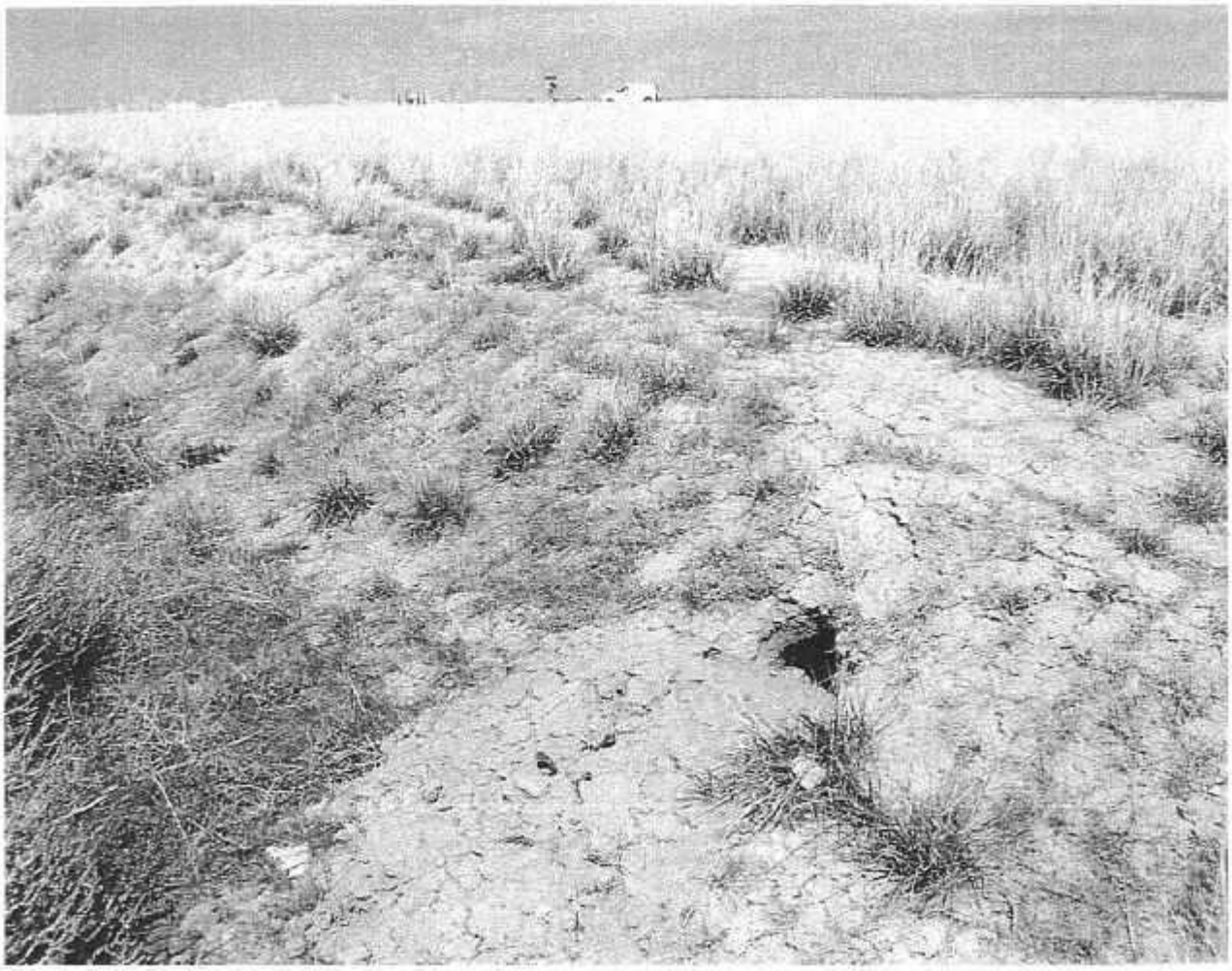


Figure C-7. Animal burrow on westside of Landfill III.

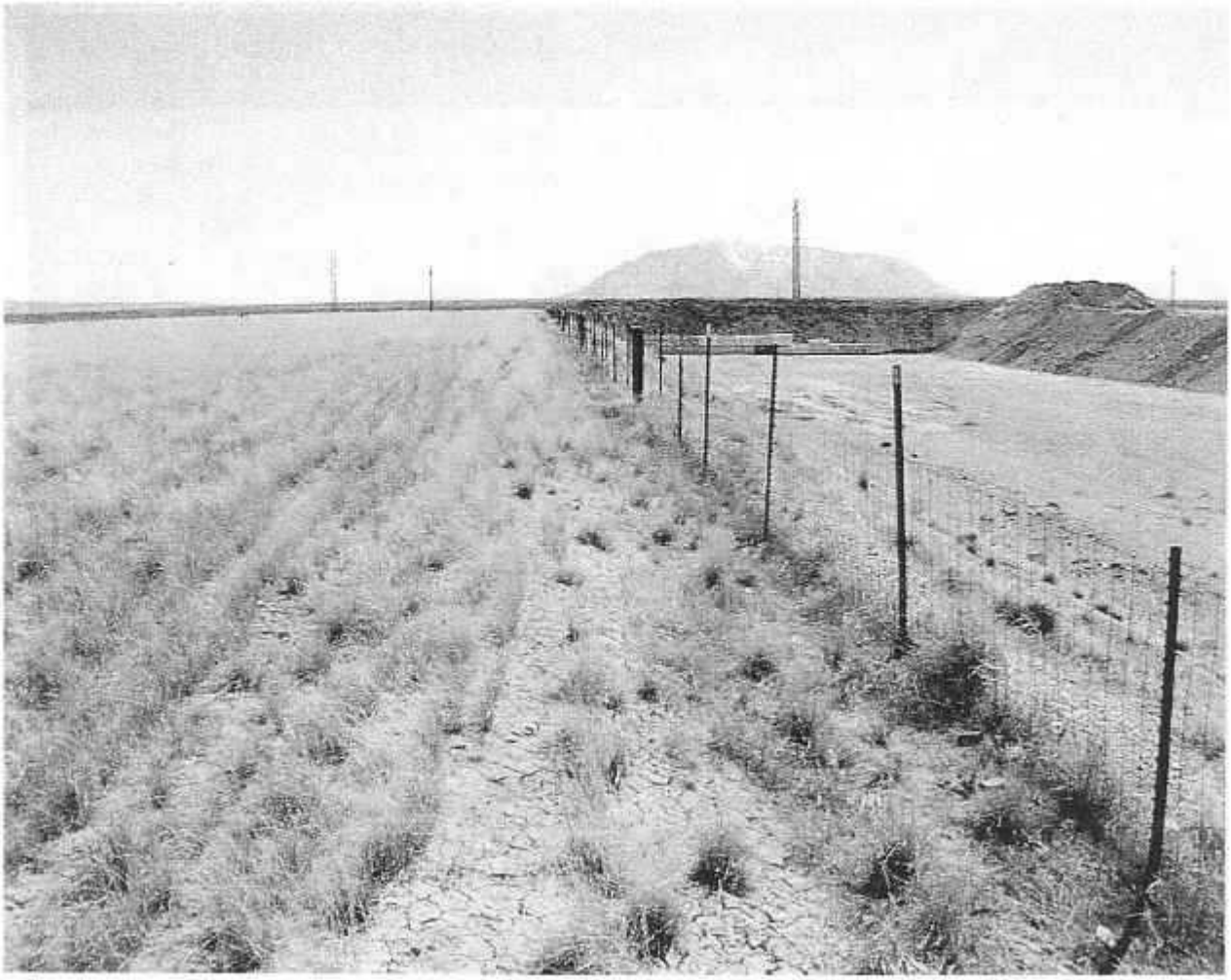


Figure C-8. Westside of Landfill III looking toward Big Southern Butte.

Figure C-9. Westside of Landfill III looking north across Borehole LF 3-03.

Figure C-10. Animal burrow on westside of Landfill III.

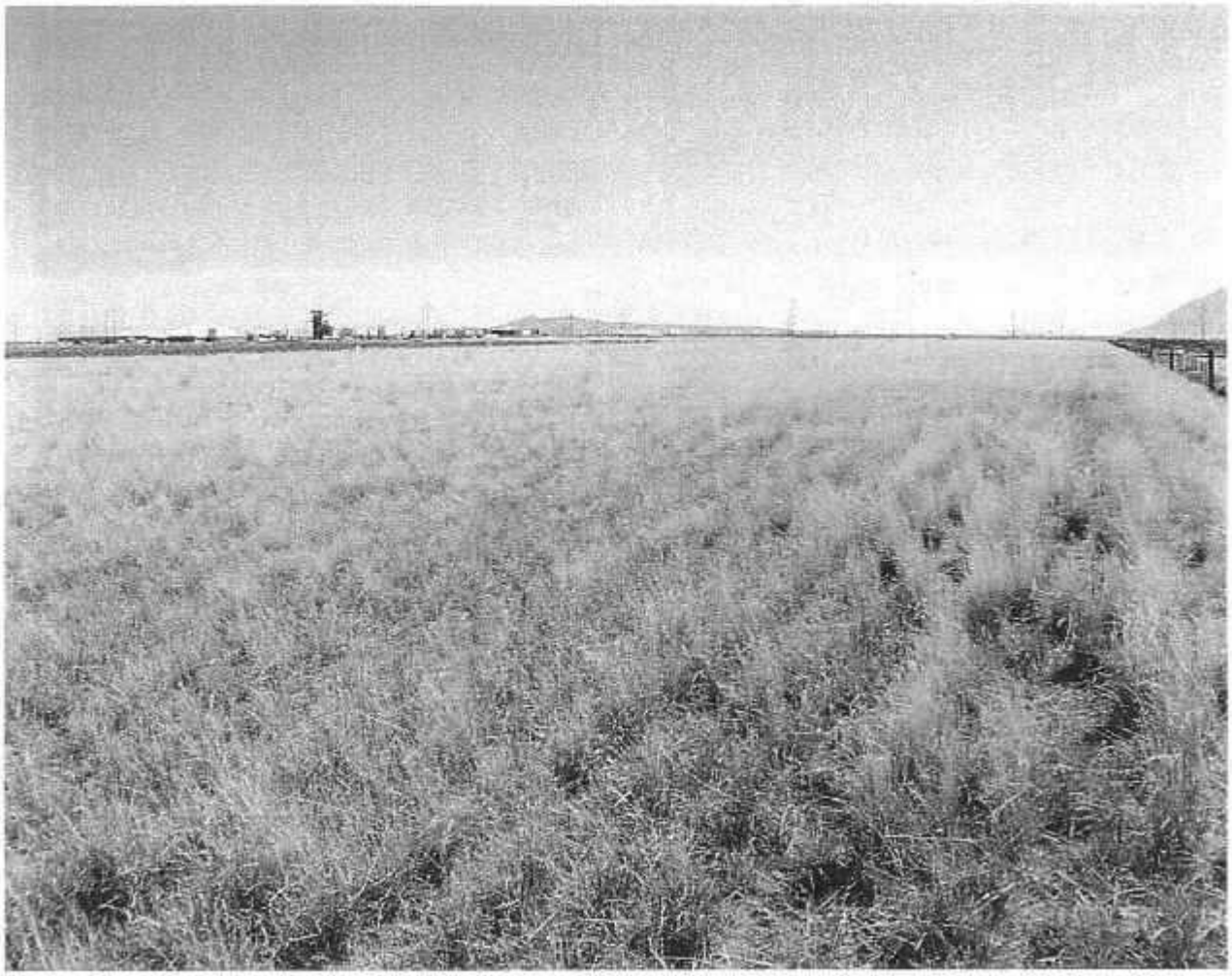


Figure C-11. Vegetation on Landfill III looking south.

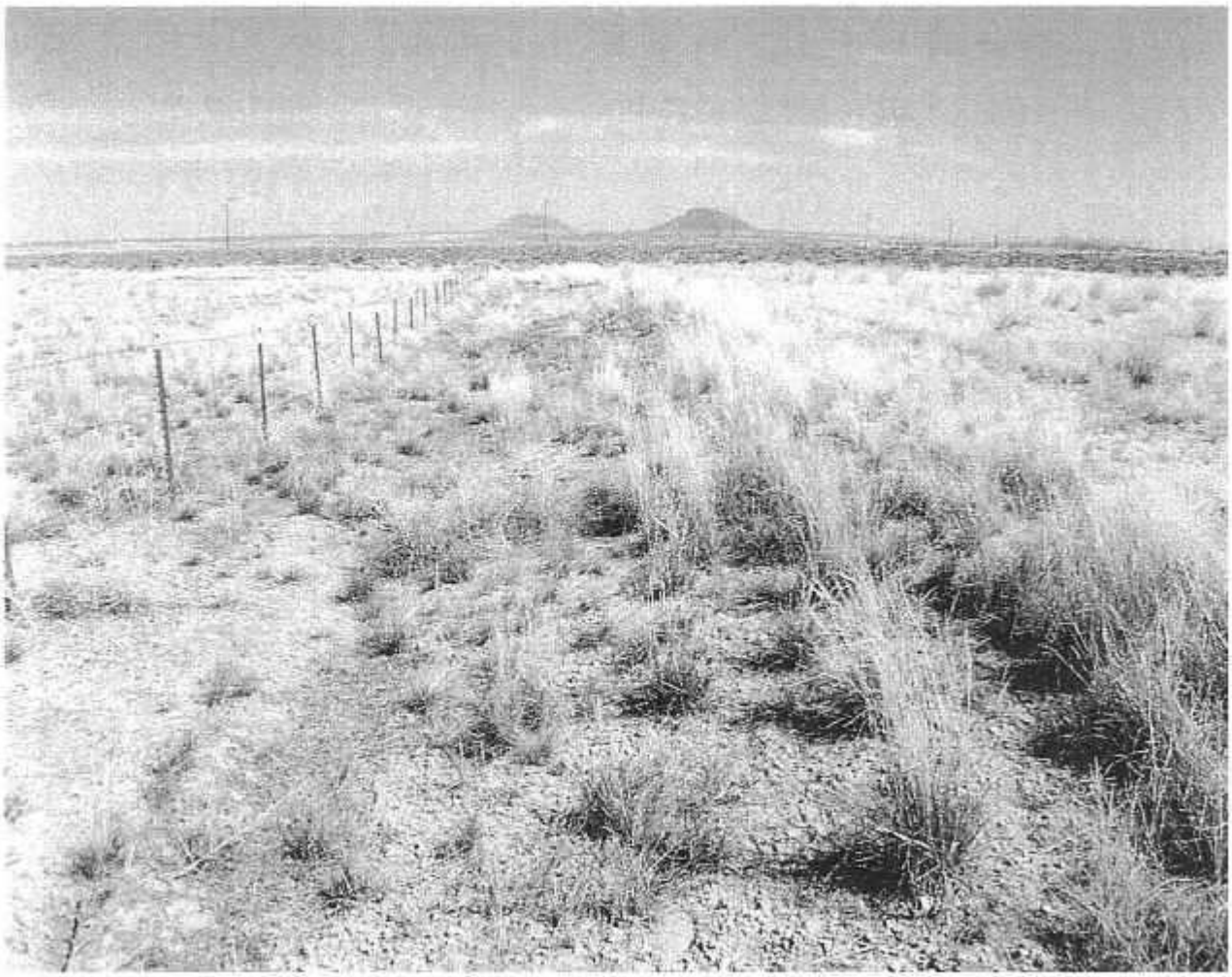


Figure C-12. Northern edge of Landfill III.

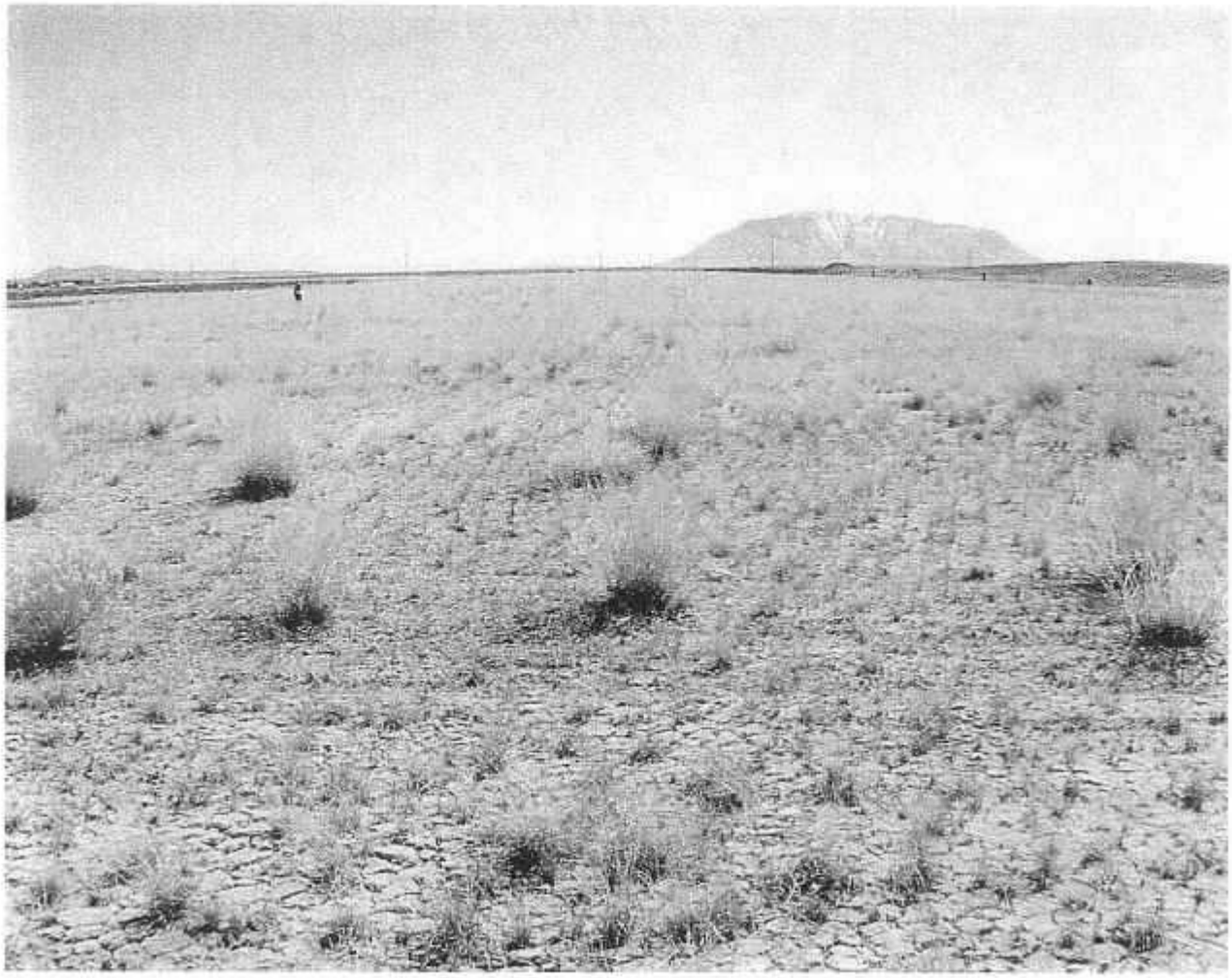


Figure C-13. Vegetation on the northern section of Landfill III.

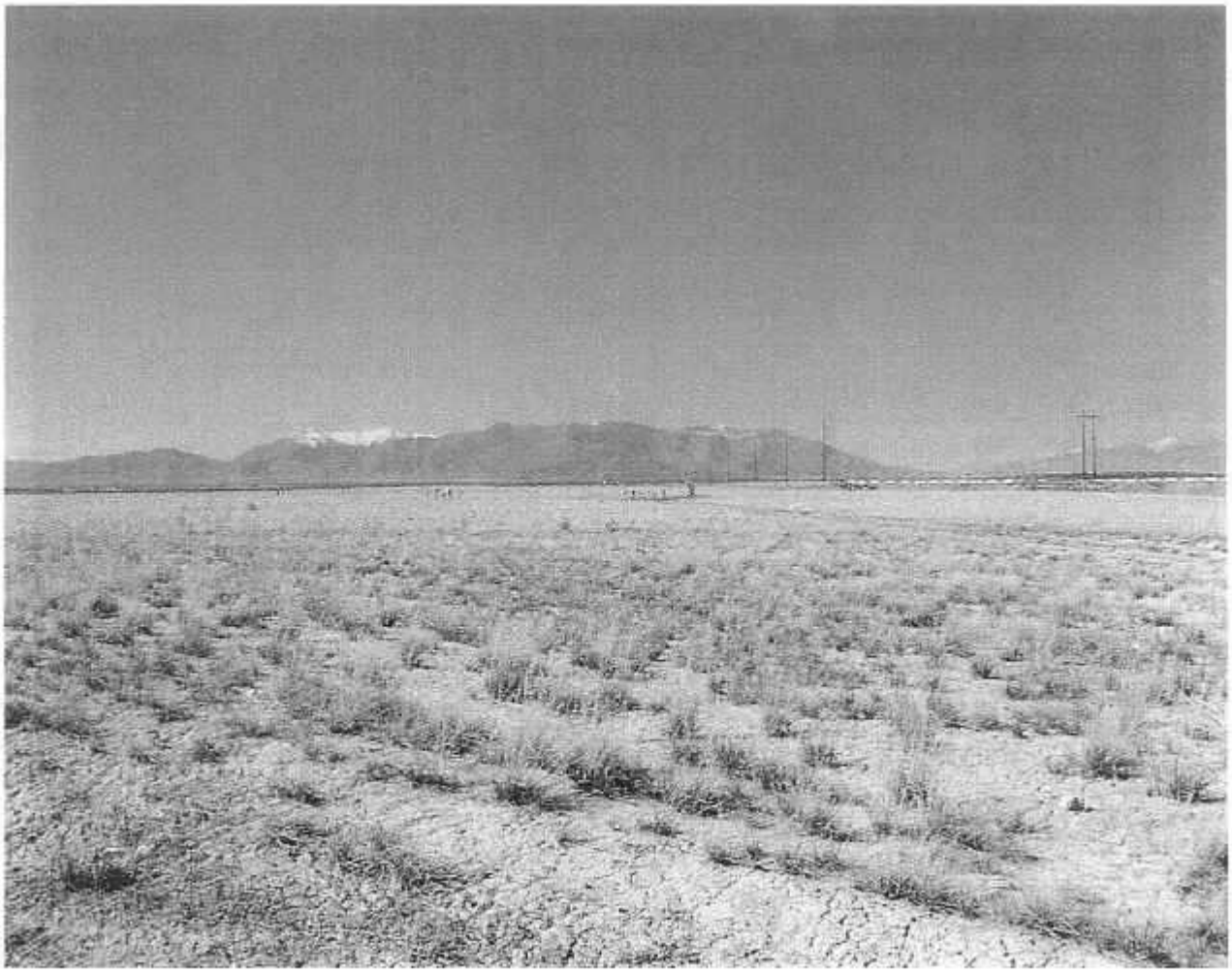


Figure C-14. Vegetation on Landfill I.

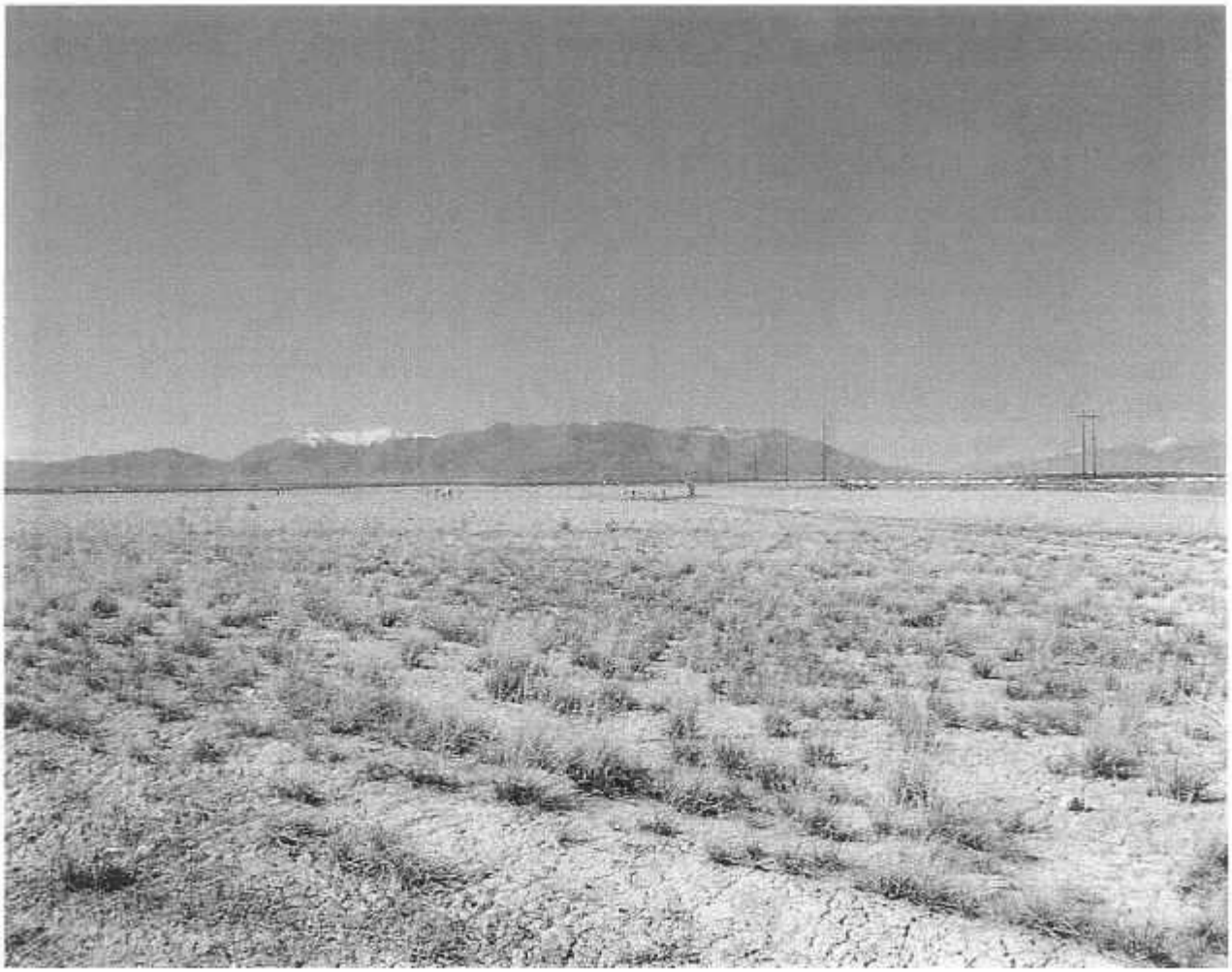


Figure C-15. Vegetation on Landfill II looking from the gate toward the time-domain reflectometer array.

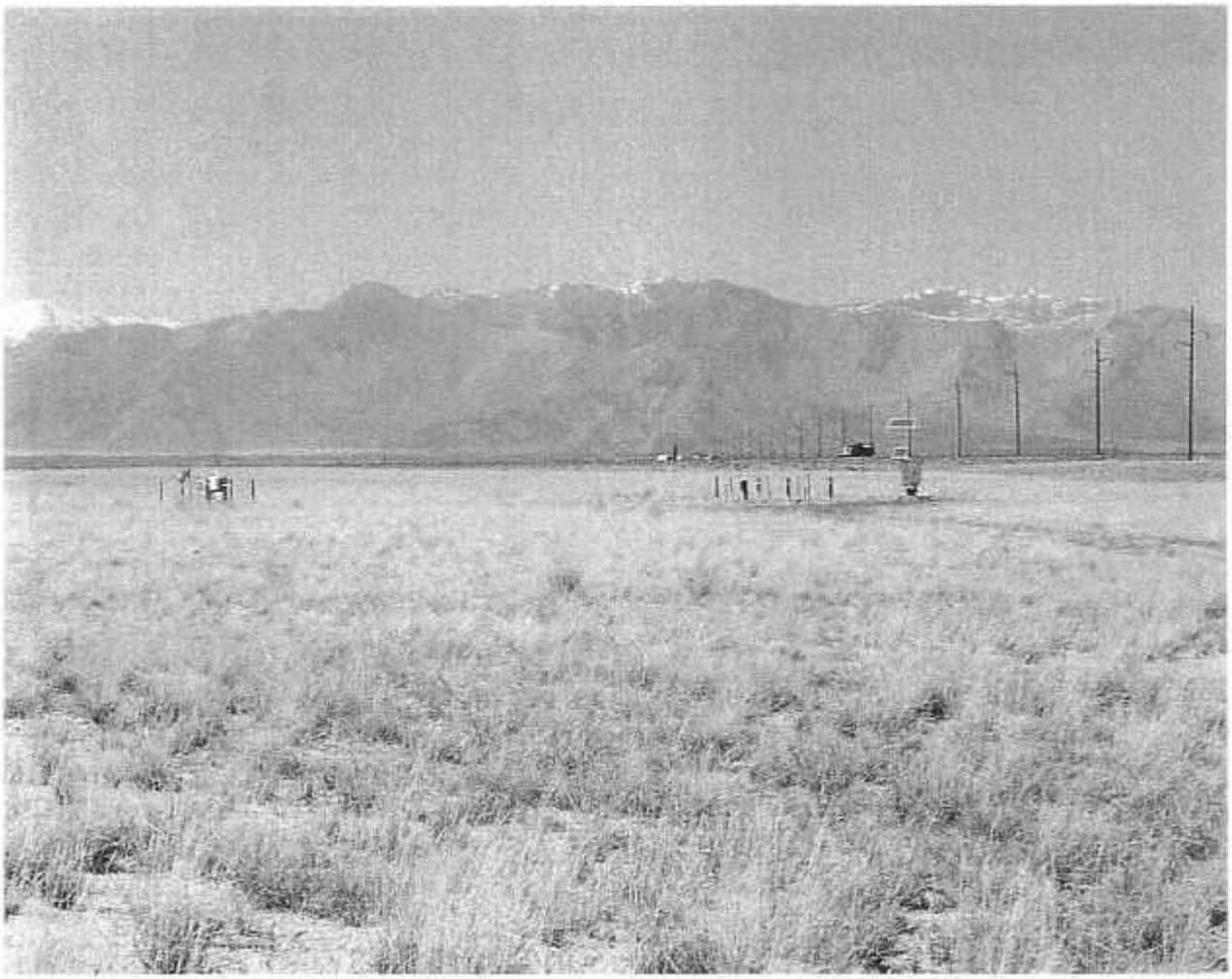


Figure C-16. Landfill II time-domain reflectometer array.

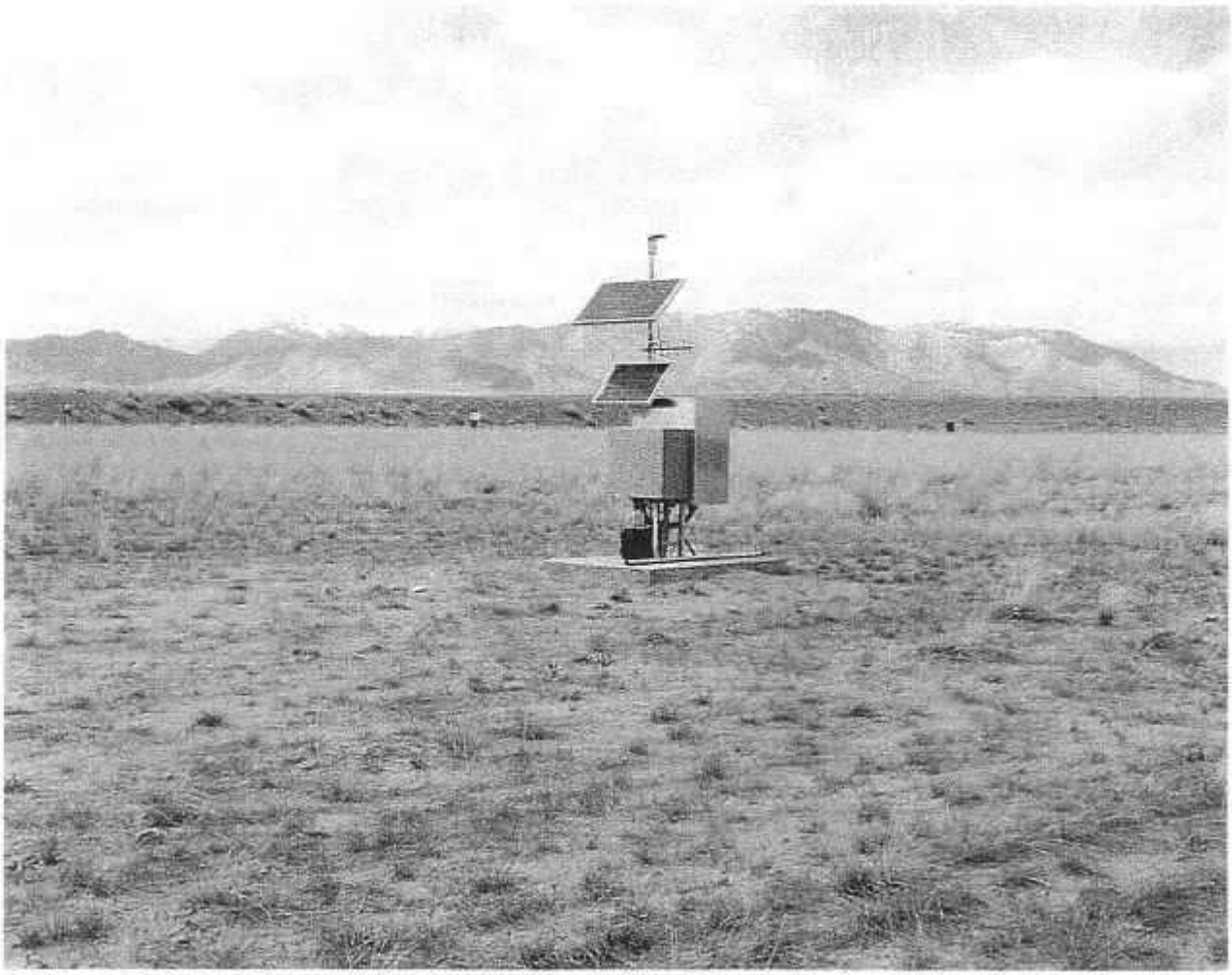


Figure C-17. Time-domain reflectometer station at Landfill III.

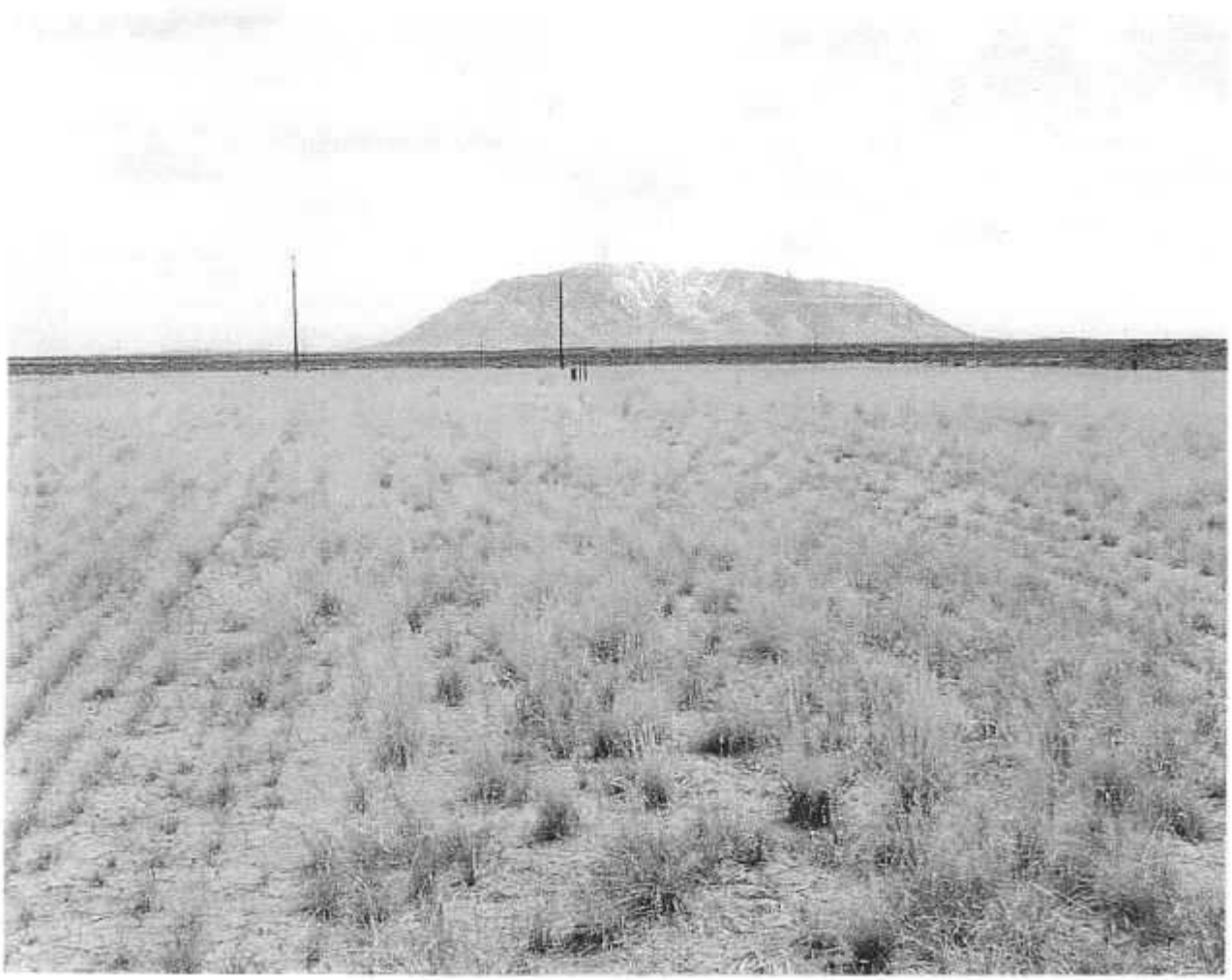


Figure C-18. Vegetation on Landfill III near the time-domain reflectometer array looking south.

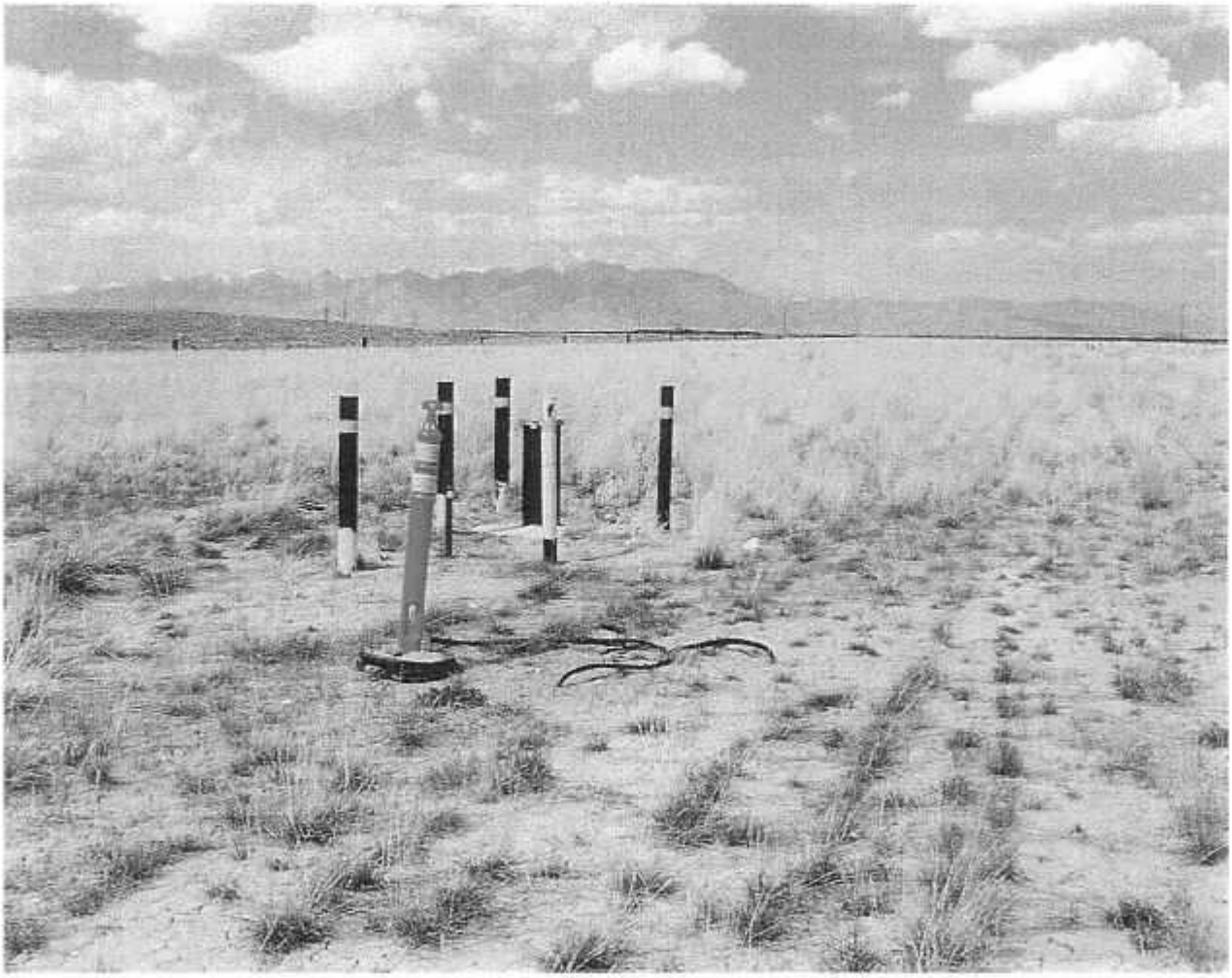


Figure C-19. West time-domain reflectometer location at Landfill III.

Figure C-20. Landfill III run-off basin.

Figure C-21. Overflow area for run-off basin.

Figure C-22. Drainage channel leading out of the overflow area.

Figure C-23. Sampling location for overflow.

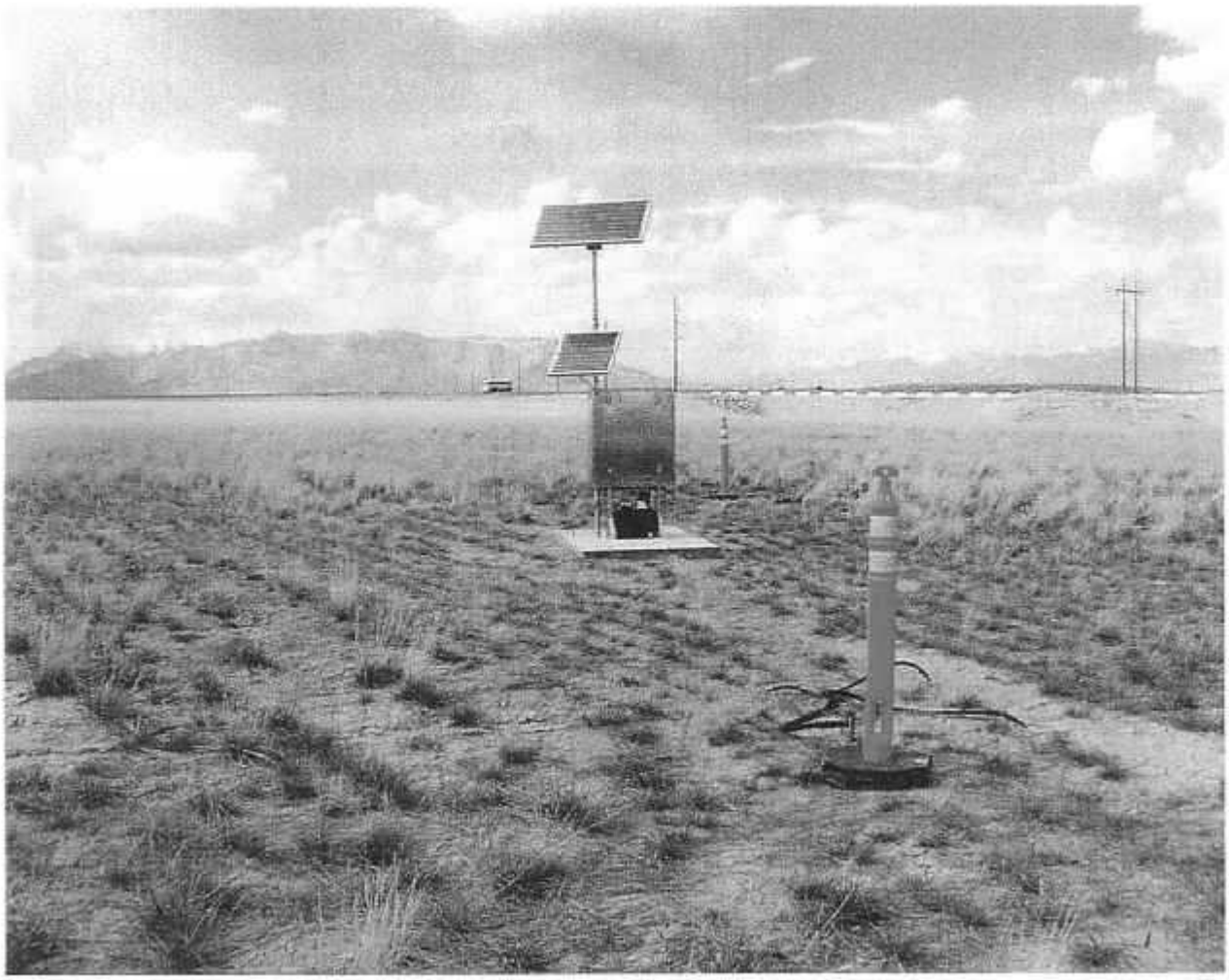


Figure C-24. Time-domain reflectometer arrays and base station at Landfill II looking northwest.

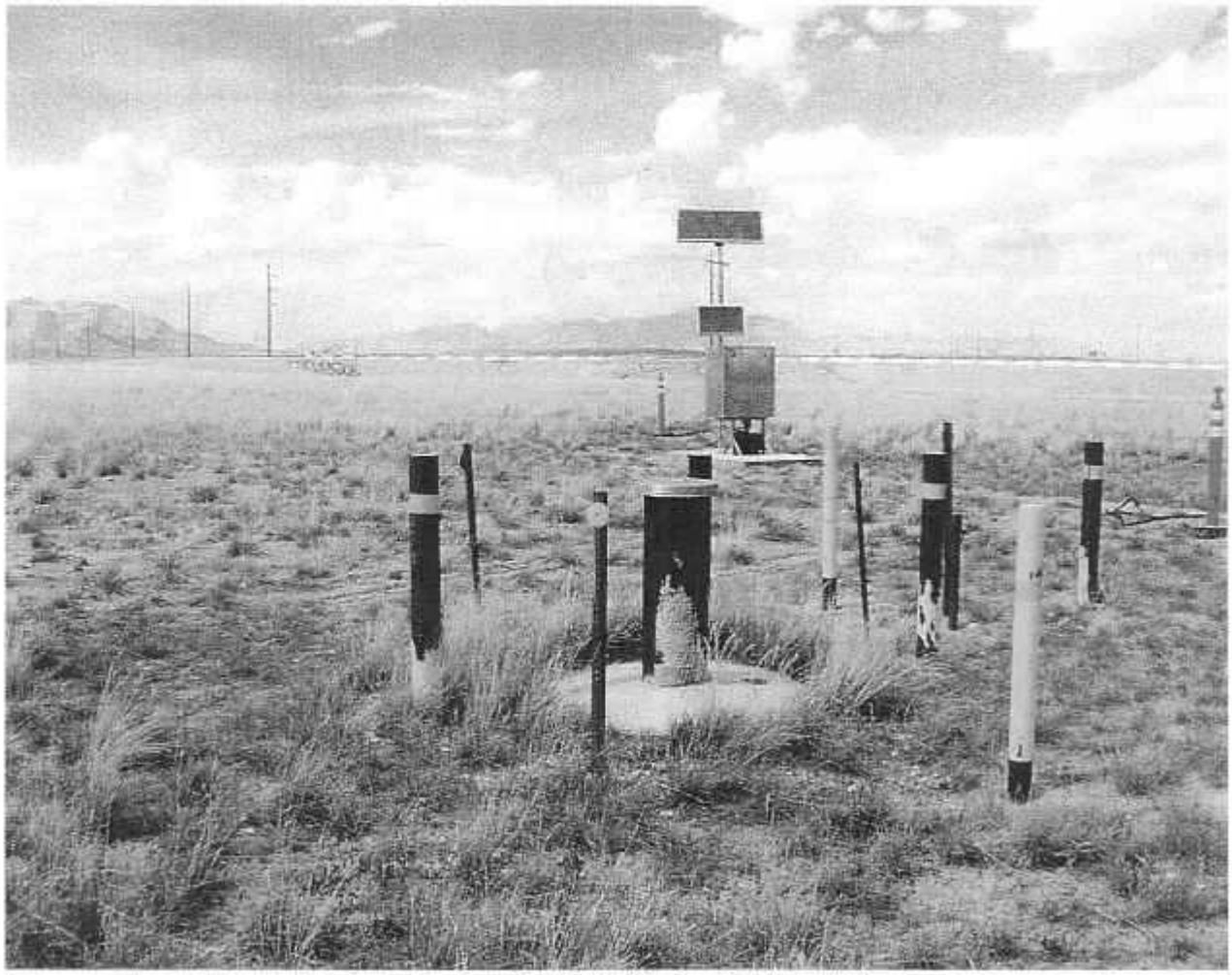


Figure C-25. Time-domain reflectometer array and neutron-probe access tube LF2-07 at Landfill II.

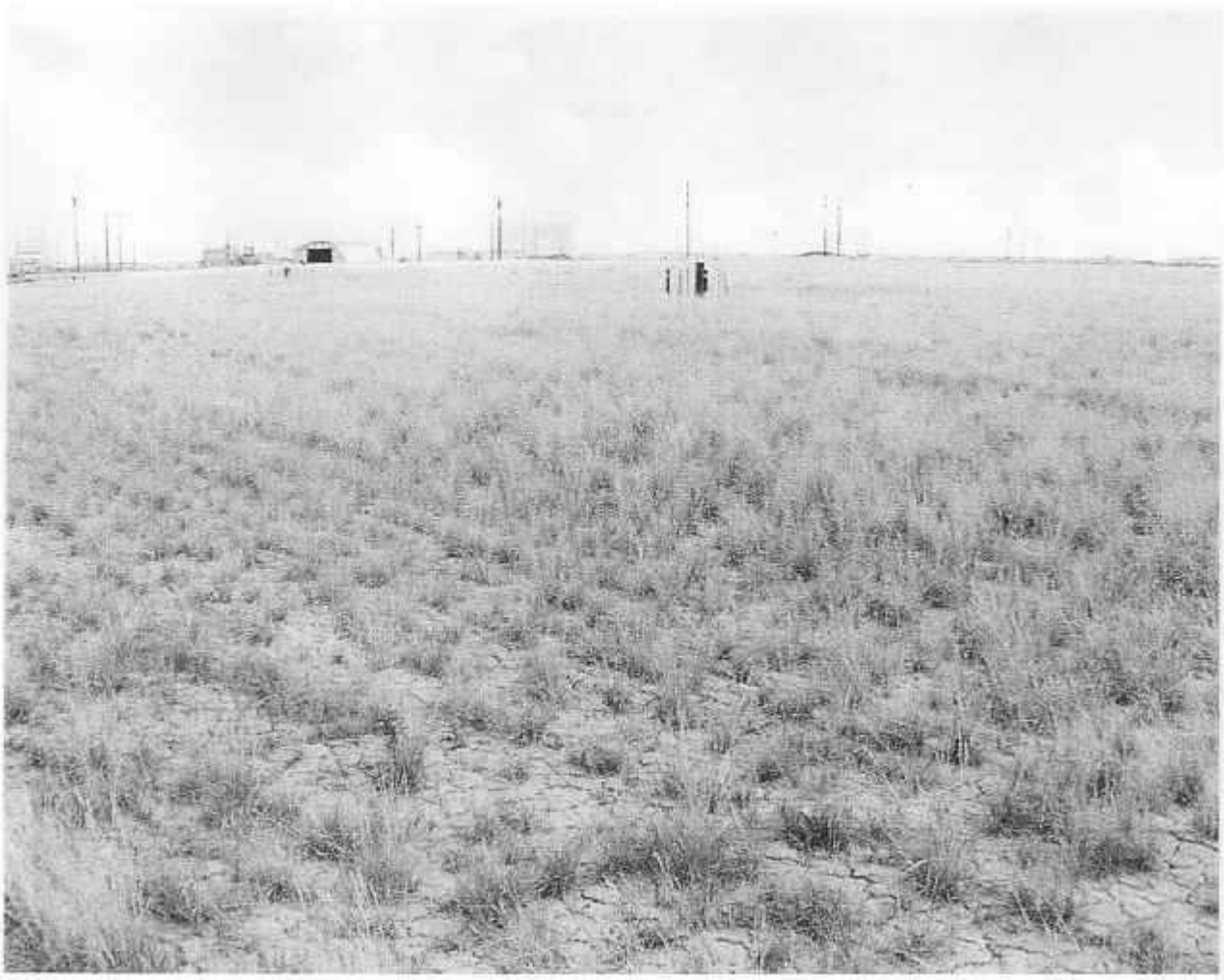


Figure C-26. Vegetation at Landfill II looking southeast.

Figure C-27. Vegetation at Landfill II looking north with rock armor at northern end.

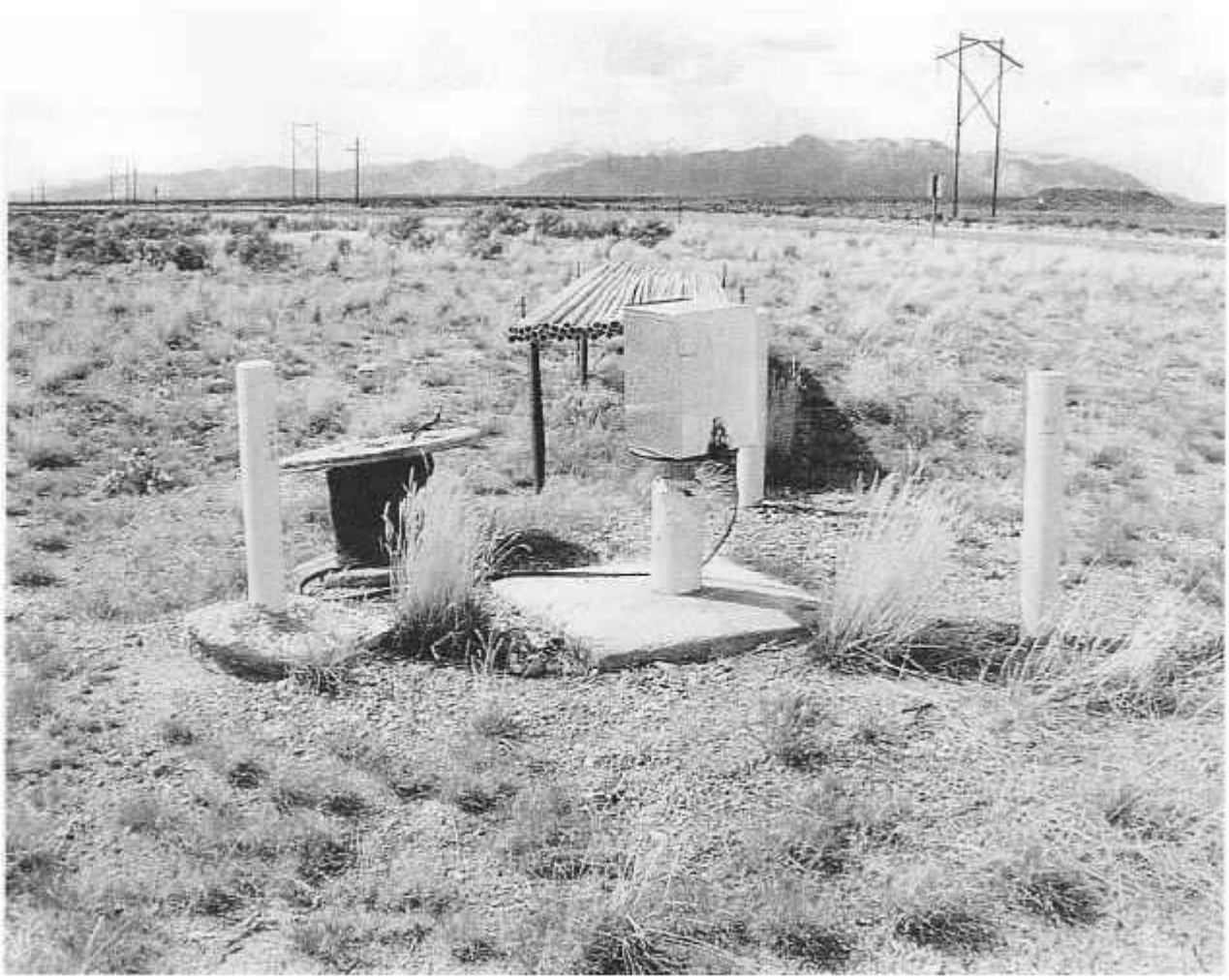


Figure C-28. Groundwater Monitoring Well LF 3-09.

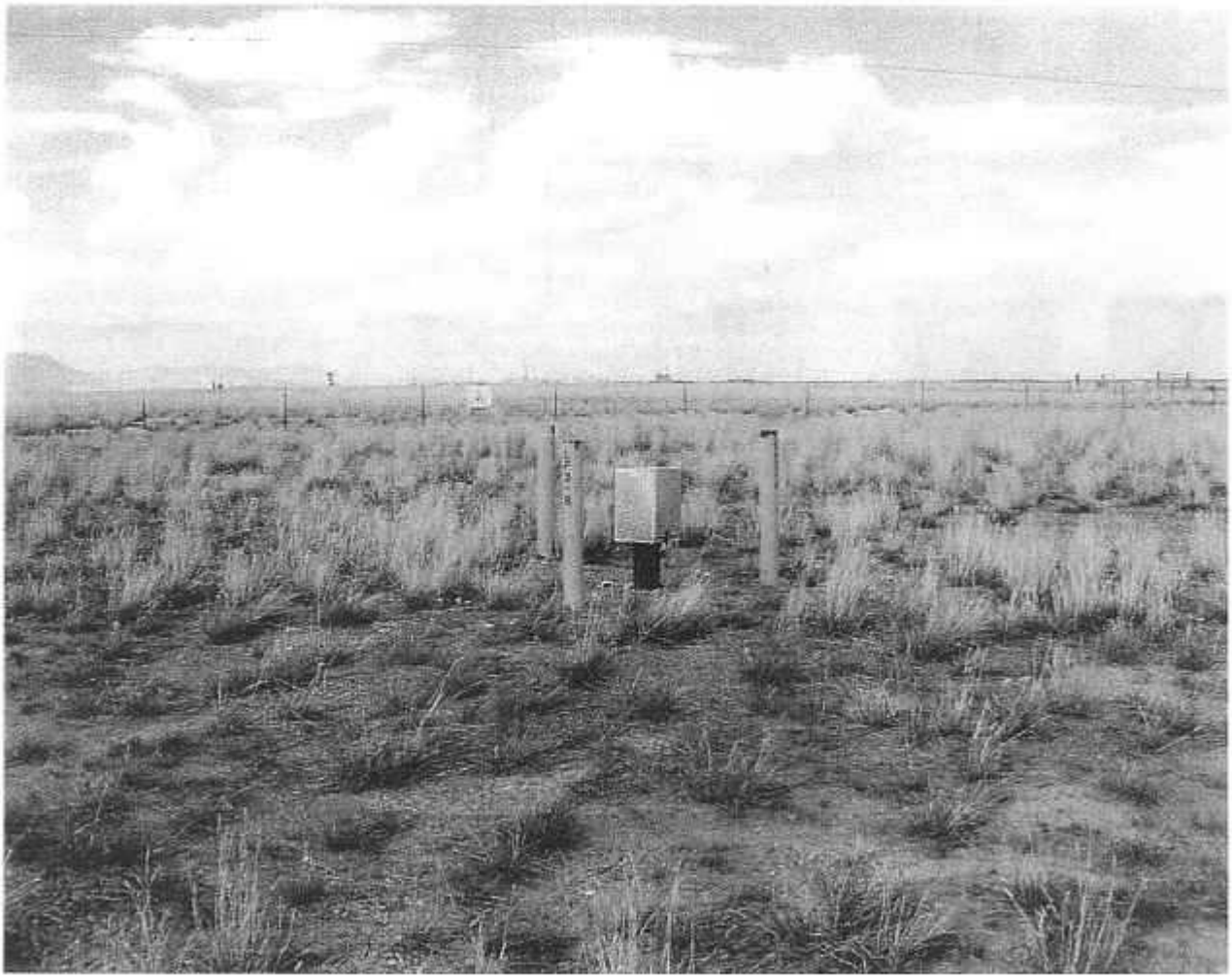


Figure C-29. Groundwater Monitoring Well LF 3-08.

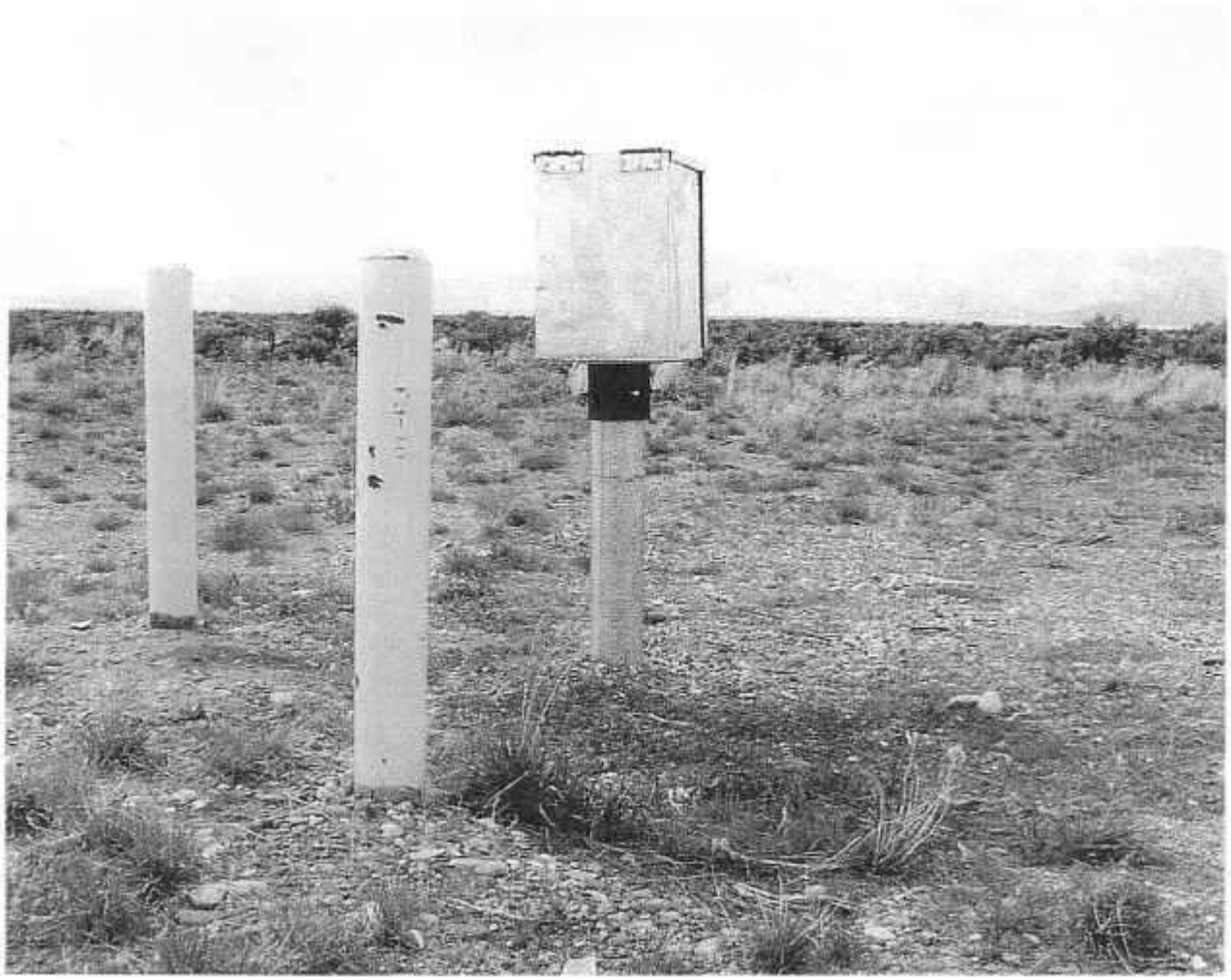


Figure C-30. Groundwater Monitoring Well LF 3-10.

Figure C-31. Southern edge of Landfill III looking north.

Appendix D

Soil Gas Monitoring Analytical Results

Appendix D

Soil Gas Monitoring Analytical Results

The soil gas monitoring results are provided as an Excel file on a compact diskette. The file can be opened by clicking on the file name “Appendix D Protected.xls.” The file is password protected, but can be opened for viewing by clicking on the “Read Only” tab that will be presented to the user when opening the file. The following worksheets are presented in the workbook file to enable the user to review the data of interest. Each worksheet is for a specific borehole and sampling port within that borehole. Data have been sorted by analyte with a secondary sort by date to facilitate viewing of the data.

CFA-GAS-V-004 (13 ft)

CFA-GAS-V-004 (38 ft)

CFA-GAS-V-004 (78 ft)

CFA-GAS-V-004 (107 ft)

CFA-GAS-V-005 (13 ft)

CFA-GAS-V-005 (38 ft)

CFA-GAS-V-005 (78 ft)

CFA-GAS-V-005 (108 ft)

CFA-GAS-V-006 (13 ft)

CFA-GAS-V-006 (38 ft)

CFA-GAS-V-006 (78 ft)

CFA-GAS-V-006 (108 ft)

CFA-GAS-V-007 (13 ft)

CFA-GAS-V-007 (38 ft)

CFA-GAS-V-007 (78 ft)

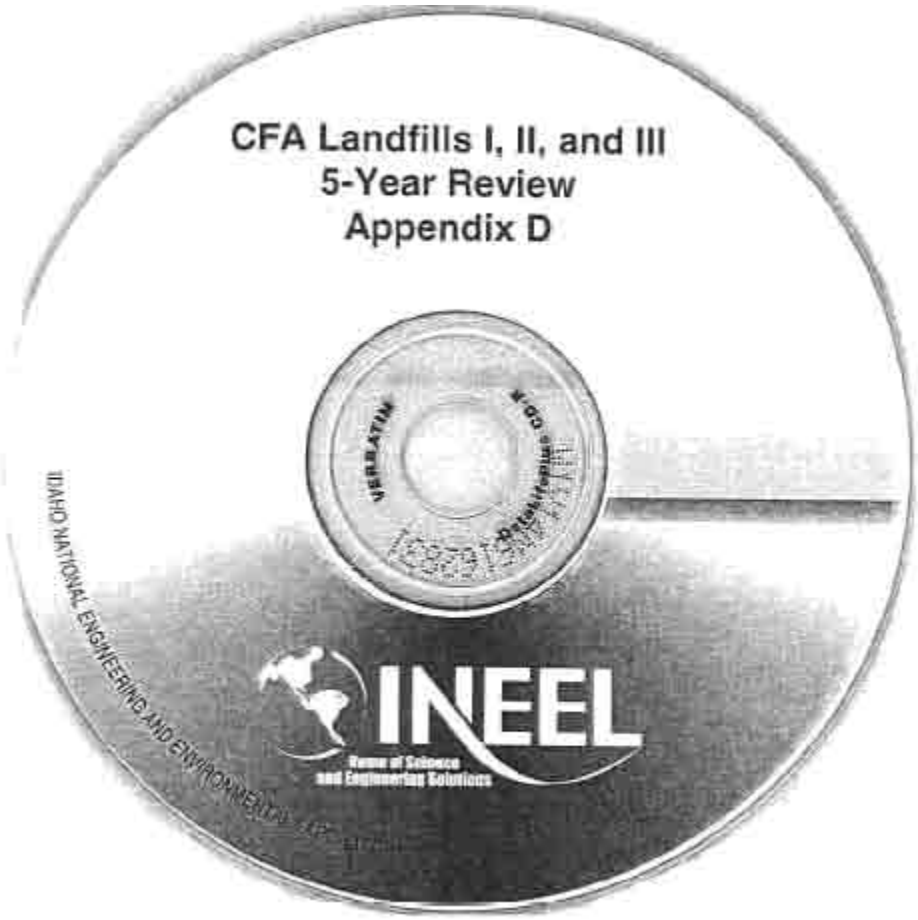
CFA-GAS-V-007 (107 ft)

CFA-GAS-V-008 (13 ft)

CFA-GAS-V-008 (38 ft)

CFA-GAS-V-008 (78 ft)

CFA-GAS-V-008 (108 ft)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and Engineering Solutions
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Appendix E

Groundwater Monitoring Analytical Results

Appendix E

Groundwater Monitoring Analytical Results

The groundwater monitoring results are provided as an Excel file on a compact diskette. The file can be opened by clicking on the file name “Appendix E Protected.xls.” The file is password protected, but can be opened for viewing by clicking on the “Read Only” tab that will be presented to the user when opening the file. The following worksheets are presented in the workbook file to enable the user to review the data of interest. Each worksheet is for a specific borehole and sampling port within that borehole. Data have been sorted by analyte with a secondary sort by date to facilitate viewing of the data.

CFA-MON-A-001

CFA-MON-A-002

CFA-MON-A-003

LF 2-08

LF 2-09

LF 2-10

LF 2-11

LF 3-08

LF 3-09

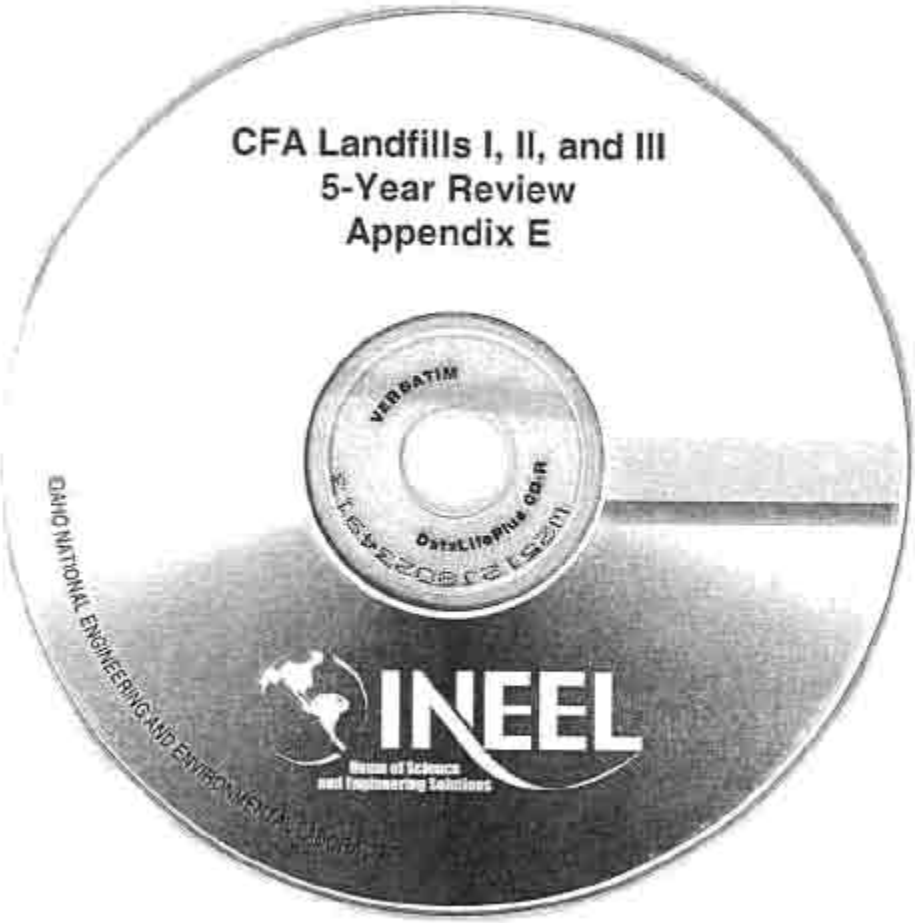
LF 3-10

USGS-083

USGS-085

QC Data

Water Level Data


CFA Landfills I, II, and III
5-Year Review
Appendix E
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Appendix F

Groundwater Contour Maps

Appendix F

Groundwater Contour Maps

Table F-1. Summarized calculations of aquifer hydraulic gradient in the vicinity of CFA.

Triangulated Well Combination (Well#1-Well#2-Well#3)	Calculated Direction Of Hydraulic Gradient (Degrees From North)					USGS-Developed Borehole Deviation Correction Factors Used In These Calculations			Area Formed By Triangle of Wells (mi^2)
	Oct-00	Jan-02	Apr-02	Jul-02	Avg	Well#l (ft)	Well#2 (ft)	Well#3 (ft)	
USGS020-USGS038-USGS083	176	176	186	181	180	0.05	0.06	0.02	2.38
USGS020-USGS077-USGS115	175	181	175	180	178	0.05	0.01	2.23	0.11
USGS020-USGS112-USGS115	171	164	173	171	170	0.05	2.61	2.23	0.21
USGS038-USGS077-USGS115	182	187	186	185	185	0.06	0.01	2.23	0.05
USGS038-USGS083-USGS115	182	187	184	185	185	0.06	0.02	2.23	1.48
CFAMONA001-CFAMONA003-USGS083	136	132	127	143	134	0.01	0.01	0.02	0.24
CFAMONA001-CFAMONA003-LF208	142	143	106	141	133	0.01	0.01	2.95	0.42
CFAMONA001-LF208-LF308	169	156	176	175	169	0.01	2.95	4.77	0.38
CFAMONA001-LF308-M12S	207	199	—[a]	213	206	0.01	4.77	0.00	1.61
CFAMONA003-LF308-USGS020	147	145	152	149	148	0.01	4.77	0.05	1.59
CFAMONA002-USGS112-USGS115	171	165	174	171	170	0.02	2.61	2.23	0.86
LF209-USGS020-USGS077	102	104	108	104	105	5.72	0.05	0.01	0.60
LF308-USGS020-USGS115	133	127	140	138	134	4.77	0.05	2.23	0.67

a. The April 2001 water level measurement for RWMC-M12S was found to be incorrect and was not used here.

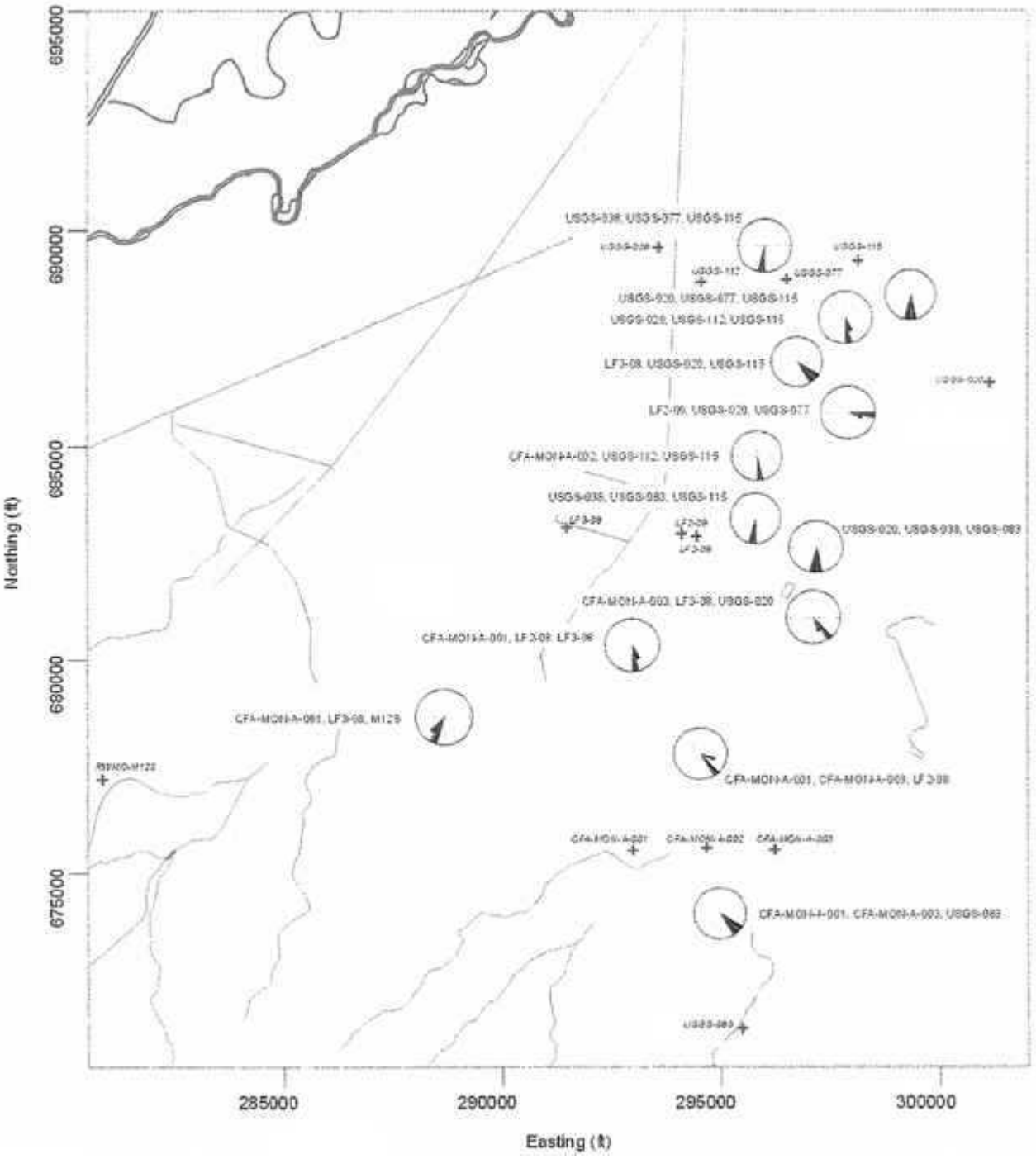

Figure F-1. Direction and magnitude of the aquifer hydraulic gradient.

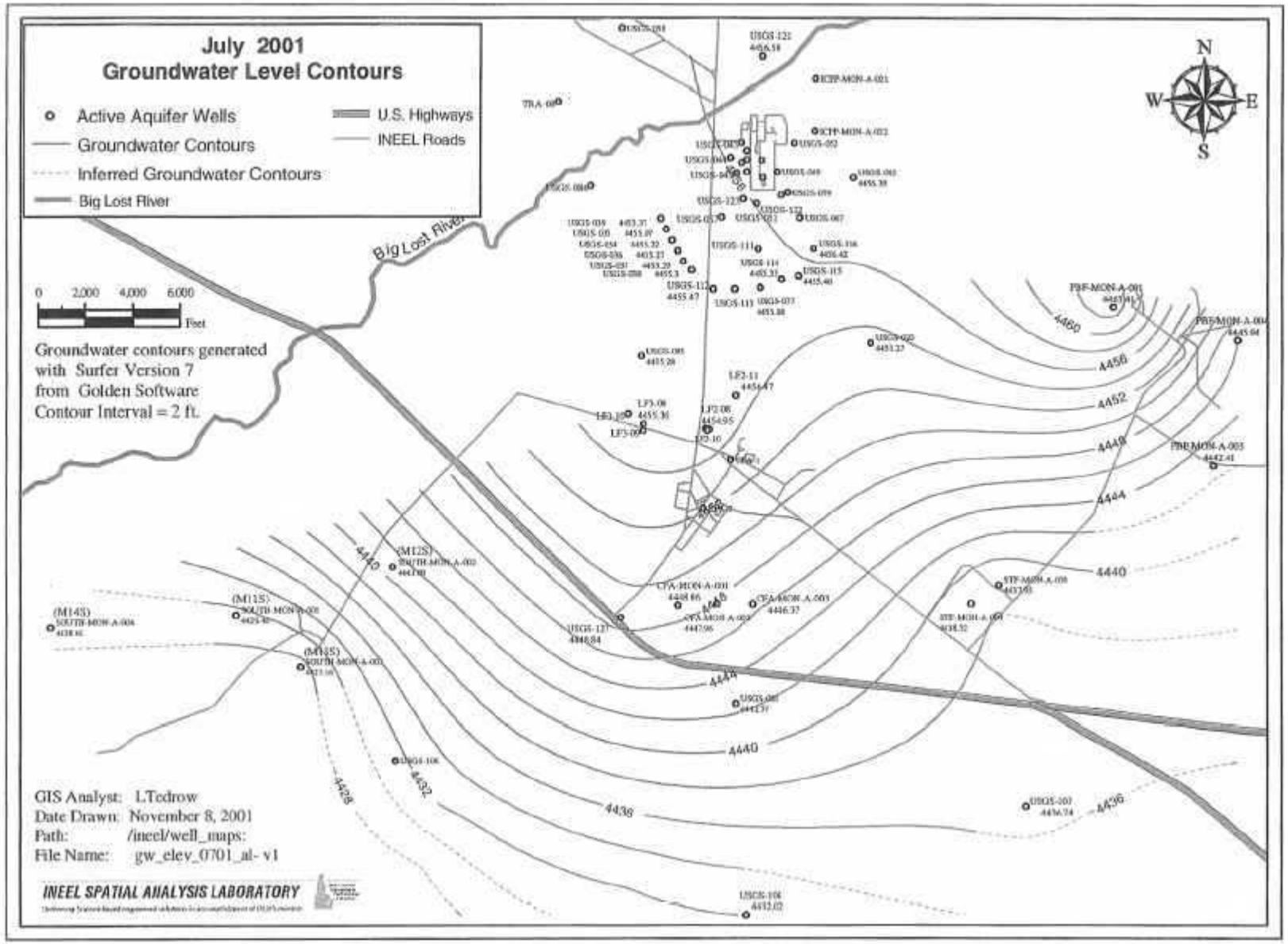

Figure F-2. Regional water-level contour plot.

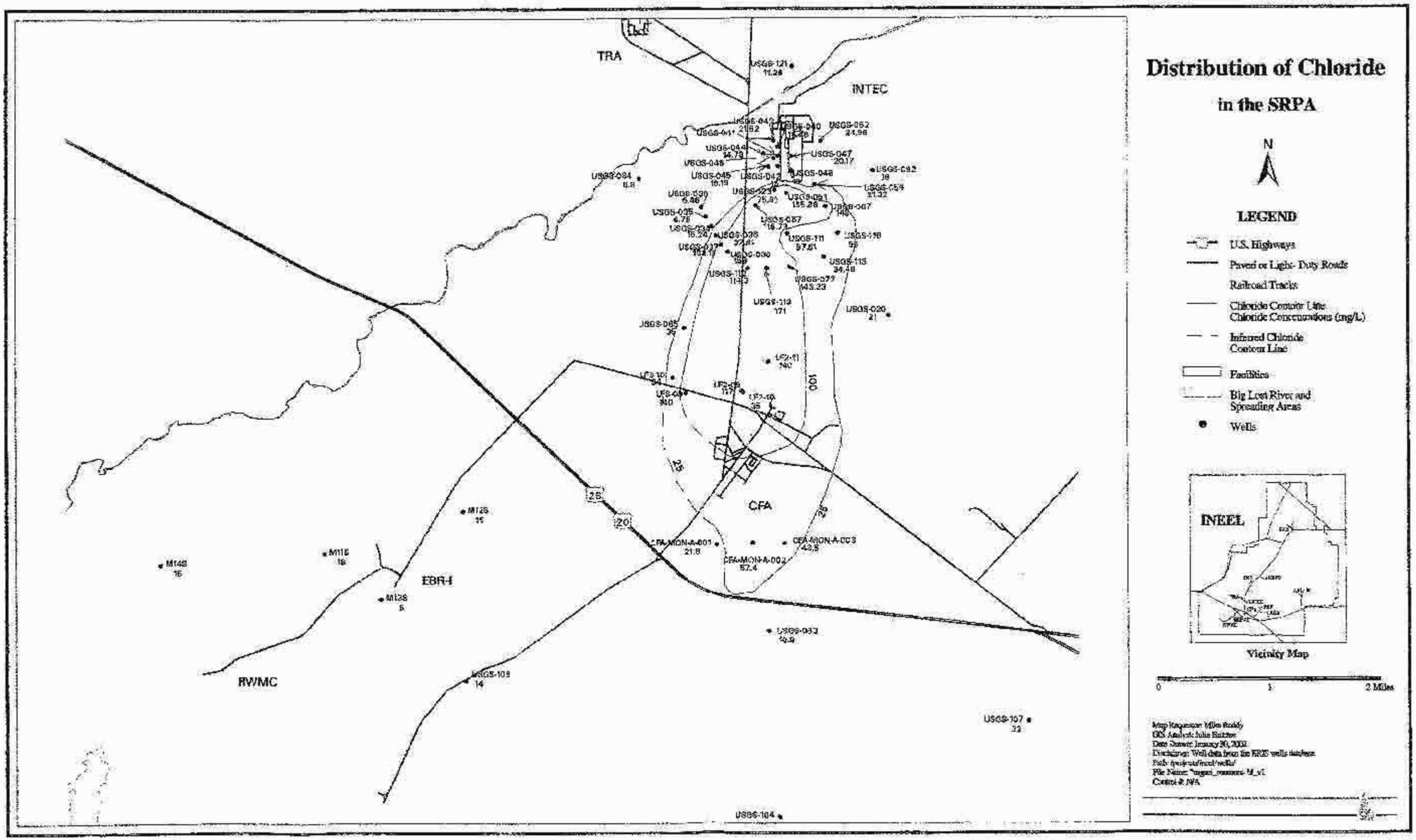

Figure F-3. INTEC chloride plume map.

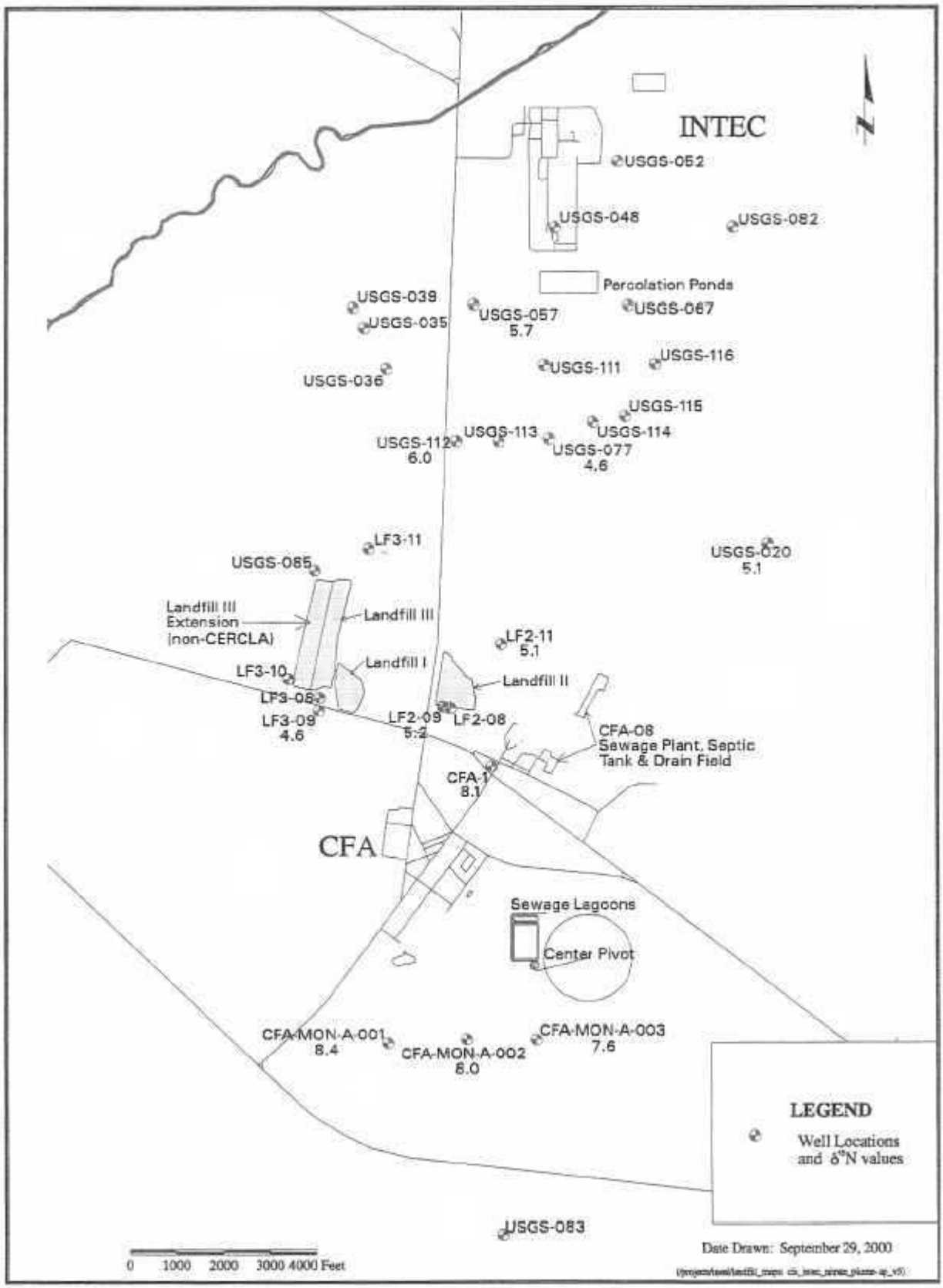

Figure F-4. Nitrogen isotope data in the CFA vicinity.

Table of Water Level Measurements
September 2000 to August 2001, WAG 4 - Central Facilities Area (CFA), INEEL, Idaho

Well ID#	Well Name	Well Alias	Brass Cap (BC) Elevation (ft)	Stickup (ft)	Date of Measurement	Measured Depth to Groundwater (ft bbc) (a)	Groundwater Elevation (ft amsl)	Measured Depth to Groundwater (ft bmp)	Existing Deviation Correction (ft)	Adjusted Groundwater Level (ft)	Comments and *Deviation Survey Information (b)*
1077	CFA-MON-A-001	CFA-MON-00l	4,936.44	2.13	9/21/00	486.43	4,450.01	488.56			*Deviation previously checked by*
					10/30/00	486.66	4,449.78	488.79			*magnetic gyro*
					11/22/00	486.85	4,449.59	488.98			*This well will be checked with latest*
					12/14/00	486.73	4,449.71	488.86			*USGS digital gym during CY2002*
					1/18/01	487.16	4,449.28	489.29			
					2/27/01	487.04	4,449.40	489.17			
					3/30/01	486.93	4,449.51	489.06			
					4/19/01	487.46	4,448.98	489.59			
					5/31/01	487.38	4,449.06	489.51			
					6/27/01	487.35	4,449.09	489.48			
					7/30/01	487.58	4,448.86	489.71			
					8/27/01	488.44	4,448.00	490.57			
					9/25/01	NM	NM	NM			
					10/17/01	488.77	4,447.67	490.90			
1078	CFA-MON-A-002	CFA-MON-002	4,932.24	1.93	9/21/00	483.73	4,448.51	485.66			*Deviation previously checked by*
					10/30/00	483.36	4,448.88	485.29			*magnetic gyro*
					11/22/00	483.39	4,448.85	485.32			*This well will be checked with latest*
					12/14/00	483.33	4,448.91	485.26			*USGS digital gyro during CY2002*
					1/18/01	484.72	4,447.52	486.65			
					2/27/01	484.65	4,447.59	486.58			
					3/30/01	483.54	4,448.70	485.47			
					4/19/01	484.19	4,448.05	486.12			
					5/31/01	484.06	4,448.18	485.99			
					6/27/01	484.04	4,448.20	485.97			
					7/30/01	484.28	4,447.96	486.21			
					8/27/01	485.15	4,447.09	487.08			
					9/25/01	NM	NM	NM			
					10/17/01	485.41	4,446.83	487.34			

Figure F-5. Water-level measurements.

Table of Water Level Measurements
September 2000 to August 2001, WAG 4 - Central Facilities Area (CFA), INEEL, Idaho

Well ID#	Well Name	Well Alias	Brass Cap (BC) Elevation (ft)	Stickup (ft)	Date of Measurement	Measured Depth to Groundwater (ft bbc) (a)	Groundwater Elevation (ft amsl)	Measured Depth to Groundwater (ft bmp)	Existing Deviation Correction (ft)	Adjusted Groundwater Level (ft)	Comments and *Deviation Survey Information (b)*
1089	CFA-MON-A-003	CFA-MON-003	4,930.31	1.83	9/21/00	482.86	4,447.45	484.69			*This well will be checked with latest*
					10/30/00	483.13	4,447.18	484.96			*USGS digital gyro during CY2002*
					11/22/00	483.24	4,447.07	485.07			
					12/14/00	483.09	4,447.22	484.92			
					1/18/01	483.57	4,446.74	485.40			
					2/27/01	483.41	4,446.90	485.24			
					3/30/01	483.30	4,447.01	485.13			
					4/19/01	483.89	4,446.42	485.72			
					5/31/01	483.81	4,446.50	485.64			
					6/27/01	483.68	4,446.63	485.51			
					7/30/01	483.94	4,446.37	485.77			
					8/27/01	NM	NM	NM			
					9/14/01	NM	NM	NM			
					10/17/01	492.87	4,437.44	494.70			
196	LF2-08		4,931.72	1.42	9/21/00	477.69	4,454.03	479.11	-2.95	4,456.98	*Deviation previously checked by*
					10/30/00	478.14	4,453.58	479.56	-2.95	4,456.53	*use of magnetic and photogyro.*
					11/22/00	478.17	4,453.55	479.59	-2.95	4,456.50	*This well will be checked with latest*
					12/19/00	478.17	4,453.55	479.59	-2.95	4,456.50	*USGS digital gyro during CY2002*
					1/18/01	478.44	4,453.28	479.86	-2.95	4,456.23	
					2/27/01	478.56	4,453.16	479.98	-2.95	4,456.11	
					3/30/01	478.57	4,453.15	479.99	-2.95	4,456.10	
					4/19/01	479.29	4,452.43	480.71	-2.95	4,455.38	
					5/31/01	479.00	4,452.72	480.42	-2.95	4,455.67	
					6/27/01	479.11	4,452.61	480.53	-2.95	4,455.56	
					7/31/01	479.72	4,452.00	481.14	-2.95	4,454.95	
					8/27/01	480.20	4,451.52	481.62	-2.95	4,454.47	
					9/14/01	NM	NM	NM		NM	
					10/17/01	NM	NM	NM		NM	

Figure F-5. (continued).

Table of Water Level Measurements
September 2000 to August 2001, WAG 4 - Central Facilities Area (CFA), INEEL, Idaho

Well ID#	Well Name	Well Alias	Brass Cap (BC) Elevation (ft)	Stickup (ft)	Date of Measurement	Measured Depth to Groundwater (ft bbc) (a)	Groundwater Elevation (ft amsl)	Measured Depth to Groundwater (ft bmp)	Existing Deviation Correction (ft)	Adjusted Groundwater Level (ft)	Comments and *Deviation Survey Information (b)*
197	LF2-09		4,932.23	1.23	9/21/00	480.66	4,451.57	481.89	-5.72	4,457.29	*Deviation previously checked by*
					10/30/00	480.91	4,451.32	482.14	-5.72	4,457.04	*use of magnetic and digital gyro.*
					11/22/00	481.12	4,451.11	482.35	-5.72	4,456.83	*This well will be checked with latest*
					12/19/00	481.20	4,451.03	482.43	-5.72	4,456.75	*USGS digital gyro during CY2002*
					1/18/01	481.29	4,450.94	482.52	-5.72	4,456.66	
					2/27/01	481.43	4,450.80	482.66	-5.72	4,456.52	
					3/30/01	481.51	4,450.72	482.74	-5.72	4,456.44	
					4/19/01	482.22	4,450.01	483.45	-5.72	4,455.73	
					5/31/01	481.93	4,450.30	483.16	-5.72	4,456.02	
					6/27/01	482.08	4,450.15	483.31	-5.72	4,455.87	
					7/31/01	482.59	4,449.64	483.82	-5.72	4,455.36	
					8/27/01	483.15	4,449.08	484.38	-5.72	4,455.80	
					9/14/01	NM	NM	NM		NM	
					10/17/01	NM	NM	NM		NM	
199	LF2-11		4,928.36	1.35	9/21/00	471.51	4,456.85	472.86			*Deviation previously checked by*
					10/30/00	471.35	4,456.07	472.70			*photo gyro*
					11/22/00	471.83	4,456.53	473.18			*This well will be checked with latest*
					12/19/00	472.29	4,456.07	473.64			*USGS digital gyro during CY2002*
					1/18/01	NM	NM	NM			Well Plugged
					2/27/01	472.90	4,455.46	474.25			Needs well box repair/does not lock
					3/30/01	NM	NM	NM			No access
					4/19/01	473.46	4,454.90	474.81			
					5/31/01	473.16	4,455.20	474.51			
					6/27/01	473.32	4,455.04	474.67			
					7/31/01	473.89	4,454.47	475.24			
					8/27/01	474.17	4,454.19	475.52			
					9/14/01	NM	NM	NM			
					10/17/01	NM	NM	NM			

Figure F-5. (continued).

Table of Water Level Measurements
September 2000 to August 2001, WAG 4 - Central Facilities Area (CFA), INEEL, Idaho

Well ID#	Well Name	Well Alias	Brass Cap (BC) Elevation (ft)	Stickup (ft)	Date of Measurement	Measured Depth to Groundwater (ft bbc) (a)	Groundwater Elevation (ft amsl)	Measured Depth to Groundwater (ft bmp)	Existing Deviation Correction (ft)	Adjusted Groundwater Level (ft)	Comments and *Deviation Survey Information (b)*
207	LF3-08		4,940.22	1.6	9/21/00	487.76	4,452.46	489.36	-4.77	4,457.23	*Deviation previously checked by*
					10/30/00	487.73	4,452.49	489.33	-4.77	4,457.26	*use of photo gyro.*
					11/22/00	488.28	4,451.94	489.88	-4.77	4,456.71	*This well will be checked with latest*
					12/19/00	488.29	4,451.93	489.89	-4.77	4,456.70	*USGS digital gyro during CY2002*
					1/18/01	487.20	4,453.02	488.80	-4.77	4,457.79	
					2/27/01	488.60	4,451.62	490.20	-4.77	4,456.39	
					3/30/01	488.70	4,451.52	490.30	-4.77	4,456.29	
					4/19/01	489.47	4,450.75	491.07	-4.77	4,455.52	
					5/31/01	489.14	4,451.08	490.74	-4.77	4,455.85	
					6/27/01	489.31	4,450.91	490.91	-4.77	4,455.68	
					7/31/01	489.63	4,450.59	491.23	-4.77	4,455.36	
					8/27/01	490.26	4,449.96	491.86	-4.77	4,454.73	
					9/14/01	NM	NM	NM			
					10/17/01	NM	NM	NM			
726	LF3-09		4,941.08	1.69	9/21/00	NM	NM	NM			Well under repair
					10/30/00	NM	NM	NM			
					11/22/00	NM	NM	NM			Well under repair
					12/19/00	NM	NM	NM			Well under repair
					1/18/01	NM	NM	NM			
					2/27/01	NM	NM	NM			Well under major repair/unlocked
					3/30/01	NM	NM	NM			Well under repair
					4/19/01	NM	NM	NM			Well under repair
					5/31/01	NM	NM	NM			
					6/27/01	NM	NM	NM			*Deviation previously checked by*
					7/31/01	NM	NM	NM			*use of magnetic and photogyro.*
					8/27/01	NM	NM	NM			*This well will be checked with latest*
					9/14/01	NM	NM	NM			*USGS digital gyro during CY2002*
					10/17/01	NM	NM	NM			

Figure F-5. (continued).

Table of Water Level Measurements
September 2000 to August 2001, WAG 4 - Central Facilities Area (CFA), INEEL, Idaho

Well ID#	Well Name	Well Alias	Brass Cap (BC) Elevation (ft)	Stickup (ft)	Date of Measurement	Measured Depth to Groundwater (ft bbc) (a)	Groundwater Elevation (ft amsl)	Measured Depth to Groundwater (ft bmp)	Existing Deviation Correction (ft)	Adjusted Groundwater Level (ft)	Comments and *Deviation Survey Information (b)*
727	LF3-10		4,942.62		9/21/00	NM	NM	487.78			Well repaired 1999 - Needs resurvey
					10/30/00	NM	NM	487.96			
					11/22/00	NM	NM	NM			Well repaired 1999 - Needs resurvey
					12/19/00	NM	NM	488.29			Stickup needs to be resurveyed
					1/18/01	NM	NM	488.56			
					2/27/01	NM	NM	NM			Needs brass cap resurvey/pad/posts
					3/30/01	NM	NM	NM			Needs brass cap resurvey
					4/19/01	NM	NM	NM			No measuring point
					5/31/01	NM	NM	NM			
					6/27/01	NM	NM	NM			Needs to be resurveyed
					7/31/01	NM	NM	NM			
					8/27/01	NM	NM	NM			*This well will be checked with latest*
					9/25/01	NM	NM	NM			*USGS digital gyro during CY2002*
					10/17/01	NM	NM	NM			
1213	M12S	SOUTH-MON-A-002	4,975.28	1.75	9/21/00	531.00	4,444.18	532.75			
					10/30/00	532.11	4,443.17	533.86			
					11/22/00	532.17	4,443.11	533.92			
					12/19/00	532.57	4,442.71	534.32			
					1/18/01	530.86	4,442.67	532.61			
					2/28/01	532.16	4,443.12	533.91			
					3/29/01	NM	NM	NM			New locks
					4/19/01	NA	NA	NA			
					5/29/01	534.16	4,439.37	535.91			
					6/28/01	534.01	4,439.52	535.76			
					7/31/01	534.19	4,439.34	535.94			
					8/27/01	534.54	4,438.99	536.29			
					9/25/01	535.17	4,438.36	536.92			
					10/17/01	535.36	4,438.17	537.11			

Figure F-5. (continued).

Table of Water Level Measurements
September 2000 to August 2001, WAG 4 - Central Facilities Area (CFA), INEEL, Idaho

Well ID#	Well Name	Well Alias	Brass Cap (BC) Elevation (ft)	Stickup (ft)	Date of Measurement	Measured Depth to Groundwater (ft bbc) (a)	Groundwater Elevation (ft amsl)	Measured Depth to Groundwater (ft bmp)	Existing Deviation Correction (ft)	Adjusted Groundwater Level (ft)	Comments and *Deviation Survey Information (b)*
1306	STF-MON-A-004	STF-MON-A-004	4,945.37	2.16	9/21/00	504.22	4,441.65	506.38			
					10/30/00	504.40	4,438.81	506.56			
					11/22/00	504.40	4,440.97	506.56			
					12/19/00	496.35	4,441.14	498.40			
					1/18/01	504.47	4,438.74	506.63			
					2/28/01	NM	NM	NM			No access
					3/29/01	504.42	4,440.95	506.58			
					4/19/01	506.52	4,436.69	508.68			
					5/29/01	NM	NM	NM			
					6/28/01	506.52	4,436.69	508.68			
					7/31/01	506.85	4,436.36	509.01			
					8/27/01	507.16	4,436.05	509.32			
					9/25/01	NM	NM	NM			
					10/17/01	NM	NM	NM			
483	USGS-034	USGS-34	4,929.19	1.07	9/21/00	471.95	4,457.24	473.02			
					10/30/00	472.37	4,456.82	473.44			
					11/22/00	472.41	4,456.78	473.48			
					12/19/00	472.45	4,456.74	473.52			
					1/18/01	472.67	4,456.52	473.74			
					2/28/01	NM	NM	NM			No access
					3/29/01	472.79	4,456.40	473.86			
					4/19/01	473.50	4,455.69	474.57			
					5/29/01	474.98	4,454.21	476.05			
					6/28/01	NM	NM	NM			No access
					7/31/01	473.97	4,455.22	475.04			
					8/27/01	474.91	4,454.28	475.98			
					9/25/01	NM	NM	NM			
					10/17/01	474.92	4,454.27	475.99			

Figure F-5. (continued).

Table of Water Level Measurements
September 2000 to August 2001, WAG 4 - Central Facilities Area (CFA), INEEL, Idaho

Well ID#	Well Name	Well Alias	Brass Cap (BC) Elevation (ft)	Stickup (ft)	Date of Measurement	Measured Depth to Groundwater (ft bbc) (a)	Groundwater Elevation (ft amsl)	Measured Depth to Groundwater (ft bmp)	Existing Deviation Correction (ft)	Adjusted Groundwater Level (ft)	Comments and *Deviation Survey Information (b)*
484	USGS-035	USGS-35	4,929.64	1.55	9/21/00	472.48	4,457.16	474.03			
					10/30/00	472.99	4,456.65	474.54			
					11/22/00	473.08	4,456.56	474.63			
					12/19/00	473.01	4,456.63	474.56			
					1/18/01	473.33	4,456.31	474.88			
					2/28/01	NM	NM	NM			No access
					3/29/01	473.47	4,456.17	475.02			
					4/19/01	474.23	4,455.41	475.78			
					5/29/01	473.56	4,456.08	475.11			
					6/28/01	474.22	4,455.42	475.77			
					7/31/01	474.57	4,455.07	476.12			
					8/27/01	475.56	4,454.08	477.11			
					9/25/01	NM	NM	NM			
					10/17/01	475.57	4,454.07	477.12			
485	USGS-036	USGS-36	4,929.20	1.18	9/21/00	471.84	4,457.36	473.02			
					10/30/00	472.33	4,456.87	473.51			
					11/22/00	472.41	4,456.79	473.59			
					12/19/00	472.33	4,456.87	473.51			
					1/18/01	472.63	4,456.57	473.81			
					2/28/01	472.68	4,456.52	473.86			
					3/29/01	472.76	4,456.44	473.94			
					4/19/01	473.48	4,455.72	474.66			
					5/29/01	473.10	4,456.10	474.28			
					6/28/01	473.53	4,455.67	474.71			
					7/31/01	473.93	4,455.27	475.11			
					8/27/01	474.97	4,454.23	476.15			
					9/25/01	NM	NM	NM			
					10/17/01	NM	NM	NM			

Figure F-5. (continued).

Table of Water Level Measurements
September 2000 to August 2001, WAG 4 - Central Facilities Area (CFA), INEEL, Idaho

Well ID#	Well Name	Well Alias	Brass Cap (BC) Elevation (ft)	Stickup (ft)	Date of Measurement	Measured Depth to Groundwater (ft bbc) (a)	Groundwater Elevation (ft amsl)	Measured Depth to Groundwater (ft bmp)	Existing Deviation Correction (ft)	Adjusted Groundwater Level (ft)	Comments and *Deviation Survey Information (b)*
486	USGS-037	USGS-37	4,929.38	1.22	9/21/00	472.06	4,457.32	473.28			
					10/30/00	472.32	4,457.06	473.54			
					11/22/00	472.54	4,456.84	473.76			
					12/19/00	471.60	4,457.78	472.82			
					1/18/01	472.37	4,457.01	473.59			
					2/28/01	472.32	4,457.06	473.54			
					3/29/01	4472.95	456.43	4474.17			
					4/19/01	473.69	4,455.69	474.91			
					5/29/01	473.29	4,456.09	474.51			
					6/28/01	473.64	4,455.74	474.86			
					7/31/01	474.09	4,455.29	475.31			
					8/27/01	474.94	4,454.44	476.16			
					9/25/01	NM	NM	NM			
					10/17/01	475.01	4,454.62	476.23			
487	USGS-038	USGS-38	4,929.63	1.33	9/21/00	472.29	4,457.34	473.62			
					10/30/00	472.76	4,456.87	474.09			
					11/22/00	472.86	4,456.77	474.19			
					12/19/00	472.69	4,456.94	474.02			
					1/18/01	473.05	4,456.58	474.38			
					2/28/01	473.08	4,456.55	474.41			
					3/29/01	473.21	4,456.42	474.54			
					4/19/01	473.91	4,455.72	475.24			
					5/29/01	472.32	4,457.31	473.65			
					6/28/01	472.91	4,456.72	474.24			
					7/31/01	474.33	4,455.30	475.66			
					8/27/01	475.18	4,454.45	476.51			
					9/25/01	NM	NM	NM			
					10/17/01	475.24	4,454.39	476.57			

Figure F-5. (continued).

Table of Water Level Measurements
September 2000 to August 2001, WAG 4 - Central Facilities Area (CFA), INEEL, Idaho

Well ID#	Well Name	Well Alias	Brass Cap (BC) Elevation (ft)	Stickup (ft)	Date of Measurement	Measured Depth to Groundwater (ft bbc) (a)	Groundwater Elevation (ft amsl)	Measured Depth to Groundwater (ft bmp)	Existing Deviation Correction (ft)	Adjusted Groundwater Level (ft)	Comments and *Deviation Survey Information (b)*
526	USGS-077	USGS-77	4,921.79	2.18	9/21/00	464.83	4,456.96	467.01			
					10/30/00	465.19	4,456.60	467.37			
					11/22/00	465.19	4,456.60	467.37			
					12/19/00	465.03	4,456.76	467.21			
					1/18/01	465.45	4,456.34	467.63			
					2/28/01	465.50	4,456.29	467.68			
					3/29/01	465.62	4,456.17	467.80			
					4/19/01	466.23	4,455.56	468.41			
					5/29/01	465.84	4,455.95	468.02			
					6/28/01	466.25	4,455.54	468.43			
					7/31/01	466.71	4,455.08	468.89			
					8/28/01	467.49	4,454.30	469.67			
					9/25/01	NM	NM	NM			
					10/17/01	NM	NM	NM			
532	USGS-083	USGS-83	4,941.59	2.15	9/21/00	NM	NM	NM			
					10/30/00	497.38	4,444.21	499.53			
					11/22/00	497.06	4,444.53	499.21			
					12/18/00	497.76	4,443.83	499.91			
					1/19/01	497.27	4,444.32	499.42			
					2/28/01	497.22	4,444.37	499.37			
					3/30/01	497.32	4,444.27	499.47			
					4/18/01	506.88	4,434.71	509.03			
					5/31/01	499.16	4,442.43	501.31			
					6/27/01	498.97	4,442.62	501.12			
					7/30/01	499.02	4,442.57	501.17			
					8/29/01	499.21	4,442.38	501.36			
					9/14/01	499.88	4,441.71	502.03			
					10/17/01	NM	NM	NM			

Figure F-5. (continued).

Table of Water Level Measurements
September 2000 to August 2001, WAG 4 - Central Facilities Area (CFA), INEEL, Idaho

Well ID#	Well Name	Well Alias	Brass Cap (BC) Elevation (ft)	Stickup (ft)	Date of Measurement	Measured Depth to Groundwater (ft bbc) (a)	Groundwater Elevation (ft amsl)	Measured Depth to Groundwater (ft bmp)	Existing Deviation Correction (ft)	Adjusted Groundwater Level (ft)	Comments and *Deviation Survey Information (b)*
560	USGS-111		4,920.50	2.27	9/21/00	469.04	4,451.46	471.31	-5.24	4,456.70	*Deviation previously checked by*
					10/30/00	469.72	4,450.78	471.99	-5.24	4,456.02	*use of a photo gyro.*
					11/22/00	469.57	4,450.93	471.84	-5.24	4,456.17	*This well will be checked with latest*
					12/19/00	469.58	4,450.92	471.85	-5.24	4,456.16	*USGS digital gyro during CY2002*
					1/18/01	469.62	4,450.88	471.89	-5.24	4,456.12	
					2/28/01	469.93	4,450.57	472.20	-5.24	4,455.81	
					3/29/01	470.05	4,450.45	472.32	-5.24	4,455.69	
					4/19/01	470.76	4,449.74	473.03	-5.24	4,454.98	
					5/29/01	470.29	4,450.21	472.56	-5.24	4,455.45	
					6/28/01	470.72	4,449.78	472.99	-5.24	4,455.02	
					7/31/01	NM	NM	NM		NM	
					8/28/01	472.16	4,448.34	474.43	-5.24	4,453.58	
					9/25/01	NM	NM	NM		NM	
					10/22/01	472.09	4,448.41	474.36	-5.24	4,453.65	
561	USGS-112		4,927.84	2.29	9/21/00	473.05	4,454.79	475.34	-2.61	4,457.40	*Deviation previously checked by*
					10/30/00	473.57	4,454.27	475.86	-2.61	4,456.88	*use of magnetic and photo gyro.*
					11/22/00	473.29	4,454.55	475.58	-2.61	4,457.16	*This well will be checked with latest*
					12/19/00	473.46	4,454.38	475.75	-2.61	4,456.99	*USGS digital gyro during CY2002*
					1/18/01	473.28	4,454.56	475.57	-2.61	4,457.17	
					2/28/01	473.65	4,454.19	475.94	-2.61	4,456.80	
					3/29/01	473.94	4,453.90	476.23	-2.61	4,456.51	
					4/19/01	474.66	4,453.18	476.95	-2.61	4,455.79	
					5/29/01	474.25	4,453.59	476.54	-2.61	4,456.20	
					6/28/01	474.60	4,453.24	476.89	-2.61	4,455.85	
					7/31/01	474.98	4,452.86	477.27	-2.61	4,455.47	
					8/27/01	475.96	4,451.88	478.25	-2.61	4,454.49	
					9/25/01	NM	NM	NM		NM	
					10/22/01	476.02	4,451.82	478.31	-2.61	4,454.43	

Figure F-5. (continued).

Table of Water Level Measurements
September 2000 to August 2001, WAG 4 - Central Facilities Area (CFA), INEEL, Idaho

Well ID#	Well Name	Well Alias	Brass Cap (BC) Elevation (ft)	Stickup (ft)	Date of Measurement	Measured Depth to Groundwater (ft bbc) (a)	Groundwater Elevation (ft amsl)	Measured Depth to Groundwater (ft bmp)	Existing Deviation Correction (ft)	Adjusted Groundwater Level (ft)	Comments and *Deviation Survey Information (b)*
562	USGS-113		4,925.28	2.34	9/21/00	473.64	4,451.64	475.98	-6.46	4,458.10	*Deviation previously checked by*
					10/30/00	474.01	4,451.27	476.35	-6.46	4,457.73	*use of magnetic and digital gyro.*
					11/22/00	473.98	4,451.30	476.32	-6.46	4,457.76	*This well will be checked with latest*
					12/19/00	473.77	4,451.51	476.11	-6.46	4,457.97	*USGS digital gyro during CY2002*
					1/18/01	474.23	4,451.05	476.57	-6.46	4,457.51	
					2/28/01	474.25	4,451.03	476.59	-6.46	4,457.49	
					3/29/01	474.39	4,450.89	476.73	-6.46	4,457.35	
					4/19/01	475.12	4,450.16	477.46	-6.46	4,456.62	
					5/29/01	474.69	4,450.59	477.03	-6.46	4,457.05	
					6/28/01	NM	NM	NM		NM	No access
					7/31/01	475.50	4,449.78	477.84	-6.46	4,456.24	
					8/27/01	NM	NM	NM		NM	
					9/25/01	NM	NM	NM		NM	
					10/22/01	NM	NM	NM		NM	
563	USGS-114		4,920.09	2.28	9/21/00	467.45	4,452.64	469.73	-4.70	4,457.34	*Deviation previously checked by*
					10/30/00	470.00	4,450.09	472.28	-4.70	4,454.79	*use of a photo gyro.*
					11/22/00	467.89	4,452.20	470.17	-4.70	4,456.90	*This well will be checked with latest*
					12/19/00	467.96	4,452.13	470.24	-4.70	4,456.83	*USGS digital gyro during CY2002*
					1/18/01	468.34	4,451.75	470.62	-4.70	4,456.45	
					2/28/01	468.32	4,451.77	470.60	-4.70	4,456.47	
					3/29/01	468.27	4,451.82	470.55	-4.70	4,456.52	
					4/19/01	468.96	4,451.13	471.24	-4.70	4,455.83	
					5/29/01	468.60	4,451.49	470.88	-4.70	4,456.19	
					6/28/01	469.09	4,451.00	471.37	-4.70	4,455.70	
					7/31/01	469.44	4,450.65	471.72	-4.70	4,455.35	
					8/27/01	470.28	4,449.81	472.56	-4.70	4,454.51	
					9/25/01	NM	NM	NM		NM	
					10/22/01	470.33	4,449.76	472.61	-4.70	4,454.46	

Figure F-5. (continued).

Table of Water Level Measurements
September 2000 to August 2001, WAG 4 - Central Facilities Area (CFA), INEEL, Idaho

Well ID#	Well Name	Well Alias	Brass Cap (BC) Elevation (ft)	Stickup (ft)	Date of Measurement	Measured Depth to Groundwater (ft bbc) (a)	Groundwater Elevation (ft amsl)	Measured Depth to Groundwater (ft bmp)	Existing Deviation Correction (ft)	Adjusted Groundwater Level (ft)	Comments and *Deviation Survey Information (b)*
564	USGS-115		4,918.84	2.3	9/21/00	463.76	4,455.08	466.06	-2.23	4,457.31	*Deviation previously checked by*
					10/30/00	464.19	4,454.65	466.49	-2.23	4,456.88	*use of a photo gyro.*
					11/22/00	464.18	4,454.66	466.48	-2.23	4,456.89	*This well will be checked with latest*
					12/19/00	464.38	4,454.46	466.68	-2.23	4,456.69	*USGS digital gyro during CY2002*
					1/18/01	464.23	4,454.61	466.53	-2.23	4,456.84	
					2/28/01	464.18	4,454.66	466.48	-2.23	4,456.89	
					3/29/01	464.56	4,454.28	466.86	-2.23	4,456.51	
					4/19/01	465.19	4,453.65	467.49	-2.23	4,455.88	
					5/29/01	464.81	4,454.03	467.11	-2.23	4,456.26	
					6/28/01	465.26	4,453.58	467.56	-2.23	4,455.81	
					7/31/01	465.61	4,453.23	467.91	-2.23	4,455.46	
					8/28/01	466.54	4,452.30	468.84	-2.23	4,454.53	
					9/25/01	NM	NM	NM	NM	NM	
					10/22/01	466.48	4,452.36	468.78	-2.23	4,454.59	
565	USGS-116		4,916.03	2.53	9/21/00	457.73	4,458.30	460.26			
					10/30/00	458.08	4,457.95	460.61			
					11/22/00	NM	NM	NM			Time not available
					12/19/00	458.16	4,457.87	460.69			
					1/18/01	458.20	4,457.83	460.73			
					2/28/01	458.66	4,457.37	461.19			
					3/29/01	458.51	4,457.52	461.04			
					4/19/01	459.23	4,456.80	461.76			
					5/29/01	458.82	4,457.21	461.35			
					6/28/01	459.28	4,456.75	461.81			
					7/31/01	459.61	4,456.42	462.14			
					8/28/01	460.52	4,455.51	463.05			
					9/25/01	NM	NM	NM			
					10/22/01	460.42	4,455.61	462.95			

Figure F-5. (continued).

Table of Water Level Measurements
September 2000 to August 2001, WAG 4 - Central Facilities Area (CFA), INEEL, Idaho

Well ID#	Well Name	Well Alias	Brass Cap (BC) Elevation (ft)	Stickup (ft)	Date of Measurement	Measured Depth to Groundwater (ft bbc) (a)	Groundwater Elevation (ft amsl)	Measured Depth to Groundwater (ft bmp)	Existing Deviation Correction (ft)	Adjusted Groundwater Level (ft)	Comments and *Deviation Survey Information (b)*
988	USGS-127	USGS-OBS-A-125	4,956.44	1.57	9/21/00	NM	NM	NM			Well not completed
					10/30/00	NM	NM	NM			
					11/22/00	NM	NM	NM			Well not completed
					12/19/00	NM	NM	NM			Well not completed
					1/18/01	NM	NM	NM			Well not completed
					2/28/01	507.26	4,449.18	508.83			Stickup needs to be surveyed
					3/30/01	505.42	4,451.02	506.99			
					4/19/01	507.33	4,449.11	508.90			
					5/31/01	507.25	4,449.19	508.82			
					6/27/01	507.24	4,449.20	508.81			
					7/30/01	507.55	4,448.89	509.12			
					8/27/01	986.43	3,970.01	988.00			
					9/25/01	NM	NM	NM			
					10/16/01	508.78	4,447.66	510.35			

Notes:

(a) Measured with either steel tapes or electronic water level meters

(b) *Additional wells not listed that will be checked for deviation during CY2002 using the latest USGS digital gyro tool include Wells LF2-10, USGS-020, and USGS-128.*

NM Not measured
NA Information not available due to equipment error during measurements
bbc Measuring point below brass cap
bmp Below measuring point
amsl Above mean sea level
ft feet

Figure F-5. (continued).

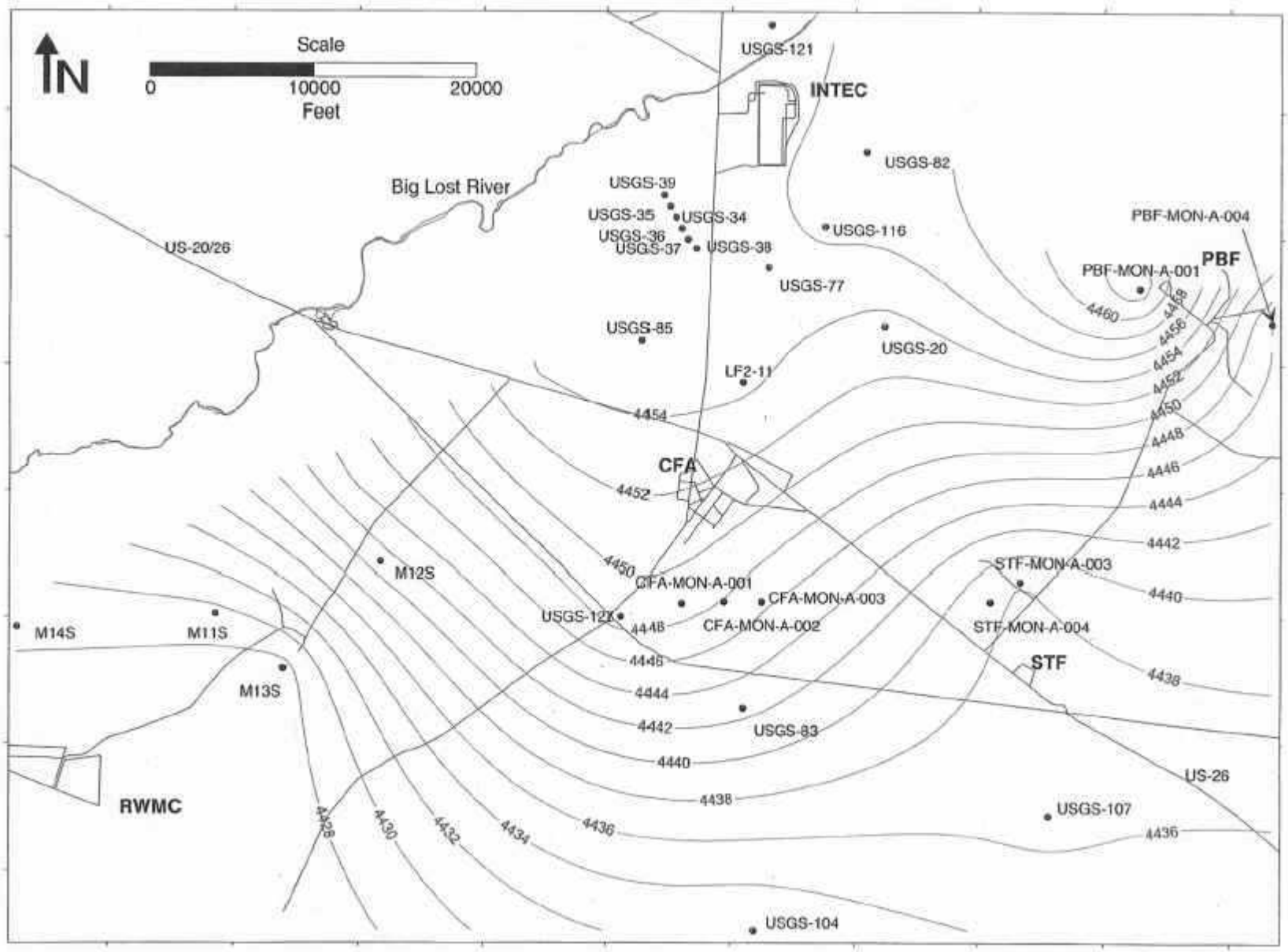

Figure F-6. Water-level contour map without highly deviated wells.

Appendix G

CFA Landfill Moisture Monitoring
(October 2000 through September 2001)

G-1. CFA LANDFILL MOISTURE MONITORING (OCTOBER 2000 THROUGH SEPTEMBER 2001)

The overall objective of infiltration monitoring at the Central Facilities Area (CFA) landfills is to document the effectiveness of the landfill covers for minimizing infiltration into the landfill wastes (INEL 1997b). The moisture content of the soil was monitored using time-domain reflectometer and neutron probe instruments. The data from the new deep or vertical time-domain reflectometer systems that were installed in the native soil cover at Landfills II and III to a depth of 2.4 m (8 ft) during August and September 2000 are reported and discussed. Moisture monitoring data from five existing neutron-probe access tubes (NATs) are also reported and discussed.

The terms “infiltration, recharge, and drainage” are used throughout this appendix and are defined in the following sentences. Water that moves into the soil is defined as “infiltration.” Water that continues to move downward beyond the evapotranspiration (ET) depth and out of the soil profile is termed “recharge.” Infiltration and recharge are represented by an increase in water storage within a system. In addition to recharge, evapotranspiration is a large contributor to decreasing storage in near-surface soils, moving water upward and out of the soil. The term “drainage” refers to water movement out of a unit thickness of soil or a decrease in soil moisture content, but does not indicate the direction of movement.

G-1.1 Neutron-Probe Moisture Monitoring Data

The target for the neutron probe monitoring at the landfills is the volume of water infiltrating past the evapotranspiration or rooting depth. Water that passes through the evapotranspiration depth may pick up contaminants in the landfill waste and carry them to the depth monitored by the NATs. The volumes for infiltration, drainage, and recharge have been calculated for each landfill NAT location from October 2000 through September 2001. The raw data for the five neutron probe monitoring locations are provided in Tables 1 through 5. Calculated infiltration, recharge, and drainage for the five locations are summarized in Table 6.

Neutron probe logs for each NAT show fluctuations through time in the upper 0.9 m (3 ft) that are caused by annual precipitation/snow melt cycles (Figures 1 through 5). The three-dimensional plots show a spike in moisture content in March 2001, but the spike does not penetrate more than 0.9 m (3 ft) except at LF 2-04 located off the landfills. The timing of the moisture increases in the landfill soil indicates that snowmelt is the most significant infiltration event at the landfills. The undulating floor in the three-dimensional charts probably reflects neutron data precision. However, none of the NAT locations showed a ridge of water penetrating the entire soil column as occurred in 1998. The 1998 occurrence was prior to the vegetation becoming established on the landfill covers.

G-1.1.1 Infiltration and Recharge Estimates Using Neutron-Probe Access Tube Data

The calculations of moisture content and volumetric water content are described below. Methods for estimating infiltration and recharge are also described.

The infiltration and recharge for 2001 was estimated by calculating the change in water storage using the following calibration equations:

MC = 0.000808 x counts, for sand and gravel

MC = 0.00166 x counts + 4.74, for clay

where:

MC = moisture content.

The mass water content was converted to a volumetric water content by multiplying the mass water content by the soil bulk density value, determined for samples collected from the boreholes adjacent to the NATs (Edgerton, Germeshausen, and Grier [EG&G] 1988). The equations to calculate volumetric water content (Vol) are:

Vol = MC x 1.98, for sand and gravel

Vol = MC x 1.69, for clay.

The calibration curves were assigned to 0.3-m (1-ft) increments of the NATs based on lithology logs for boreholes drilled next to the tubes located off the landfills (Table 8). For the NATs located on the landfills, 0.3-m (1-ft) increments with count rates less than 5,500 were assigned to the sand and gravel calibration curve, and those with count rates greater than 5,500 were assigned to the clay calibration.

Figures 1 through 5 show that the only measurable infiltration event that penetrates beyond the first foot occurred in the spring of 2001. Consequently, infiltration and recharge were calculated for this spring event and these calculations also reflect recharge for the entire year. Based on the change in storage using the calibration calculations and the assumed evapotranspiration (ET) depth, the estimates of recharge for spring 2001 are less than 0.64 cm (0.25 in.) for all locations except LF 2-04 (Table 9). The recharge at LF 2-04 was calculated to be 0.76 cm (0.30 in.). Infiltration calculations for the five NATs for the spring 2001 ranged from 2.34 to 3.61. cm (0.92 to 1.42 in.). The highest amount of infiltration occurred at LF 2-04, which is located off Landfill II. The infiltration estimates of 2.34 to 3.61 cm (0.92 to 1.42 in.) are consistent with the measured precipitation at the CFA National Oceanic and Atmospheric Administration (NOAA) weather station of 4.6 cm (1.8 in.). The precipitation from November 2000, the time that the surface soil started to freeze, until the spring thaw, approximately March 8, 2001, was 4.6 cm (1.8 in.) (Table 7).

G-1.1.2 Water Storage Analysis for Neutron-Probe Data

Changes in storage refer to changes in soil moisture content over a period that represents a full moisture cycle that is typically a one-year period. Changes in storage at the NAT locations for the period of October 2000 to September 2001 indicate that the entire soil column over the length of the tubes is decreasing in moisture content (Table 6). The change in water storage indicates that moisture contents are decreasing slightly or holding steady within the landfill caps and within the evapotranspiration zones. Location LF 2-07 showed the largest decrease in water storage of 2.54 cm (1.00 in.) over the entire soil column and 2.31 cm (0.91 in.) below the evapotranspiration zone. In contrast, LF 2-03 located near Landfill II showed almost no change in storage over the entire soil column, within the evapotranspiration zone, and below the evapotranspiration zone (Table 6). The other NATs showed slight negative changes in storage over the entire soil column, within the evapotranspiration zone, and below the evapotranspiration zone.

G-1.1.3 Evaluation of Evapotranspiration Depth

The depth to which evapotranspiration is influential depends on the plants and their rooting depths, soil types, and the meteorological conditions that are present. The evapotranspiration depth is assumed to be 0.9 to 1.2 m (3 to 4 ft). For the evapotranspiration depth to be evaluated, enough data are necessary so that yearly variations in moisture content in the upper part of the soil profile can be assessed. The

evapotranspiration depths for the NAT locations are based on the amount of drainage occurring at 0.3-m (1-ft) increments. The drainage from one layer to the next within the evapotranspiration zone should steadily decrease until the zero flux boundary is reached. The depth at which drainage becomes nearly constant is assumed to be the evapotranspiration depth. Plots of drainage for the five NATs are shown on Figure (G-71).

Drainage estimates were made by calculating the change in storage for each 0.3-m (1-ft) layer over the course of one year and then summing the negative changes in storage. The monthly change in storage is calculated for a 1-ft layer and for the soil column as follows:

One foot layer

$$\Delta \text{Volumetric water content} = (VOl_{march} - Vol_{februaryl})* 12 \text{ in.}$$

Soil Column

$$\Delta \text{Volumetric water content} = \Sigma \Delta \text{ Volumetric water contents for each one-foot layer.}$$

The total drainage varied from 3.16 inches for LF2-03 to 4.32 inches for LF2-07. The drainage below the ET zone varied from 3.45 cm (1.36 in.) for LF3-03 to 7.39 cm (2.91 in.) for LF2-07 (Table 6).

The plots suggest an ET depth of 3 feet for all locations except LF2-04; however, the monitoring period year was significantly below the average winter (November-April) precipitation and yearly precipitation amounts (Table 6).

G-1.2 Time-Domain Reflectometer Data Analysis

Time-domain reflectometer data were collected from two locations at both Landfills II and III, with the volumetric moisture data collected at 15-cm (6-in.) intervals from the surface to a depth of 2.4 m (8 ft) (Figure 6-2 in Section 6). The new time-domain reflectometer systems were installed in August and September 2000. The systems installed were Moisture Point systems from Environmental Sensors, Inc. The Moisture Point system consists of an MP-917, Moisture Point Type-K probes, Campbell Scientific CR10X data logger and COM200 phone modem, solar panel, battery, and probe cables. The MP-917 interrogates the probes and reduces the segment data to a numerical probe data set for export to the CR10X data logger.

Data collection at Landfill III commenced on September 26, 2000. Time-domain reflectometer data collection at Landfill II began on November 9 and December 6, 2000. The data collection at Landfill II started later than that at Landfill III because of communication problems between the two sites. Plots of the time-domain reflectometer data from the beginning of data collection to September 30, 2001, are provided in Figures 7 through 10. The plots show the volumetric moisture content for 15-cm (6-in.) intervals from the surface to a depth of 2.4 m (8 ft). In general, the time-domain reflectometer data showed that the most significant increase in moisture content occurred during the spring 2001 snowmelt event. From September 2000 until February 2001, the time-domain reflectometer probes exhibited wide variations between measurements that reflected data noise rather than changes in moisture content. In February 2001, Environmental Sensors, Inc., loaded a new data reduction algorithm into the MP-917 to reduce data noise, and the MP-917 was insulated to reduce the effects of sub-freezing weather on the electronics.

The monitoring of water movement or absence of infiltration through the soil cover on the landfills is the primary concern of the time-domain reflectometer monitoring at Landfills II and III. The low-

permeability layer of the soil cover is located 15 to 45 cm (6 to 18 in.) below land surface (bls). Moisture contents that increase and decrease within the low-permeability layer indicate the movement of water into and out of this compacted layer. Downward water movement through the low-permeability layer can be determined by examining time-domain reflectometer moisture content data below the low-permeability layer. Increasing moisture contents below the low-permeability layer indicate water moved vertically through the low-permeability layer.

G-1.2.1 Infiltration Calculations Based on Time-Domain Reflectometer Data

In general, the time-domain reflectometer data show an increase in moisture content to depths of less than 0.9 m (3 ft) during the spring snow melt of 2001, which was the most significant infiltration event of the year (Table 10). However, not all increases are due to infiltration. A portion of the rapid "apparent" increase in moisture in March 2001 is attributed to soil thawing. The weather data from October 2000 to April 2001 indicate that the air temperatures were near freezing or colder from November 5, 2000, until approximately March 7, 2001 (Figure 11). Changes in moisture content to depths of 0.6 m (2 ft) would reflect both an adjustment due to soil thawing and an influx of water from snowmelt. When soil water freezes, the dielectric constant of water reduces from approximately 80 to 5. The time-domain reflectometer probes then indicate a false decrease in water content that is consistent with the decrease in the dielectric constant of water when it is frozen. When the soil thaws, the probes reflect the rise in the dielectric constant as ice turns to liquid, and a false increase in water content is detected. Because the spring thaw occurs more suddenly than soil freezing in the fall, the spring shift is more pronounced on the moisture content curves. The apparent decrease in soil moisture for the surface to 0.6-m (2-ft) deep time-domain reflectometer probes probably reflects soil moisture freezing (Figures 7 through 10).

Infiltration and drainage calculations for the spring snow melt of 2001 indicate that the time-domain reflectometer results are greater than the measured precipitation at the CFA NOAA weather station. The calculated infiltration for the three functioning time-domain reflectometer locations ranges from 5.41 to 9.80 cm (2.12 to 3.86 in) (Table 11). However, the measured precipitation at the CFA NOAA weather station is only 4.6 cm (1.8 in.). Similarly, drainage or losses in storage for the three time-domain reflectometer arrays ranges from 5.72 to 9.75 cm (2.25 to 3.84 in.) of water. An explanation for the discrepancy between the measured precipitation at the CFA NOAA weather station and infiltration could be ponding of water or snowdrifts above the time-domain reflectometer locations. However, neither ponding nor snowdrifts were observed at the locations during snowmelt. The high time-domain reflectometer readings could be related to probe calibration or to physical nonconformities in the subsurface, such as water filling void pockets beside the probe.

In contrast to the spring snowmelt event, several precipitation events in 2000 and 2001 appeared to affect only the 0- to 15-cm (0- to 6-in.) depth interval. In 2000, two precipitation events in the form of rain occurred on October 10 and 11 (1.20 cm [0.48 in.]) and October 29 and 30 (1.19 cm [0.47 in.]). These precipitation events are strongly reflected at the 15-cm (6-in.) depth, but there appears to be little response below this depth, with the calculated amount of infiltration into the 0- to 15-cm (0- to 6-in.) depth being similar to the amount of precipitation (Figures 7 through 10). Additionally, two smaller precipitation events occurred in April 2001 after the snowmelt. These precipitation events show up as small spikes in the 0- to 15-cm (0- to 6-in.) and 15- to 30-cm (6- to 12-in.) intervals for all four time-domain reflectometer locations (Figures 7 through 10). A precipitation event of 1.19 cm (0.47 in.) in September 2001 appears as a small spike in only the 0- to 15-cm (0- to 6-in.) interval at all four time-domain reflectometer locations, with the calculated amount of infiltration less than half the precipitation.

G-1.2.2 Water Storage Analyses for the Time-Domain Reflectometer Locations

Infiltration, drainage, and evapotranspiration affect the amount of water in storage in the soil profile. Water storage analysis in this section reflects the change in moisture content over a period of approximately one year (October 2000 through September 2001). This one-year period is used to evaluate the net impacts of infiltration, drainage, and evapotranspiration on the soil profile (i.e., gaining or losing moisture). The change in storage is represented by the following equation:

$$\Delta S = I - D - ET$$

where:

ΔS = change in storage

I = infiltrattion

D = drainage out of a system

ET = evapotranspiration.

The infiltration, drainage, and evapotranspiration out of soil are nearly impossible to measure directly. However, the time-domain reflectometer probes do measure moisture content from which change in storage (ΔS) can be inferred. If the change in storage is positive over time, there is a net gain of water in the soil profile. Conversely, if the change is negative, there is a net water loss from the soil profile.

Changes in storage were estimated for the entire 2.4-m (8-ft) depth of each time-domain reflectometer below land surface (Table 6). The change in storage (ΔS) was calculated for each interval by multiplying the change in moisture content, ΔMC, by the thickness of the soil unit (L) or 15 cm (6 in.) for each segment, mathematically expressed as follows:

$$\Delta S = \Delta MC \times L$$

where:

ΔS = change in storage

ΔMC = moisture content

L = soil unit thickness.

The change in storage for the 2.4-m (8-ft) profile was calculated for September 26, 2000, through September 30, 2001, for the time-domain reflectometers at Landfill III and November 9, 2000, through September 30, 2001, for those at Landfill II. This encompasses spring infiltration as well as the summer evapotranspiration.

There was little change in storage over the monitoring period for the 0- to 0.6-m (0- to 2-ft) depth intervals for the landfill caps at the four time-domain reflectometer locations (Table 12). Changes in storage at Landfill II were 0.08 and -1.04 cm (0.03 and -0.41 in.). At Landfill III, changes in storage were 0.28 and -0.48 cm (0.11 and -0.19 in.) Three of the four locations showed a gain in storage for the 0- to 2.4-m (0- to 8-ft) depth interval over the monitoring period (Table 12). Changes in storage ranged from 2.21 cm (0.87 in.) for Landfill II (north) to -0.48 cm (-0.19 in.) for Landfill III (west).

At Landfill III, from depths of 1.2 to 2.4 m (4 to 8 ft) or below the estimated evapotranspiration depth of 0.9 to 1.2 m (3 to 4 ft), there was essentially no change in storage. However, at Landfill II, both probe locations showed an approximate 1.3-cm (0.5-in.) increase in soil moisture storage. Only one 15-cm (6-in.) interval at each probe location showed a significant increase in moisture content (an increase greater than 2.5% moisture content) below 1.2 m (4 ft). The gains in water storage at the Landfill II probe locations for 2001 suggest that water moved through the low-permeability layer and into the soil below. However, most of the increase below the ET depth (1.2 m or 4 ft) is from segments that do not show a significant increase in moisture content. The changes in moisture content for the other 15-cm (6-in.) intervals could reflect measurement uncertainty or probe measurement error, but summing these changes added up to nearly 1.3 cm (0.5 in.). Because only one interval showed a significant increase in moisture content, this suggests that any recharge was slight, less than 0.64 cm (0.25 in.), and that evapotranspiration consumed most to all of the infiltrated water for the spring 2001 snowmelt.

G-1.3 Comparison of Time-Domain Reflectometer and Neutron-Probe Data

The neutron-probe data for LF 3-05 and LF 2-07 and the time-domain reflectometer data from Landfills II and III were compared, because the NAT locations and time-domain reflectometers are in the same proximity (refer to Figure 6-2 in Section 6). The neutron probe and time-domain reflectometer data were compared with regard to recharge estimates, depth of wetting front penetration, and infiltration estimates.

The time-domain reflectometer and the neutron probe monitoring on the landfills both indicate that recharge was less than 0.64 cm (0.25 in.) on the landfills, and that the wetting front in the spring of 2001 penetrated only about 0.9 m (3 ft). Off Landfill II, NAT LF 2-04 showed a wetting front penetration to at least 1.8 m (6 ft), but no time-domain reflectometers were located off the landfills for comparison.

The primary difference between the time-domain reflectometer and neutron probe measurements was that the calculated amount of infiltration using the time-domain reflectometers was considerably higher than determined from the neutron probe measurements and also much greater than the measured precipitation at the CFA NOAA weather station. Part of the overestimation by the time-domain reflectometers could be that the rapid increase in water content in mid-March 2001 is due to both the soil thaw and infiltration. The calibration of the time-domain reflectometers needs to be evaluated.

Table G-1. Neutron-probe measurements and change in moisture content for LF 2-03 from 10/26/00 to 9/17/01.

Depth	10/26/2000[a]	11/29/2000		12/21/2000		2/15/2001		2/28/2001		3/15/2001		3/28/2001		4/18/2001		5/17/2001		6/12/2001		7/19/2001		8/21/2001		9/17/2001		Change in Storage 10/00–9/01	Sum of Drainage (-) 10/00–9/01
0	1,818	2,745	0.09	3,082	0.03	3,882	0.08	4,502	0.06	3,721	-0.07	3,003	-0.07	2,789	-0.02	2,094	-0.07	1,674	-0.04	1,367	-0.03	1,220	-0.01	1,725	0.05	-0.01	-0.32
0.92	3,279	3,362	0.02	3,314	-0.01	3,273	-0.01	3,448	0.03	6,526	0.59	6,221	-0.06	5,913	-0.06	4,968	-0.18	3,941	-0.20	3,446	-0.10	3,307	-0.03	3,324	0.00	0.01	-0.63
1.92	2,974	3,055	0.02	2,956	-0.02	3,085	0.02	3,098	0.00	3,722	0.12	4,500	0.15	4,504	0.00	4,213	-0.06	3,727	-0.09	3,271	-0.09	3,082	-0.04	3,119	0.01	0.03	-0.29
2.92	3,265	3,228	-0.01	3,159	-0.01	3,317	0.03	3,233	-0.02	3,182	-0.01	3,250	0.01	3,339	0.02	3,316	0.00	3,384	0.01	3,083	-0.06	3,102	0.00	2,975	-0.02	-0.06	-0.12
3.92	3,214	3,150	-0.01	3,178	0.01	3,204	0.00	3,239	0.01	3,198	-0.01	3,223	0.00	3,211	0.00	3,196	0.00	3,294	0.02	3,244	-0.01	3,124	-0.02	3,216	0.02	0.00	-0.05
4.92	3,389	3,377	0.00	3,176	-0.04	3,355	0.03	3,266	-0.02	3,343	0.01	3,320	0.00	3,308	0.00	3,376	0.01	3,232	-0.03	3,168	-0.01	3,378	0.04	3,207	-0.03	-0.03	-0.12
5.92	3,515	3,587	0.01	3,601	0.00	3,421	-0.03	3,570	0.03	3,585	0.00	3,466	-0.02	3,456	0.00	3,581	0.02	3,411	-0.03	3,389	0.00	3,476	0.02	3,473	0.00	-0.01	-0.09
6.92	4,101	4,165	0.02	4,231	0.02	4,111	-0.03	4,031	-0.02	4,069	0.01	3,919	-0.04	4,004	0.02	4,116	0.03	4,178	0.02	3,941	-0.06	3,934	0.00	4,069	0.04	-0.01	-0.16
7.92	3,614	3,838	0.04	3,656	-0.03	3,807	0.03	3,748	-0.01	3,761	0.00	3,767	0.00	3,708	-0.01	3,779	0.01	3,726	-0.01	3,702	0.00	3,585	-0.02	3,588	0.00	0.00	-0.09
8.92	3,588	3,636	0.01	3,537	-0.02	3,498	-0.01	3,418	-0.02	3,400	0.00	3,461	0.01	3,540	0.02	3,550	0.00	3,592	0.01	3,555	-0.01	3,524	-0.01	3,602	0.01	0.00	-0.06
9.92	4,513	4,408	-0.02	4,362	-0.01	4,366	0.00	4,324	-0.01	4,216	-0.02	4,488	0.05	4,264	-0.04	4,327	0.01	4,376	0.01	4,408	0.01	4,389	0.00	4,463	0.01	-0.01	-0.10
10.92	4,228	4,180	-0.01	4,233	0.01	4,269	0.01	4,178	-0.02	4,270	0.02	4,181	-0.02	4,089	-0.02	4,287	0.04	4,233	-0.01	4,189	-0.01	4,018	-0.03	4,178	0.03	-0.01	-0.11
11.92	3,584	3,682	0.02	3,641	-0.01	3,697	0.01	3,610	-0.02	3,602	0.00	3,653	0.01	3,631	0.00	3,751	0.02	3,740	0.00	3,642	-0.02	3,687	0.01	3,697	0.00	0.02	-0.05
12.92	3,860	3,989	0.02	3,775	-0.04	3,842	0.01	3,855	0.00	3,801	-0.01	3,917	0.02	3,823	-0.02	4,003	0.03	3,777	-0.04	3,899	0.02	3,921	0.00	3,862	-0.01	0.00	-0.08
13.92	4,077	4,138	0.01	4,178	0.01	4,002	-0.03	4,164	0.03	4,272	0.02	4,201	-0.01	4,081	-0.02	4,105	0.00	4,081	0.00	3,980	-0.02	4,142	0.03	4,079	-0.01	0.00	-0.10
14.92	4,131	4,135	0.00	4,116	0.00	4,133	0.00	4,092	-0.01	4,026	-0.01	4,070	0.01	4,077	0.00	4,192	0.02	4,089	-0.02	4,094	0.00	4,140	0.01	4,151	0.00	0.00	-0.04
15.92	3,696	3,703	0.00	3,670	-0.01	3,608	-0.01	3,751	0.03	3,765	0.00	3,708	-0.01	3,674	-0.01	3,717	0.01	3,803	0.02	3,637	-0.03	3,766	0.02	3,730	-0.01	0.01	-0.07
16.92	4,485	4,774	0.06	4,733	-0.01	4,509	-0.04	4,714	0.04	4,549	-0.03	4,535	0.00	4,611	0.01	4,645	0.01	4,487	-0.03	4,590	0.02	4,634	0.01	4,753	0.02	0.05	-0.04
17.92	5,879	5,752	-0.02	5,652	-0.02	5,674	0.00	5,823	0.03	5,798	0.00	5,878	0.02	5,743	-0.03	5,843	0.02	5,762	-0.02	5,802	0.01	5,642	-0.03	5,911	0.05	0.01	-0.12
18.92	4,245	4,310	0.01	4,220	-0.02	4,188	-0.01	4,264	0.01	4,320	0.01	4,308	0.00	4,377	0.01	4,274	-0.02	4,229	-0.01	4,205	0.00	4,435	0.04	4,409	0.00	0.03	-0.06
19.92	7,547	7,432	-0.04	7,588	0.05	7,651	0.02	7,674	0.01	7,623	-0.02	7,575	-0.02	7,516	-0.02	7,636	0.04	7,697	0.02	7,616	-0.03	7,585	-0.01	7,400	-0.06	-0.05	-0.19
20.92	9,075	8,972	-0.03	8,953	-0.01	8,820	-0.04	8,996	0.06	9,018	0.01	8,957	-0.02	8,920	-0.01	8,987	0.02	9,016	0.01	9,045	0.01	8,908	-0.05	9,099	0.06	0.01	-0.16
21.92						9,724		9,914	0.06	9,788	-0.04	9,785	0.00	9,739	-0.02	9,815	0.03	9,865	0.02	9,945	0.03	9,751	-0.07			0.01	-0.12

Total change in storage:	-0.01
Total change in storage below ET depth:	0.02
Total drainage:	-3.16
Total drainage below ET depth:	-1.76

Note: ET depth was set at 3.92 feet to be consistent with previous data analysis. The ET depth will be evaluated after four years of data are available.
a. Under the date, there are two columns. The first column is the neutron probe counts. The second column shows the change in moisture content from the previous month.

Table G-2. Neutron-probe measurements and change in moisture content for LF 2-04 from 10/26/01 to 9/17/01.

Depth	10/26/2000[a]	11/29/2000		12/21/2000		2/15/2001		2/28/2001		3/15/2001		3/28/2001		4/18/2001		5/17/2001		6/12/2001		7/19/2001		8/21/2001		9/17/2001		Change in Storage 10/00–9/01	Sum of Drainage (-) 10/00–9/01
0.14	2,997	4,058	0.10	4,297	0.02	4,575	0.03	5,254	0.07	5,587	0.03	4,980	-0.06	4,763	-0.02	2,829	-0.19	2,520	-0.03	2,380	-0.01	2,180	-0.02	2,799	0.06	-0.02	-0.33
1.14	2,974	2,803	-0.03	2,838	0.01	2,905	0.01	2,863	-0.01	4,785	0.37	4,328	-0.09	4,253	-0.01	3,534	-0.14	3,174	-0.07	2,957	-0.04	2,482	-0.09	2,804	0.06	-0.03	-0.48
2.14	3,079	3,041	-0.01	3,019	0.00	3,112	0.02	3,060	-0.01	4,650	0.31	4,238	-0.08	4,090	-0.03	3,849	-0.05	3,690	-0.03	3,342	-0.07	3,150	-0.04	2,933	-0.04	-0.03	-0.35
3.14	3,312	3,277	-0.01	3,229	-0.01	3,280	0.01	3,231	-0.01	4,503	0.24	4,281	-0.04	4,085	-0.04	3,910	-0.03	3,796	-0.02	3,425	-0.07	3,064	-0.07	3,091	0.01	-0.04	-0.30
4.14	3,597	3,451	-0.03	3,347	-0.02	3,388	0.01	3,419	0.01	4,803	0.27	4,285	-0.10	3,966	-0.06	3,916	-0.01	3,724	-0.04	3,597	-0.02	3,466	-0.03	3,361	-0.02	-0.05	-0.32
5.14	4,066	3,858	-0.04	4,014	0.03	3,854	-0.03	3,798	-0.01	4,780	0.19	4,591	-0.04	4,428	-0.03	4,392	-0.01	4,397	0.00	4,098	-0.06	4,125	0.01	3,892	-0.04	-0.03	-0.26
6.14	3,622	3,661	0.01	3,485	-0.03	3,525	0.01	3,494	-0.01	3,578	0.02	4,313	0.14	4,163	-0.03	4,147	0.00	3,975	-0.03	3,744	-0.04	3,723	0.00	3,460	-0.05	-0.03	-0.20
7.14	3,784	3,697	-0.02	3,739	0.01	3,742	0.00	3,667	-0.01	3,699	0.01	3,817	0.02	3,906	0.02	4,007	0.02	3,991	0.00	3,943	-0.01	3,830	-0.02	3,714	-0.02	-0.01	-0.09
8.14	3,850	3,850	0.00	4,017	0.03	3,943	-0.01	3,918	0.00	3,967	0.01	3,902	-0.01	3,801	-0.02	4,001	0.04	3,952	-0.01	3,915	-0.01	3,960	0.01	3,961	0.00	0.02	-0.07
9.14	4,459	4,524	0.01	4,427	-0.02	4,318	-0.02	4,371	0.01	4,349	0.00	4,383	0.01	4,476	0.02	4,349	-0.02	4,453	0.02	4,531	0.01	4,529	0.00	4,446	-0.02	0.00	-0.07
10.14	4,624	4,531	-0.02	4,414	-0.02	4,481	0.01	4,402	-0.02	4,552	0.03	4,553	0.00	4,556	0.00	4,621	0.01	4,542	-0.02	4,508	-0.01	4,762	0.05	4,649	0.02	0.00	-0.10
11.14	3,737	3,699	-0.01	3,863	0.03	3,788	-0.01	3,958	0.03	3,783	-0.03	3,787	0.00	3,736	-0.01	3,769	0.01	3,792	0.00	3,826	0.01	3,837	0.00	3,807	-0.01	0.01	-0.06
12.14	4,160	4,168	0.00	4,085	-0.02	4,106	0.00	4,128	0.00	4,068	-0.01	3,977	-0.02	4,133	0.03	4,021	-0.02	4,079	0.01	4,009	-0.01	4,154	0.03	4,068	-0.02	-0.02	-0.09
13.14	3,944	3,985	0.01	3,889	-0.02	3,962	0.01	3,853	-0.02	3,970	0.02	3,862	-0.02	3,958	0.02	3,936	0.00	3,808	-0.02	3,926	0.02	3,940	0.00	3,947	0.00	0.00	-0.08
14.14	4,122	4,114	0.00	4,167	0.01	4,233	0.01	4,125	-0.02	4,171	0.01	4,055	-0.02	4,060	0.00	4,142	0.02	4,153	0.00	4,170	0.00	4,156	0.00	4,153	0.00	0.01	-0.03
15.14	3,700	3,820	0.02	3,831	0.00	3,715	-0.02	3,865	0.03	3,679	-0.04	3,718	0.01	3,791	0.01	3,645	-0.03	3,756	0.02	3,825	0.01	3,766	-0.01	3,794	0.01	0.02	-0.10
16.14	4,106	4,137	0.01	4,078	-0.01	4,070	0.00	4,197	0.02	4,041	-0.03	3,915	-0.02	4,197	0.05	4,116	-0.02	4,113	0.00	4,053	-0.01	4,133	0.02	4,165	0.01	0.01	-0.09
17.14	3,474	3,512	0.01	3,465	-0.01	3,386	-0.02	3,439	0.01	3,436	0.00	3,376	-0.01	3,445	0.01	3,503	0.01	3,418	-0.02	3,392	0.00	3,505	0.02	3,476	-0.01	0.00	-0.06
18.14	3,524	3,590	0.01	3,568	0.00	3,480	-0.02	3,551	0.01	3,622	0.01	3,538	-0.02	3,530	0.00	3,536	0.00	3,491	-0.01	3,603	0.02	3,768	0.03	3,660	-0.02	0.03	-0.07
19.14	4,164	4,096	-0.01	4,155	0.01	4,188	0.01	4,280	0.02	4,033	-0.05	4,144	0.02	4,113	-0.01	4,280	0.03	4,195	-0.02	4,217	0.00	4,121	-0.02	4,148	0.01	0.00	-0.09
20.14	6,188	6,144	-0.01	6,156	0.00	5,932	-0.08	6,076	0.05	6,119	0.01	5,981	-0.05	6,119	0.05	5,987	-0.04	5,971	-0.01	6,093	0.04	6,007	-0.03	5,852	-0.05	-0.11	-0.22
21.14	8,819	8,758	-0.02	8,675	-0.03	8,726	0.02	8,664	-0.02	8,697	0.01	8,580	-0.04	8,832	0.08	8,837	0.00	8,735	-0.03	8,755	0.01	8,731	-0.01	8,777	0.02	-0.01	-0.15

Total change in storage:	-0.29
Total change in storage below ET depth:	-0.13
Total drainage:	-3.62
Total drainage below ET depth:	-1.83

Note: ET depth was set at 4.14 feet to be consistent with previous data analysis. The ET depth will be evaluated after four years of data are available.
a. Under the date, there are two columns. The first column is the neutron probe counts. The second column shows the change in moisture content from the previous month.

Table G-3. Neutron-probe measurements and change in moisture content for LF 2-07 from 10/26/01 to 9/17/01.

Depth	10/26/2000[a]	11/29/2000		12/21/2000		2/15/2001		2/28/2001		3/15/2001		3/28/2001		4/18/2001		5/17/2001		6/12/2001		7/19/2001		8/21/2001		9/17/2001		Change in Storage 10/00–9/01	Sum of Drainage (-) 10/00–9/01
	87	86		91		190		903		89		96		91		79		63		79		89		79			
0	1497	2,425		2,832		3,767		4,526		5,151		3,465		3,237		2,257		1,666		1,327		914		1,407			
0.84	4476	4,489	0.00	4,459	-0.01	4,469	0.00	4,390	-0.03	7,056	0.90	7,801	0.25	7,423	-0.13	6,806	-0.21	6,128	-0.23	4,901	-0.41	4,466	-0.15	4,483	0.01	0.00	-1.15
1.84	3601	3,954	0.07	3,915	-0.01	3,999	0.02	3,851	-0.03	3,825	0.00	3,944	0.02	4,157	0.04	4,136	0.00	4,012	-0.02	3,774	-0.05	3,698	-0.01	3,637	-0.01	0.01	-0.14
2.84	4641	4,657	0.00	4,590	-0.01	4,831	0.05	4,689	-0.03	4,688	0.00	4,829	0.03	4,720	-0.02	4,795	0.01	4,744	-0.01	4,859	0.02	4,719	-0.03	4,613	-0.02	-0.01	-0.12
3.84	6085	6,017	-0.02	5,975	-0.01	5,929	-0.02	5,800	-0.04	5,869	0.02	5,831	-0.01	5,875	0.01	5,861	0.00	5,833	-0.01	5,913	0.03	5,964	0.02	5,822	-0.05	-0.09	-0.17
4.84	5456	5,360	-0.03	5,244	-0.04	5,014	-0.08	5,114	0.03	5,100	0.00	5,094	0.00	5,064	-0.01	5,310	0.08	5,025	-0.10	5,131	0.04	5,137	0.00	5,214	0.03	-0.08	-0.26
5.84	5011	4,997	0.00	4,975	-0.01	4,916	-0.02	4,945	0.01	5,083	0.05	5,038	-0.02	4,810	-0.08	4,911	0.03	4,799	-0.04	4,985	0.06	4,891	-0.03	4,934	0.01	-0.03	-0.18
6.84	6277	6,286	0.00	6,251	-0.01	6,170	-0.03	6,094	-0.03	6,105	0.00	6,134	0.01	6,246	0.04	6,206	-0.01	6,266	0.02	6,127	-0.05	6,181	0.02	6,106	-0.03	-0.06	-0.14
7.84	6860	6,932	0.02	6,786	-0.05	6,764	-0.01	6,666	-0.03	6,532	-0.05	6,486	-0.02	6,676	0.06	6,684	0.00	6,846	0.05	6,613	-0.08	6,728	0.04	6,857	0.04	0.00	-0.23
8.84	6704	6,802	0.02	6,630	-0.03	6,871	0.05	6,567	-0.06	6,641	0.01	6,576	-0.01	6,658	0.02	6,682	0.00	6,699	0.00	6,681	0.00	6,657	0.00	6,690	0.01	0.00	-0.10
9.84	5489	5,532	0.01	5,438	-0.03	5,588	0.05	5,442	-0.05	5,541	0.03	5,506	-0.01	5,431	-0.03	5,416	-0.01	5,378	-0.01	5,436	0.02	5,421	-0.01	5,358	-0.02	-0.04	-0.16
10.84	7534	7,301	-0.08	7,329	0.01	7,366	0.01	7,496	0.04	7,276	-0.07	7,356	0.03	7,348	0.00	7,370	0.01	7,352	-0.01	7,264	-0.03	7,161	-0.03	7,167	0.00	-0.12	-0.22
11.84	5358	5,210	-0.03	5,188	0.00	5,058	-0.02	5,221	0.03	5,310	0.02	5,287	0.00	5,208	-0.02	5,199	0.00	5,175	0.00	5,339	0.03	5,213	-0.02	5,198	0.00	-0.03	-0.11
12.84	5543	5,521	0.00	5,551	0.01	5,581	0.01	5,508	-0.01	5,504	0.00	5,615	0.02	5,542	-0.01	5,479	-0.01	5,556	0.01	5,508	-0.01	5,521	0.00	5,572	0.01	0.01	-0.05
13.84	6325	6,320	0.00	6,200	-0.04	6,057	-0.05	6,203	0.05	6,252	0.02	6,147	-0.04	6,130	-0.01	6,159	0.01	6,171	0.00	6,053	-0.04	6,035	-0.01	6,081	0.02	-0.08	-0.17
14.84	7706	7,608	-0.03	7,450	-0.05	7,510	0.02	7,578	0.02	7,593	0.01	7,505	-0.03	7,454	-0.02	7,592	0.05	7,298	-0.10	7,519	0.07	7,485	-0.01	7,358	-0.04	-0.12	-0.29
15.84	8760	8,714	-0.02	8,490	-0.08	8,448	-0.01	8,560	0.04	8,498	-0.02	8,605	0.04	8,509	-0.03	8,413	-0.03	8,436	0.01	8,438	0.00	8,340	-0.03	11,519		-0.14	-0.22
16.84	14741	14,951	0.07	14,692	-0.09	14,824	0.04	14,822	0.00	14,751	-0.02	14,556	-0.07	14,560	0.00	14,638	0.03	14,535	-0.03	14,605	0.02	14,858	0.09	8,504		0.04	-0.21
17.84	7539	7,614	0.03	7,506	-0.04	7,445	-0.02	7,460	0.01	7,470	0.00	7,466	0.00	7,548	0.03	7,414	-0.05	7,460	0.02	7,417	-0.01	7,399	-0.01	7,941		-0.05	-0.12
18.84		8,109		8,168	0.02			7,996	-0.06	7,443	-0.19	7,311	-0.04	7,571	0.09	7,484	-0.03	7,389	-0.03	7,470	0.03	7,509	0.01			-0.20	-0.26

Total change in storage:	-1.00
Total change in storage below ET depth:	-0.91
Total drainage:	-4.32
Total drainage below ET depth:	-2.91
Change in storage within the cap (2 feet)	0.01

Note: ET depth was set at 3.84 feet to be consistent with previous data analysis. The ET depth will be evaluated after four years of data are available.
a. Under the date, there are two columns. The first column is the neutron probe counts. The second column shows the change in moisture content from the previous month.

Table G-4. Neutron-probe measurements and change in moisture content for LF 3-03 from 10/26/00 to 9/17/01.

Depth	10/26/2000[a]	11/29/2000		12/21/2000		2/15/2001		2/28/2001		3/15/2001		3/28/2001		4/18/2001		5/17/2001		6/12/2001		7/19/2001		8/21/2001		9/18/2001		Change in Storage 10/00–9/01	Sum of Drainage (-) 10/00–9/01
	68	66		62		108		360		75		64		58		52		53		55		50		74			
-0.3	479	954		2,021		2,771		3,791		1,965		1,420		1,182		678		449		340		320		454			
0.7	3,588	3,790	0.07	3,689	-0.03	3,813	0.04	3,848	0.01	7,638	1.28	7,136	-0.17	6,860	-0.09	5,394	-0.49	4,240	-0.39	3,883	-0.12	3,718	-0.06	3,616	-0.03	0.01	-1.39
							-																				
1.7	4,698	4,636	-0.01	4,752	0.02	4,545	0.04	4,719	0.03	4,681	-0.01	5,672	0.19	5,745	0.01	5,523	-0.04	5,320	-0.04	4,929	-0.08	4,844	-0.02	4,655	-0.04	-0.01	-0.27
2.7	4,227	4,181	-0.02	4,067	-0.04	4,079	0.00	4,092	0.00	4,278	0.06	4,159	-0.04	4,235	0.03	4,328	0.03	4,362	0.01	4,359	0.00	4,251	-0.04	4,092	-0.05	-0.05	-0.18
3.7	3,000	2,891	-0.02	3,013	0.02	3,085	0.01	3,020	-0.01	3,023	0.00	3,038	0.00	3,083	0.01	3,085	0.00	3,035	-0.01	3,078	0.01	3,090	0.00	2,965	-0.02	-0.01	-0.06
4.7	2,913	2,837	-0.01	2,842	0.00	2,879	0.01	2,942	0.01	2,922	0.00	2,872	-0.01	2,952	0.02	2,973	0.00	2,910	-0.01	2,903	0.00	2,832	-0.01	2,897	0.01	0.00	-0.05
							-																				
5.7	2,972	2,882	-0.02	3,003	0.02	2,922	0.02	2,932	0.00	2,837	-0.02	3,050	0.04	2,939	-0.02	2,992	0.01	2,889	-0.02	2,864	0.00	2,844	0.00	2,921	0.01	-0.01	-0.10
6.7	2,940	3,030	0.02	3,046	0.00	3,083	0.01	3,089	0.00	2,996	-0.02	3,007	0.00	3,123	0.02	3,013	-0.02	2,835	-0.03	2,928	0.02	2,910	0.00	2,990	0.02	0.01	-0.07
7.7	3,533	3,702	0.03	3,628	-0.01	3,614	0.00	3,564	-0.01	3,631	0.01	3,623	0.00	3,679	0.01	3,614	-0.01	3,395	-0.04	3,317	-0.01	3,386	0.01	3,345	-0.01	-0.04	-0.11
8.7	4,067	4,050	0.00	3,942	-0.02	3,940	0.00	3,859	-0.02	3,989	0.02	3,861	-0.02	3,915	0.01	3,919	0.00	3,788	-0.03	3,732	-0.01	3,783	0.01	3,789	0.00	-0.05	-0.10
							-																				
9.7	3,915	3,943	0.01	3,843	-0.02	3,800	0.01	3,898	0.02	3,874	0.00	3,854	0.00	3,889	0.01	3,812	-0.01	3,860	0.01	3,802	-0.01	3,751	-0.01	3,775	0.00	-0.03	-0.07
10.7	3,532	3,434	-0.02	3,353	-0.02	3,528	0.03	3,560	0.01	3,539	0.00	3,447	-0.02	3,491	0.01	3,507	0.00	3,481	0.00	3,484	0.00	3,448	-0.01	3,572	0.02	0.01	-0.06
11.7	4,059	4,194	0.03	4,046	-0.03	4,069	0.00	4,118	0.01	3,941	-0.03	4,045	0.02	4,015	-0.01	4,071	0.01	3,985	-0.02	4,021	0.01	3,975	-0.01	3,973	0.00	-0.02	-0.07
12.7	3,977	3,976	0.00	3,948	-0.01	4,007	0.01	4,115	0.02	3,974	-0.03	3,909	-0.01	3,986	0.01	4,010	0.00	4,022	0.00	3,937	-0.02	4,008	0.01	4,072	0.01	0.02	-0.05
							-																				
13.7	4,211	4,297	0.02	4,189	-0.02	4,104	0.02	4,217	0.02	4,138	-0.02	4,140	0.00	4,252	0.02	4,149	-0.02	4,236	0.02	4,132	-0.02	4,287	0.03	4,119	-0.03	-0.02	-0.12
14.7	3,697	3,651	-0.01	3,698	0.01	3,675	0.00	3,715	0.01	3,638	-0.01	3,782	0.03	3,689	-0.02	3,811	0.02	3,619	-0.04	3,644	0.00	3,700	0.01	3,730	0.01	0.01	-0.08
15.7	3,885	3,957	0.01	4,013	0.01	4,105	0.02	4,018	-0.02	4,076	0.01	4,032	-0.01	3,904	-0.02	3,985	0.02	4,093	0.02	4,048	-0.01	3,944	-0.02	3,838	-0.02	-0.01	-0.10
16.7	3,911	3,692	-0.04	3,802	0.02	3,836	0.01	3,764	-0.01	3,833	0.01	3,800	-0.01	3,822	0.00	3,774	-0.01	3,882	0.02	3,770	-0.02	3,772	0.00	3,702	-0.01	-0.04	-0.10
17.7	3,714	3,810	0.02	3,696	-0.02	3,788	0.02	3,692	-0.02	3,726	0.01	3,672	-0.01	3,894	0.04	3,776	-0.02	3,804	0.01	3,738	-0.01	3,608	-0.02	3,841	0.04	0.02	-0.11
18.7	4,053	4,049	0.00	3,900	-0.03	3,972	0.01	4,001	0.01	3,986	0.00	4,001	0.00	4,035	0.01	4,061	0.00	3,946	-0.02	4,044	0.02	3,833	-0.04	3,964	0.03	-0.02	-0.09
							-																				
19.7	4,244	4,234	0.00	4,317	0.02	4,228	0.02	4,195	-0.01	4,249	0.01	4,175	-0.01	4,252	0.01	4,157	0.02	4,195	0.01	4,202	0.00	4,146	-0.01	4,089	-0.01	-0.03	-0.08

Total change in storage:	-0.24
Total change in storage below ET depth:	-0.19
Total drainage:	-3.25
Total drainage below ET depth:	-1.36
Change in storage within the cap (2 feet)	0.00

Note: ET depth was set at 3.84 feet to be consistent with previous data analysis. The ET depth will be evaluated after four years of data are available.
a. Under the date, there are two columns. The first column is the neutron probe counts. The second column shows the change in moisture content from the previous month.

Table G-5. Neutron-probe measurements and change in moisture content for LF 3-05 from 10/26/00 to 9/17/01.

Depth	10/26/2000[a]	11/29/2000		12/21/2000		2/15/2001		2/28/2001		3/15/2001		3/28/2001		4/18/2001		5/17/2001		6/12/2001		7/19/2001		8/21/2001		9/17/2001		Change in Storage 10/00–9/01	Sum of Drainage (-) 10/00–9/01
	111	130		127		435		1,379		142		132		110		91		85		79		113		94			
0.1	3,165	3,803	0.07	3,845	0.00	4,298	0.05	4,623	0.03	7,790	0.38	6,734	-0.14	6,443	-0.04	4,631	-0.23	3,864	-0.10	3,026	-0.11	2,694	-0.05	3,021	0.03	-0.09	-0.67
1.1	3,855	3,918	0.02	3,843	-0.03	3,703	-0.05	3,728	0.01	5,765	0.69	6,175	0.14	6,032	-0.05	5,554	-0.16	4,709	-0.28	4,140	-0.19	3,962	-0.06	3,945	-0.01	0.03	-0.82
2.1	3,572	3,631	0.01	3,703	0.01	3,661	-0.01	3,781	0.02	3,716	-0.01	3,723	0.00	3,732	0.00	3,704	-0.01	3,630	-0.01	3,614	0.00	3,573	-0.01	3,539	-0.01	-0.01	-0.05
3.1	3,910	4,076	0.03	3,999	-0.01	4,083	0.02	4,159	0.01	4,165	0.00	4,179	0.00	4,232	0.01	4,201	-0.01	4,068	-0.03	3,972	-0.02	3,791	-0.03	3,994	0.04	0.02	-0.10
4.1	5,922	5,875	-0.02	5,810	-0.02	5,767	-0.01	5,811	0.01	5,806	0.00	5,919	0.04	5,812	-0.04	5,847	0.01	5,823	-0.01	5,810	0.00	5,663	-0.05	5,567	-0.03	-0.12	-0.18
5.1	3,934	4,123	0.04	3,955	-0.03	4,027	0.01	3,970	-0.01	3,965	0.00	4,028	0.01	3,995	-0.01	4,002	0.00	3,883	-0.02	3,920	0.01	4,025	0.02	3,844	-0.03	-0.02	-0.11
6.1	2,767	2,736	-0.01	2,715	0.00	2,687	-0.01	2,686	0.00	2,797	0.02	2,732	-0.01	2,738	0.00	2,802	0.01	2,694	-0.02	2,617	-0.01	2,732	0.02	2,756	0.00	0.00	-0.06
7.1	2,915	2,990	0.01	2,946	-0.01	2,872	-0.01	2,915	0.01	2,855	-0.01	2,928	0.01	2,747	-0.03	2,874	0.02	2,862	0.00	2,926	0.01	2,932	0.00	2,879	-0.01	-0.01	-0.08
8.1	2,986	3,022	0.01	2,986	-0.01	3,032	0.01	2,955	-0.01	2,885	-0.01	2,934	0.01	2,868	-0.01	2,875	0.00	2,922	0.01	3,032	0.02	2,967	-0.01	3,005	0.01	0.00	-0.06
9.1	3,125	3,164	0.01	3,181	0.00	3,127	-0.01	3,209	0.02	3,069	-0.03	3,201	0.03	3,110	-0.02	3,042	-0.01	3,032	0.00	3,154	0.02	3,169	0.00	3,180	0.00	0.01	-0.06
10.1	3,326	3,292	-0.01	3,255	-0.01	3,409	0.03	3,298	-0.02	3,272	0.00	3,302	0.01	3,252	-0.01	3,344	0.02	3,186	-0.03	3,255	0.01	3,261	0.00	3,205	-0.01	-0.02	-0.09
11.1	3,947	3,992	0.01	3,939	-0.01	3,883	-0.01	3,963	0.02	4,055	0.02	3,826	-0.04	3,957	0.03	3,995	0.01	3,976	0.00	4,080	0.02	3,938	-0.03	3,942	0.00	0.00	-0.10
12.1	4,193	4,212	0.00	4,338	0.02	4,220	-0.02	4,268	0.01	4,105	-0.03	4,362	0.05	4,297	-0.01	4,317	0.00	4,311	0.00	4,302	0.00	4,351	0.01	4,160	-0.04	-0.01	-0.10
13.1	3,531	3,582	0.01	3,535	-0.01	3,518	0.00	3,574	0.01	3,494	-0.02	3,499	0.00	3,593	0.02	3,457	-0.03	3,659	0.04	3,444	-0.04	3,629	0.04	3,612	0.00	0.02	-0.10
14.1	4,164	3,946	-0.04	4,086	0.03	4,083	0.00	4,016	-0.01	4,036	0.00	4,026	0.00	4,023	0.00	4,092	0.01	4,140	0.01	4,031	-0.02	4,047	0.00	4,094	0.01	-0.01	-0.07
15.1	4,463	4,309	-0.03	4,317	0.00	4,200	-0.02	4,108	-0.02	4,361	0.05	4,267	-0.02	4,295	0.01	4,276	0.00	4,352	0.01	4,247	-0.02	4,368	0.02	4,364	0.00	-0.02	-0.11
16.1	4,044	3,934	-0.02	4,076	0.03	3,998	-0.01	4,030	0.01	4,040	0.00	4,005	-0.01	3,931	-0.01	4,047	0.02	3,936	-0.02	3,925	0.00	3,923	0.00	3,940	0.00	-0.02	-0.08
17.1	3,976	4,006	0.01	3,967	-0.01	4,131	0.03	3,995	-0.03	3,913	-0.02	3,901	0.00	3,953	0.01	3,946	0.00	3,953	0.00	4,004	0.01	3,935	-0.01	3,823	-0.02	-0.03	-0.08
18.1	4,823	4,934	0.02	4,815	-0.02	4,925	0.02	4,921	0.00	4,897	0.00	4,862	-0.01	4,886	0.00	4,904	0.00	4,968	0.01	4,968	0.00	4,888	-0.02	4,811	-0.01	0.00	-0.06
19.1	5,633	5,638	0.00	5,718	0.02	5,505	-0.04	5,922	0.08	5,768	-0.03	5,751	0.00	5,730	0.00	5,750	0.00	5,786	0.01	5,741	-0.01	5,659	-0.02	5,654	0.00	0.00	-0.08
20.1	3,678	4,852		3,806		3,760	-0.01	3,860	0.02	3,674	-0.04	3,854	0.03	3,729	-0.02	3,745	0.00	3,826	0.02	3,720	-0.02	3,826	0.02	3,648	-0.03	-0.03	-0.12
21.1	10,052	10,620		9,976		9,959	-0.01	9,957	0.00	9,932	-0.01	10,013	0.03	9,892	-0.04	10,073	0.06	9,957	-0.04	10,060	0.03	10,068	0.00	9,937	-0.04	-0.01	-0.14
22.1	10,494	9,616		10,629		10,583	-0.02	8,484		10,491	-0.03	10,495	0.00	10,560	0.02	10,553	0.00	10,516	-0.01	10,760	0.08	10,276	-0.16	10,400	0.04	-0.08	-0.22
23.1	8,216			8,471		8,384	-0.03	8,485	0.03	8,524	0.01	8,349	-0.06	8,202	-0.05	8,371	0.06	8,440	0.02	8,326	-0.04	8,323	0.00	8,385	0.02	-0.03	-0.18
23.8												8,571		8,461	-0.04	8,731	0.09	8,701	-0.01	8,883	0.06	8,891	0.00	8,878	0.00	0.10	-0.05

Total change in storage:	-0.32
Total change in storage below ET depth:	-0.15
Total drainage:	-3.75
Total drainage below ET depth:	-1.92
Change in storage within the cap (2 feet)	-0.07

Note: ET depth was set at 4.1 feet to be consistent with previous data analysis. The ET depth will be evaluated after four years of data are available.
a. Under the date, there are two columns. The first column is the neutron probe counts. The second column shows the change in moisture content from the previous month.

Table G-6. Summary of landfill cover NAT and time-domain reflectometer monitoring results.

	Neutron Probe Location					Time-Domain Reflectometer			
	LF2-03	LF2-04	LF2-07	LF3-03	LF3-05	LF3-east	LF3-west	LF2-north	LF2-south
Spring 2001 Infiltration event (in.)									
Infiltration	0.8	1.42	1.19	1.31	1.07	2.12	2.85	3.86	NA
Recharge (2)	<0.25	0.3	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
10/00 to 9/01 Yearly Drainage (in.)									
Total Drainage	3.16	3.62	4.32	3.25	3.75				
Change in Storage from 10/00 to 9/01 (in.)									
Total	-0.01	-0.29	-1.00	-0.24	-0.32	0.07	-0.28	0.76	0.33
Within Cap	--	--	0.01	0.00	-0.07	0.12	-0.09	0.08	-0.35
Within ET Zone	-0.03	-0.16	-0.09	-0.05	-0.17	0.36	-0.11	0.4	-0.14
Below ET Zone	0.02	-0.13	-0.91	-0.19	-0.15	-0.21	-0.21	0.37	0.45

(a) The ET depth is assumed to be 3 to 4 feet. The ET depth can be more reliably determined after 4 years of data are collected.

(b) The amount of recharge is estimated to be the increase in moisture content below ET depth (4 feet).

Table G-7. Precipitation summary for FY 2001.

Month	Precipitation (in.)
October-00	0.98
November-00	0.31
December-00	0.13
January-01	0.36
February-01	0.8
March-01	0.2
April-01	0.68
May-01	0.02
June-01	0.33
July-01	0.2
August-01	0.12
September-01	0.55
Total	4.68
Nov-00 thru Mar-01	1.8

Table G-8. Layer classification for neutron probe measurements.

LF2-07 Depth/Type[a] (ft)	LF2-04 Depth/Type (ft)	LF2-03 Depth/Type (ft)	LF3-05 Depth/Type (ft)	LF3-03 Depth/Type (ft)
0.84C	0.14S	-0.08S	1.1C	0.7C
1.84S	1.14S	0.92S	2.1S	1.7S
2.84S	2.14S	1.92S	3.1S	2.7C
3.84C	3.14S	2.92S	4.1C	3.7S
4.84C	4.14S	3.92S	5.1S	4.7S
5.84C	5.14S	4.92S	6.1S	5.7S
6.84C	6.14S	5.92S	7.1S	6.7S
7.84C	7.14S	6.92S	8.1S	7.7S
8.84S	8.14S	7.92S	9.1S	8.7S
9.84C	9.14S	8.92S	10.1S	9.7S
10.84C	10.14S	9.92S	11.1S	10.7S
11.84C	11.14S	10.92S	12.1S	11.7S
12.84S	12.14S	11.92S	13.1S	12.7S
13.84C	13.14S	12.92S	14.1S	13.7S
14.84C	14.14S	13.92S	15.1S	14.7S
15.84C	15.14S	14.92S	16.1S	15.7S
16.84C	16.14S	15.92S	17.1S	16.7S
17.84C	17.14S	16.92S	18.1S	17.7S
	18.14S	17.92S	19.1S	18.7S
	19.14C	18.92S	20.1S	19.7S
	20.14C	19.92C	21.1C	
	21.14C	20.92C	22.1C	
		21.92C	23.1C	
			23.8C	

a. Type is either S =Sand and Gravel; or C = Clay or silt.

Table G-9. Infiltration and recharge calculations for neutron probe measurements in spring 2001.

Depth	**LF2-3** 2/28/2001	3/15/2001	Change MC 3/15–2/28	3/28/2001	Change MC 3/28–2/28	4/18/2001	5/17/2001	Infiltration event (in.) 2/28–3/28	Recharge - Increase below ET depth (in.) 2/28/01–5/17/01
0	1818[a]	3721	0.18	3003	0.11	2789	2094	0.11	
0.92	3448	6526	0.59	6221	0.53	5913	4968	0.53	
1.92	3098	3722	0.12	4500	0.27	4504	4213	0.27	
2.92	3233	3182	-0.01	3250	0.01	3339	3316		
3.92	3239	3198	-0.01	3223	0.00	3211	3196		
4.92	3266	3343	0.01	3320	0.00	3308	3376		0.02
5.92	3570	3585	0.00	3466	-0.02	3456	3581		0.00
								0.92	**0.02**

Depth	**LF2-4** 2/28/2001	3/15/2001	Change MC 3/15–2/28	3/28/2001	Change MC 3/28–2/28	4/18/2001	5/17/2001	Infiltration event (in.) 2/28–/15	Recharge - Increase below ET depth (in.) 2/28/01–5/17/01
0.14	5254	5587	0.03	4980	-0.03	4763	2829	0.03	
1.14	2863	4785	0.37	4328	0.28	4253	3534	0.37	
2.14	3060	4650	0.31	4238	0.23	4090	3849	0.31	
3.14	3231	4503	0.24	4281	0.20	4085	3910	0.24	
4.14	3419	4803	0.27	4285	0.17	3966	3916	0.27	
5.14	3798	4780	0.19	4591	0.15	4428	4392	0.19	0.11
6.14	3494	3578	0.02	4313	0.16	4163	4147	0.02	0.13
7.14	3667	3699	0.01	3817	0.03	3906	4007	0.01	0.07
								1.43	**0.30**

Table G-9. (continued).

Depth	**LF2-07** 2/28/2001	3/15/2001	Change MC 3/15-2/28	3/28/2001	Change MC 3/28-2/28	4/18/2001	5/17/2001	Infiltration event (in.) 2/28-3/28	Recharge - Increase below ET depth (in.) 2/28/01-5/17/2001
	903	89		96		91	79		
-0.16	4526	5151		3465		3237	2257		
0.84	4390	7056	0.90	7801	1.15	7423	6806	1.15	
1.84	3851	3825	0.00	3944	0.02	4157	4136	0.02	
2.84	4689	4688	0.00	4829	0.03	4720	4795		
3.84	5800	5869	0.02	5831	-0.01	5875	5861		
4.84	5114	5100	0.00	5094	0.00	5064	5310		0.04
5.84	4945	5083	0.05	5038	-0.02	4810	4911		-0.01
								1.17	**0.03**

Depth	**LF3-03** 2/28/2001	3/15/2001	Change MC 3/15-2/28	3/28/2001	Change MC 3/28-2/28	4/18/2001	5/17/2001	Infiltration event (in.) 2/28-3/28	Recharge - Increase below ET depth (in.) 2/28/01-5/17/2001
	360	75		64		58	52		
-0.3	3791	1965		1420		1182	678		
0.7	3848	7638	1.28	7136	1.11	6860	5394	1.11	
1.7	4719	4681	-0.01	5672	0.18	5745	5523	0.18	
2.7	4092	4278	0.06	4159	0.02	4235	4328	0.02	
3.7	3020	3023	0.00	3038	0.00	3083	3085		
4.7	2942	2922	0.00	2872	-0.01	2952	2973		0.01
5.7	2932	2837	-0.02	3050	0.04	2939	2992		0.01
								1.31	**0.02**

Table G-9. (continued).

	LF3-05		Change MC		Change MC			Infiltration event (in.)	Recharge - Increase below ET depth (in.)
Depth	2/28/2001	3/15/2001	3/15-2/28	3/28/2001	3/28-2/28	4/18/2001	5/17/2001	2/28-3/28	2/28/01-5/17/2001
	1379	142		132		110	91		
0.1	4623	7790	0.38	6734	0.25	6443	4631	0.25	
1.1	3728	5765	0.69	6175	0.82	6032	5554	0.82	
2.1	3781	3716	-0.01	3723	-0.01	3732	3704		
3.1	4159	4165	0.00	4179	0.00	4232	4201		
4.1	5811	5806	0.00	5919	0.04	5812	5847		0.01
5.1	3970	3965	0.00	4028	0.01	3995	4002		0.01
6.1	2686	2797	0.02	2732	-0.01	2738	2802		0.02
								1.08	**0.04**

a. Data from Oct. 2000 used because readings in February reflect snow buildup on surface.

Table G-10. Depth of wetting front or water penetration from spring and recharge estimates.

LF2 north Depth (ft)	Moisture content Change >2.5%	Peak change in moisture content[a]	Moisture content increase below 4 ft	LF2 south Depth	Moisture content Change >2.5%	Peak change in moisture content[a]	Moisture content increase below 4 ft
0.0-0.5	Yes	3/13/2001	—	0.0-0.5	Yes	---[3]	—
0.5-1.0	Yes	3/23/2001	—	0.5-1.0	Yes	4/17/2001	—
1.0-1.5	Yes	4/5/2001	—	1.0-1.5	Yes	5/29/2001	—
1.5-2.0	Yes	6/11/2001	—	1.5-2.0	No	NA	—
2.0-2.5	Yes	7/6/2001	—	2.0-2.5	No	NA	—
2.5-3.0	Yes	7/6/2001	—	2.5-3.0	No	NA	—
3.0-3.5	No	NA[2]	—	3.0-3.5	No	NA	—
3.5-4.0	No	NA	—	3.5-4.0	No	NA	—
4.0-4.5	Yes	9/10/2001	0.16	4.0-4.5	No	NA	—
4.5-5.0	No	NA	—	4.5-5.0	Yes	8/18/2001	0.17
5.0-5.5	No	NA	—	5.0-5.5	No	NA	—
5.5-6.0	No	NA	—	5.5-6.0	No	NA	—
6.0-6.5	No	NA	—	6.0-6.5	No	NA	—
6.5-7.0	No	NA	—	6.5-7.0	No	NA	—
7.0-7.5	No	NA	—	7.0-7.5	No	NA	—
7.5-8.0	No	NA	—	7.5-8.0	No	NA	—
LF3-east Depth	**Moisture content Change >2.5%**	**Peak change in moisture content[a]**	**Moisture content Increase below 4 ft**	**LF3- west Depth**	**Moisture content Change >2.5%**	**Peak change in moisture content[a]**	**Moisture content Increase below 4 ft**
0.0-0.5	Yes	3/17/2001	—	0.0-0.5	Yes	3/19/2001	—
0.5-1.0	Yes	3/23/2001	—	0.5-1.0	Yes	3/21/2001	—
1.0-1.5	Yes	7/12/2001	—	1.0-1.5	Yes	4/30/2001	—
1.5-2.0	Yes	7/19/2001	—	1.5-2.0	No	NA	—
2.0-2.5	Yes	7/31/2001	—	2.0-2.5	Yes	7/29/2001	—
2.5-3.0	No	NA	—	2.5-3.0	No	NA	—
3.0-3.5	No	NA	—	3.0-3.5	No	NA	—
3.5-4.0	No	NA	—	3.5-4.0	No	NA	—
4.0-4.5	No	NA	—	4.0-4.5	No	NA	—
4.5-5.0	No	NA	—	4.5-5.0	No	NA	—
5.0-5.5	No	NA	—	5.0-5.5	No	NA	—
5.5-6.0	No	NA	—	5.5-6.0	No	NA	—
6.0-6.5	No	NA	—	6.0-6.5	No	NA	—
6.5-7.0	No	NA	—	6.5-7.0	No	NA	—
7.0-7.5	No	NA	—	7.0-7.5	No	NA	—
7.5-8.0	No	NA	—	7.5-8.0	No	NA	—

a. Spring snowmelt started about the 7th of March. Peak change in moisture content dates are approximates.
b. NA = Not Applicable
c. Peak probably occurred when probe was not functioning.

Table G-11. TDR infiltration and recharge calculations for 2001.[a]

		Infiltration			Drainage		
		Moisture content		Change in moisture content (in.)	Moisture content		Change in moisture content (in.)
LF3-west		11/5/2001	4/1/2001		4/1/2001	9/10/2001	
	0.0-0.5	0.162	0.267	0.63	0.267	0.0549	1.2726
	0.5-1.0	0.064	0.317	1.518	0.317	0.0647	1.5138
	1.0-1.5	0.163	0.2799	0.7014	0.2799	0.1695	0.6624
			Total	2.8494		Total	3.4488
Recharge—No intervals below 4 feet with an increase in moisture content greater than 2.5%.							
		Moisture content		Change in moisture content (in.)	Moisture content		Change in moisture content (in.)
LF3-east		11/5/2001	4/1/2001		4/1/2001	9/10/2001	
	0.0-0.5	0.116083	0.227	0.6655	0.227	0.042	1.11
	0.5-1.0	0.139125	0.363917	1.34875	0.363917	0.1592	1.2283
	1.0-1.5	0.198083	0.216125	0.10825	0.216125	0.2314	-0.09165
			Total	2.1225		Total	2.24665
Recharge—No intervals below 4 feet with an increase in moisture content greater than 2.5%.							
		Moisture content		Change in moisture content (in.)	Moisture content		Change in Moisture content (in.)
LF2-north		12/6/2001	4/1/2001		4/1/2001	9/10/2001	
	0.0-0.5	0.16	0.316625	0.93975	0.316625	0.1099	1.24035
	0.5-1.0	0.053333	0.35075	1.7845	0.35075	0.0639	1.7211
	1.0-1.5	0.093444	0.282	1.131333333	0.282	0.1361	[illegible]
			Total	3.855583333		Total	3.
Recharge—Intervals below 4 feet showing greater than 2.5% increase in moisture content.							
		Moisture content		Change in moisture content (in.)	Moisture content		Change in Moisture content (in.)
LF2-north		NA	NA		2/28/2001	9/10/2001	
	4.0-4.5	—	—	—	0.126	0.153	0.162
						Total	0.16
		Moisture content		Change in moisture content (in.)	Moisture content		Change in moisture content (in.)
LF2-south(3)		NA	NA		NA	NA	
	0.0-0.5	—	—	—	—	—	—
	0.5-1.0	—	—	—	—	—	—
	1.0-1.5	—	—	—	—	—	—
			Total	—	—	Total	—
Recharge—Intervals below 4 feet showing greater than 2.5% increase in moisture content.							
		Moisture content		Change in moisture content (in.)	Moisture content		Change in moisture content (in.)
LF2-south		NA	NA		2/28/2001	8/18/2001	
	4.5-5.0	—	—		0.118	0.146	0.168
						Total	0.17

a. Infiltration calculations are for the spring, because this was the only time of year that moisture infiltration was noted beyond a 1-ft depth.

b. Soil moisture contents at beginning of freeze (approx. November 5, 2000, and after thaw April 1, 2001).

c. The surface probe for this array was not functioning from February 15, 2001, to March 22, 2001.

Table G-12. Water balance for time-domain reflectometer arrays.

LF2-North	11/1/2000	9/30/2001	Change in Water Content[a] 0-8 feet	4-8 feet	0-2 feet
0.0-0.5	0.1776	0.123917	-0.3221		-0.3221
0.5-1.0	0.054	0.063625	0.05775		0.05775
1.0-1.5	0.091	0.130208	0.23525		0.23525
1.5-2.0	0.081	0.098667	0.106		0.106
2.0-2.5	0.149	0.1625	0.081		
2.5-3.0	0.066	0.095917	0.1795		
3.0-3.5	0.0096	0.011625	0.01215		
3.5-4.0	0.046	0.05225	0.0375		
4.0-4.5	0.121667	0.145609	0.143652	0.143652	
4.5-5.0	0.125	0.129478	0.02687	0.02687	
5.0-5.5	0.053	0.049826	-0.01904	-0.01904	
5.5-6.0	0.144	0.150696	0.040174	0.040174	
6.0-6.5	0.117	0.133708	0.10025	0.10025	
6.5-7.0	0.115	0.125375	0.06225	0.06225	
7.0-7.5	0.194	0.196375	0.01425	0.01425	
7.5-8.0	0.148	0.148792	0.00475	0.00475	
		Totals	0.760202	0.373152	0.0769

LF2-South	11/1/2000	9/30/2001	Change in Water Content[a] 0-8 feet	4-8 feet	0-2 feet
0.0-0.5	0.1075	0.06575	-0.2505		-0.2505
0.5-1.0	0.083	0.091083	0.0485		0.0485
1.0-1.5	0.126	0.131833	0.035		0.035
1.5-2.0	0.106	0.075292	-0.18425		-0.18425
2.0-2.5	0.0565	0.080792	0.14575		
2.5-3.0	0.008	0.012542	0.02725		
3.0-3.5	0.011	0.017625	0.03975		
3.5-4.0	0.153	0.15625	0.0195		
4.0-4.5	0.1825	0.191792	0.05575	0.05575	
4.5-5.0	0.1165	0.141583	0.1505	0.1505	
5.0-5.5	0.1525	0.154375	0.01125	0.01125	
5.5-6.0	0.222	0.224958	0.01775	0.01775	
6.0-6.5	0.156	0.165958	0.05975	0.05975	
6.5-7.0	0.084	0.094625	0.06375	0.06375	
7.0-7.5	0.102	0.114667	0.076	0.076	
7.5-8.0	0.216	0.218542	0.01525	0.01525	
		Totals	0.331	0.45	-0.35125

LF3-East	9/27/2000	9/30/2001	Change in Water Content[a] 0-8 feet	4-8 feet	0-2 feet
0.0-0.5	0.066	0.05175	-0.0855		-0.0855
0.5-1.0	0.1458	0.16	0.0852		0.0852
1.0-1.5	0.213	0.23	0.102		0.102
1.5-2.0	0.107	0.109708	0.01625		0.01625
2.0-2.5	0.1678	0.197417	0.1777		
2.5-3.0	0.0736	0.0815	0.0474		
3.0-3.5	0.2181	0.213542	-0.02735		
3.5-4.0	0.2321	0.227375	-0.02835		
4.0-4.5	0.1123	0.105542	-0.04055	-0.04055	
4.5-5.0	0.1538	0.14425	-0.0573	-0.0573	
5.0-5.5[2]	0.1462	0.145	-0.0072	-0.0072	
5.5-6.0[2]	0.1601	0.155	-0.0306	-0.0306	
6.0-6.5	0.1159	0.119875	0.02385	0.02385	
6.5-7.0	0.0866	0.07225	-0.0861	-0.0861	
7.0-7.5	0.0928	0.092417	-0.0023	-0.0023	
7.5-8.0	0.1235	0.121208	-0.01375	-0.01375	
		Totals	0.0734	-0.21395	0.11795

LF3-West	9/27/2000	9/30/2001	Change in Water Content[a] 0-8 feet	4-8 feet	0-2 feet
0.0-0.5	0.0685	0.072083	0.0215		0.0215
0.5-1.0	0.0786	0.072435	-0.03699		-0.03699
1.0-1.5	0.1739	0.167958	-0.03565		-0.03565
1.5-2.0	0.1119	0.105565	-0.03801		-0.03801
2.0-2.5	0.2076	0.22125	0.0819		
2.5-3.0	0.1136	0.12225	0.0519		
3.0-3.5	0.0552	0.042208	-0.07795		
3.5-4.0	0.1593	0.15275	-0.0393		
4.0-4.5	0.1045	0.110667	0.037	0.037	
4.5-5.0	0.0582	0.048875	-0.05595	-0.05595	
5.0-5.5	0.1042	0.100083	-0.0247	-0.0247	
5.5-6.0	0.0952	0.092458	-0.01645	-0.01645	
6.0-6.5	0.1226	0.113125	-0.05685	-0.05685	
6.5-7.0	0.0692	0.075625	0.03855	0.03855	
7.0-7.5	0.03	0.013417	-0.0995	-0.0995	
7.5-8.0	0.0637	0.058625	-0.03045	-0.03045	
		Totals	-0.28095	-0.20835	-0.08915

a. Change in water content is equal to change in moisture content multiplied by the 6-in. length of each time-domain reflectometer segment.

b. Values from Aug. 18 and Aug. 22 used for 5-5.5 and 5.5-6 ft segments because of shift in data.

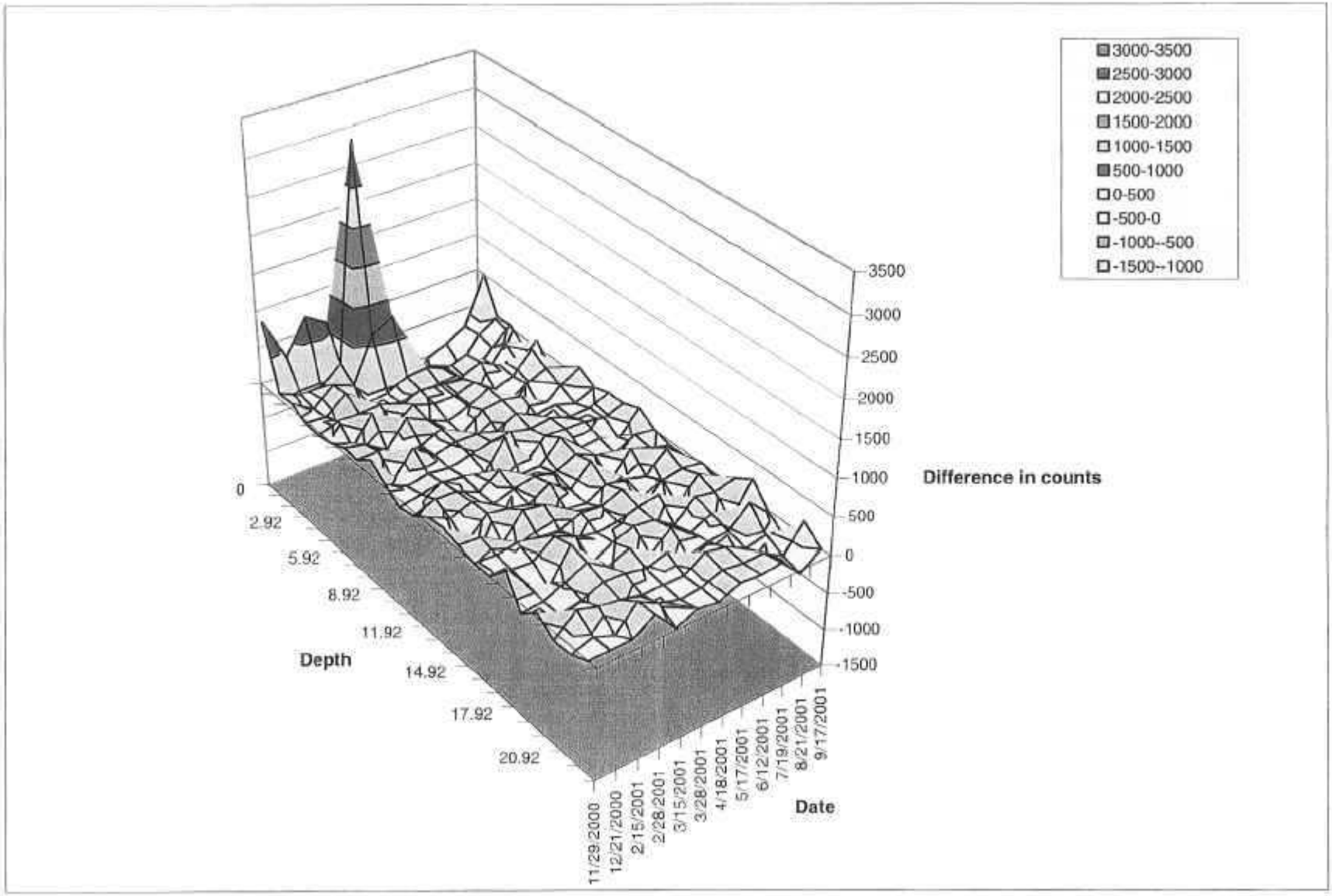

Figure G-1. Neutron probe measurements for LF 2-03.

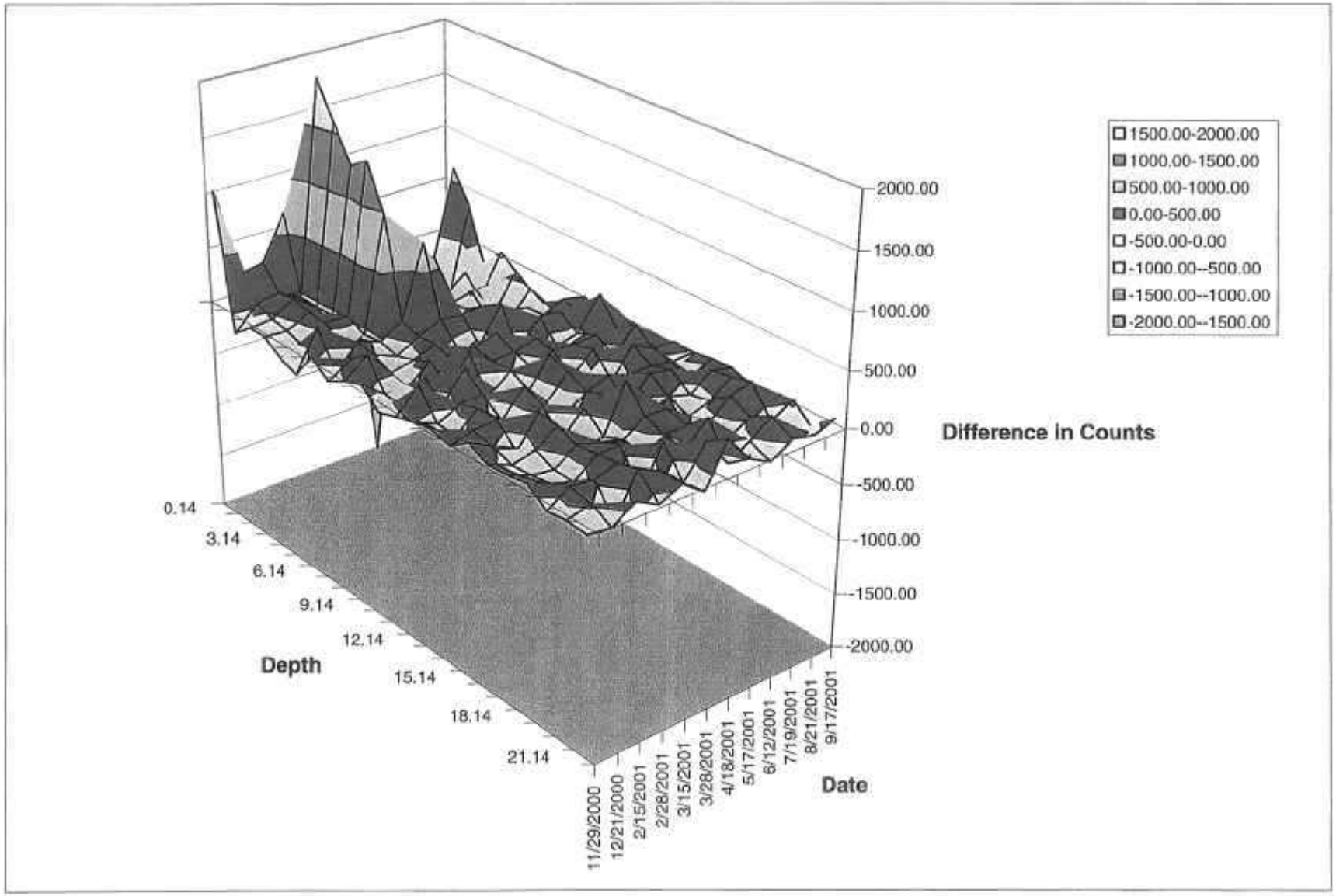

Figure G-2. Neutron probe measurements for LF 2-04.

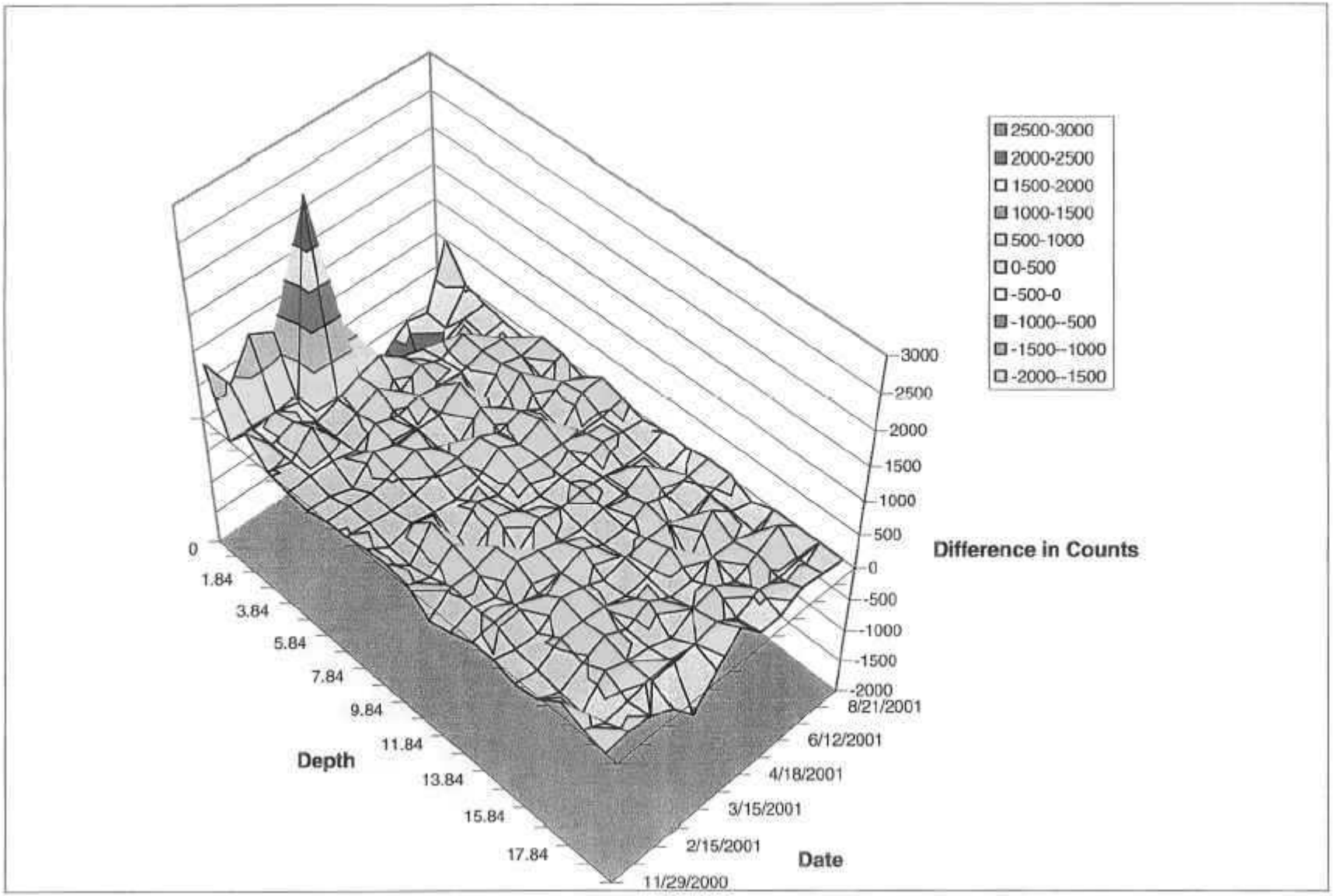

Figure G-3. Neutron probe measurements for LF 2-07.

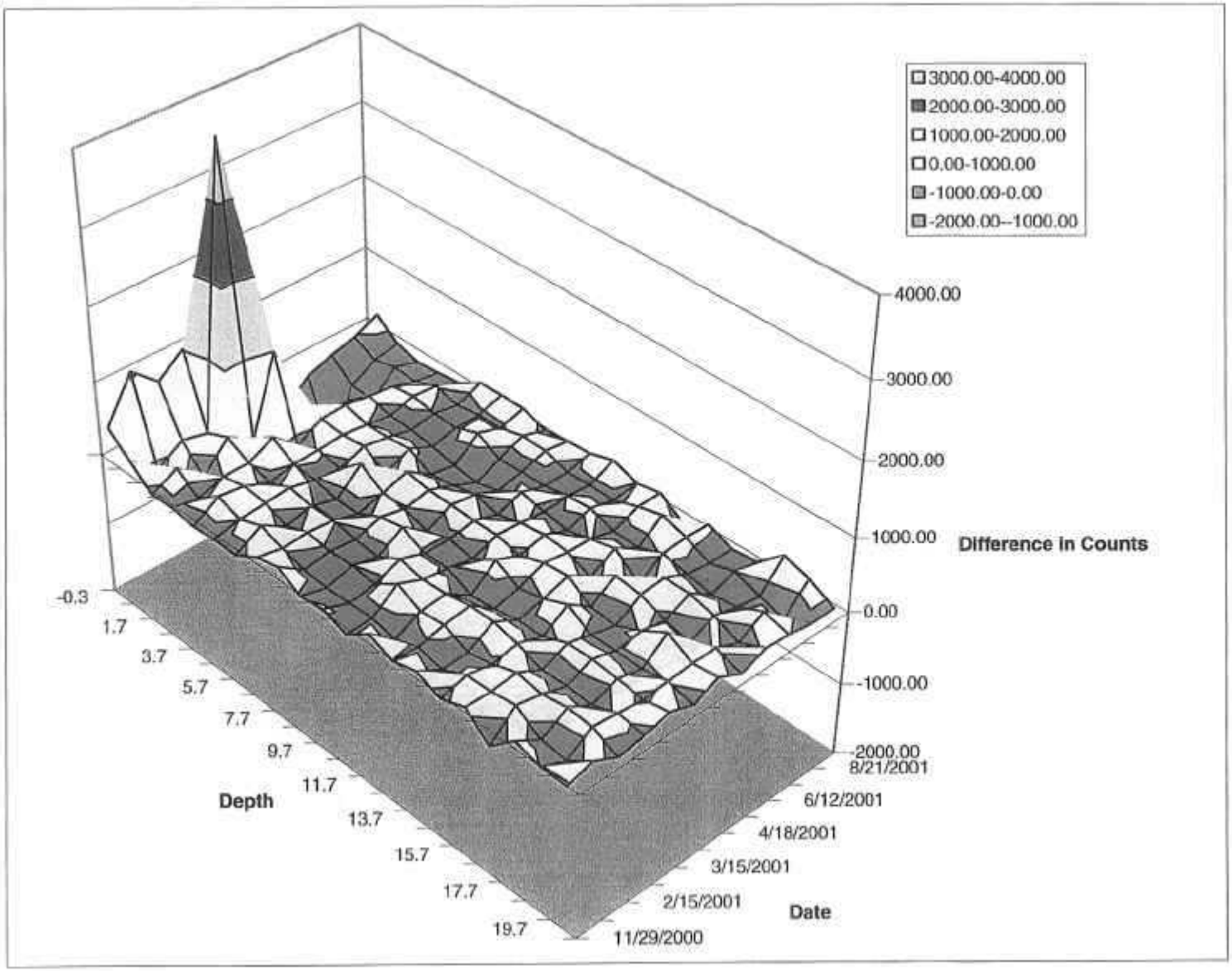

Figure G-4. Neutron probe measurements for LF 3-03.

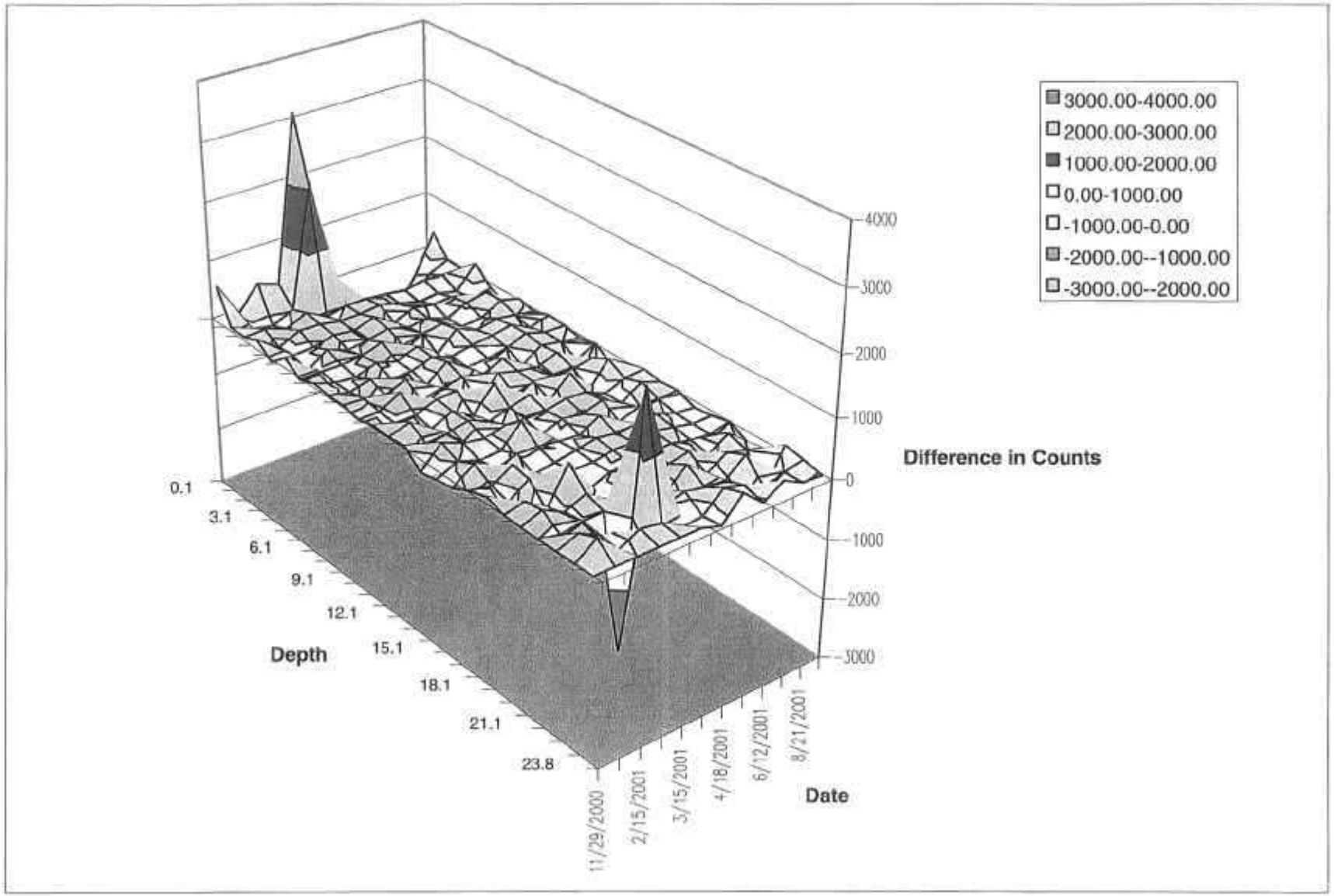

Figure G-5. Neutron probe measurements for LF 3-05.

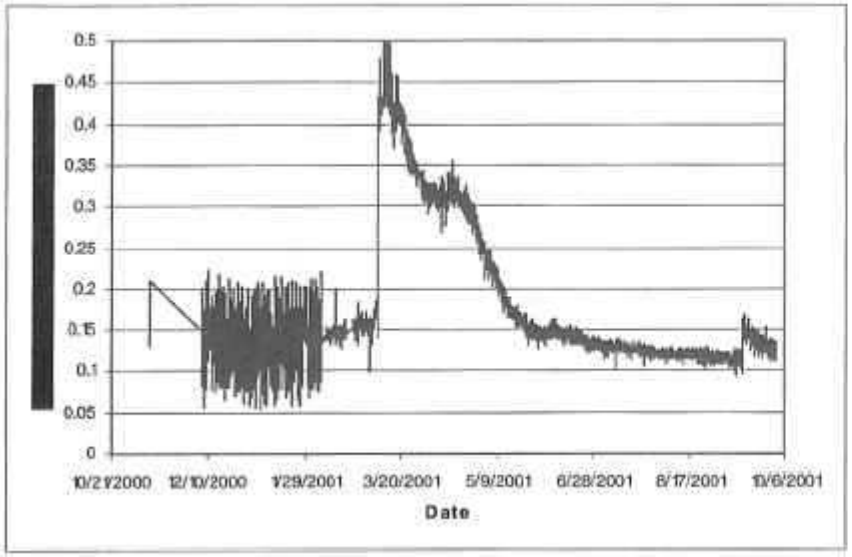

Figure G-6. LF 2-north 0 to 0.5 ft.

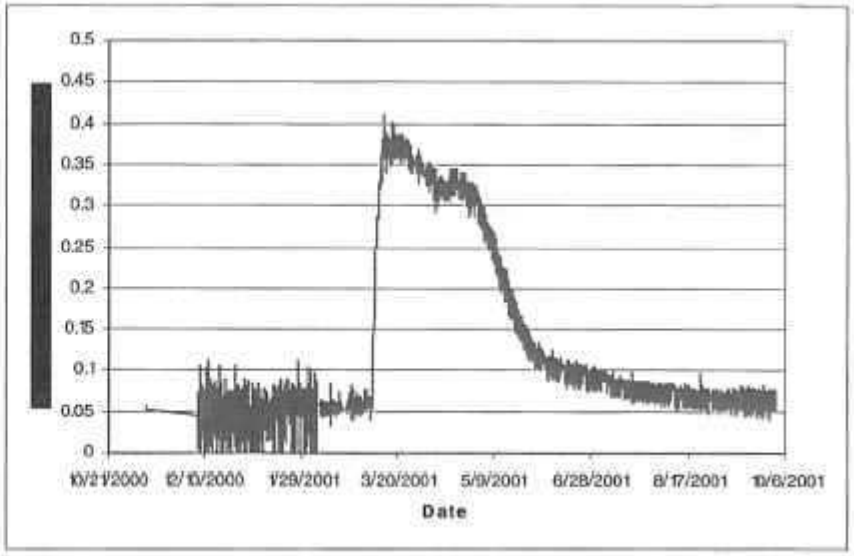

Figure G-7. LF 2-north 0.5 to 1.0 ft.

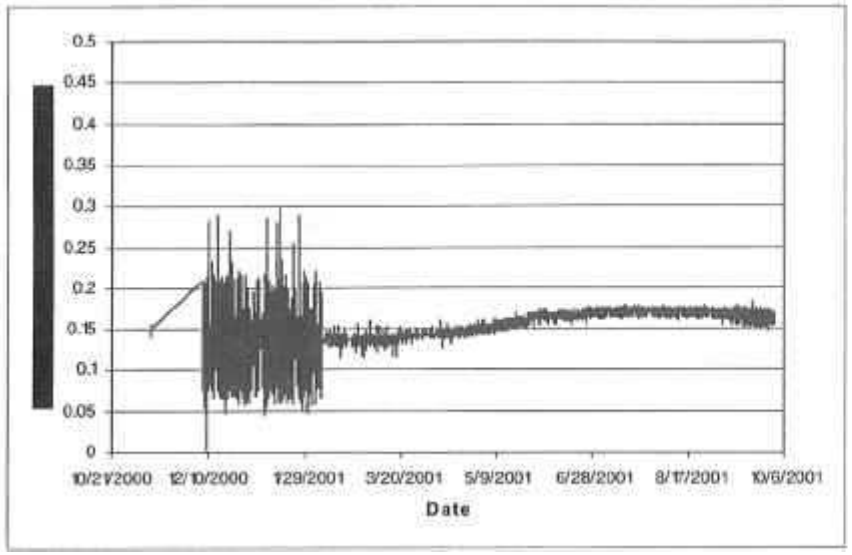

Figure G-8. LF 2-north 1.0 to 1.5 ft.

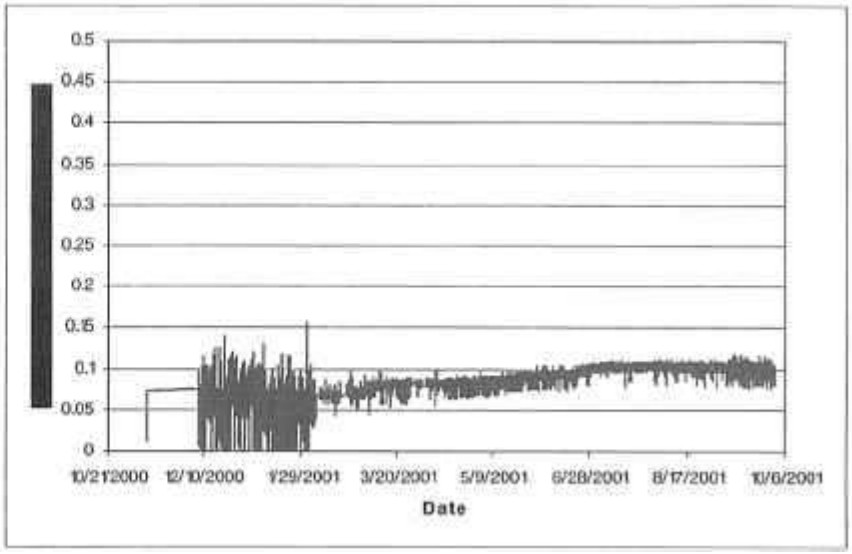

Figure G-9. LF 2-north 1.5 to 2.0 ft.

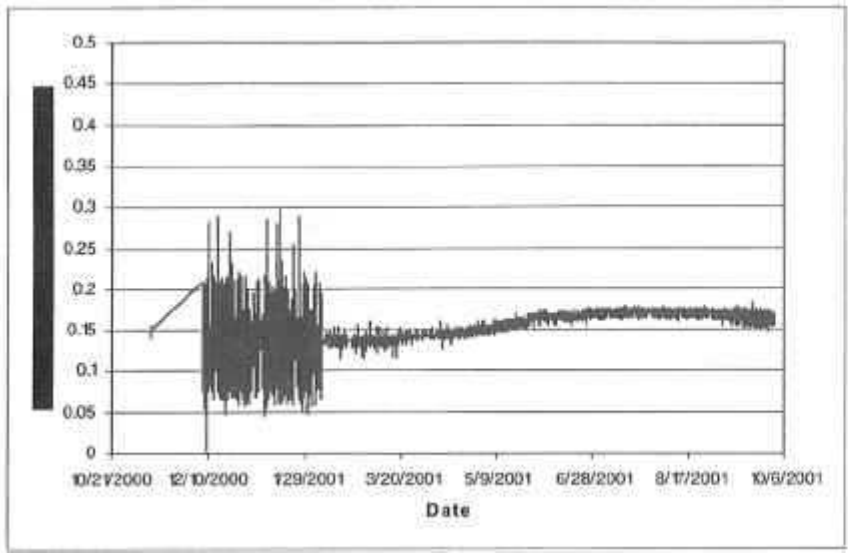

Figure G-10. LF 2-north 2.0 to 2.5 ft.

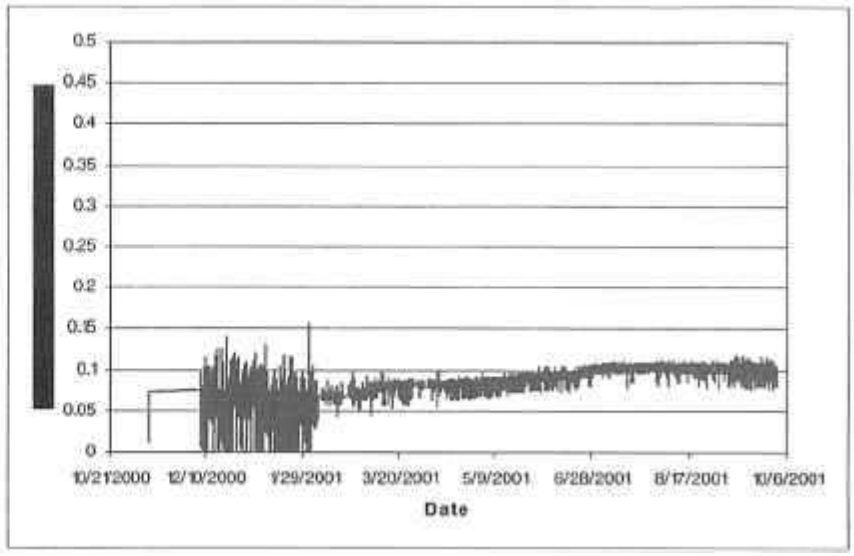

Figure G-11. LF 2-north 2.5 to 3.0 ft.

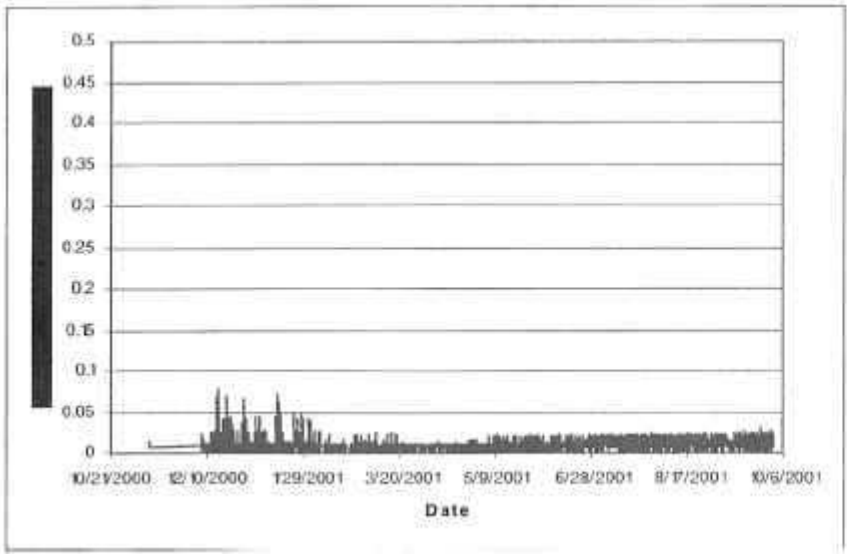

Figure G-12. LF 2-north 3.0 to 3.5 ft.

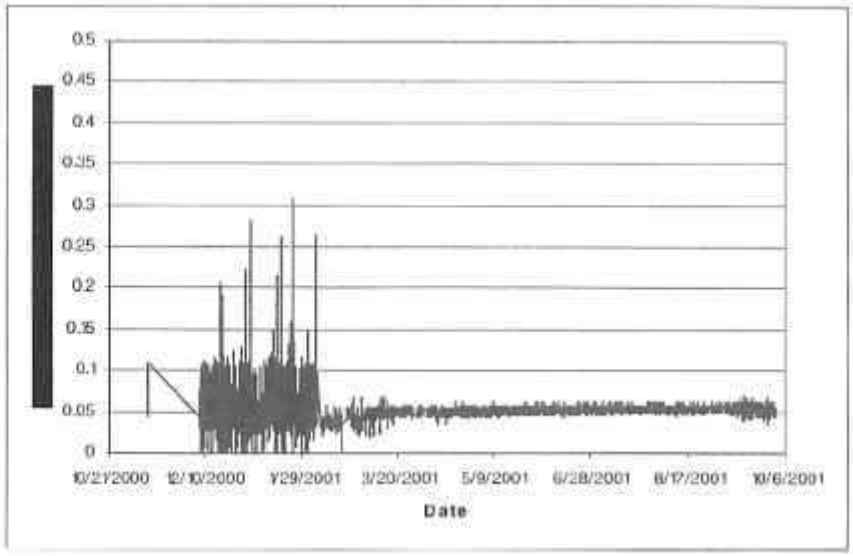

Figure G-13. LF 2-north 3.5 to 4.0 ft.

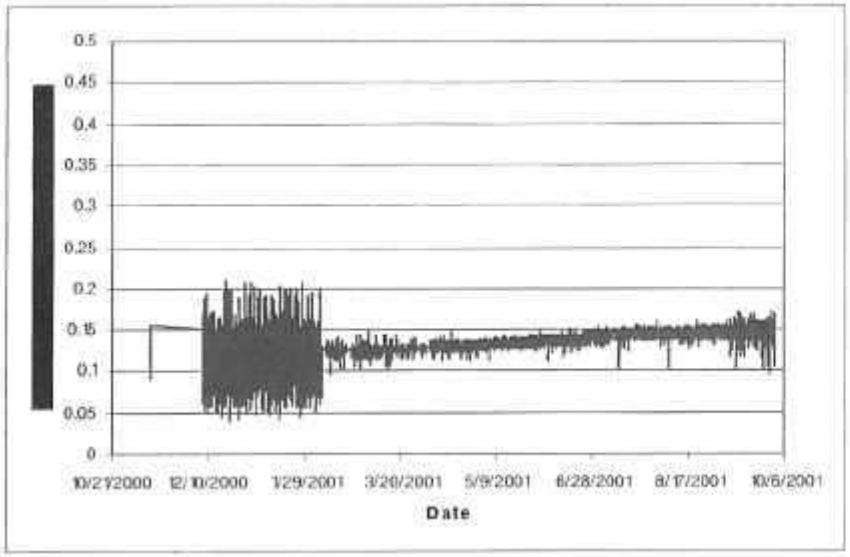

Figure G-14. LF 2-north 4.0 to 4.5 ft.

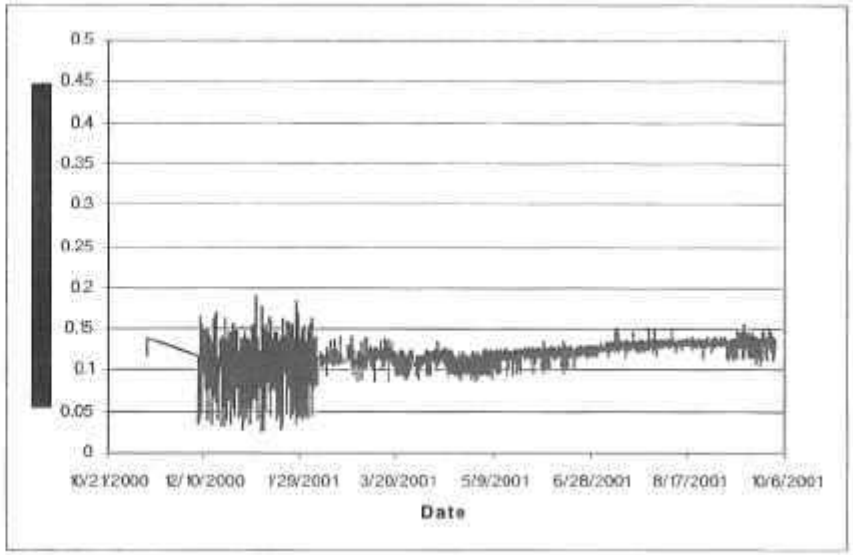

Figure G-15. LF 2-north 4.5 to 5.0 ft.

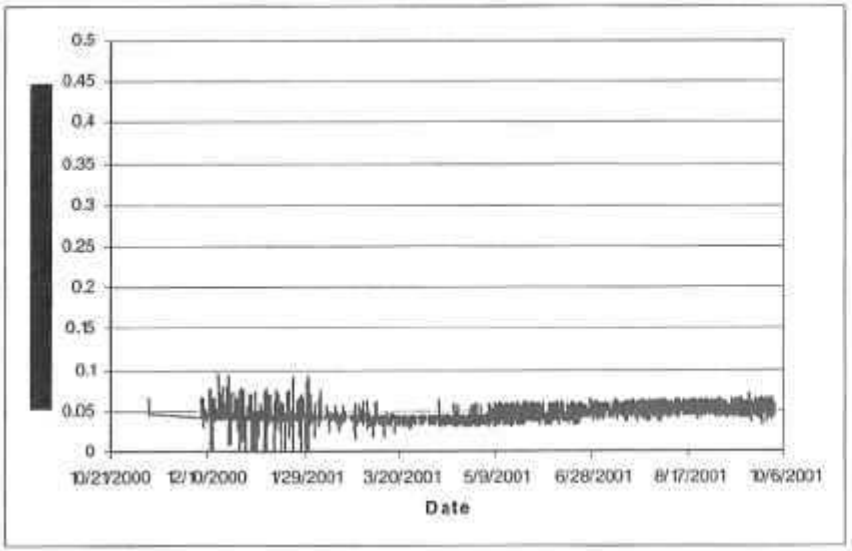

Figure G-16. LF 2-north 5.0 to 5.5 ft.

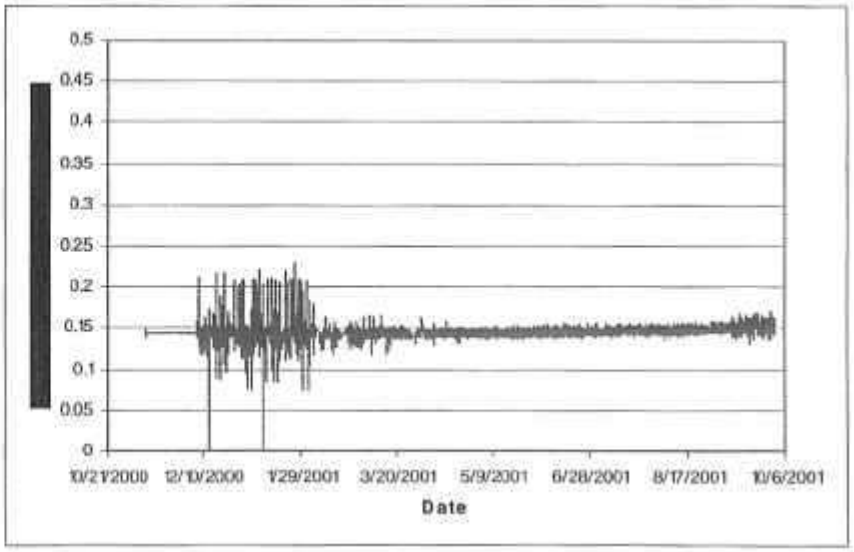

Figure G-17. LF 2-north 5.5 to 6.0 ft.

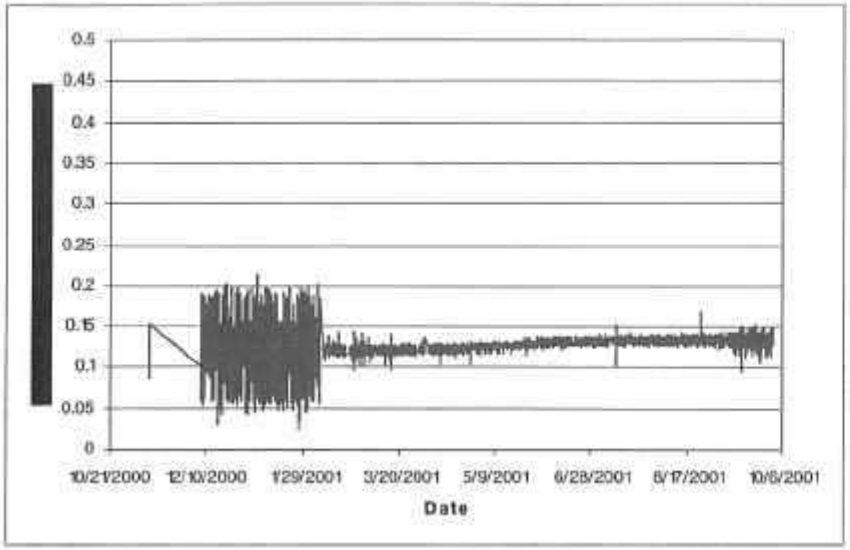

Figure G-18. LF 2-north 6.0 to 6.5 ft.

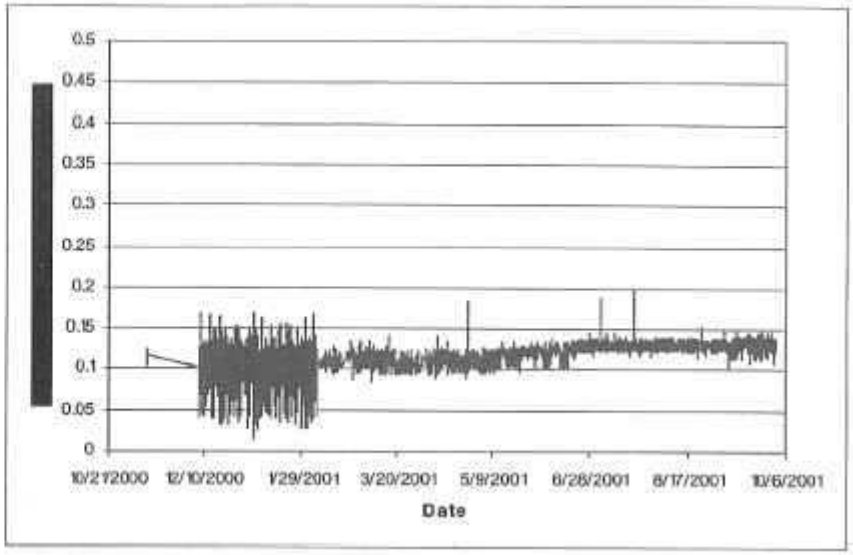

Figure G-19. LF 2-north 6.5 to 7.0 ft.

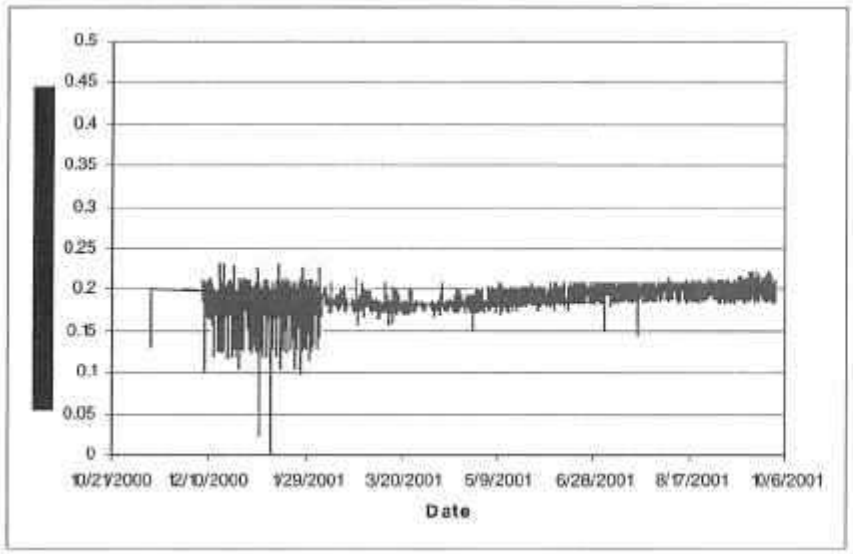

Figure G-20. LF 2-north 7.0 to 7.5 ft.

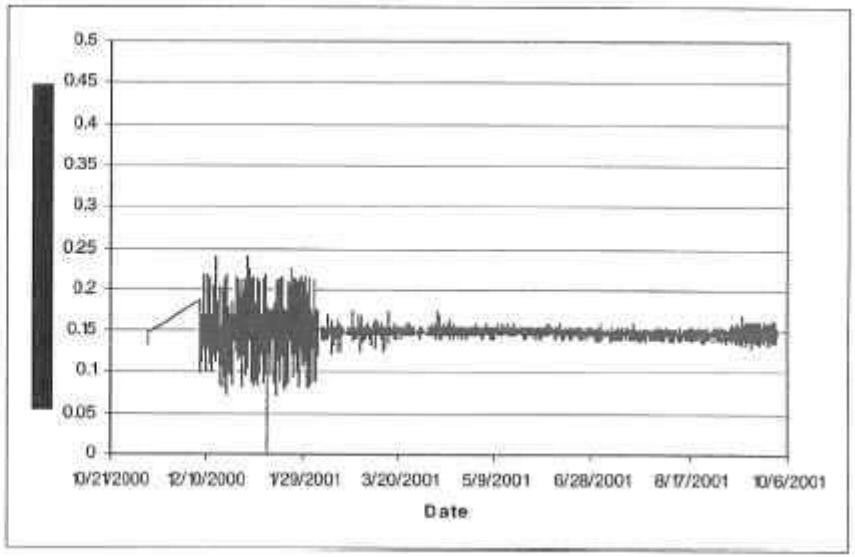

Figure G-21. LF 2-north 7.5 to 8.0 ft.

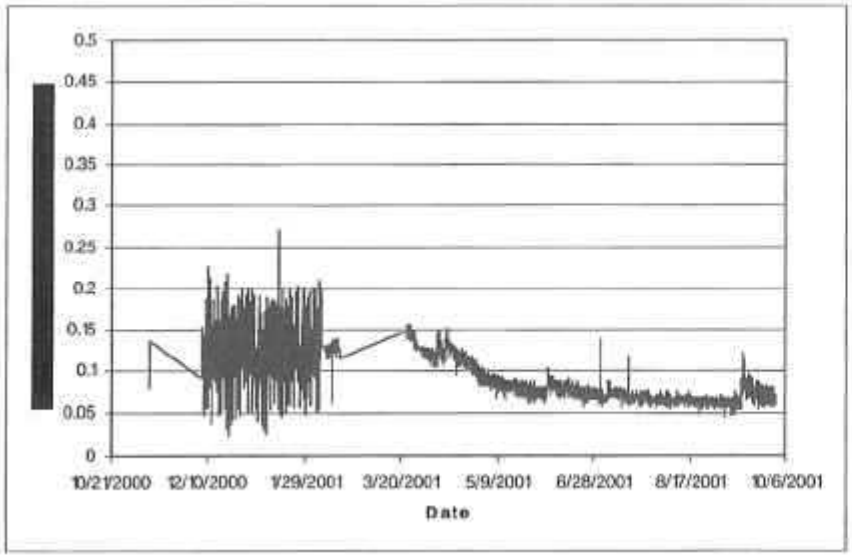

Figure G-22. LF 2-south 0.0 to 0.5 ft.

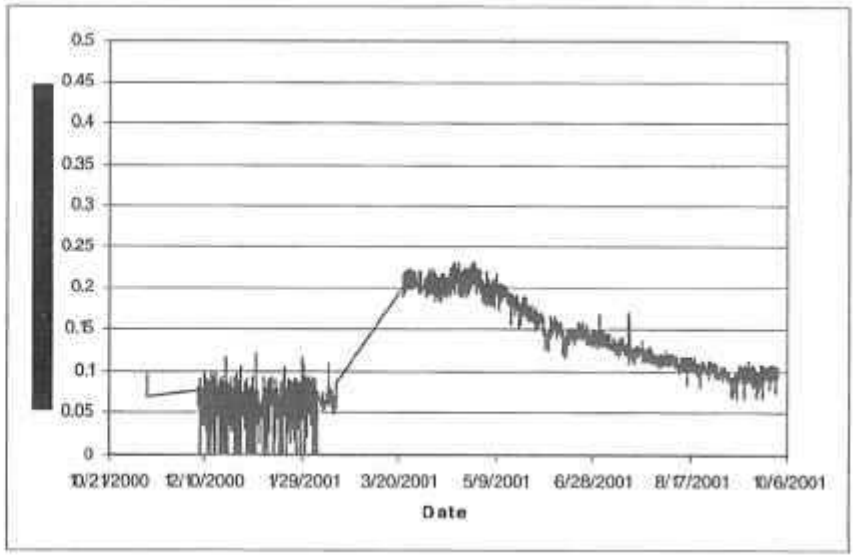

Figure G-23. LF 2-south 0.5 to 1.0 ft.

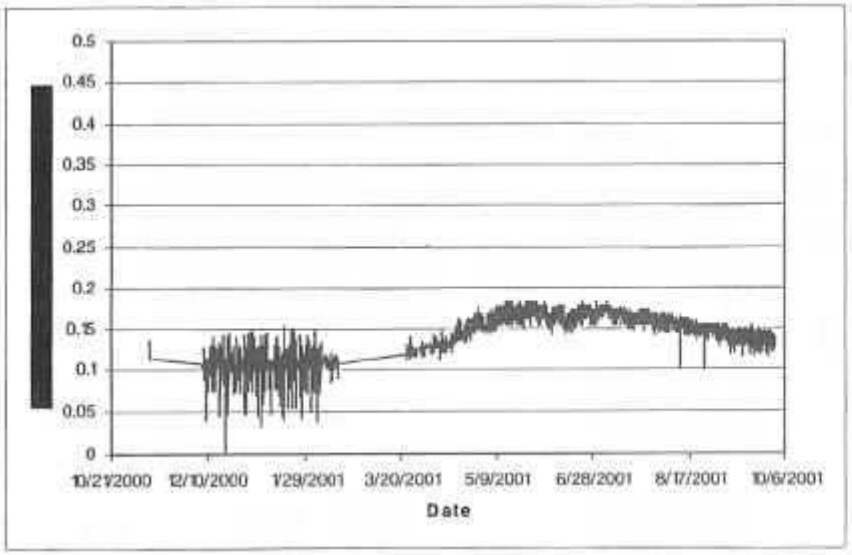

Figure G-24. LF 2-south 1.0 to 1.5 ft.

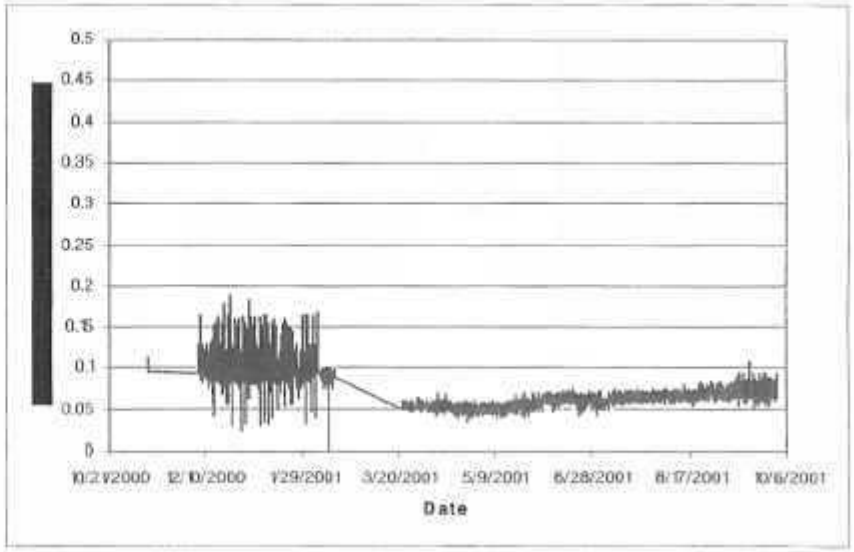

Figure G-25. LF 2-south 1.5 to 2.0 ft.

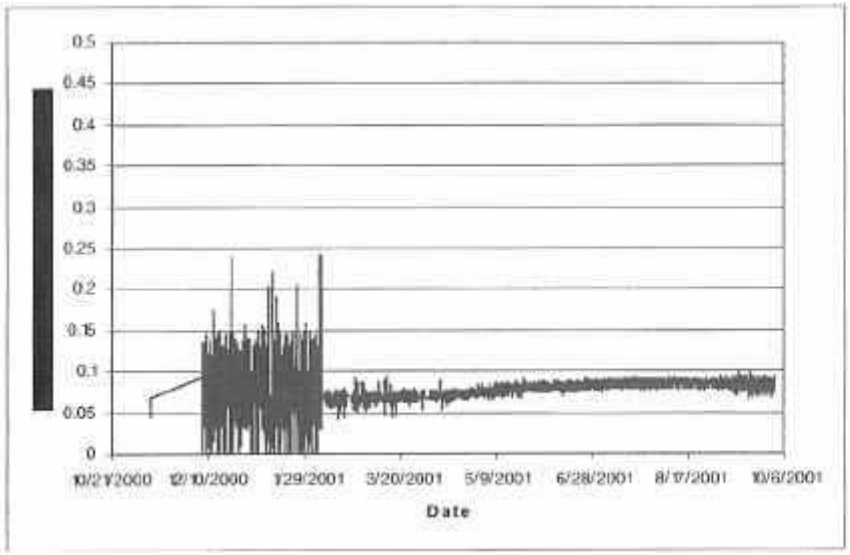

Figure G-26. LF 2-south 2.0 to 2.5 ft.

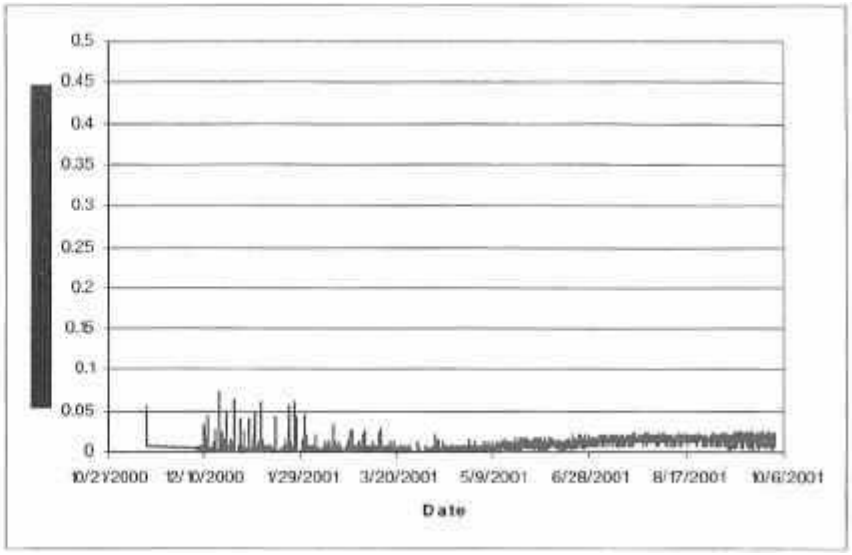

Figure G-27. LF 2-south 2.5 to 3.0 ft.

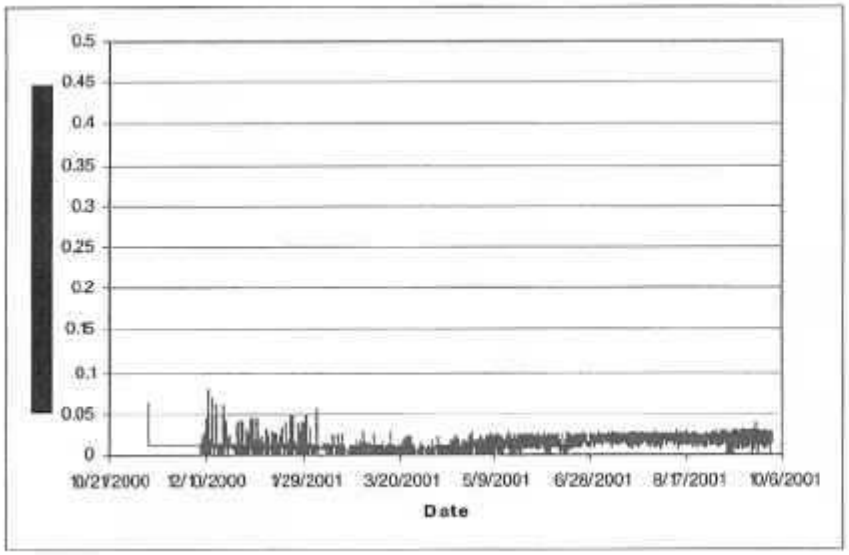

Figure G-28. LF 2-south 3.0 to 3.5 ft.

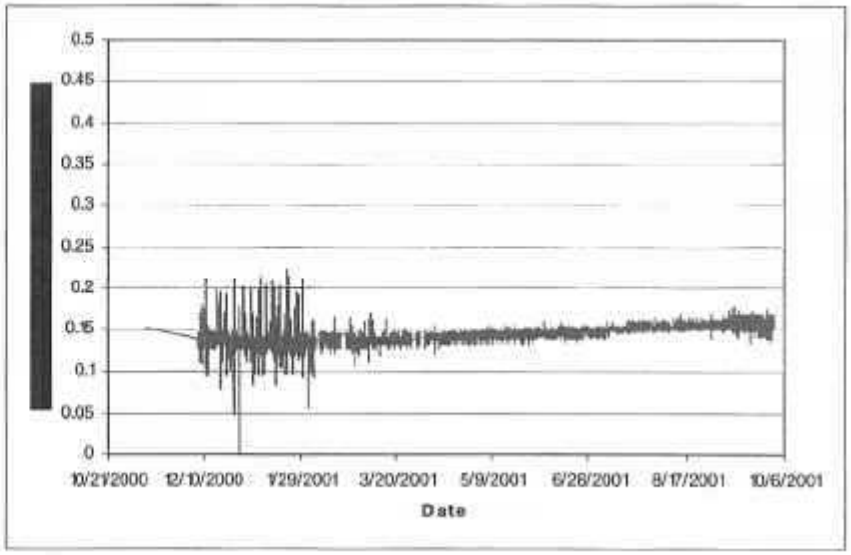

Figure G-29. LF 2-south 3.5 to 4.0 ft.

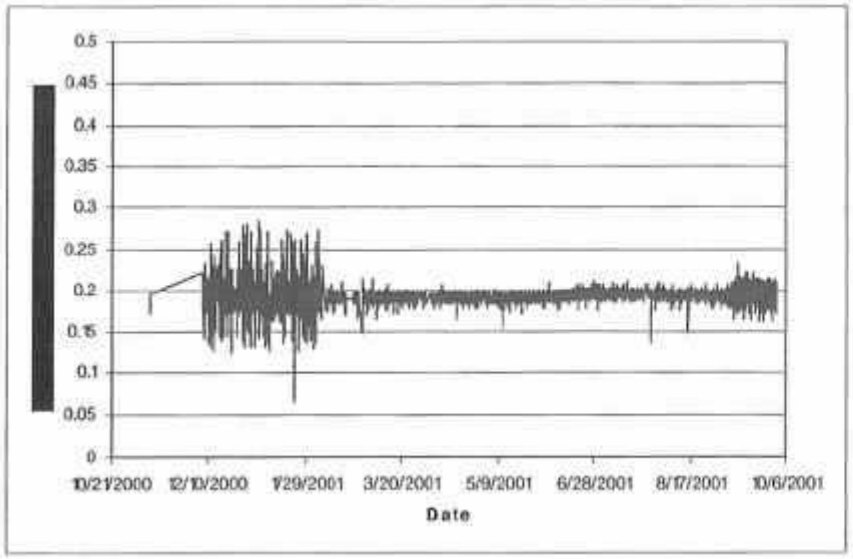

Figure G-30. LF 2-south 4.0 to 4.5 ft.

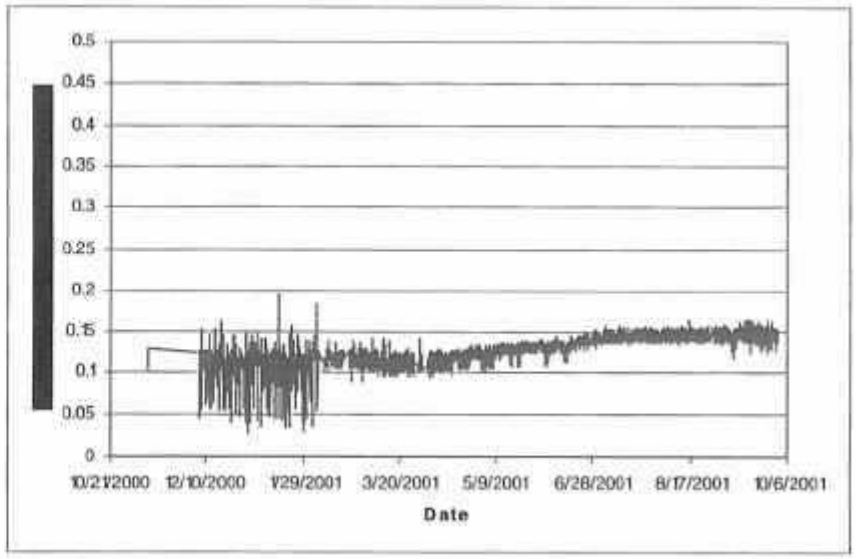

Figure G-31. LF 2-south 4.5 to 5.0 ft.

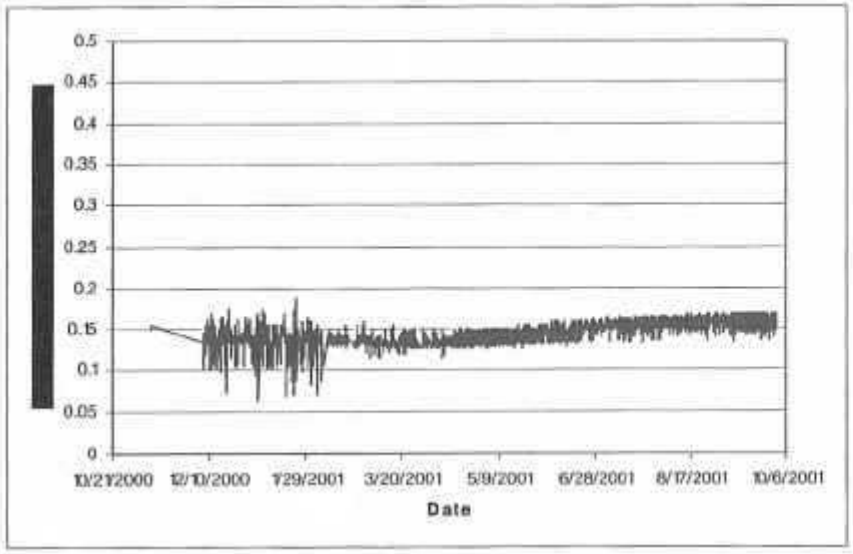

Figure G-32. LF 2-south 5.0 to 5.5 ft.

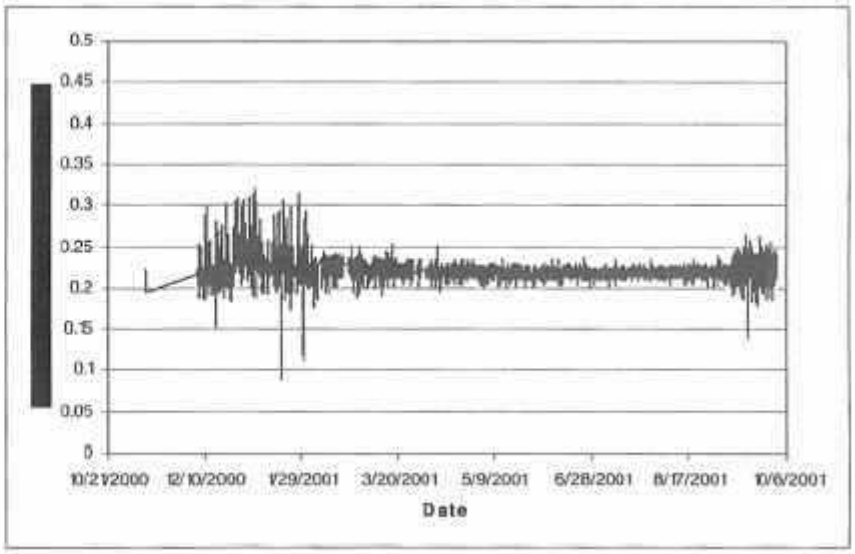

Figure G-33. LF 2-south 5.5 to 6.0 ft.

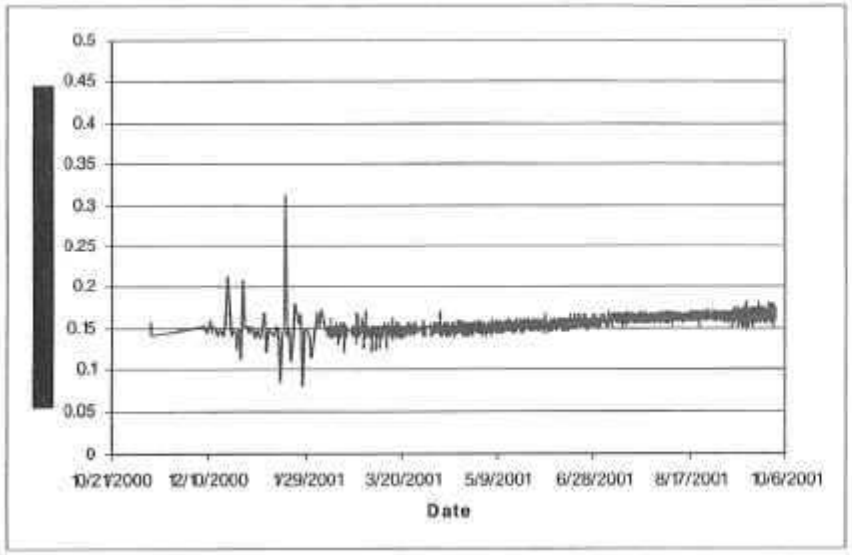

Figure G-34. LF 2-south 6.0 to 6.5 ft.

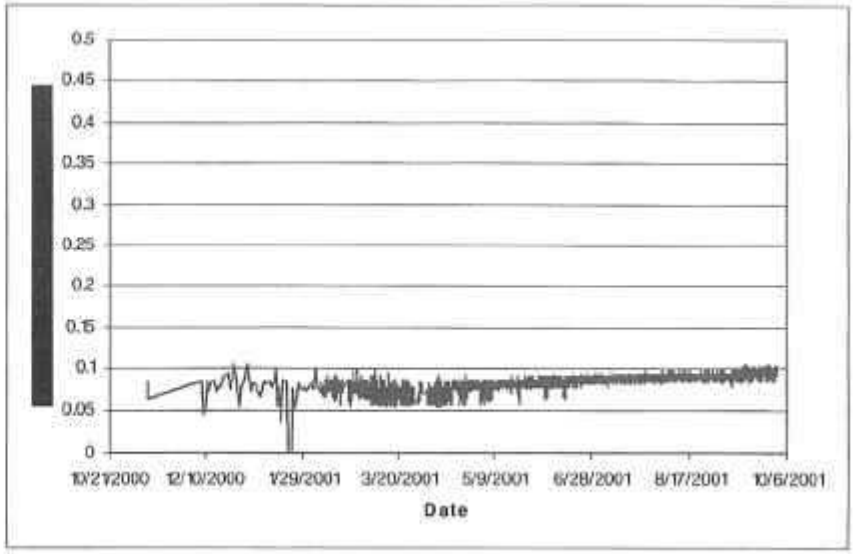

Figure G-35. LF 2-south 6.5 to 7.0 ft.

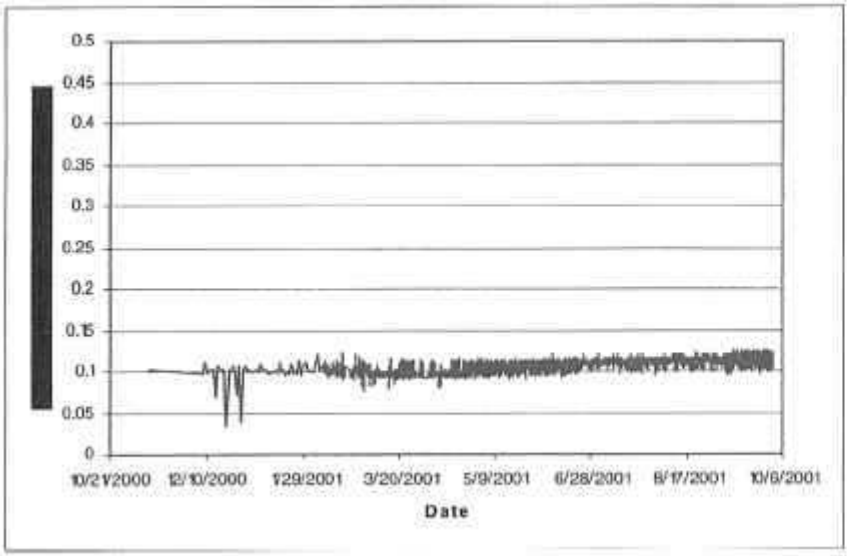

Figure G-36. LF 2-south 7.0 to 7.5 ft.

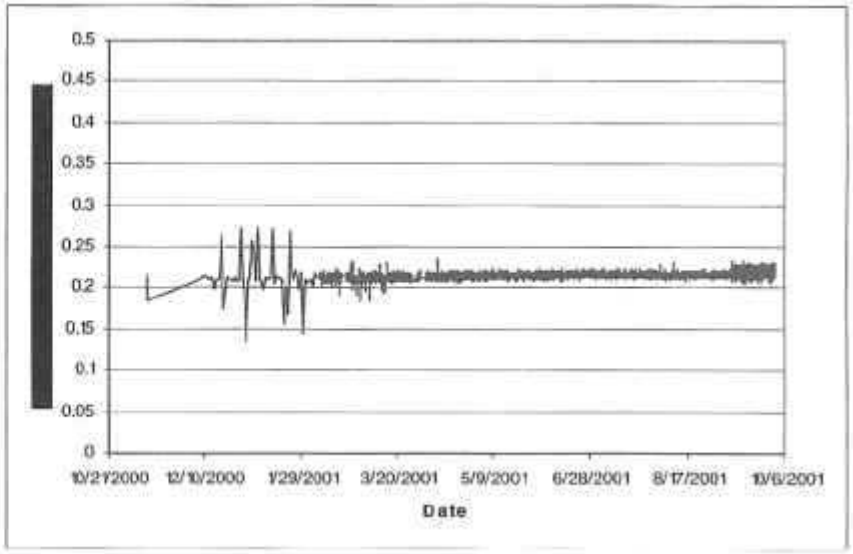

Figure G-37. LF 2-south 7.5 to 8.0 ft.

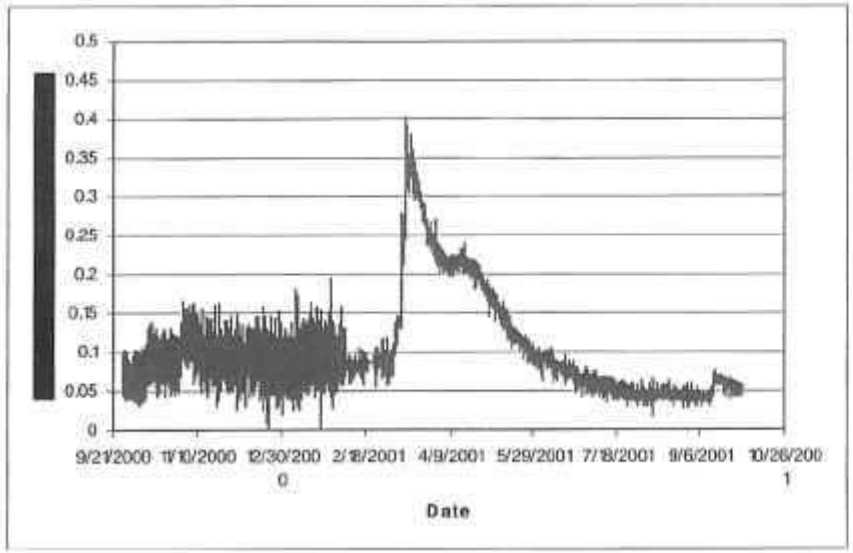

Figure G-38. LF 3-east 0.0 to 0.5 ft.

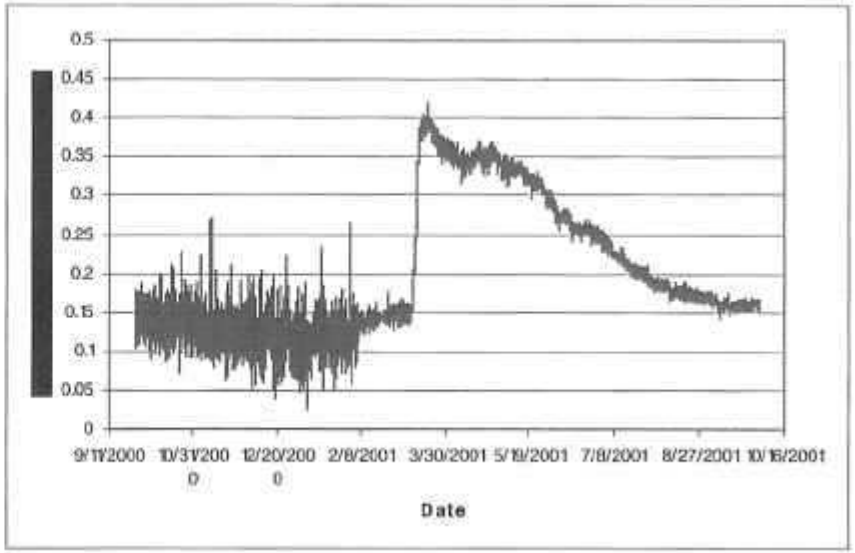

Figure G-39. LF 3-east 0.5 to 1.0 ft.

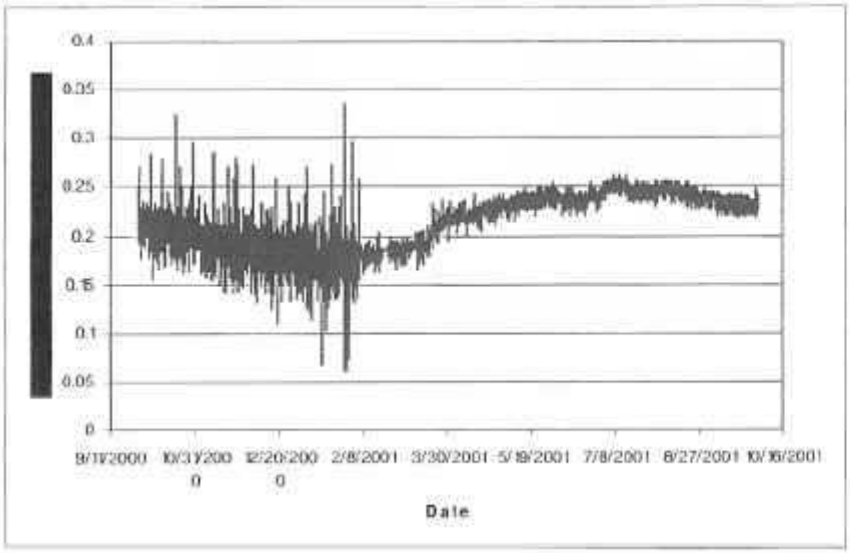

Figure G-40. LF 3-east 1.0 to 1.5 ft.

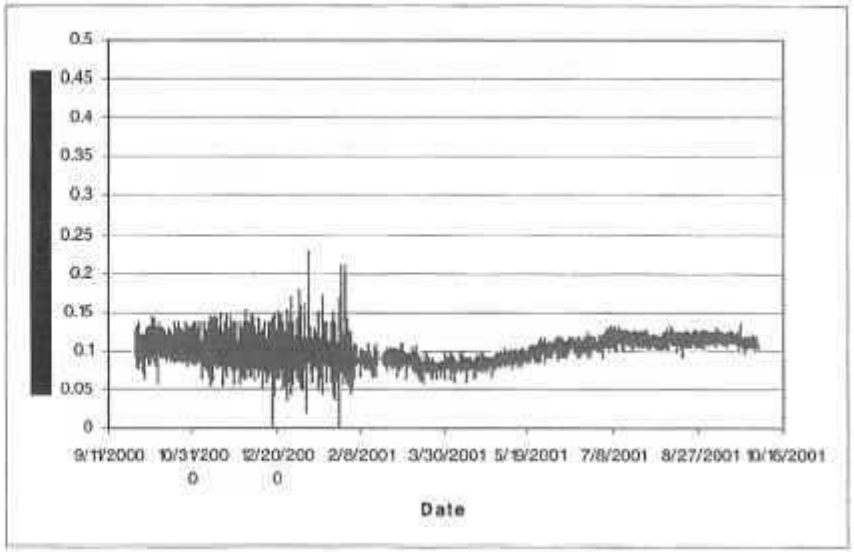

Figure G-41. LF 3-east 1.5 to 2.0 ft.

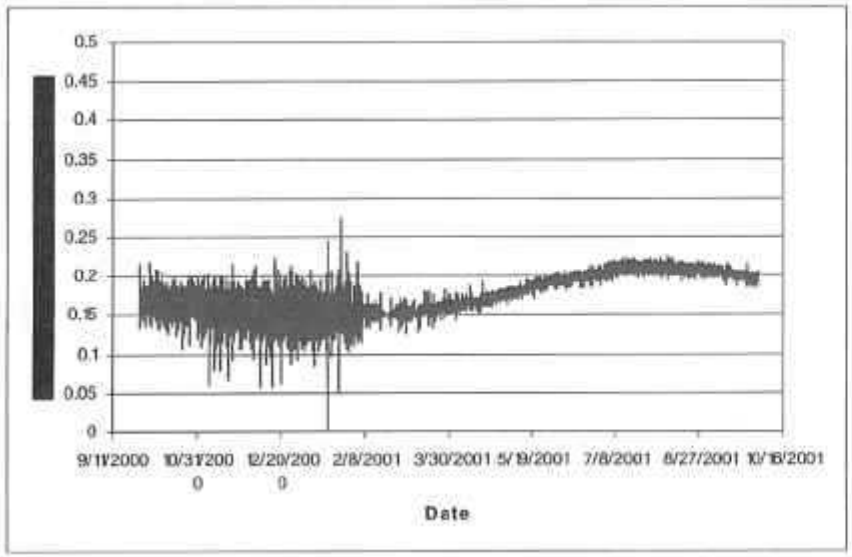

Figure G-42. LF 3-east 2.0 to 2.5 ft.

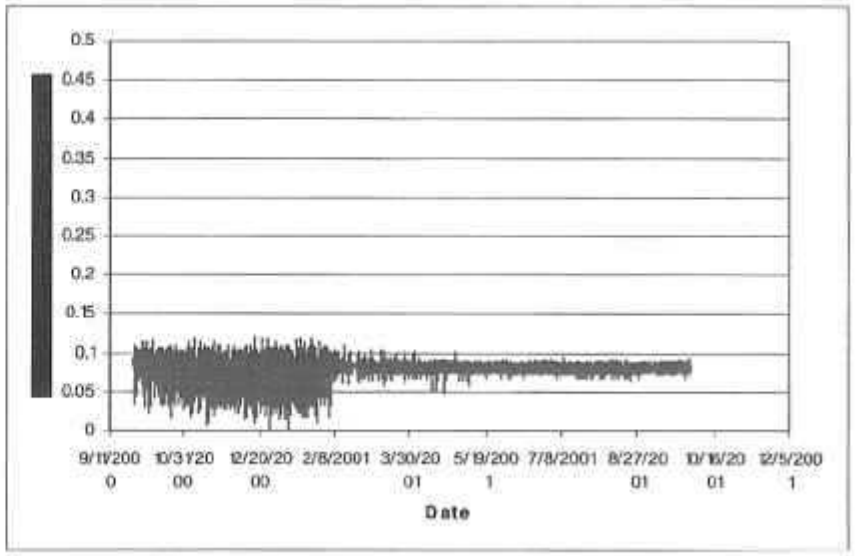

Figure G-43. LF 3-east 2.5 to 3.0 ft.

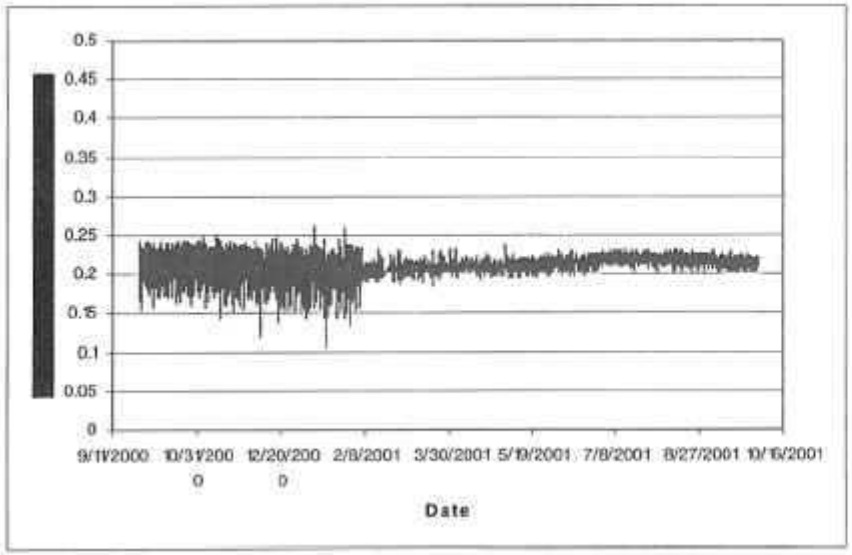

Figure G-44. LF 3-east 3.0 to 3.5 ft.

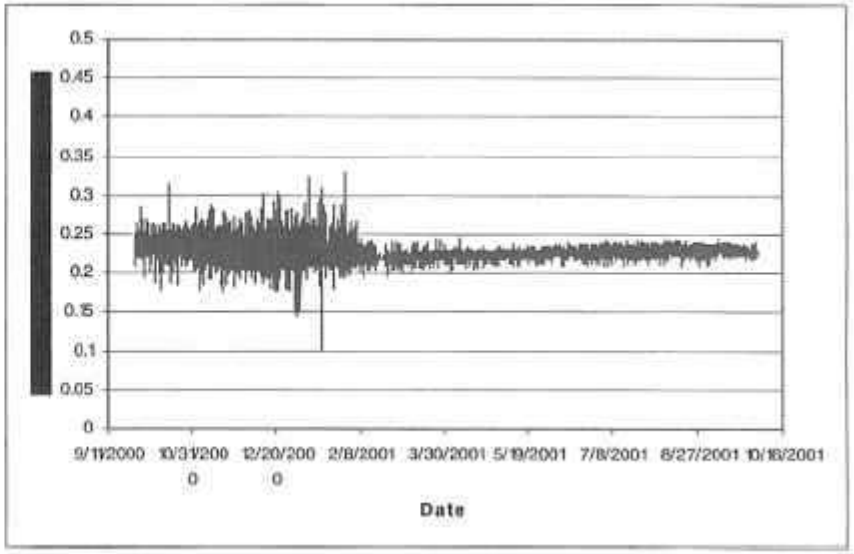

Figure G-45. LF 3-east 3.5 to 4.0 ft.

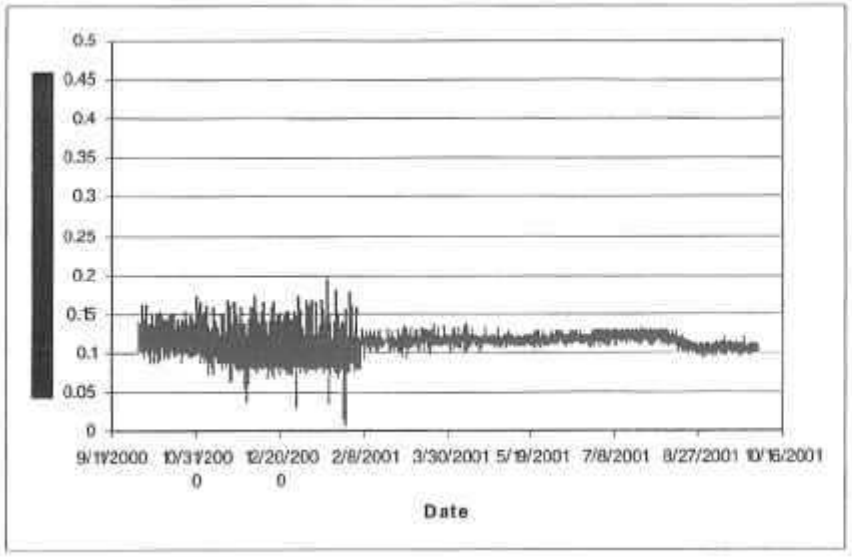

Figure G-46. LF 3-east 4.0 to 4.5 ft.

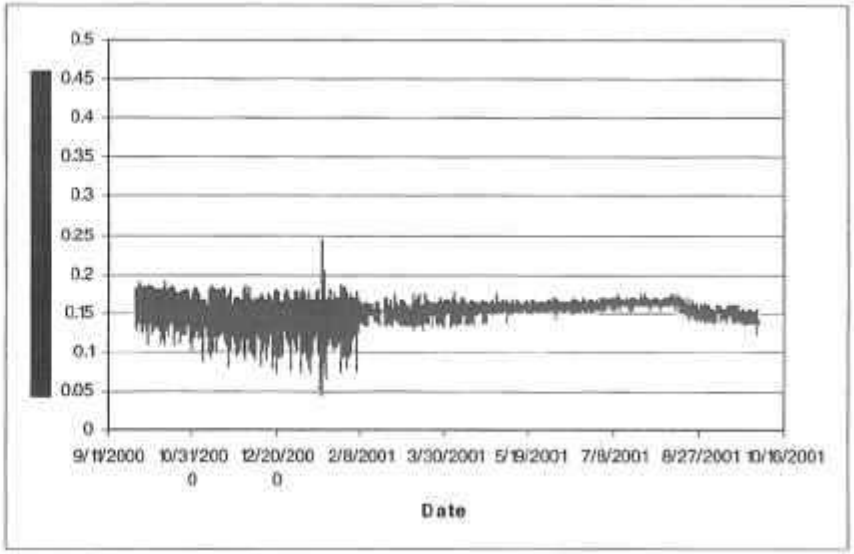

Figure G-47. LF 3-east 4.5 to 5.0 ft.

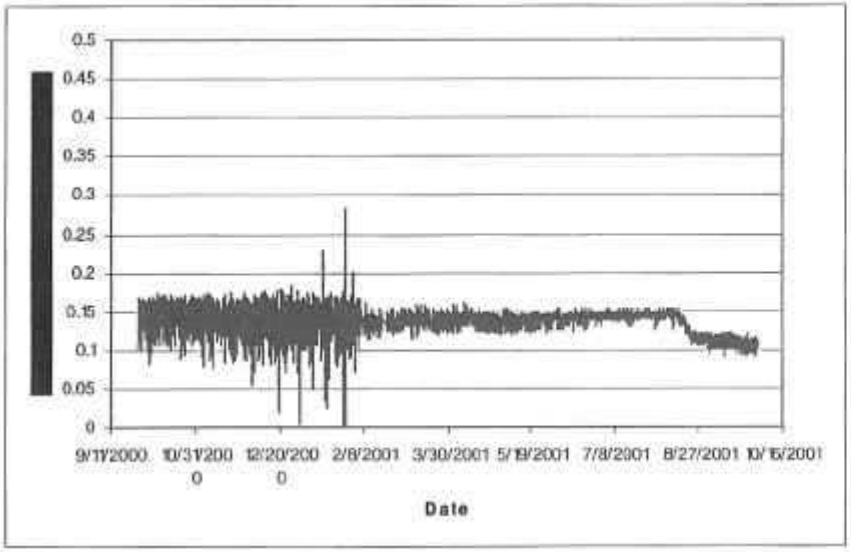

Figure G-48 LF 3-east 5.0 to 5.5 ft.

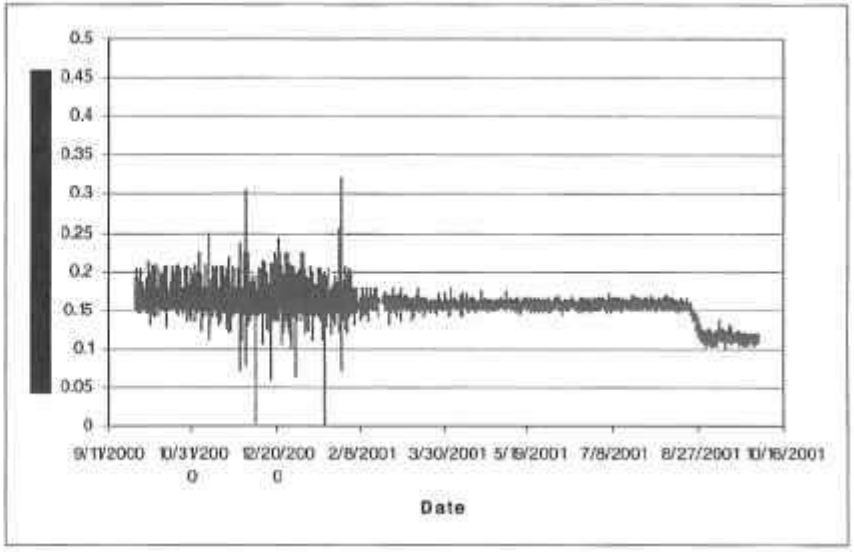

Figure G-49. LF 3-east 5.5 to 6.0 ft.

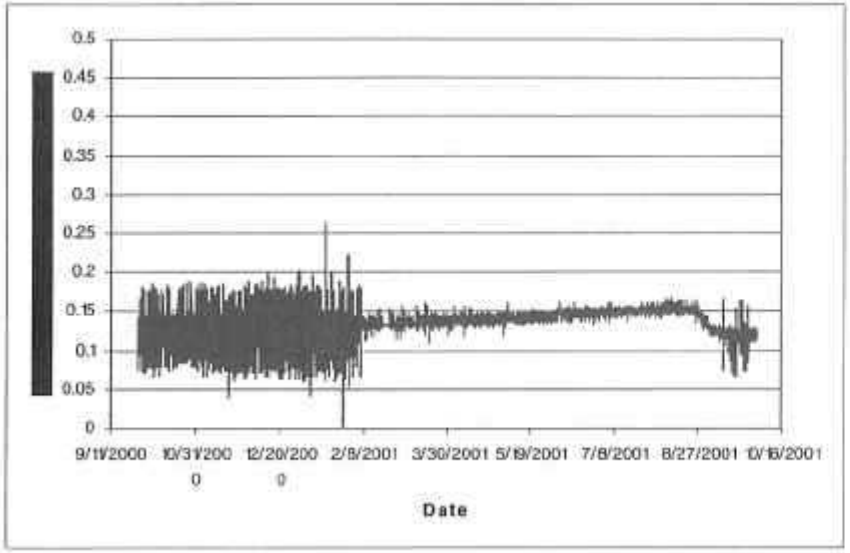

Figure G-50. LF 3-east 6.0 to 6.5 ft.

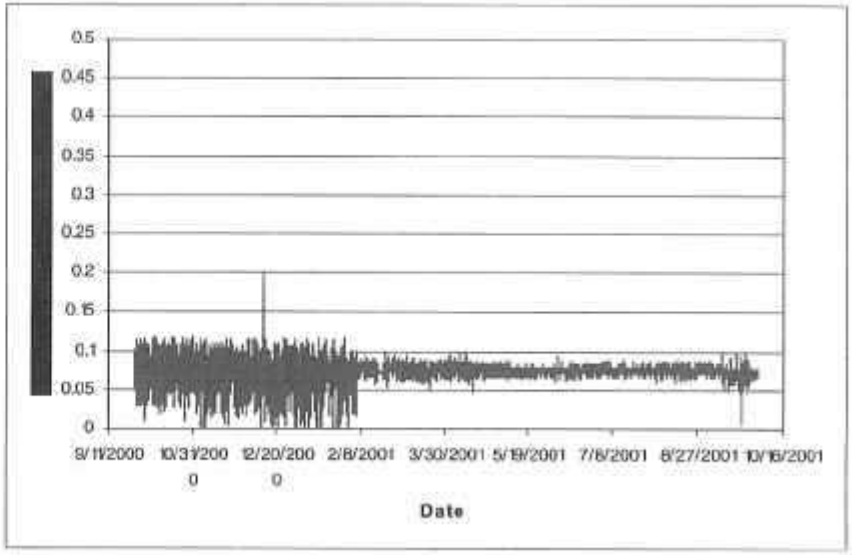

Figure G-51. LF 3-east 6.5 to 7.0 ft.

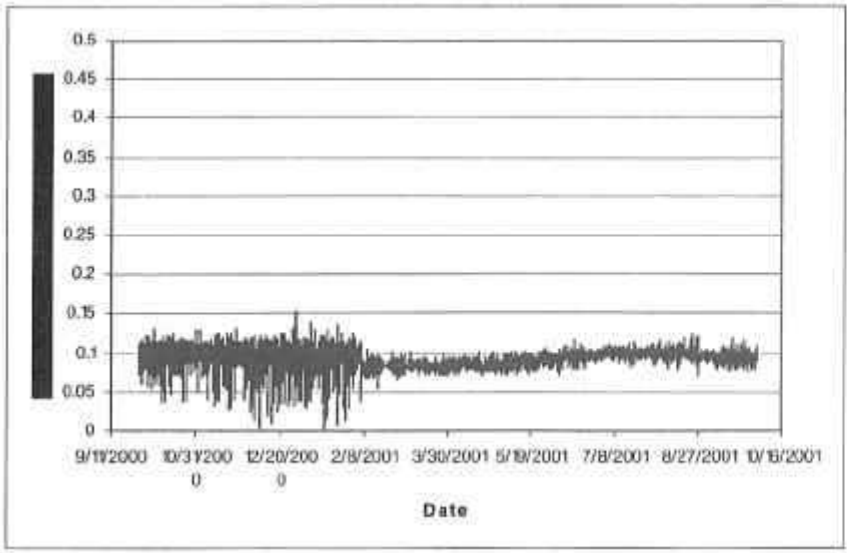

Figure G-52. LF 3-east 7.0 to 7.5 ft.

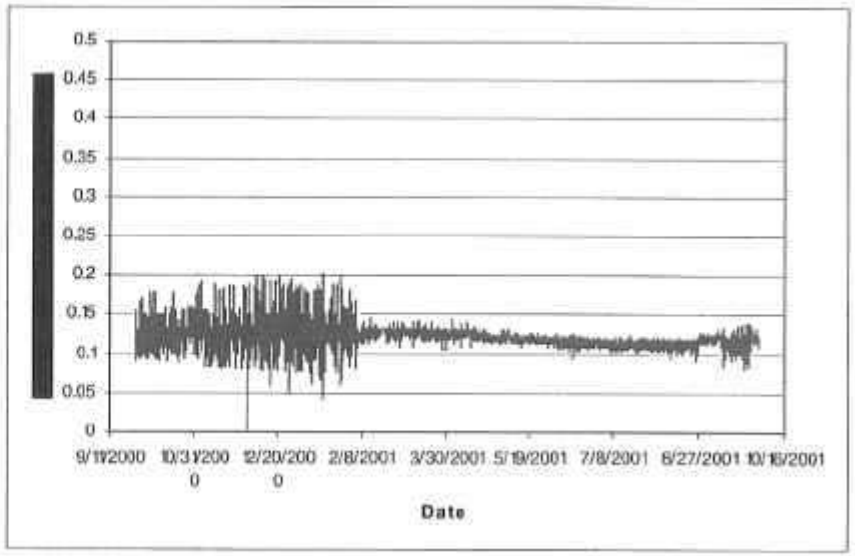

Figure G-53. LF 3-east 7.5 to 8.0 ft.

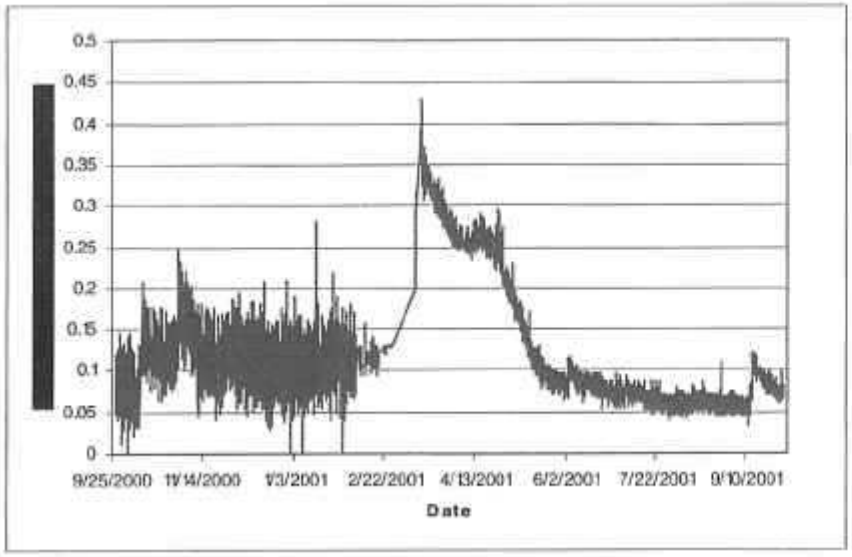

Figure G-54. LF 3-west 0.0 to 0.5 ft.

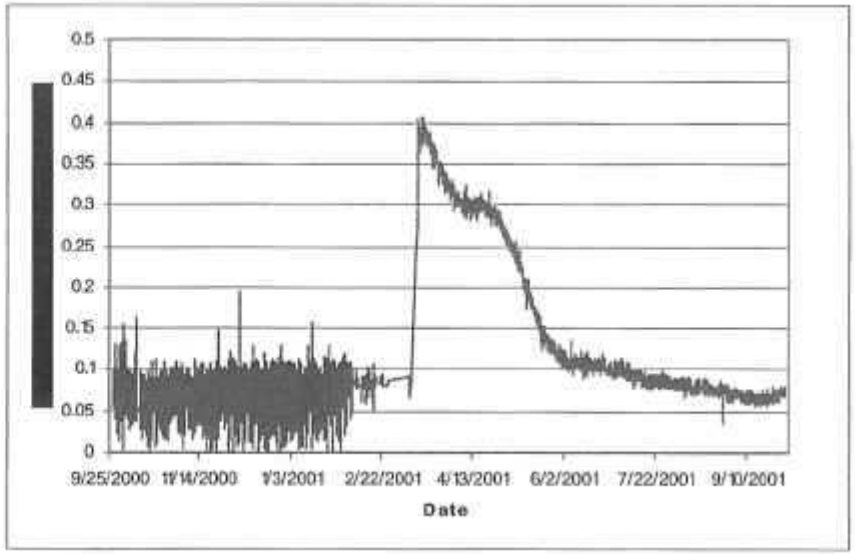

Figure G-55. LF 3-west 0.5 to 1.0 ft.

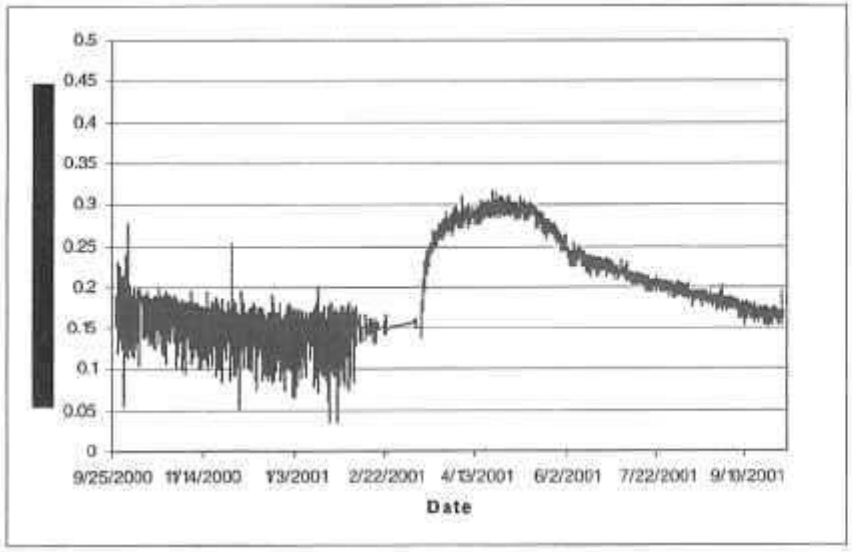

Figure G-56. LF 3-west 1.0 to 1.5 ft.

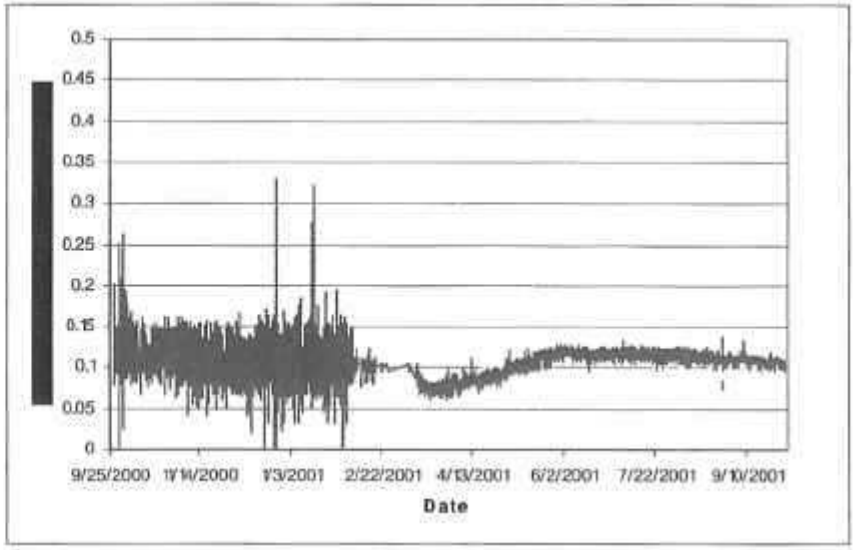

Figure G-57. LF 3-west 1.5 to 2.0 ft.

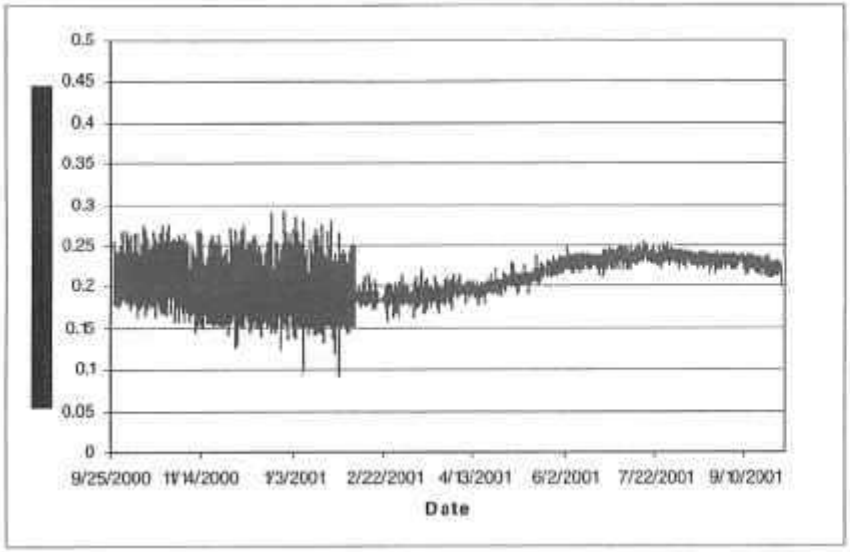

Figure G-58. LF 3-west 2.0 to 2.5 ft.

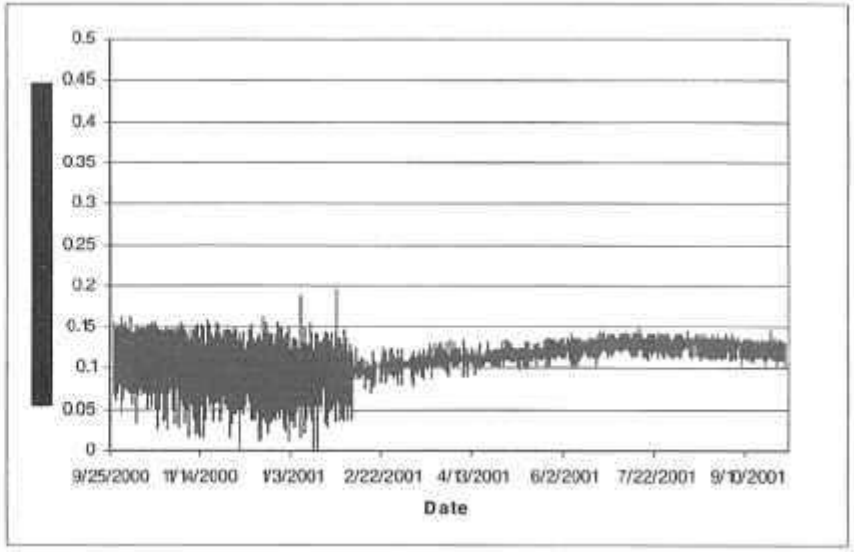

Figure G-59. LF 3-west 2.5 to 3.0 ft.

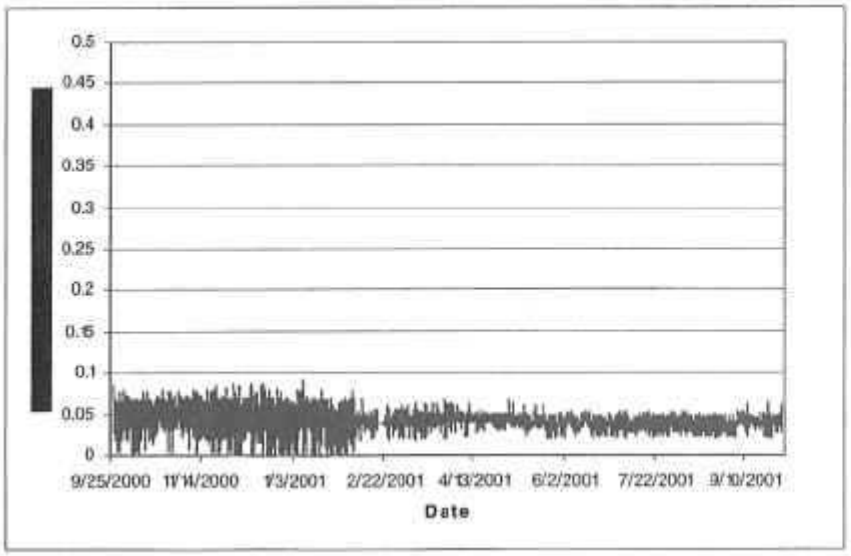

Figure G-60. LF 3-west 3.0 to 3.5 ft.

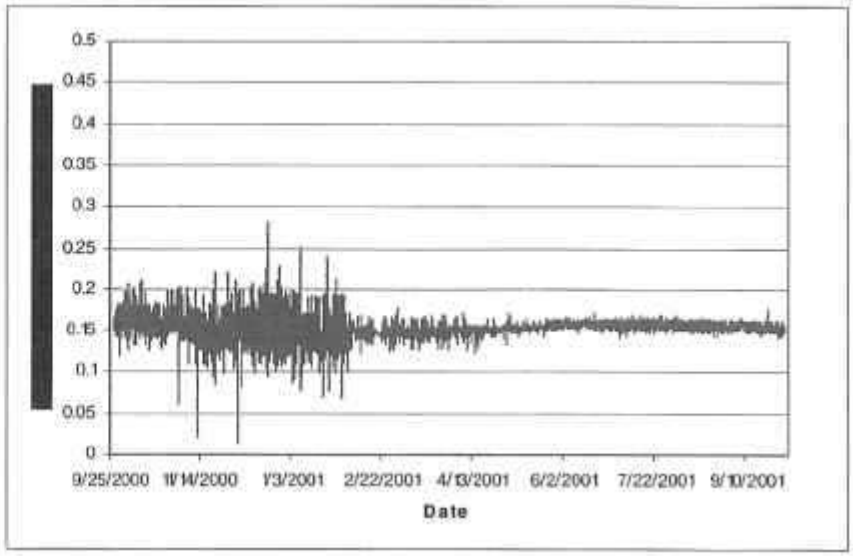

Figure G-61. LF 3-west 3.5 to 4.0 ft.

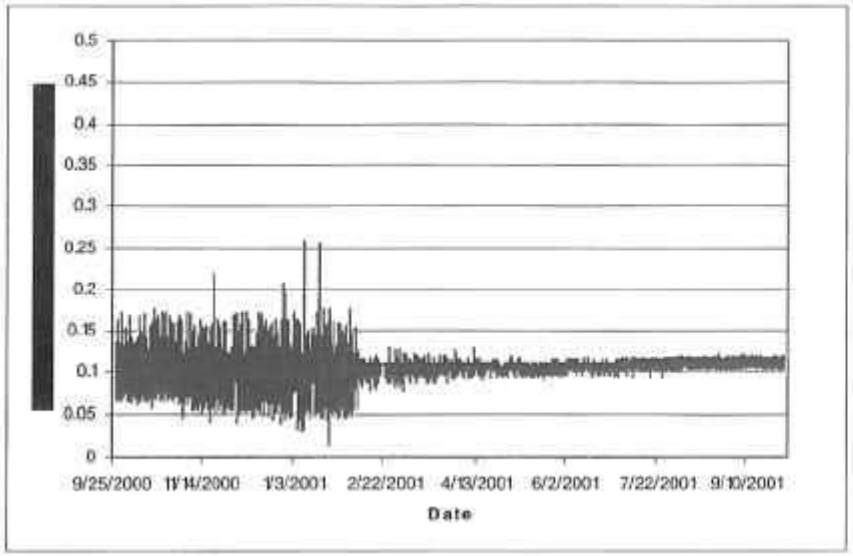

Figure G-62. LF 3-west 4.0 to 4.5 ft.

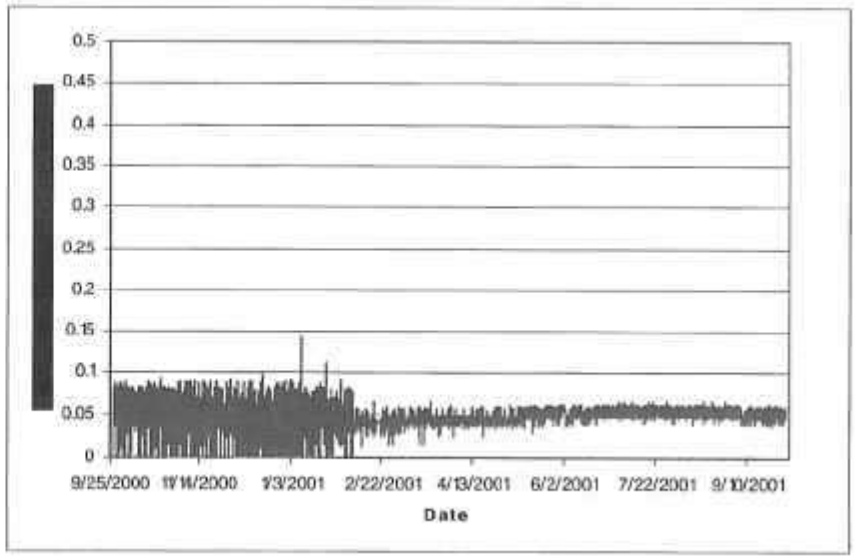

Figure G-63. LF 3-west 4.5 to 5.0 ft.

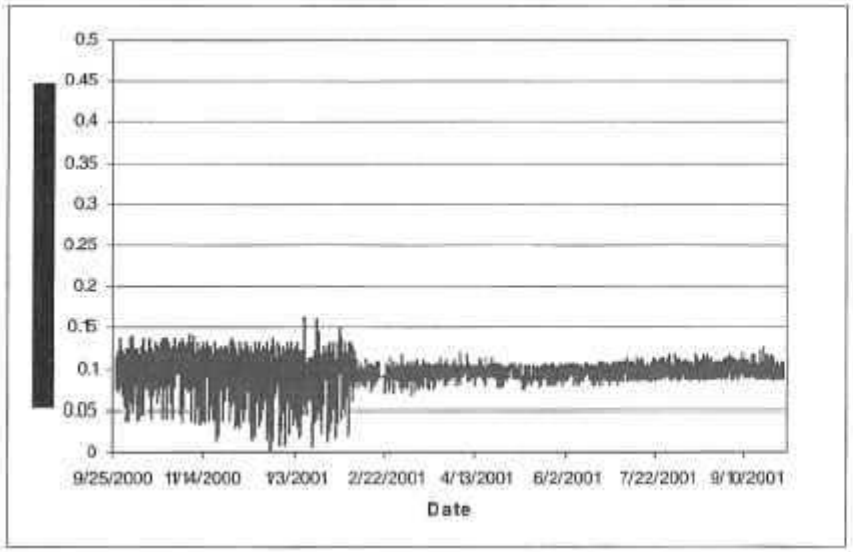

Figure G-64. LF 3-west 5.0 to 5.5 ft.

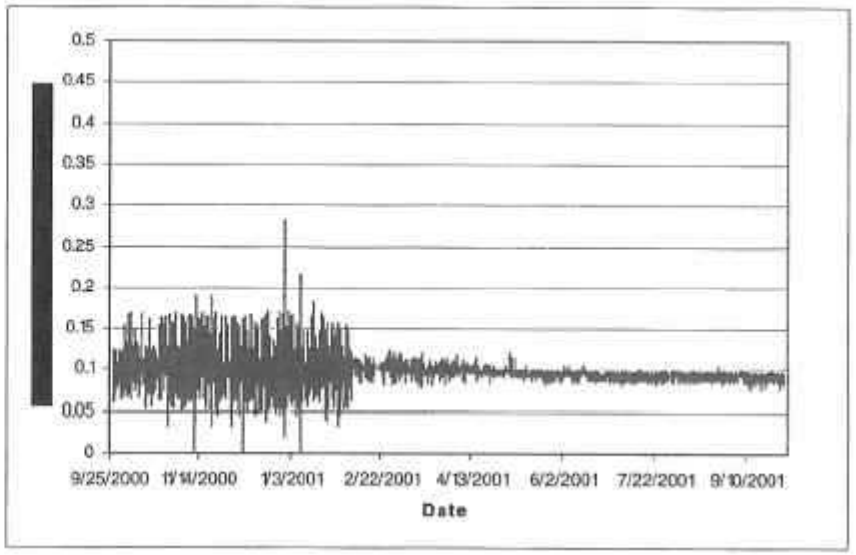

Figure G-65. LF 3-west 5.5 to 6.0 ft.

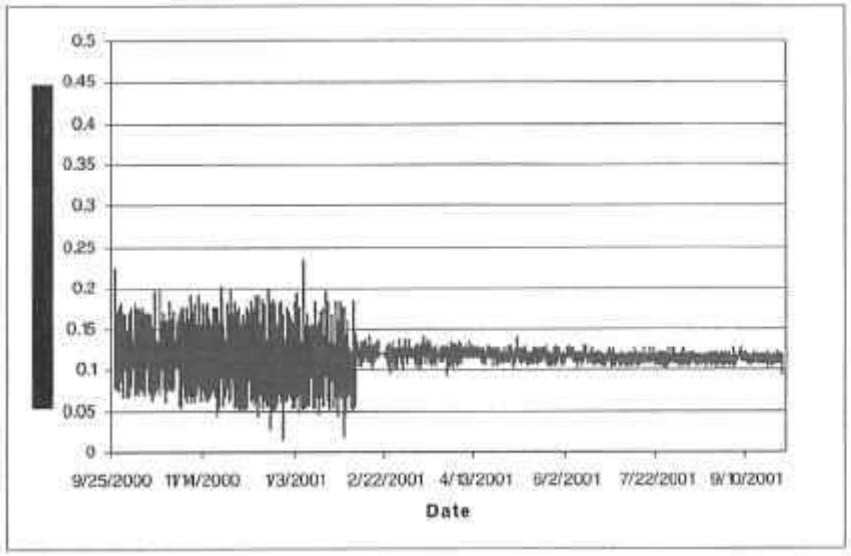

Figure G-66. LF 3-west 6.0 to 6.5 ft.

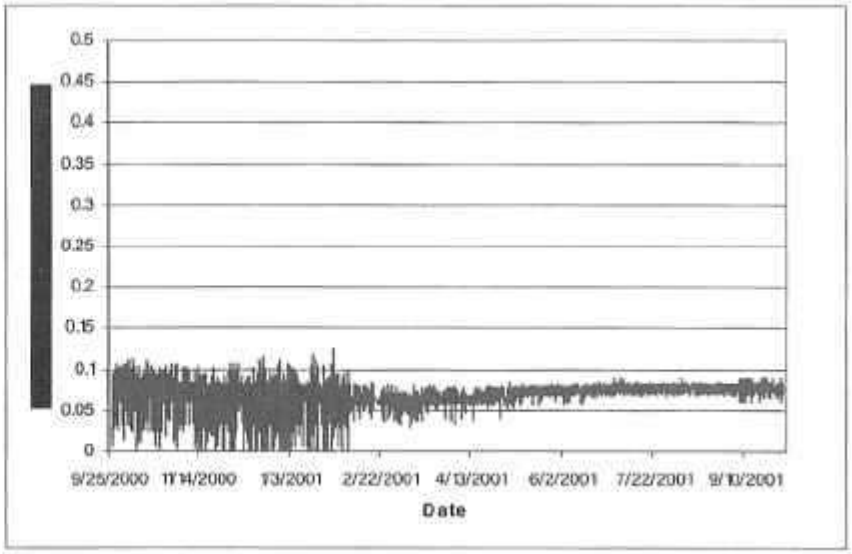

Figure G-67. LF 3-west 6.5 to 7.0 ft.

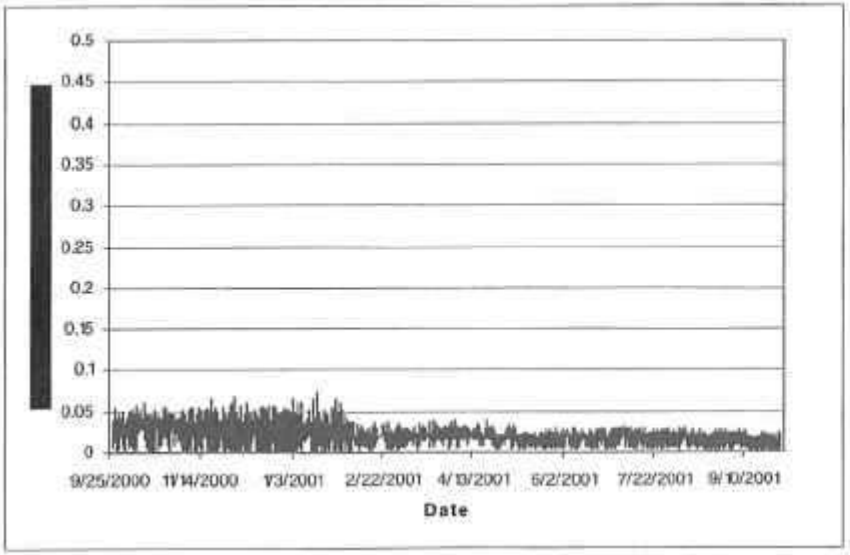

Figure G-68. LF 3-west 7.0 to 7.5 ft.

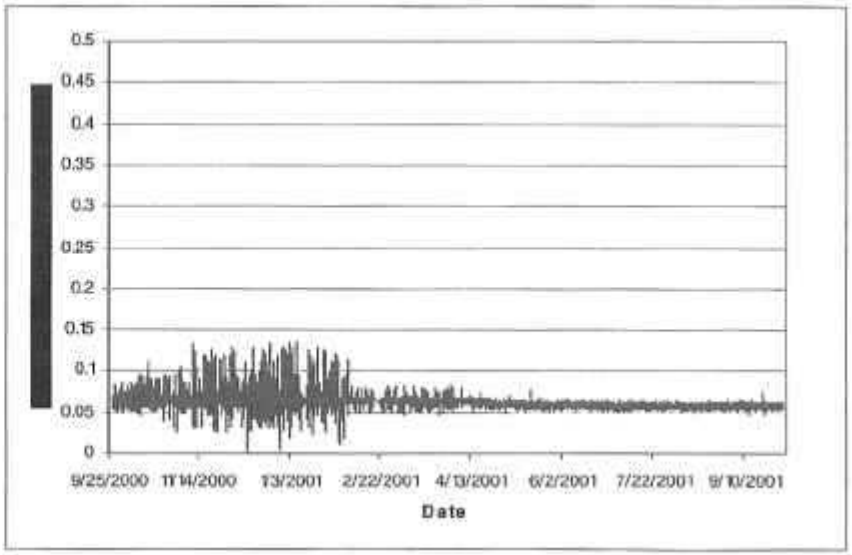

Figure G-69. LF 3-west 7.5 to 8.0 ft.

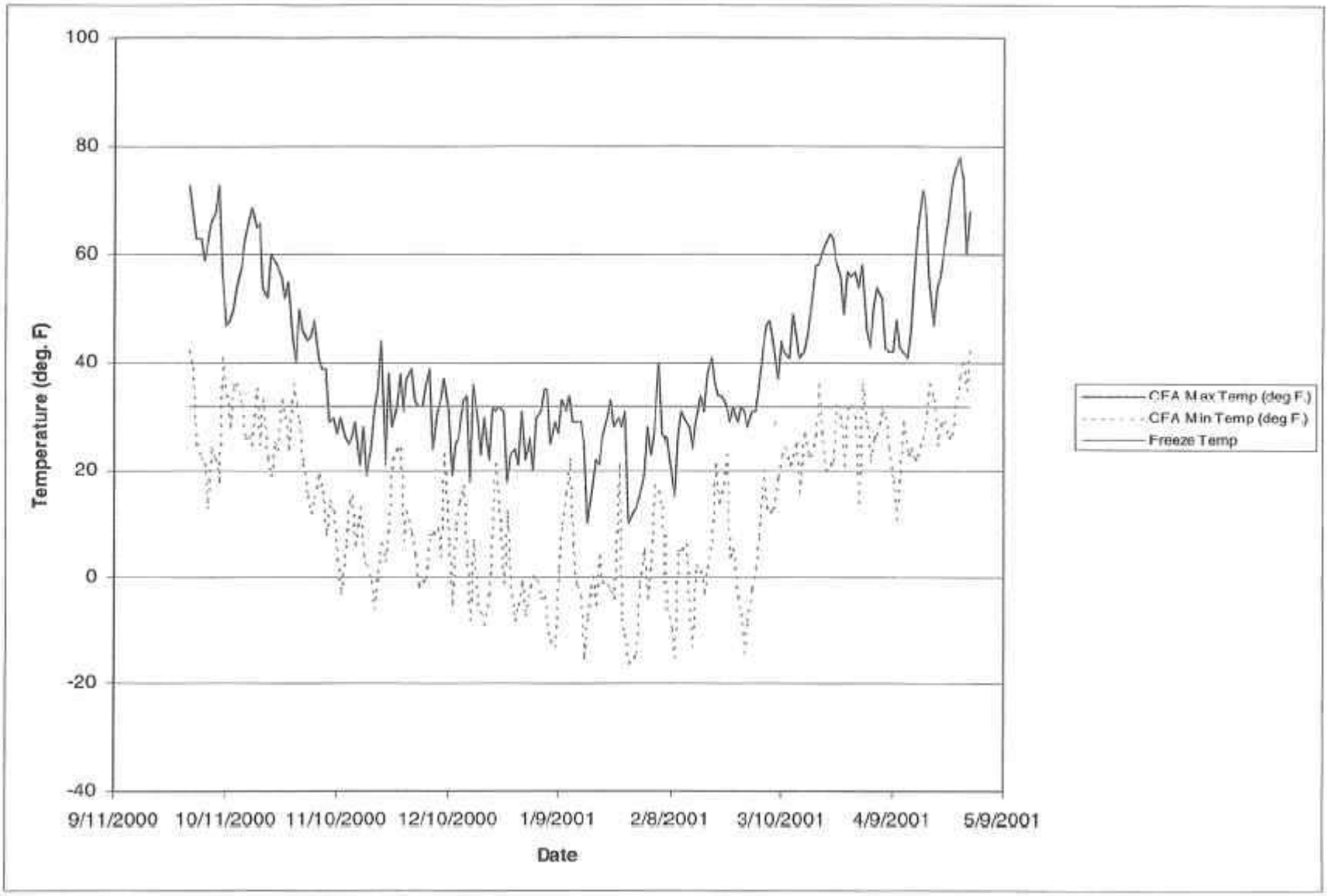

Figure G-70. Daily minimum and maximum temperatures.

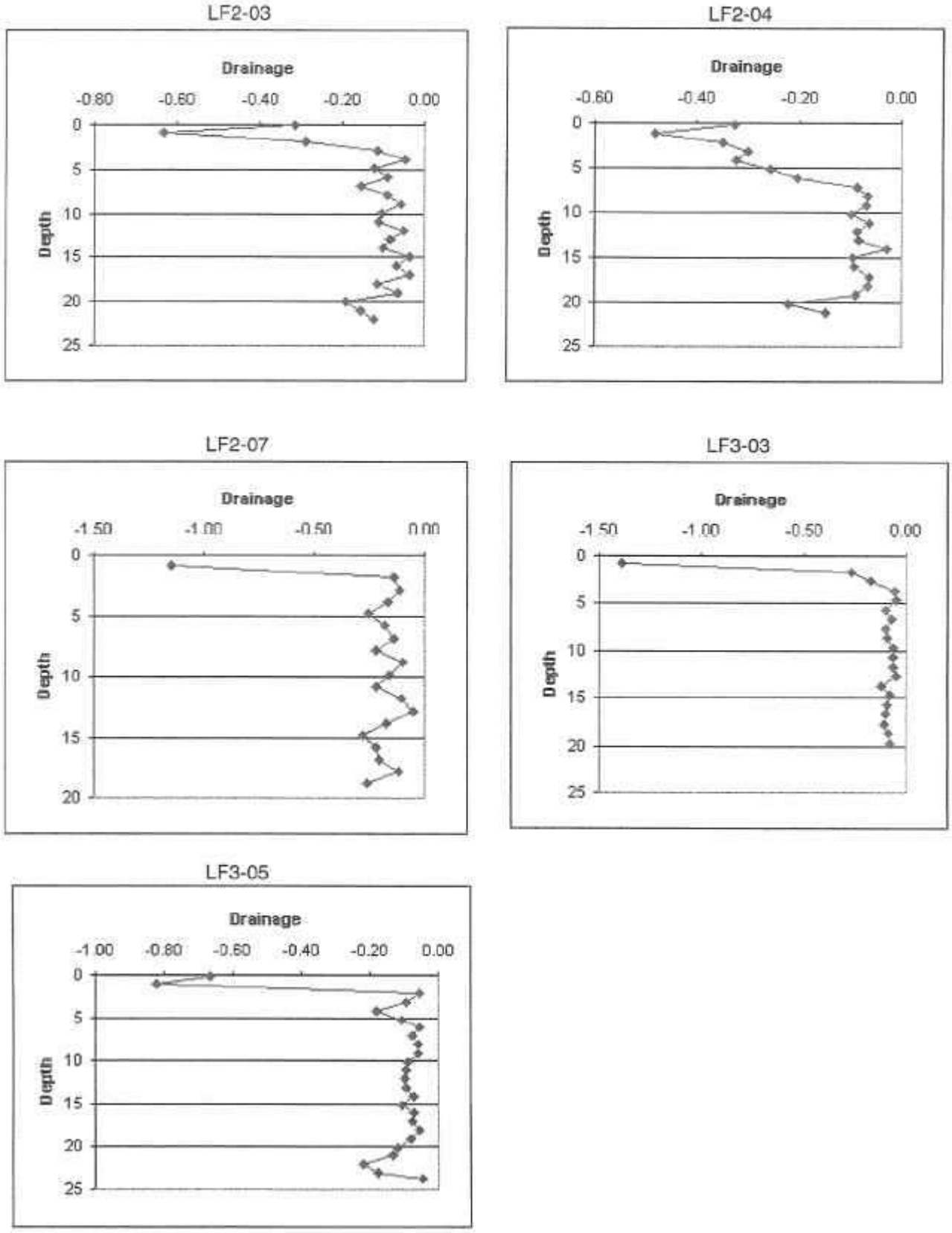

Figure G-71. Drainage plots for the NAT locations.