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Revision 0

Fiscal Year 2003 Summary Report for the OU 7-13/14 Probing Project

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Idaho Completion Project

Bechtel BWXT Idaho, LLC

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ABSTRACT

The Waste Area Group 7 Operable Unit 7-13/14 Probing Project captures field, electronic, and analytical data generated to support the Operable Unit 7-13/14 remedial investigation/feasibility study and a record of decision. The types of data included in this activity include data generated from analytical samples (both lysimeter [liquid] and soil vapor probe [gas]), nuclear logging activities, real-time in situ monitoring devices (tensiometers and soil moisture probes), and visual images of waste zones (borehole video and optical televiewer) within Operable Unit 7-13/14. This report documents and summarizes the data generated and collected in the Operable Unit 7-13/14 Probing Project during Fiscal Year 2003. This report also appends these data to the data from Fiscal Year 2002, supporting the remedial investigation/feasibility study process and a record of decision for Operable Unit 7-13/14.

Samples were collected from eight of the eighteen Type B vapor probes during Fiscal Year 2003. During the last quarter, samples were obtained from an additional five probes that had previously not yielded a sample because of plugging or other difficulty. Some discrepancies are being investigated between the photoacoustic portable multigas analyzer and on-Site laboratory analysis. The volatile organic compound concentrations are steady or decreasing slightly, depending on the location. The results also support information and assumptions used to estimate the original amount of volatile organic compounds buried in the Subsurface Disposal Area as well as burial locations of the volatile organic compound waste. Volatile organic compound concentrations from the probes are comparable to those predicted to be in equilibrium with Series 743 sludge. Some volatile organic compound concentrations appear to be seasonally dependent. This is plausible given the volatilization and partitioning dependence on temperature. The C-14-specific activity is substantially elevated (on the order of 100 times) above the naturally occurring levels at SVR-12 and originates from activated carbon steel.

One waste-zone lysimeter at Probe 741-08-L1 yielded approximately 10 mL of water during Fiscal Year 2003. The sample was analyzed for gamma-emitting radionuclides with no positive detections. There was inadequate volume to perform other radiological analyses.

Continuous water potential data from four tensiometer locations in the Subsurface Disposal Arsa indicate that infiltration occurs through surficial sediment and through waste despite less-than-average precipitation in the last 2 years. The lack of working tensiometers over a depth profile prevents use of water potential data for hydraulic gradients or estimates of infiltration rates. It is recommended that the tensiometers be monitored through fall 2004 to provide needed corroboration of soil moisture data in a year that should provide greater potential for infiltration through snowmelt. If the functionality of tensiometers does not improve, it also is recommended that consideration be given to halting the collection of tensiometer data at the end of Fiscal Year 2004.

The soil moisture probes have received considerable attention this past year to correct problems and bring as many probes online as possible. The soil moisture probes were individually interrogated to collect readings and determine

functionality. All dataloggers have been reprogrammed with calibrations for probes that had corrupt calibrations. Soil moisture probe communication wiring was reconfigured so that each probe is on an individual RS-485 driver. This work resulted in successfully bringing several clusters of soil moisture probes online. The recommendations are to collect raw and processed data from representative probes for one quarter and reevaluate the soil moisture probes at that time, to develop and apply a temperature correction to the soil moisture probe measurements, and to perform controlled experiments to determine impact of soil resistivity and salinity on moisture measurements.

The visual probes were logged for a second time with the optical televiewer during Fiscal Year 2003, and no change in subsurface conditions could be identified. The images are available for inspection on CD in the Operable Unit 7-13/14 Project files as required. The visual probe and optical televiewer have proven to be useful tools for visual examination of subsurface conditions, but no further utilization of the visual probes is anticipated at this time.

Thirty-seven Type A probes were installed in the Subsurface Disposal Area and were logged with a suite of nuclear logging tools including spectral gamma, neutron moisture, passive neutron, neutron capture, and azimuthal. The combined use of WasteOScope inventory data and surface geophysics was generally successful for locating subsurface contamination within the Subsurface Disposal Area. In most cases, the contamination was consistent with the expected waste inventory. Very high cesium-cobalt levels were observed in the west end of Trench 24. Europium-154 was identified as a common constituent in many of the new study areas. Measurement of azimuthal data at 6-in. depth intervals in two probes showed that both apparent concentration and position of radionuclide sources change continually with depth, supporting the conclusion that radionuclide contamination in the Subsurface Disposal Area is highly heterogeneous. High-sensitivity measurements within underburden soil in two probes showed that downward vertical migration of radionuclides is very limited.

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ACRONYMS

ARA	Applied Research Associates, Inc.
DU	depleted uranium
ECL	Environmental Chemistry Laboratory
FY	fiscal year
GC/MS	gas chromatography/mass spectrometry
INEEL	Idaho National Engineering and Environmental Laboratory
OU	operable unit
PCE	tetrachloroethene
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
SMR	soil moisture, resistivity, and temperature
SWLO	Southwest Laboratory of Oklahoma
TCA	1,1,1-trichloroethane
TCE	trichloroethene
VOC	volatile organic compound

Fiscal Year 2003 Summary Report for the OU 7-13/14 Probing Project

1. INTRODUCTION

1.1 Purpose

The field, electronic, and analytical data generated for the Waste Area Group 7 Operable Unit (OU) 7-13/14 Probing Project during Fiscal Year (FY) 2003 are summarized in this report. The types of data addressed in this report include data generated from the analysis of lysimeter samples (liquid) and soil vapor probe samples (gas); data from nuclear logging activities, real-time in situ monitoring using tensiometers, and soil moisture probes; and data from visual probe images of waste zones (optical televiewer) within OU 7-13/14. The OU 7-13/14 Probing Project is being conducted in the Subsurface Disposal Area (SDA) of the Radioactive Waste Management Complex (RWMC) at the Idaho National Engineering and Environmental Laboratory (INEEL) to support the OU 7-13/14 remedial investigation/feasibility study, leading to a record of decision. The designation for the RWMC is Waste Area Group 7, recognized under the *Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory* (DOE-ID 1991) and the "Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA/Superfund)" (42 USC § 9601 et seq., 1980).

1.2 Scope

Documentation for the OU 7-13/14 Probing Project includes the *Operable Unit 7-13/14 Plan for the Installation, Logging, and Monitoring of Probeholes in the Subsurface Disposal Area* (INEEL 2000), hereinafter referred to as the *Probehole Plan*; *Field Sampling Plan for Monitoring Type B Probes for the Operable Unit 7-13/14 Integrated Probing Project* (Salomon 2003), hereinafter referred to as the *Field Sampling Plan*; and *Data Management Plan for the Operable Unit 7-13/14 Integrated Probing Project* (Salomon 2002), hereinafter as the *Data Mangement Plan*. The *Probehole Plan* (INEEL 2000) is the initial planning document for the OU 7-13/14 Probing Project and is a plan for two phases of probing. The first phase is the installation of Type A probes that are installed in selected focus areas in the SDA and that provide access to the subsurface for nuclear logging. The data from logging of the Type A probes provide information for the selection of locations for Type B probes to be installed as the second phase of the probing project. The *Field Sampling Plan* (Salomon 2003) describes how and where Type B probes will be installed, how samples will be collected from the Type B probes, and how the Type B probes will be monitored. The *Data Management Plan* (Salomon 2002) describes the process for the capture and maintenance of all field, electronic, and analytical data generated in the OU 7-13/14 Probing Project. The OU 7-13/14 probing activities conducted through the end of FY 2002 are summarized in the *Fiscal Year 2002 Summary Report for the OU 7-13/14 Probing Project* (Myers et al. 2003), hereinafter referred to as the *FY 2002 Summary Report*. The data within the scope of this summary report were derived from probes installed in the SDA, which are Type A Probes (nuclear logging) and Type B probes (soil vapor probes, lysimeters, tensiometers, soil moisture probes, and visual probes) collected during FY 2003.

1.3 Background

The OU 7-13/14 Probing Project has been involved in the designing, constructing, installing, and monitoring of Type A and Type B probes in the SDA. This work is conducted to support the OU 7-13/14 remedial investigation/feasibility study process and to reach a record of decision. Monitoring within the waste zone is a unique application of these technologies at the INEEL. All previous monitoring at the

SDA has been between waste disposal locations or at depth in sedimentary interbeds. Table 1-1 contains additional detail on the types of probes and the data collected by the probes.

Table 1-1. Types of data collected for the Operable Unit 7-13/14 Probing Project.

Data Source	Data Type	Data Examples
Type A probe: downhole nuclear logging tools	Digital files—counts/second and energy levels	Single-event digitally collected logs from the following instruments: • Passive-gamma detector for identifying gamma-emitting sources • Neutron activation instrument to detect prompt gamma from Cl-35, an indicator for halogenated hydrocarbons • Neutron-neutron detector to evaluate soil moisture • Passive-neutron detector for detecting transuranic radionuclides • Shielded, directional gamma detector to identify azimuthal location of gamma-emitting sources.
Type B probe: tensiometers	Matric potential in a soil matrix	Pressure data collected initially on dataloggers. Ambient pressure (centimeter of water). Gross matric potential (centimeter of water).
Type B probe: soil moisture probes	Relative moisture content in the surrounding material	Moisture content (percent by volume), resistivity (ohm-meters), dielectric constant (MHz), and temperature data (°C) collected initially on dataloggers.
Type B probe: lysimeters	Analytical results	Analytical laboratory results for contaminants of concern contained in water samples.
Type B probe: visual probes	Video recordings, optical televiewer, and digital images	Video recording and potentially digital stills taken as downhole optical logs.
Type B probe: vapor ports	Analytical results	Volatile organic compound concentrations (from field instruments and laboratory gas chromatography/mass spectrometry analyses) from vapor ports located within the pits. Radioactive gas (C-14 and tritium) laboratory samples from vapor ports located next to soil vaults.

Type A probes are steel pipes fitted with a drive point, installed in the waste zones. The probes allow nuclear logging instruments to be lowered to the subsurface (inside the uncontaminated pipe) so that nuclear sources and nuclear detection devices can record nuclear spectral data from the waste zone. Type A probe data, generated by the nuclear logging instruments, have been used to select locations for many of the Type B probes.

Type B probes also are drilled into the landfill to collect physical samples (gas and liquid) or to collect in situ geotechnical data. Soil vapor probes are installed to collect soil gas samples from specific locations for laboratory analysis. Lysimeters are designed to extract soil moisture and provide a liquid

sample for analysis. Tensiometers measure matric potential by sensing how tightly water is held in the soil. Soil moisture probes measure the temperature and electrical characteristics of the soil to determine soil moisture content. Visual probes are constructed from steel rods, stabilizers, tool joints, and Lexan tubes. The insides of the visual probes are open so visual images can be recorded from the inside of the probe looking out through the Lexan tubes, which form the outside wall of the probes. Table 1-1 provides additional detail on the characteristics of the data collected by the Type A and Type B probes.

The general approach to the OU 7-13/14 Probing Project, including placement of original Type A probes, was outlined in the *Probehole Plan* (INEEL 2000). The general approach established focus areas for investigation based on the shipping and inventory records. Type A probes were installed in transects to identify certain specific waste types and waste shipments. The Type A data were analyzed and used to establish the locations for individual and clusters of Type B probes.

Installation and monitoring of the Type B probes are described in *Field Sampling Plan* (Salomon 2003). Type B probes include tensiometers, suction lysimeters, vapor ports, visual probes, and soil moisture probes. Three hundred and thirty-seven Type A and Type B probe and instrument packages were installed in the SDA as part of the probing project between December 1999 and November 2001. Specific numbers of the types of probes include:

- 66 tensiometers.
- 78 soil moisture probe instruments (51 physical probes, some being multi-instrumented).
- 30 vapor ports.
- 18 lysimeters.
- 10 visual probes.
- 135 Type A probes, which excludes 10 probes not logged because of shallow completions (less than 6 ft 3 in.). Five of the shallow probes were replaced with deeper probes, which were logged.

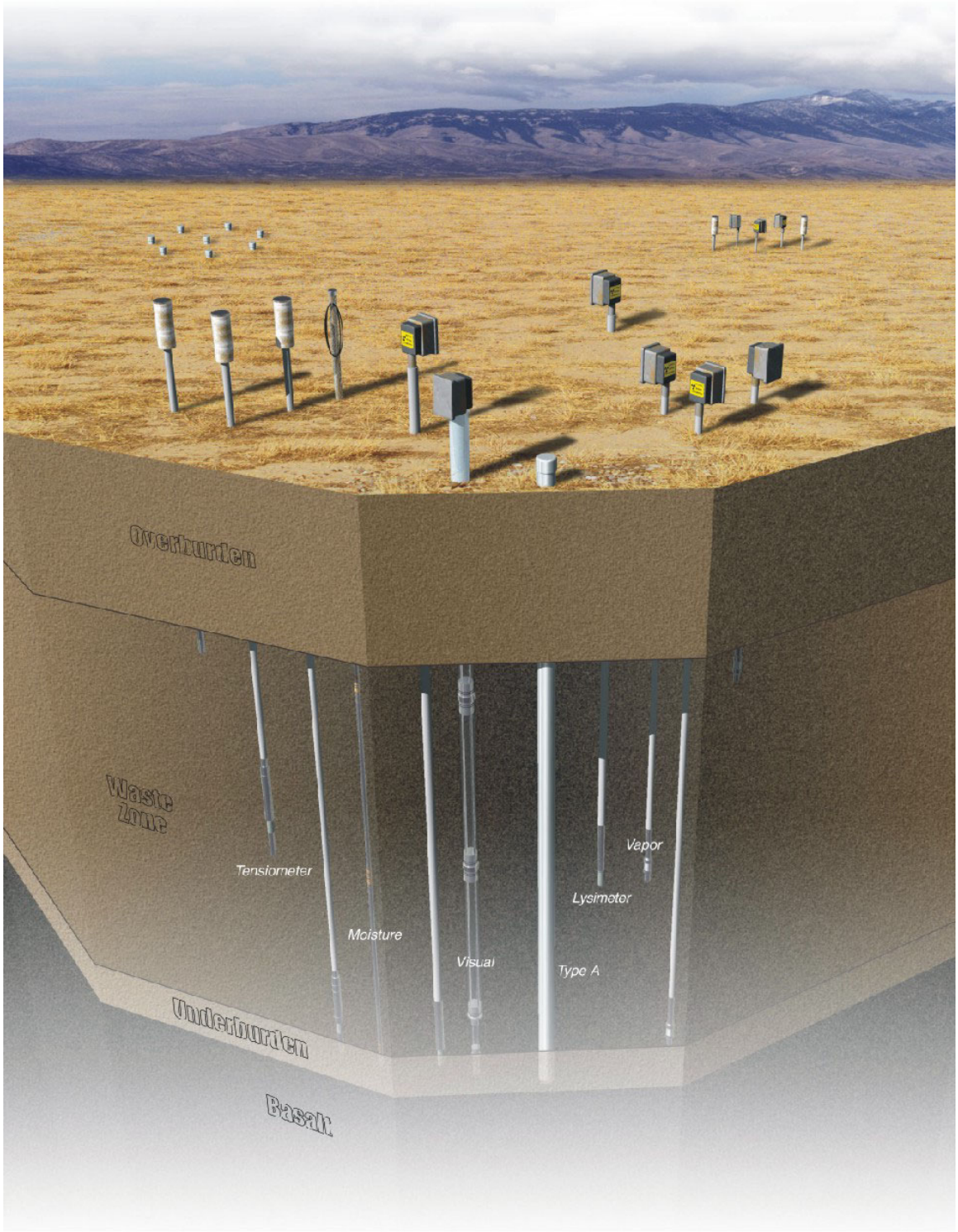
An additional 37 Type A probes were installed in the SDA during FY 2003, as shown in Table 1-2, and the nuclear logging data from these probes are discussed in Section 7. The data from these Type A probes will be used to select locations for additional Type A probes and to select locations for new and replacement lysimeters and soil moisture, resistivity, and temperature (SMR) probes in FY 2004. Locations of the new Type A probes listed as tasks in Table 1-2 are shown in Figure A-1 with each task referencing an area of the same number.

The types of probes used in the OU 7-13/14 Probing Project are illustrated in Figure 1-1. Figure 1-2 provides a view of a typical probe suite. Appendix A contains maps representing the surveyed locations of Type A and Type B probes installed in the SDA. Data generated from these probes are being used to support assessment of infiltration through the waste, release rate and solubility of uranium, release rate of C-14, and mass of the volatile organic compound (VOC) source remaining. The results will support the OU 7-13/14 Probing Project and ultimately verify and validate the Comprehensive Environmental Response, Compensation, and Liability Act-based OU 7-13/14 comprehensive remedial investigation/feasibility study. Operable Unit 7-13/14 is the comprehensive OU for Waste Area Group 7.

Table 1-2. Fiscal Year 2003 Phase I new Type A probes.

Task	Location	Target	Objective	Type A Probes (yes/no)	Phase I Type A Probes Installed	
1a	West end of Trench 3 in proximity of Well W 23. Analytical data indicate uranium in vadose zone.	Uranium mobility and uranium disposal in Subsurface Disposal Area	Characterize location in Subsurface Disposal Area with uranium disposal	Yes. Type A probes required to confirm location and allow determining source.	4 probes installed, no enriched uranium, possible still bottoms, high Cs-137	4
1b	Trench 47, eight spent nuclear fuel packages disposed of in 75-ft section of trench.	Waste with characteristics of spent nuclear fuel disposed of in Subsurface Disposal Area	Characterize spent nuclear fuel disposal in Subsurface Disposal Area	Yes.	4 probes installed; colbalt, cesium, and europium observed; azimuthal recommended	4
1c	Deep lysimeter clusters between Pit 15 and Trench 57.	Irradiated fuel material	East end of Subsurface Disposal Area monitoring	No. Two lysimeters will be collocated with deep lysimeters.	No Type A probes required; Type B lysimeters will be placed in locations selected for deep lysimeter monitoring	—
1d	Unrecorded shipment between Pits 1 and 2, and Pit 3.	Unrecorded shipment in Subsurface Disposal Area	Characterize unrecorded shipment location	Yes.	9 probes installed, possible azimuthal logging and additional probes	9
2	West end Trench 24, close to Trench 22. Two shipments, 3,000 gal, 2 yd, water and diatomaceous earth. 1.6 Ci Co-60.	Liquid disposals in Trench 24	High-activity liquid waste disposals could change release assumptions	Yes.	4 probes installed, HAL-2 saturated gamma tool, high neutron also, azimuthal recommended	4
3	Unknown source of the C-14, Tc-99, and tritium. Several uranium shipments in Pit 5.	Define source of contaminant of concern detections near and beneath Pit 5	Uranium trends and plutonium beneath Pit 5	Yes. Type A probes to confirm location and allow determining source amount required.	8 probes installed, the presence of large quantities of plutonium, americium, and neptunium waste and uranium waste is confirmed, azimuthal logging recommended	8
4	See replacement probe summary for detail of probe placements.	Replacement probes	Some existing Type B probes are not working, or further Type A investigation targets the source areas	Yes. Type A probes are necessary to better delineate source of moisture at Cluster 741-08.	2 probes installed, plutonium, americium, and neptunium not located, enriched uranium present, azimuthal logging recommended and possible Type A probe cluster	2
5	Upper-central part of Pit 6, area with high plutonium density.	High plutonium density in Pit 6	Characterize Rocky Flats Plant drum shipments with high plutonium densities in Pit 6	Yes. Characterize with nuclear logging tools.	3 probes installed, high levels americium, azimuthal recommended	3
6	Upper-central part of Pit 10, area with high plutonium density.	High plutonium density in Pit 10	Characterize Rocky Flats Plant drum shipments with high plutonium densities in Pit 10	Yes. Characterize with nuclear logging tools.	3 probes installed, no significant detections	3
Total					37	37

Figure 1-1. Probe types used in the Operable Unit 7-13/14 Probing Project.



03-GA50310-04

Figure 1-2. Typical probe suite installed in the Subsurface Disposal Area.

1.4 Document Organization

This document is organized by probe and the type of data collected by the probe. The Type B probes are presented first and are presented in the following order: soil vapor probe, lysimeter, tensiometer, soil moisture probe, visual probe, and Type A probe. The nuclear logging data from the Type A probes are presented last. Appendix A contains maps showing the focus areas and probes installed within the focus areas. Appendix B contains a table of probe attribute data (e.g., probe names, survey information, sample port depths, and various other support information compiled during installation). Appendixes C and D contain supporting data for SMR probes and tensiometers.

1.5 Meteorology

The lysimeters, tensiometers, and soil moisture probes all rely on the water in the soil to perform their function. While some instruments have had mechanical or electrical problems that have inhibited their ability to provide as much data as desired, the monitoring environment also has made in situ monitoring very difficult. The very dry soil conditions can contribute to difficulty in obtaining a lysimeter soil moisture sample, to additional maintenance required on tensiometers, and to difficulty in measuring resistance and conductivity with SMR probes. The INEEL Site has experienced three of the driest years on record in 2001, 2002, and 2003 with 4.87, 4.53, and 3.91 in. of precipitation, respectively, which have caused extremely dry waste-zone conditions.[a] See Figure 1-3, which shows the annual precipitation since 1951. In 52 years of keeping records, the only year that has been as dry is 1966 with 4.5 in. of precipitation. Lysimeters also have been unable to produce reliable samples and data. Only Probe 741-08-L1 has produced consistent samples for a short period but has failed to produce any water in the last sampling rounds.

The amount of winter precipitation is another indicator of the amount of soil moisture available to increase subsurface moisture content. Snow typically accumulates in the winter and melts in spring, infiltrating into the soil when there is little evaporation usually providing one of the best opportunities for encountering soil moisture during the year. Precipitation that occurs in the summer has a much greater potential to be evaporated back into the atmosphere before infiltrating into the soil beyond the evaporation range. The winter precipitation for the last 4 years, 1999–2000, 2000–2001, 2001–2002, and 2002–2003 has been 2.57, 1.8, 2.63, and 1.5 in., respectively, well below the 51-year average of 3.23 in. See Figure 1-4, which shows the winter precipitation since 1951. Extremely dry conditions are a contributing factor in the performance of the lysimeters, tensiometers, and soil moisture probes.

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a. Data for the Central Facilities Area weather station obtained from Neil Hukari at the National Oceanic and Atmospheric Administration.

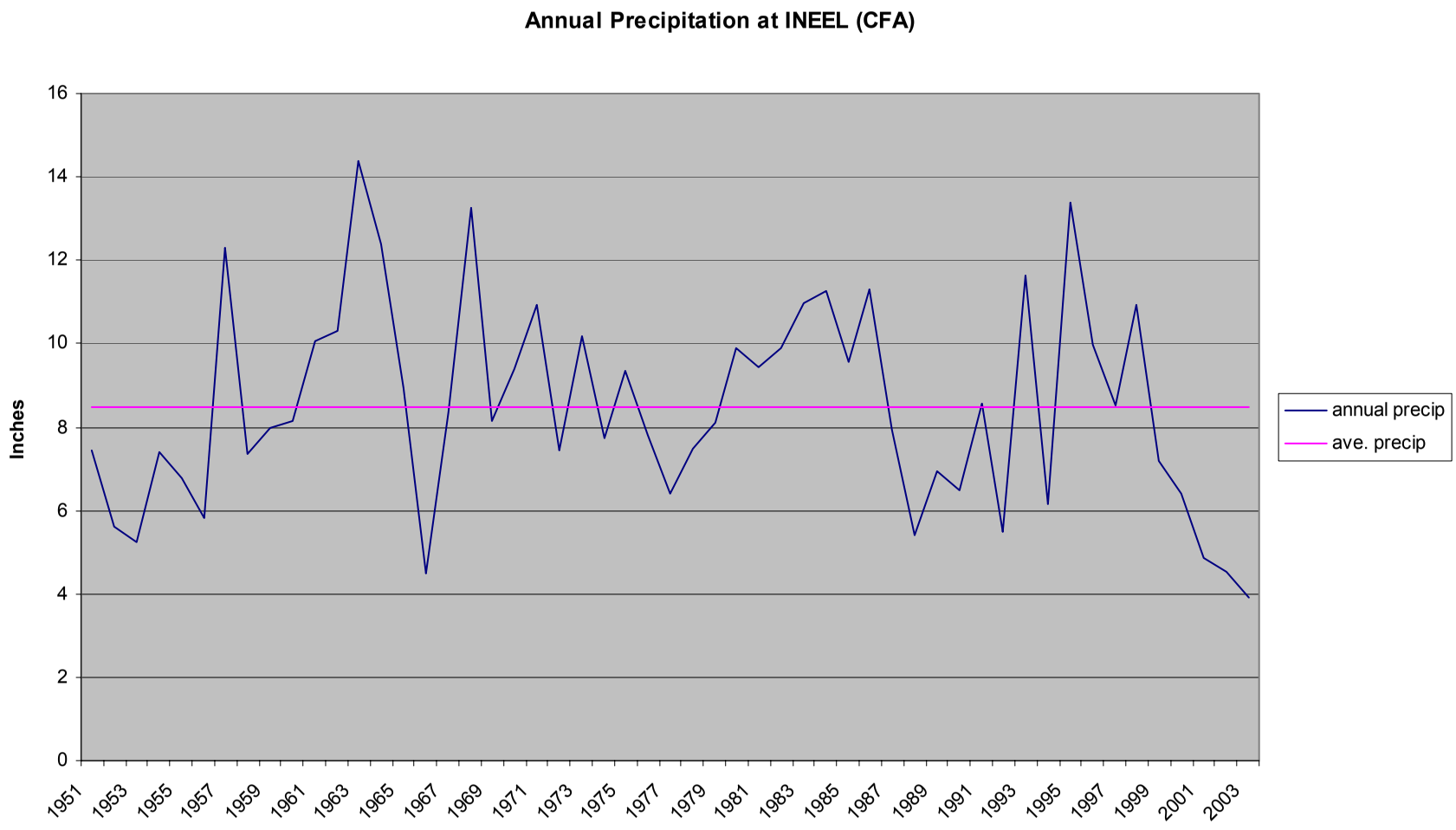

Figure 1-3. Annual precipitation at the Idaho National Engineering and Environmental Laboratory (Central Facilities Area).

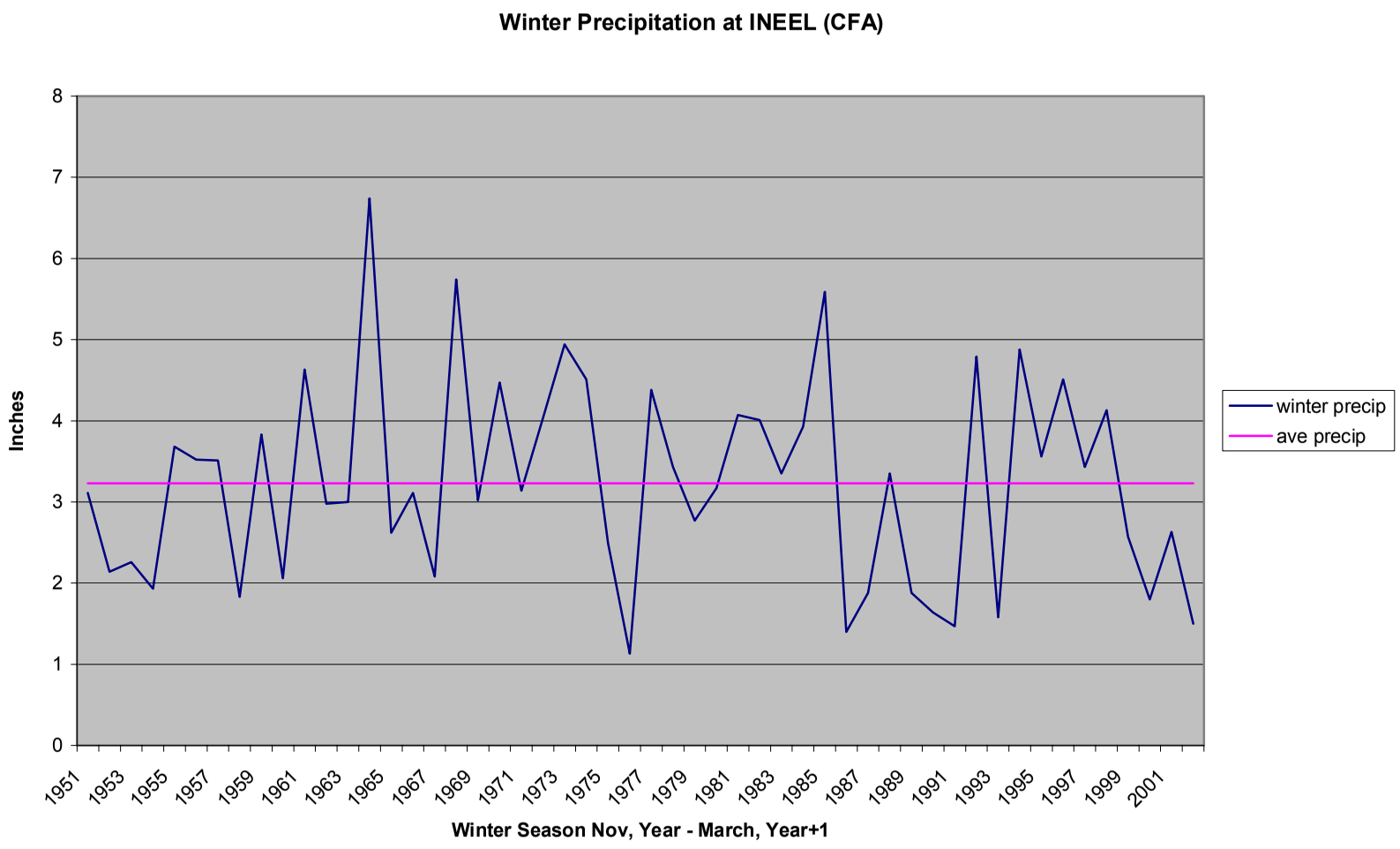

Figure 1-4. Winter precipitation at the Idaho National Engineering and Environmental Laboratory (Central Facilities Area).

2. SOIL VAPOR PROBE

2.1 Introduction

Between April and September of 2001, 29 Type B vapor-sampling probes were installed in the SDA for the purpose of monitoring VOCs; C-14, present in CO_2; and tritium (H-3), present in water vapor. During FY 2003, quarterly vapor samples were taken and analyzed for VOCs, C-14, and tritium.

The *FY 2002 Summary Report* (Myers et al. 2003), hereinafter referred to as the *FY 2002 Summary Report*, contains descriptions of the probes and how they were installed. This report contains results from the FY 2003 samples and a discussion of the results as they relate to waste characterization, trends in VOC release, and validity of analysis methods and instruments. Probe locations and descriptions of the sample collection and analysis methods are repeated in this report for completeness.

2.1.1 Probe Locations

Sixteen of the Type B vapor probes were placed in the Series 743 sludge and depleted uranium (DU) focus areas (see Figures A-1 and A-2 in Appendix A) for monitoring VOC concentrations and some reducing/oxidizing gases. Thirteen probes for monitoring the radionuclide C-14 (as CO_2) were placed near SVR-12 and SVR-20 (see Figure A-3 in Appendix A). The four probes at SVR-20 are sampled also for tritium. See Table 2-1 for a list of probes and their depths, arranged by area.

Table 2-1. Type B vapor probe locations and port depths.

Probe	Probe Depth (ft)
Series 743 sludge focus area (volatile organic compounds)	
743-03-VP1	18.0
743-03-VP2	13.3
743-03-VP3	4.8
743-08-VP1	20.2
743-08-VP2	13.4
743-08-VP3	4.9
743-18-VP1	20.0
743-18-VP3	7.6
743-18-VP4	14.6
Depleted uranium focus area (volatile organic compounds)	
DU-08-VP2	15.8
DU-10-VP1	11.6
DU-10-VP2	10.0
DU-10-VP3	6.2
DU-14-VP1	16.1
DU-14-VP2	11.7

Table 2-1. (continued).

Probe	Probe Depth (ft)
DU-14-VP3	4.9
SVR-12 (C-14)	
SVR-12-1-VP1	11.7
SVR-12-1-VP2	7.6
SVR-12-1-VP3	2.7
SVR-12-2-VP1	11.9
SVR-12-2-VP2	7.7
SVR-12-2-VP3	2.6
SVR-12-3-VP1	11.8
SVR-12-3-VP2	7.6
SVR-12-3-VP3	2.5
SVR-20 (C-14)	
SVR-20-5-VP3	17.2

2.2 Volatile Organic Compounds

2.2.1 Sample Collection Method

Type B vapor probe VOC samples are collected inside of a glovebag in accordance with "Glovebag Supported Sample Acquisition from Type B Probes in the Subsurface Disposal Area" (TPR-1674). This technical procedure includes all aspects of acquiring VOC samples and handling the samples in the sample preparation facility. Inside the glovebag, samples are collected in either 1-L Tedlar bags or precleaned Summa canisters (250 mL or 6 L).

The Tedlar bags are filled by connecting them to a port on the inside of a vacuum chamber box that is connected to the vapor probe sample port. Vacuum is then applied to the vacuum chamber box, allowing the Tedlar bag to fill with soil vapor. Summa canisters are filled by removing the vacuum chamber box and connecting the Summa canister directly to the vapor-port line inside the glovebag. The Summa canister is preevacuated so that, when the valve on the canister is opened, the vapor sample is drawn inside until the gauge reaches zero or until the preset time in the procedure (TPR-1674) has elapsed, whichever occurs first.

2.2.2 Sample Schedule

The original sampling schedule, as outlined in the *Field Sampling Plan* (Salomon 2003), called for quarterly sampling until a baseline was established. However, a baseline had not been established, according to the *FY 2002 Summary Report* (Myers et al. 2003), and it was recommended that quarterly sampling continue at least through FY 2003. Therefore, samples were collected from selected probes in all four quarters of FY 2003.

2.2.3 Probe Functionality

Since installation, only eight of the 16 vapor probes installed in the Series 743 sludge and DU focus areas have yielded samples on a consistent basis. During the second quarter of FY 2003, only seven probes yielded samples, as Probe 743-18-VP4 did not yield a sample for the first time. During the last quarter, however, 13 of the 16 probes yielded samples. This included five probes that had never yielded a sample before this time. The historical functionality of the probes is shown in Figure 2-1. The ability to get samples from five previously unyielding probes is attributed to modifications to the glovebox and replacement of the line at the vacuum pump.

Vapor Probe	Depth (ft)	Sampling Event								
		Sum 01	Fall 01	Feb-02	Jun-02	Aug-02	Nov-02	Feb-03	May-03	Aug-03
743-03-VP1	18.6									
743-03-VP2	13.9									
743-03-VP3	5.2									
743-08-VP1	20.8									
743-08-VP2	14									
743-08-VP3	5.5									
743-18-VP1	20.6									
743-18-VP3	8.2									
743-18-VP4	14.9									
DU-08-VP2	16.1									
DU-10-VP1	12.1									
DU-10-VP2	10.6									
DU-10-VP3	6.8									
DU-14-VP1	16.6									
DU-14-VP2	12.3									
DU-14-VP3	5.5									
Number Probes Working		8	8	9	9	8	8	7	8	12
Percent Probes Working		50%	50%	56%	56%	50%	50%	44%	50%	75%

Working (yields a full sample)
Yielded less than a full sample
Not Working (did not yield any sample)
Worked for 1st time, results questionable

Figure 2-1. Functionality summary for the Subsurface Disposal Area vapor probes.

2.2.4 Analysis Methods

The Type B vapor probe samples were analyzed with an Innova Model 1314 photoacoustic multigas analyzer for the VOCs shown in Table 2-2. The table also contains the concentration range of the filters in the Innova analyzer. Since these are the only filters in the instrument, only the VOCs shown in Table 2-2 are measured.

Table 2-2. Volatile organic compounds analyzed by the Innova photoacoustic multigas analyzer and the filter concentration ranges.

Analyte	Formula	Optical Filter Range (ppmv)
Carbon tetrachloride	CCl_4	6 to 100,000
Chloroform	$CHCl_3$	1 to 10,000
Trichloroethene	C_2HCl_3	0.09 to 9,000
Tetrachloroethene	C_2Cl_4	0.3 to 10,000
1,1,1-trichloroethane	$C_2H_3Cl_3$	0.04 to 4,000

The measurement principle of the Innova analyzer is based on the photoacoustic infrared detection method. The instrument can measure almost any vapor that absorbs infrared light (e.g., most chlorinated solvents). The Innova analyzer compensates any measurement for temperature fluctuations, water-vapor interference, and interferences from other gases or vapors known to be present.

In accordance with the *Field Sampling Plan* (Salomon 2003), some of the field duplicate samples were collected in Summa canisters and analyzed using standard laboratory gas chromatography/mass spectrometry (GC/MS) methods as an accuracy check on the Innova results. After the first quarter of FY 2003, the duplicate samples were analyzed by the INEEL Environmental Chemistry Laboratory (ECL) using modified U.S. Environmental Protection Agency Method TO-14 with a target analyte list of 29 VOCs, including the five VOCs analyzed by the Innova analyzer. The on-Site lab (INEEL ECL) was chosen because it performs VOC analysis for the Waste Isolation Pilot Plant 3,100 m^3 Program and is considered an outstanding technical resource. Off-Site labs were used for VOC analysis for the first quarter of FY 2003. However, use of the off-Site labs was discontinued after the first quarter because the results were considered unusable (Myers et al. 2003).

2.2.5 Results

The Type B vapor probe VOC sampling results and duplicate analyses for the four quarters of FY 2003 are shown in Table 2-3 (only the five VOCs analyzed by the Innova analyzer are listed). Collocated duplicate samples collected in Summa canisters were analyzed for several other VOCs in addition to the ones in Table 2-2. However, only six other VOCs were detected in those samples, and of those, only three were detected on a semiconsistent basis. The following list includes those three VOCs, their maximum measured concentrations, and the probe where they were measured:

- Methylene chloride, 700 ppmv, 743-08-VP1
- Chloromethane; 1,500 ppmv; 743-08-VP2
- 1,1,2-trichloro-1,2,2-trifluoroethane (F-113), 220 ppmv, 743-08-VP2.

Table 2-3. Vapor probe sampling results for the four quarterly sampling rounds of Fiscal Year 2003.

Probe	Probe Depth (ft)	Container	Carbon Tetrachloride (ppmv)	Chloroform (ppmv)	1,1,1-Trichloroethane (ppmv)	Trichloroethene (ppmv)	Tetrachloroethene (ppmv)
			First Quarter—Fiscal Year 2003				
743-08-VP1	20.8	TB	44,640	22,160	1,548	7,081	ND
743-08-VP2	14.0	TB	54,750	15,810	1,475	3,070	33
743-08-VP2	14.0	Summa 6 L[a]	42,000	19,000	<3,200	4,900	<3,200
743-08-VP2	14.0	Summa 6 L[a]	61,000	22,000	1,900	5,300	<390
743-08-VP2	14.0	TB	54,460	15,300	1,459	2,944	33
743-18-VP4	14.9	TB	10,760	1,670	374	2,074	66
DU-08-VP2	16.1	TB	12,670	8,185	3,793	8,863	1,963
DU-10-VP2	10.6	TB	6,218	1,885	2,218	4,162	2,070
DU-10-VP3	6.8	TB	10,190	1,568	1,880	2,866	2,162
DU-14-VP2	12.3	TB	7,298	5,113	1,649	10,240	ND
DU-14-VP3	5.5	TB	840	571	449	1,016	546

Table 2-3. (continued).

Probe	Probe Depth (ft)	Container	Carbon Tetrachloride (ppmv)	Chloroform (ppmv)	1,1,1-Trichloroethane (ppmv)	Trichloroethene (ppmv)	Tetrachloroethene (ppmv)
			Second Quarter—Fiscal Year 2003				
743-08-VP1	20.8	TB	37,860	19,700	1,359	5,494	50
743-08-VP2	14.0	Summa 250 mL[b]	45,000	11,000	1,200	2,900	ND
743-08-VP2	14.0	Summa 250 mL[b]	47,000	11,000	1,300	3,000	ND
743-08-VP2	14.0	TB	42,590	13,860	1,236	2,451	38
DU-08-VP2	16.1	TB	11,120	7,516	3,484	7,618	2,219
DU-10-VP2	10.6	TB	3,976	1,360	1,570	3,000	1,694
DU-10-VP3	6.8	TB	7,077	1,150	1,448	2,220	1,700
DU-14-VP2	12.3	TB	5,902	4,322	1,433	8,400	364
DU-14-VP3	5.5	TB	891	564	449	953	493
			Third Quarter—Fiscal Year 2003				
743-08-VP1	20.8	TB	45,360	20,670	1,585	8,494	ND
743-08-VP1	20.8	Summa 250 mL[b]	29,000	12,000	1,100 J	9,700	ND
743-08-VP2	14.0	TB	45,700	14,340	1,308	3,100	48
743-08-VP2	14.0	TB	46,460	13,950	1,306	3,194	41
743-18-VP4	14.9	TB	7,567	1,218	249	1,467	58
DU-08-VP2	16.1	TB	10,170	6,826	3,167	6,096	1,664
DU-10-VP2	10.6	TB	3,657	1,499	1,471	2,656	1,374
DU-10-VP2	10.6	Summa 250 mL[b]	2,400	540	1,100	2,100	750
DU-10-VP3	6.8	TB	7,069	1,194	1,568	2,252	1,593
DU-14-VP2	12.3	TB	5,833	4,270	1,325	7,935	209
DU-14-VP3	5.5	TB	1,108	793	562	1,257	552
			Fourth Quarter—Fiscal Year 2003				
743-03-VP1	18.6	TB	169	35	9	47	14
743-03-VP2	13.9	TB	82	20	5	17	8
743-03-VP3	5.2	TB	1,011	246	50	26	-2
743-08-VP1	20.8	TB	50,370	21,670	1,701	9,116	ND
743-08-VP1	20.8	Summa 250 mL[b]	26,000	9,600	960	7,600	ND
743-08-VP2	14.0	TB	55,080	15,600	1,488	3,607	54
743-08-VP2	14.0	TB	54,680	15,090	1,462	3,585	39
743-18-VP1	20.6	TB	117	45	14	47	25
743-18-VP4	14.9	TB	8,261	1,116	270	1,459	33
DU-08-VP2	16.1	TB	10,140	6,722	3,203	5,851	1,364
DU-10-VP2	10.6	TB	5,110	2,100	1,950	3,258	1,593
DU-10-VP2	10.6	Summa 250 mL[b]	2,800	650	1,400	2,400	900
DU-10-VP3	6.8	TB	9,793	1,682	2,211	3,129	2,274
DU-14-VP1	16.6	TB	221	133	71	174	93

Table 2-3. (continued).

Probe	Probe Depth (ft)	Container	Carbon Tetrachloride (ppmv)	Chloroform (ppmv)	1,1,1-Trichloroethane (ppmv)	Trichloroethene (ppmv)	Tetrachloroethene (ppmv)
DU-14-VP2	12.3	TB	5,301	3,934	1,186	7,428	184
DU-14-VP3	5.5	TB	930	731	461	1,146	457

Sample was obtained from this port for the first time

a. Summa 6-L canisters analyzed by gas chromatography/mass spectrometry at Southwest Laboratory of Oklahoma
b. Summa 250-mL canisters analyzed by gas chromatography/mass spectrometry at Idaho National Enginering and Environmental Laboratory Environmental Chemistry Laboratory

J = estimated value
ND = nondetect
TB = Tedlar bag (These samples were analyzed with the Innova instrument.)

For completeness, Table 2-4 includes FY 2002 results as well, but only for analyses using the Innova. If duplicate or split samples were taken, only the first (regular) sample result is shown.

Table 2-4. Subsurface Disposal Area vapor probe sampling results using the Innova analyzer.

Probe	Probe Depth (ft)	Date Sampled	Carbon Tetrachloride (ppmv)	Chloroform (ppmv)	1,1,1-Trichloroethane (ppmv)	Trichloroethene (ppmv)	Tetrachloroethene (ppmv)
743-03-VP1	19.0	8/4/03	169	35	9	47	14
743-03-VP2	14.0	8/4/03	82	20	5	17	8
743-03-VP3	5.0	8/4/03	1,011	246	50	26	-2
743-08-VP1	21.0	2/11/02	30,233	22,339[a]	974	3,178	470
		6/10/02	57,466	22,119	1,881	9,723	-800[b]
		8/20/02	56,140	22,120	1,818	10,080	-856[b]
		11/20/02	44,640	22,160	1,550	7,080	-192[b]
		2/18/03	37,860	19,700	1,359	5,494	50
		5/21/03	45,360	20,670	1,585	8,494	-490[b]
		8/6/03	50,370	21,670	1,701	9,116	-599
743-08-VP2	14.0	2/11/02	36,277	15,405	918	1,451	181
		6/12/02	54,231	13,618	1,405	3,106	53
		8/27/02	62,171[a]	15,372	1,559	3,405	78
		11/20/02	54,800	15,800	1,480	3,070	33
		2/18/03	42,590	13,860	1,236	2,451	38
		5/20/03	45,700	14,340	1,308	3,100	48
		8/6/03	55,080	15,600	1,488	3,607	54
743-18-VP1	21.0	8/4/03	117	45	14	47	25
743-18-VP4	15.0	2/12/02	8,616	1,385	231	1,358	218
		6/12/02	8,904	1,353	291	1,621	68
		8/15/02	11,750	1,490	387	2,133	32
		11/18/02	10,800	1,670	374	2,070	66
		5/20/03	7,567	1,218	249	1,467	58
		8/4/03	8,261	1,116	270	1,459	33
DU-08-VP2	16.0	2/13/02	11,359	8,559	2,760	4,957	924
		6/11/02	12,478	8,571	3,479	6,626	2,331
		8/15/02	12,750	8,331	3,618	7,663	2,203
		11/18/02	12,700	8,190	3,790[a]	8,860	1,960
		2/17/03	11,120	7,516	3,484	7,618	2,219

Table 2-4. (continued).

Probe	Probe Depth (ft)	Date Sampled	Carbon Tetrachloride (ppmv)	Chloroform (ppmv)	1,1,1-Trichloroethane (ppmv)	Trichloroethene (ppmv)	Tetrachloroethene (ppmv)
		5/21/03	10,170	6,826	3,167	6,096	1,664
		8/4/03	10,140	6,722	3,203	5,851	1,364
DU-10-VP1	12.0	2/12/02	941	434	136	360	136
		6/11/02	1,053	579	271	651	187
DU-10-VP2	11.0	2/12/02	7,026	1,942	1,610	3,187	1,648
		6/10/02	6,014	1,995	1,729	3,408	1,668
		8/20/02	7,896	2,701	2,387	4,266	2,129
		11/18/02	6,220	1,890	2,220	4,160	2,070
		2/17/03	3,976	1,360	1,570	3,000	1,694
		5/21/03	3,657	1,499	1,471	2,656	1,374
		8/6/03	5,110	2,100	1,950	3,258	1,593
DU-10-VP3	6.8	2/12/02	11,381	1,719	1,310	2,098	1,449
		6/11/02	14,051	1,904	1,992	3,206	2,205
		8/15/02	17,360	2,485	2,640	4,259	2,942[a]
		11/18/02	10,200	1,570	1,880	2,870	2,160
		2/17/03	7,077	1,150	1,448	2,220	1,700
		5/21/03	7,069	1,194	1,568	2,252	1,593
		8/6/03	9,793	1,682	2,211	3,129	2,274
DU-14-VP1	17.0	8/4/03	221	133	71	174	93
DU-14-VP2	12.0	2/12/02	6,083	4,515	1,146	7,263	724
		6/11/02	6,323	4,524	1,360	7,884	365
		8/15/02	7,453	5,212	1,528	10,090	-62[b]
		11/18/02	7,300	5,110	1,650	10,200[a]	-52[b]
		2/18/03	5,902	4,322	1,433	8,400	364
		5/21/03	5,833	4,270	1,325	7,935	209
		8/4/03	5,301	3,934	1,186	7,428	184
DU-14-VP3	5.5	2/12/02	1,081	541	312	710	381
		6/11/02	1,558	1,029	694	1,612	810
		8/15/02	2,062	1,466	902	2,050	986
		11/18/02	840	571	449	1,020	546
		2/18/03	891	564	449	953	493
		5/21/03	1,108	793	562	1,257	552
		8/4/03	930	731	461	1,146	457

a. Maximum measured concentration
b. Negative results are considered undetected

2.2.6 Discussion of Results

The FY 2004 Type B vapor probe VOC sampling results contain a large amount of useful information to help characterize the VOC source. This section points out and discusses the limitations and significance of the results.

2.2.6.1 Accuracy. Each quarter beginning with the third quarter of 2002, duplicate samples have been taken from at least one and sometimes two probes and sent to a laboratory for GC/MS analysis as a check on the accuracy of the Innova results. Two laboratories have been used in the past for VOC analysis: the INEEL ECL and the Southwest Laboratory of Oklahoma (SWLO). The third-quarter

FY 2002 samples were sent to ECL, and the GC/MS results were in good agreement with the Innova results. Duplicate samples from the fourth quarter of FY 2002 and the first quarter of FY 2003 were sent to SWLO. Because of problems with dilution and holding times and other questions regarding the SWLO data, the project decided that ECL would do all future GC/MS analysis of duplicate VOC samples.

If only the ECL results are considered, the agreement between the Innova analyses and the GC/MS analyses was good up until the last two quarters of FY 2003. Results from the last two quarters of FY 2003 show significant differences between the two, and the difference is becoming larger. Figures 2-2 and 2-3 show comparisons of carbon tetrachloride results from the Innova and the GC/MS for Clusters 743-08 and DU-10, respectively. Where duplicate or split samples were analyzed by the same instrument, the average values were plotted. In third quarter FY 2002, collocated duplicate sample results from both the Innova and GC/MS were in very good agreement. Innova and GC/MS results from Probe 743-08-VP1 were within 3%, and results from Probe DU-10-VP2 were within 4%. Then, samples from second quarter FY 2003 from Probe 743-08-VP2 were sent to the INEEL ECL, and the results were still in good agreement (within 8%) with the Innova results. However, third- and fourth-quarter FY 2003 duplicate samples from both Probes 743-08-VP1 and DU-10-VP2, analyzed by both the Innova and GC/MS, were much different from each other. In addition, the results appear to be diverging with time, with the Innova results increasing and the GC/MS results decreasing. The percent difference for the third to the fourth quarters was 36% and 48%, respectively, for Probe 743-08-VP1, and 34% and 45% for Probe DU-10-VP2. The trend is similar for other VOCs.

Considering the differences between the Innova and GC/MS results, the two possible scenarios are either (1) the Innova data or the INEEL ECL data are incorrect or (2) they both are incorrect. This issue currently is being investigated to determine the cause for the discrepancy. A plan will be prepared to identify and correct the problem. The results are discussed in the remainder this section in light of these data uncertainties that became apparent during the last quarters of FY 2003.

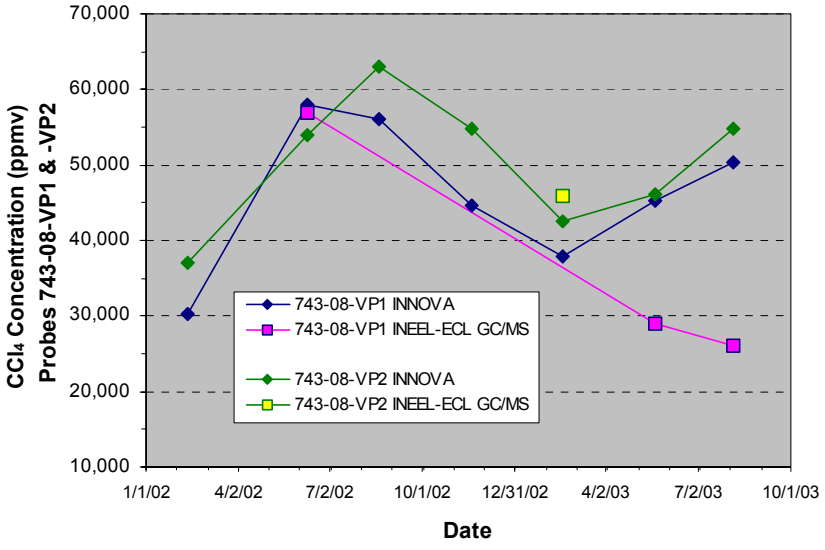

Figure 2-2. Comparison of Innova and gas chromatography/mass spectrometry results for duplicate samples taken from Probes 743-08-VP1 and 743-08-VP2.

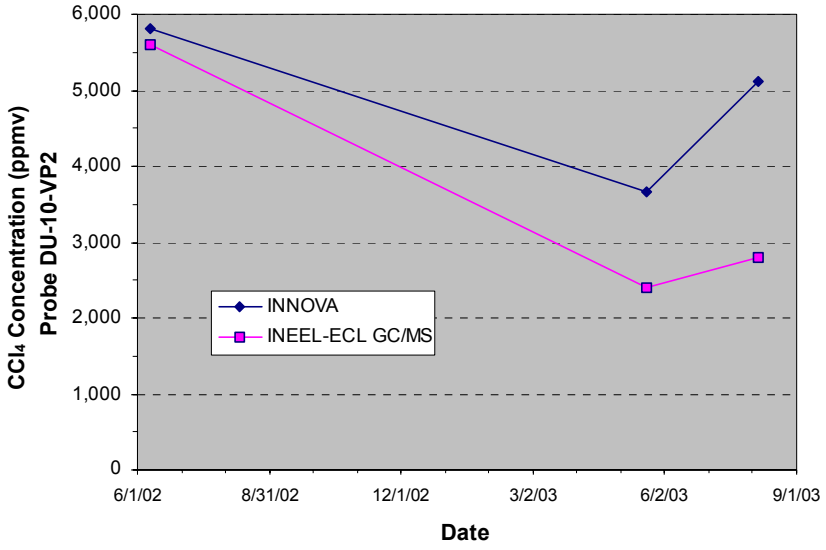

Figure 2-3. Comparison of Innova and gas chromatography/mass spectrometry results for duplicate samples taken from Probes 743-08-VP1 and 743-08-VP2.

2.2.6.2 Spatial and Temporal Trends. In FY 2003, the highest concentrations of carbon tetrachloride and chloroform were measured at Cluster 743-08. The highest concentrations of 1,1,1-trichloroethane (TCA), trichloroethene (TCE), and tetrachloroethene (PCE) were measured in the DU focus area at Clusters DU-08, DU-14, and DU-10, respectively. The locations of the maximums in FY 2003 are consistent with the previous year. Overall, there was not a significant drop in maximum concentrations, with the possible exception of carbon tetrachloride dropping from a maximum of 62,171 to 55,080 ppmv at Probe 743-08-VP2. Since the maximum concentrations occurred during the first quarter of FY 2003, this conclusion is not likely to be affected by the uncertainty in the last two quarters of data.

The fact that carbon tetrachloride concentrations are higher in the Series 743 sludge focus area than in the DU focus area is significant in that it validates key information and assumptions used by Miller and Varvel (2001) to determine the mass of VOCs, specifically carbon tetrachloride, buried in the SDA. Miller and Varvel (2001) divided Series 743 sludge drums into two populations: (1) "903-era" drums that were filled between February 1967 and August 1968 when a backlog of sludge-filled drums stored at the Rocky Flats Plant 903 Storage Area was processed along with smaller amounts of waste generated from routine operations during that period and (2) "non-903-era" drums that resulted from processing waste generated by routine operations before and after the 903-era drum processing. Miller and Varvel (2001) estimated that the 903-era drums contained a much higher percentage of carbon tetrachloride than the non-903-era drums.

The Series 743 sludge focus area contains 903-era drums exclusively. The DU focus area, on the other hand, contains almost exclusively non-903-era drums. Table 2-5 shows the ratio of the average carbon tetrachloride concentration to the average concentration of the other VOCs in both the Series 743 sludge and DU focus areas. The numbers were determined by calculating the average concentration of each VOC at each probe using all the data (FY 2002 and FY 2003). The ratios of carbon tetrachloride to the other VOCs were then calculated for both the Series 743 and DU focus areas based on the average

Table 2-5. Comparison of the average ratio of carbon tetrachloride concentrations to other volatile organic compounds in the Series 743 sludge and depleted uranium focus areas.

Volatile Organic Compound Ratio	Series 743 sludge Focus Area	Depleted Uranium Focus Area
Carbon tetrachloride/ chloroform	4	3
Carbon tetrachloride/ 1,1,1-trichloroethane	33	4
Carbon tetrachloride/ trichloroethene	10	2
Carbon tetrachloride/ tetrachloroethene	340	7

concentrations. The ratio of carbon tetrachloride to chloroform in both the Series 743 sludge and DU focus areas is nearly the same (4 and 3). This is because the chloroform is produced by degradation of carbon tetrachloride and not a component of sludge. The ratio of carbon tetrachloride to the other VOCs, however, is dramatically different between the two areas, which is consistent with *Reconstructing the Past Disposal of 743-Series Waste in the Subsurface Disposal Area for Operable Unit 7-08, Organic Contamination in the Vadose Zone* (Miller and Varvel 2001). This conclusion also is not affected by the uncertainty in the data during the last two quarters of FY 2003.

As for temporal differences in concentration, FY 2003 results appear to be slightly lower overall from FY 2002 concentrations based on the Innova results being accurate. For example, at the eight probe locations that have consistently yielded a sample, the average concentrations in FY 2003 were less than the average FY 2002 concentrations in 33 of the 40 cases (8 probes × 5 VOCs = 40 cases) although some changes were very small. If, however, the GC/MS results are more accurate than the Innova results, the FY 2003 results are definitely lower overall than the FY 2003 results.

Figures 2-4 and 2-5 show the time history of carbon tetrachloride at each of the ports with more than one data point. (In Figures 2-4 and 2-5, where duplicate or multiple samples were taken during a single sampling event, the concentration of the original sample was used.) The August 2003 (fourth quarter) data from the five probes that had not previously been sampled are not included because of data-validity questions that are discussed in Section 2.2.6.4. The data are plotted on two different figures because of the difference in the magnitude of the results. At Probes 743-08-VP1 and 743-08-VP2, the concentrations appear to rise and fall seasonally with lows occurring in the colder months and highs during the warmer months (see Figure 2-4). This is especially true if the Innova data from the last two quarters of FY 2003 are accurate. It is less so if the GC/MS data are more accurate. The fact that concentrations increase during the warmer months is consistent with the vapor pressure dependence on temperature and subsequent volatilization or release of VOCs (i.e., volatilization increases as soil or waste temperatures increase). If this is indeed a seasonal trend, it will require a longer period to confirm and understand the phenomenon and to determine overall trends (increase or decrease and rate) in the release. At the other locations (see Figure 2-5), any trends, seasonal or otherwise, are more difficult to detect. Some probes show a seasonal trend similar to the 743-08 probes, and others show a slight overall decrease in concentration.

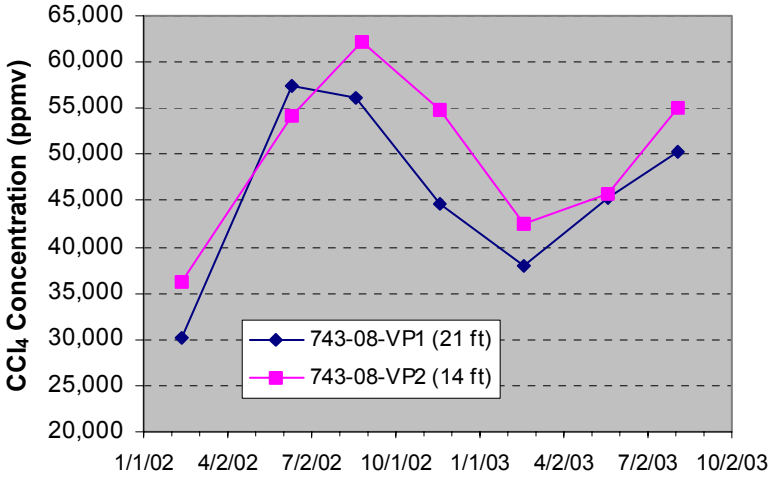

Figure 2-4. Carbon tetrachloride subsurface vapor concentrations at vapor probe Cluster 743-08.

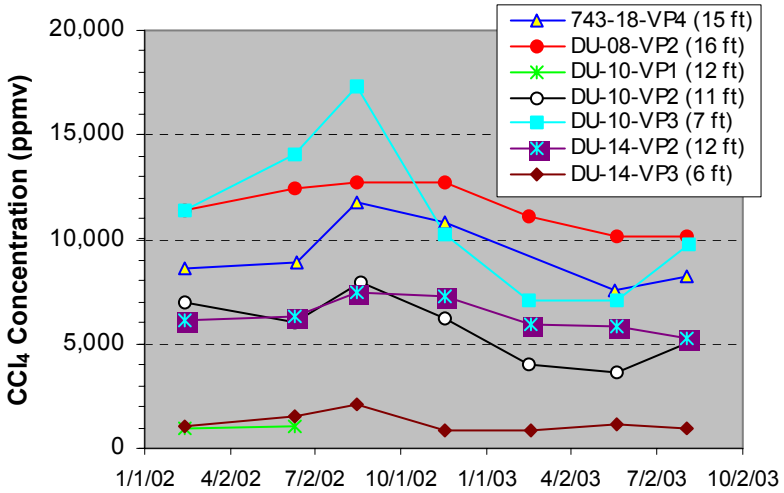

Figure 2-5. Carbon tetrachloride subsurface vapor concentrations at vapor probe Clusters 743-18, DU-08, DU-10, and DU-14.

There is also another interesting aspect to the data from Probes 743-08-VP1 and 743-08-VP2. Figure 2-4 shows the carbon tetrachloride data at Probe 743-08-VP2 lag behind the data at Probe-743-08-VP1 at least until the last two quarters of FY 2003. This does not correspond to the theory that temperature influences results, since the more shallow Probe 743-08-VP2 would respond faster to changes in surface temperature. However, if the source is stronger at the deeper probe (743-08-VP1) and the concentrations at the more shallow probe (743-08-VP2) respond to changes in release at the deeper probe (743-08-VP1), then the theory makes more sense. This will be examined further as more data are available to determine the cause of the apparent time lag.

Figures 2-6 and 2-7 show monitoring results for chloroform for the same eight ports that have consistently yielded a sample. In Figures 2-6 and 2-7, where duplicate or multiple samples were taken during a single sampling event, the concentration of the original sample was used. Again, the data are shown on two different scales because of the difference in the magnitude of the results. It makes sense that the maximum chloroform concentration is grouped with the maximum carbon tetrachloride concentration, given there was virtually no chloroform disposed of and the likely source of the chloroform is degradation of carbon tetrachloride. For chloroform, however, the same supposed seasonal trend is not as evident. This could be caused by the fact that chloroform is produced by degradation at a constant rate or that chloroform has a lower vapor pressure and is less affected by changes in temperature.

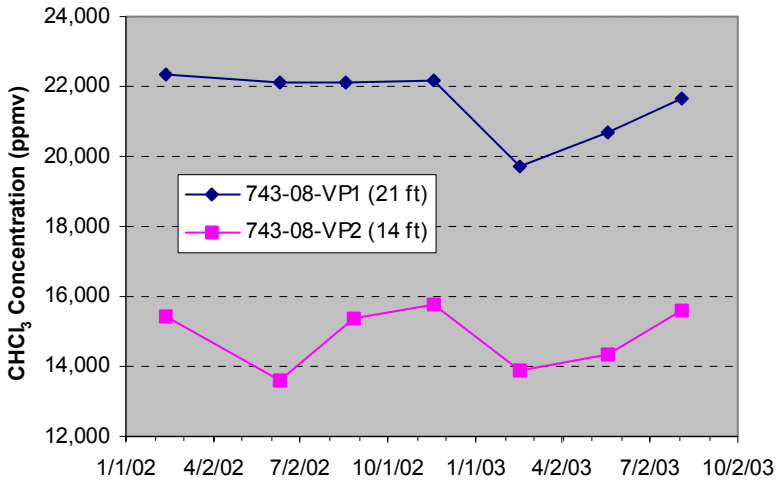

Figure 2-6. Chloroform subsurface vapor concentrations at vapor probe Cluster 743-08.

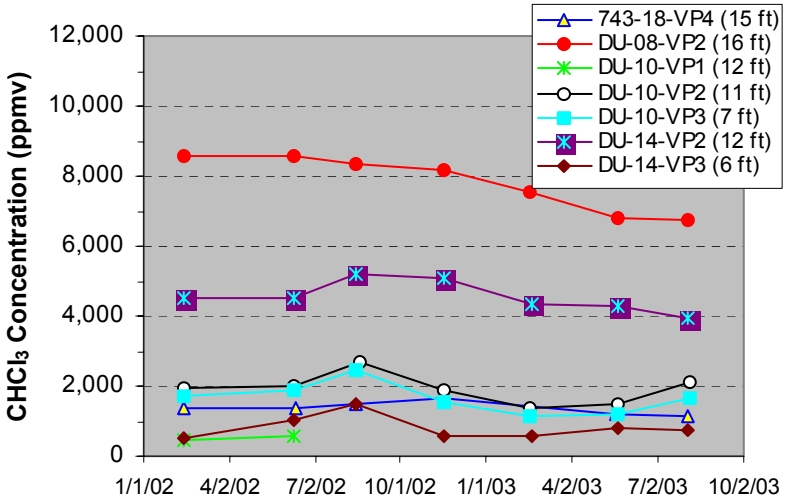

Figure 2-7. Chloroform subsurface vapor concentrations at vapor probe Clusters 743-18, DU-08, DU-10, and DU-14.

Figures 2-8 through 2-10 show the time history of concentration at the same eight ports for the other three VOCs: TCA, TCE, and PCE. In Figures 2-8 through 2-10, where duplicate or multiple samples were taken during a single sampling event, the concentration of the original sample was used. For TCA, TCE, and PCE, a seasonal trend is more evident than for chloroform. This points to temperature being an important influence on the release rate. In any case, it does not appear that concentrations are dramatically increasing or decreasing with time. Again, a seasonal trend is more likely if the Innova data for the last two quarters of FY 2003 are more accurate than the GC/MS data.

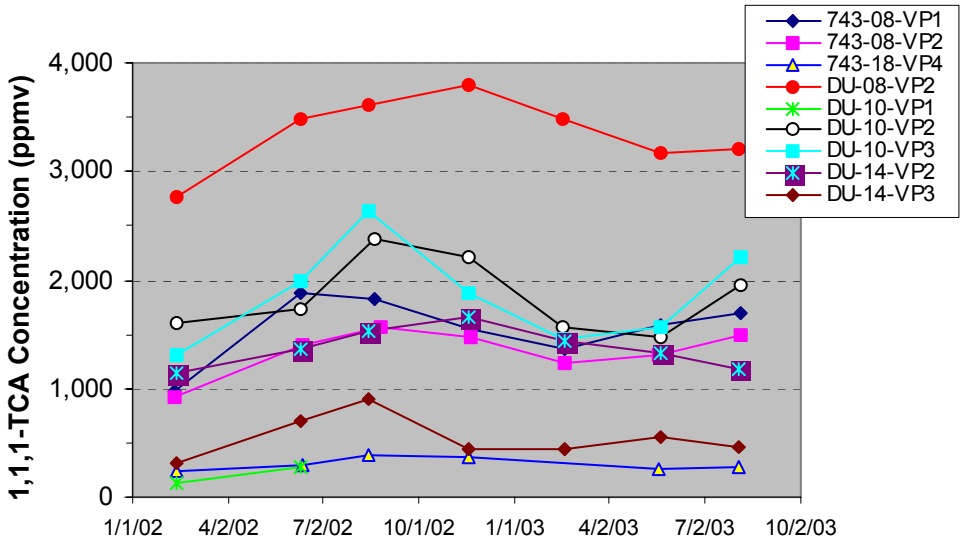

Figure 2-8. 1,1,1-trichloroethane subsurface vapor concentrations for probes consistently yielding a sample.

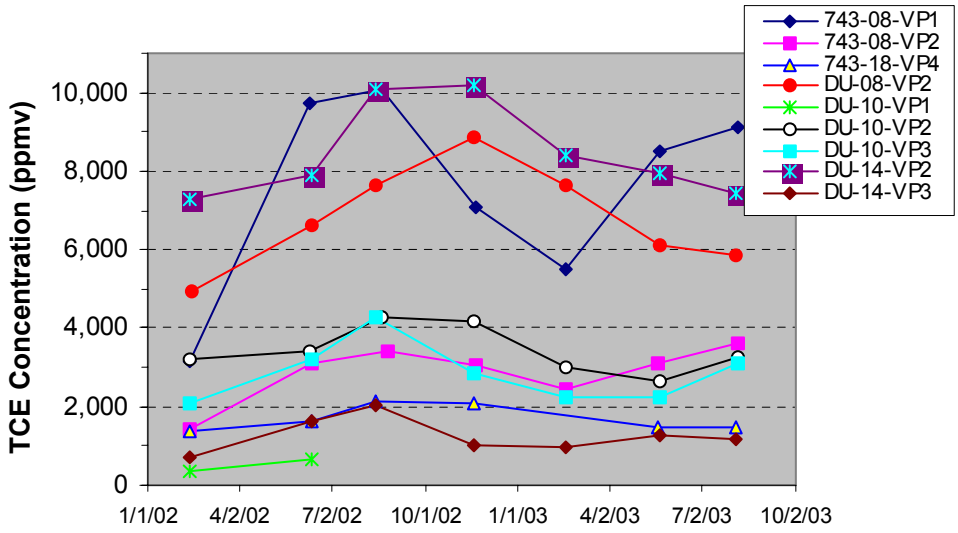

Figure 2-9. Trichloroethene subsurface vapor concentrations for probes consistently yielding a sample.

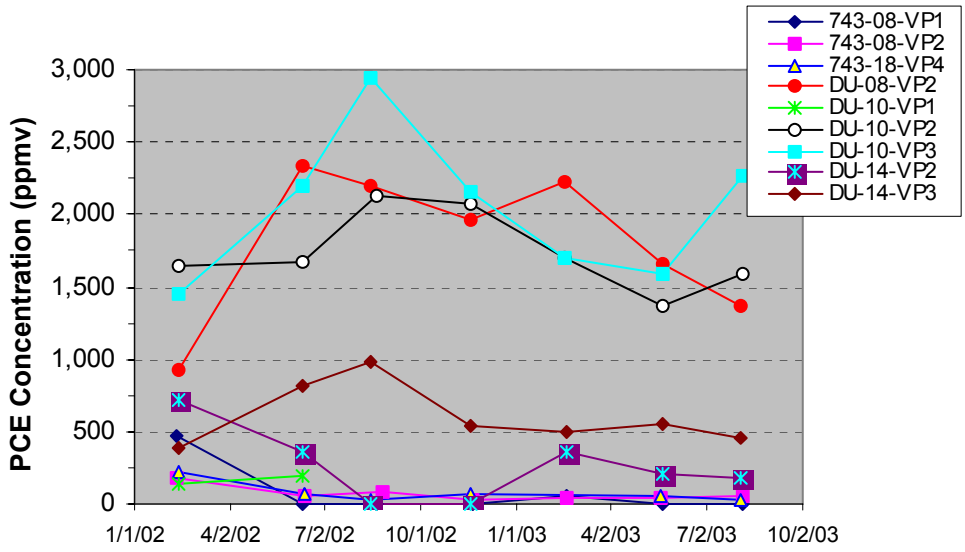

Figure 2-10. Tetrachloroethene subsurface vapor concentrations for probes consistently yielding a sample.

2.2.6.3 Indications of Residual Nonaqueous-Phase Liquid Volatile Organic Compounds in the Waste Zone. The high VOC concentrations in the waste, specifically Cluster 743-08, indicate that nonaqueous-phase liquid VOCs remain in the Series 743 sludge. Table 2-6 compares the maximum measured VOC concentrations to that of pure component equilibrium vapor concentrations and the equilibrium vapor concentrations at the estimated mole fractions in the original Series 743 sludge mixture. The vapor concentrations of the mixture are lower because the partial vapor pressures in the mixture are lower than for a pure component.

Table 2-6. Volatile organic compound pure component equilibrium vapor concentrations and equilibrium vapor concentrations at estimated mole fractions of original Series 743 sludge mixture (temperature assumed 10°C).

Volatile Organic Compound	Probe	Maximum Measured Gas Concentration (ppmv)	Pure Component Equilibrium Gas Concentration (ppmv)	Estimated Mole Fraction of Volatile Organic Compounds in Original Series 743 Sludge Mixture[a]	Equilibrium Gas Concentration of Volatile Organic Compounds in Series 743 Sludge Mixture (ppmv)
Carbon tetrachloride	743-08-VP2	**62,171**	71,000	0.65	46,000
Chloroform	743-08-VP1	22,339	129,000	NA[b]	NA[b]
1,1,1-trichloroethane	DU-08-VP2	3,790	81,000	0.07	6,000
Trichloroethene	743-08-VP1	**10,200**	48,000	0.08	3,900
Tetrachloroethene	DU-10-VP3	**2,942**	10,000	0.07	750

Boldface type indicates a maximum measured concentration greater than the equilibrium concentration of the mixture.

a. Balance of mole fraction made up of Texaco Regal Oil
b. Chloroform not a component of Series 743 sludge

The maximum measured carbon tetrachloride, TCE, and PCE concentrations are greater than the estimated equilibrium vapor concentrations of the mixture. The maximum measured concentration for carbon tetrachloride is almost equivalent to the equilibrium vapor concentration of the pure component. The maximum TCA concentration approaches the value for the mixture. If it is assumed that the mole fractions of the mixture after 30+ years of burial have not changed from the original mixture, which is appropriate for a rough comparison, the maximum measured vapor concentrations indicate that nonaqueous-phase liquid VOCs are still present in the sludge. This conclusion is not affected by the uncertainty in the data for the last two quarters of FY 2003.

2.2.6.4 Results from Previously Plugged Ports. Before the last quarter of FY 2003, eight of the 16 vapor probes had never yielded a sample (i.e., were plugged). Then, in the last quarter of FY 2003, samples were obtained from five of those eight previously plugged probes. Three of these probes are at Cluster 743-03, and the other two probes are 743-18-VP1 and DU-14-VP1. The results from these five probes seem to be much lower than would be expected. For example, the average carbon tetrachloride concentration from those five probes is 320 ppmv, while the lowest concentration measured at all the other probes is 840 ppmv at DU-14-VP3 (first quarter FY 2003). In addition, the concentration at Probe 743-18-VP1 at a depth of 21 ft was 117 ppmv, while the concentration at Probe 743-18-VP4, just 6 ft above, was 8,261 ppmv. Similarly, the concentration at Probe DU-14-VP1 at a depth of 17 ft was 221 ppmv, while the concentration at Probe DU-14-VP2, just 5 ft above, was 5,301 ppmv. The concentrations of other VOCs (chloroform, TCE, TCA, and PCE) at these five probes are similarly low.

It is possible that the low concentrations are real, but this is unlikely, given the drastic differences in concentration between neighboring probes and the high mobility of vapor-phase VOCs. The ability to get a sample from five previously unyielding probes is attributed to an increase in the vacuum pressure, which may have caused a leak in the system and diluted the samples. This and other possible explanations are being investigated by the project.

2.2.7 Conclusions and Recommendations

Samples were collected consistently from eight of the 18 Type B vapor probes at the SDA during the four quarters of FY 2003. During the last quarter, samples were obtained from an additional five probes that had previously not yielded a sample because of plugging or other difficulty. The validity of the sample results from these five probes is being investigated because of the seemingly low concentration values. All samples were analyzed with an Innova Model 1314 photoacoustic portable multigas analyzer. A small number of collocated duplicate samples were sent to laboratories for confirmatory analysis. Problems with the SWLO analyses prompted rejection of the data. Significant differences between the Innova and INEEL ECL results for the confirmatory samples from the last two quarters are being investigated.

The conclusions of the Type B vapor probe sampling and analysis are:

- VOC concentrations are steady or decreasing slightly, depending on the location. If the GC/MS results are more accurate than the Innova results for the last two quarters of FY 2003, there is a definite decrease, and it is more significant.

- The results also support information and assumptions used to estimate the original amount of VOCs buried in the SDA as well as burial locations of the VOC waste. This conclusion is independent of the data uncertainty during the last two quarters of FY 2003.

- VOC concentrations from the probes are comparable to those predicted to be in equilibrium with Series 743 sludge. This conclusion also is independent of the data uncertainty during the last two

quarters of FY 2003. However, if the GC/MS data are more accurate, then the data are becoming less comparable to the equilibrium concentrations.

- Some VOC concentrations appear to be seasonally dependent. This is plausible given the volatilization and partitioning dependence on temperature. Further monitoring is necessary to determine trends in release rates and to establish a baseline, which can then be used to validate numerical models, to estimate the persistence of the source, and to define remediation plans both for the VOCs and other contaminants whose remedy may depend on the presence of VOCs. The evidence for this conclusion is less compelling if the Innova data from the last two quarters of FY 2003 are not accurate.

- It may be possible to get samples from probes that previously did not yield a sample. This will not be known until we know why we were able to get first-time samples from five of the probes or if the sampling system has a leak.

Given the preceding conclusions, the following recommendations are offered:

- Continue quarterly monitoring until temporal trends and basis are determined. The length of time will depend on the basis for change and the rate of change.

- Use SMR temperature data at depth to support evaluation of seasonal dependence on concentrations.

- Investigate disparity in Innova and INEEL ECL analytical results to ensure equivalency.

- Determine if the data from probes that yielded a sample for the first time in the fourth quarter of FY 2003 are representative, and determine the cause for why a sample was able to be obtained.

2.3 Carbon-14

2.3.1 Sample Collection Method

The C-14 samples are withdrawn from the probes using a peristaltic pump and collected in 1-L Tedlar bags. Tritium (H-3) samples were originally to be collected using a programmable low-flow air sampler to pull soil gas through a desiccant bed. However, the single probe in SVR-20 that yields a sample requires more vacuum than can be generated by the programmable tritium sampler. To date, some C-14 samples have been taken from the SVR-20 Type B probe, but no tritium samples have been taken.

2.3.2 Sample Schedule

Currently, C-14 samples are collected quarterly from the functioning Type B vapor probes at SVR-12 and SVR-20. The *Field Sampling Plan* (Salomon 2003) calls for quarterly sampling of the SVR-20 probes for tritium, but this has not been possible because there is high resistance to flow through these probes or the soil surrounding the probes.

2.3.3 Analysis Methods

The C-14 samples are analyzed for C-14 specific activity (the C-14 activity per unit mass of total carbon). This requires analysis for total carbon and total C-14 activity in the gas sample. Total carbon is determined by using gas chromatography to measure CO_2 concentration in the sample and by measuring the total sample volume with a 1-L gas syringe. Approximately 12 mL of 0.5 normal NaOH solution is

injected into the bag to absorb the CO_2 in the sample. Then approximately 10 mL of the NaOH solution are recovered from the bag, mixed with a compatible liquid scintillation cocktail, and counted. Actual amounts of solutions used or transferred are determined gravimetrically. Liquid scintillation counting is performed using an ultra-low-level liquid scintillation counter (Wallac Quantalus® or PerkinElmer® 3170 TR/SL). Typically, 16-hour count times are used for low-level samples such as those from SVR-12. National Institute for Standards and Technology-traceable C-14 standards (as sodium carbonate) prepared with 0.5 normal NaOH are used to evaluate the counting efficiency.

2.3.4 Results

The C-14 results for the functioning Type B soil vapor probes at SVR-12 and SVR-20 are presented in Table 2-7.

Table 2-7. Specific activity of carbon-14 (pCi C-14/g carbon) from soil-vault-row Type B vapor probes.

Date	SVR-12-1-VP1	SVR-12-1-VP2	SVR-12-1-VP3	SVR-12-2-VP1	SVR-12-2-VP2	SVR-12-2-VP3	SVR-12-3-VP1	SVR-12-3-VP2	SVR-12-3-VP3	SVR-20-5-VP3
11/15/01	—	—	—	—	—	—	—	—	—	83,000
12/03/01	3,300	3,270	8,410	2,700	3,500	—	2,900	3,000	8,200	—
2/20/02	2,100	450	—	1,400	—	—	2,000	1,500	16,000	28,000
5/23/02	990	450	2,800	1,400	840	630	1,200	1,600	370	31,000
8/13/02	1,200	990	1,600	1,300	1,000	380	2,200	1,200	480	—
8/23/02	—	1,200	—	—	—	—	—	—	—	37,000
11/13/02	710	—	<MDA[a]	1,500	590	<MDA	1,100	680	<MDA	24,000
2/3/03	880	560	<MDA	970	—	480	1,100	680	<MDA	—
5/15/03	710	680	230	820	550	280	480	680	110	—
11/5/03	—	480	—	—	—	—	—	—	—	41,000[b]

— = indicates that no sample was taken on that date.
MDA = minimum detectable activity

a. Relative uncertainty >33%. The relative uncertainty of the other results is typically 5–10%. Also, the CO_2 concentrations in these samples are relatively low.

b. In the analytical report, SVR-20-5-VP3 probe results apparently were switched with the SVR-12-1-VP3 results. The value reported here is considered to be the correct value for the sample.

2.3.5 Discussion

Routine sampling of soil gas for C-14 began in FY 2002. The Tedlar bag sampling method was still in development during the first half of FY 2002, and the results are generally qualified because of limitations of the counting instrumentation. The first sample set was used to evaluate the relative performance of the Wallac Quantalus and the Beckman LS-6000 liquid scintillation counters. The Wallac was expected to have considerably better low-level counting performance and, in fact, is required for sufficiently sensitive analysis of C-14 activity. The second sample set (collected February 20, 2002) was not analyzed with the Wallac, but the Wallac was used for subsequent sample sets.

The results for C-14 analysis of SVR-12 samples indicate that the C-14-specific activity is substantially elevated (on the order of 100 times) above the naturally occurring level of 6.5 pCi C-14/g carbon.

The results for C-14 analysis of samples from the SVR-20-5-VP3 Type B probe are consistent with results for samples taken from the GSP-1 soil vapor ports at SVR-20 (Olson et al. 2003). The C-14-specific activity at SVR-20, near the activated beryllium, is generally a factor of 10 to 100 times greater than the specific activity measured near the activated stainless steel at SVR-12. This is consistent with the source-term model for these wasteforms—the fractional rate of C-14 release from activated steel is expected to be much less than from activated beryllium, and the C-14 concentration within activated steel is much lower than in activated beryllium.

2.3.6 Conclusions and Recommendations

Although the specific activity of C-14 in CO_2 from soil gas near activated steel is elevated by approximately two orders of magnitude relative to natural levels, the C-14 activity contained in a typical 1-L bag sample is on the order of 1 pCi. Low-level liquid scintillation counting methods are required for C-14 analysis of the SVR-12 samples. The C-14 bag method appears to be well suited for characterizing C-14 in SDA soil gas, provided that an ultra-low-level liquid scintillation counter is used for C-14 assay. The method development work should be documented in an engineering design file, which would serve as the basis for writing a standard procedure for routine work. As expected, the concentration of C-14 in soil near activated steel is much less than the concentration observed near activated beryllium. The relatively low concentration of tritium at SVR-12 confirms that the SVR-12 location is not affected by tritium migration from other sources (i.e., activated beryllium) and suggests that the location is not affected by C-14 from buried beryllium. If possible, some additional soil gas samples should be taken at other SDA locations to confirm that the SVR-12 C-14 results are representative of buried activated steel rather than of broadly distributed C-14 contamination.

3. LYSIMETER

3.1 Introduction

Eighteen drive-point soil-water solution samplers, referred to as lysimeters, were designed by the INEEL; constructed by Northeast Manufacturing of Meridian, Idaho; and installed using the INEEL sonic drill. The lysimeter design and operation are described in *OU 7-13/14 Integrated Probing Project Type B Probes Lysimeter Probe Design* (Clark 2001a). Lysimeters can be used to collect soil moisture solution samples (pore water) from either saturated or unsaturated sediment. The lysimeters have a semipermeable stainless steel membrane that allows water to move through but restricts air movement. Soil water is withdrawn from the surrounding soil by applying a lower pressure in the lysimeter than in the soil for a period to collect water in a chamber. Once water has accumulated in the lysimeter, a positive pressure is applied to push the water to land surface, where it is placed in sampling bottles and submitted to laboratories for analyses. Difficulty has been experienced in obtaining lysimeter samples, and installation of the lysimeters with the sonic drill rig is suspected of causing mechanical problems. The lysimeters have been redesigned to avoid installation damage and to improve sampling success.

3.2 Probe Development

Instrument development was conducted on the Type B suction lysimeter probe design to protect the inner workings during installation and to allow the porous stainless steel membrane to be rewetted following installation. A new design was conceived, and prototypes were constructed and then tested in both the laboratory and field. The improved probe design, named the INEEL Geologic and Environmental Probe System, incorporates a universal probe tip and casing that are driven into the subsurface, and then an instrument insert is placed into the probe to complete the instrument. The two-piece design avoids placing the instrument's inner workings under sonic installation stresses, while allowing the porous membrane to be rewetted following installation. An additional advantage of this design is that different instrument inserts can be placed within the probe to obtain other measurements important for characterizing water and contaminant transport within the waste. This design allows the probe to be used not only for soil-water sampling (lysimeter) but also for gas sampling, monitoring of soil-water potential, and monitoring of other geophysical properties (e.g., water content, spectral, and clay distribution) with the insertion of other geophysical instruments. This enhanced design combines the Type A and B probes to allow all of the same measurements with one universal probe. Forty-two new lysimeters have been fabricated and are scheduled for installation in FY 2004.

3.3 Analytical Data

One waste-zone lysimeter yielded water during FY 2003. Approximately 10 mL of soil moisture was collected from Probe 741-08-L1 on September 8, 2003, and analyzed for gamma-emitting radionuclides. There were no positive detections. The sample ID is IPL135013A. There was inadequate volume to perform other radiological analyses. Historically, Pu-239/240 has been detected in soil moisture from this lysimeter in November 2001 and April 2002. Neptunium-237 has been detected in moisture samples from Probe 741-08-L1 in April 2002.

4. TENSIOMETER

4.1 Introduction

In 2001, 66 drive-point tensiometers were installed in surficial sediment in the SDA using a sonic drill. The tensiometers were installed at three target depths (at the top of the waste, at the midpoint within the waste, and in sediment beneath the waste) to determine if sediment or waste was saturated, to calculate hydraulic gradients, and to monitor infiltration and drainage through waste.

4.2 Direct-Push Tensiometers

Direct-push tensiometers are instruments that yield water potential and soil gas pressure in the surrounding material. The direct-push tensiometer has a drive point and a sealed porous stainless steel chamber filled with water that is installed at a specified depth. This chamber is connected by lines to a second upper water chamber, and the upper chamber, in turn, has two lines that extend to land surface for refilling with water. The lines in the lower chamber have valves located immediately above the lower water chamber, and when closed, these valves isolate the upper chamber from the water in the water lines. When open, the lines can be used to refill the lower chamber from the upper chamber reservoir. Two transducers are located in the direct-push tensiometer. An absolute pressure transducer in hydraulic connection with the lower chamber senses the soil-water pressure in the surrounding sediment through the porous stainless steel membrane. A second pressure transducer, located above the lower transducer, measures the gas pressure in the soil. A third line extends to land surface that, when combined with the other lines and valves, allows the sensors to be tested relative to a reference pressure in the field.

In operation, a measured volume of water is placed in the upper water chamber and then the lower water chamber by opening a combination of valves. The lower chamber is filled with water from the upper water chamber and then sealed. Water in the porous stainless steel cup then moves into or out of the formation in response to soil-water changes in the soil matrix. Water, moving from the initial atmospheric pressure in the porous cup to a subatmospheric (negative) pressure in the soil (unsaturated conditions), creates a partial vacuum in the porous cup that is sensed by the lower pressure transducer. Tensiometer design and operations are fully described in *OU 7-13/14 Integrated Probing Project OU 7-13/14 Tensiometer Probe Design* (Grover 2001).

The water potential data from these advanced tensiometers are used to track changes in moisture over time and to describe relative moisture conditions at each location. Under fully saturated conditions, water is at hydrostatic pressures greater than atmospheric pressure, and water potential is positive. Under unsaturated conditions, capillary and adsorptive forces hold water in the soil matrix. In this unsaturated state, water potential is negative by convention because the hydrostatic pressures are less than atmospheric pressures. For a homogeneous medium, the more negative the water potential, the dryer the medium; decreasing water potentials indicate decreasing water content, and conversely, increasing water potentials indicate increasing water content.

4.3 Installation

Direct-push tensiometers were installed at the SDA in fall of 2001 at three target depths: at the top of the waste, at the midpoint within the waste, and in sediment beneath the waste. Probes were installed by driving them with drill-rig down pressure until consolidated sediment was encountered at a depth of about 2 ft. Then, the probe was sonically pushed to the specified depth. Locations of the tensiometers are shown in Figure A-1.

4.4 Data Collection

Pressure transducers are connected to a datalogger (Campbell Scientific, Inc.) for continuous monitoring and data storage. The data are queried on a 2-hour interval, and data are transmitted to a computer at the RWMC for retrieval and analysis. The data are posted on a shared directory and imported into Excel spreadsheets for evaluation.

In FY 2003, system checks were performed on all dataloggers and instruments. Selected transducers were individually interrogated to check readings and determine functionality. As a result of these checks, all datalogger enclosures were configured to

- Address problems of instrument communications
- Reposition batteries to prevent acid damage in the event of a leak
- Standardize the configuration so all boxes were identical in hardware and software
- Revise software to make boxes field-configurable
- Add input to measure solar power output voltage
- Add connectors to remove problems with spliced wires and facilitate field replacement.

Five multiplexers also were built and added to the system as part of addressing these problems. A new set of design files for the instruments and datalogger network was completed (EDF-3612) and entered into the Electronic Data Management System.

4.5 Use and Accuracy of the Data

Data from the tensiometers are used to calculate soil-water potential. Water potential is a means of measuring the relative energy state of water to evaluate the status and movement of water. The sensor measurement from the soil gas pressure (upper sensor) is subtracted from the soil-water potential sensor (absolute, lower sensor) to calculate the soil-water potential relative to atmospheric pressure (standard measurement technique). In order for the lower soil-water potential (absolute) sensor to work, sufficient water must be held in the lower reservoir, and the porous membrane must remain saturated to prevent air entry through the membrane. If the membrane is not saturated, the sensor will track atmospheric pressure.

4.5.1 Laboratory Calibration

All the sensors (15-psia Sensotec pressure transducers) have undergone the initial INEEL Standards and Calibration Laboratory calibration with the required specification that the sensors are within $\pm 2\%$ of full scale or ± 5 cm of water pressure over the range of measurements.

4.5.2 Field Calibration

Once the tensiometers were installed, the contained sensors could not be removed for laboratory calibration. The sonic insertion technique placed the pressure sensors under moderate-to-very-high stresses from the sonic insertion technique, and the vibration from the sonic drilling had the potential to alter the calibration. Using the third line that extended from the sensors to land surface, the sensors were

field calibrated to a reference pressure in the field in FY 2003. These new calibrations may be applied to the calculated soil-water potential (relative to atmospheric pressure) for increased accuracy.

4.6 Results and Discussion

Eight of the direct-push tensiometers provided calculated soil-water potential (relative to atmospheric pressures) responses over an extended period. These responses are shown in Figures 4-1, 4-2, 4-3, and 4-4. Figure 4-1 will be discussed in detail to better understand the tensiometer responses, but discussion of the remainder of the figures will focus on the representative data.

The tensiometer data shown in Figure 4-1 are from the 19.9-ft probe in Cluster 741-08 and the 18.5-ft probe in Cluster 743-03. The initial data from both of these instruments are near zero because the tensiometer was not yet functioning. In March (Probe 741-08-T3) and April (Probe 743-03-T3) 2002, water was added to the porous cup of the tensiometer, and the water potential began to drop. Field maintenance in April 2002 caused a steep rise to zero at Probe 743-03-T3 but again began to drop as the tensiometer continued equilibrating with the surrounding soil. When the steep drop in water potentials began to level off (i.e., late April at Probe 743-03-T3), the tensiometers were in equilibrium with the soil water and collecting representative data. Probe 741-08-T3 showed approximately –90 cm water, and Probe 743-03-T3 indicated approximately –350 cm water. Both tensiometers then show a slight increase in water potentials that reaches a maximum in December 2002 and then decrease until late spring 2003. This increase and decrease in water potentials reflects minor infiltration and drainage over that period. The sudden rise in water potentials to zero in May 2003 at Probe 743-03-T3 was caused by field maintenance, but the water potential values that follow show the tensiometer reequilibrated with the soil water by August 2003.

The water potentials at Probe 743-03-T3 after August 2003 are approximately 30 cm lower than the May 2003 values and show greater variation. It is possible the transducer in Probe 743-03-T3 is no longer stable or needs to be recalibrated and should be field checked. A field check also should be performed at Probe 741-08-T3. The output data from Probes 741-08-T2 (10.6 ft) and 741-08-T3 (19.9 ft) were switched in the datalogger in September 2003. The depth (19.9 ft) listed in Figure 4-1 for Probe 741-08-T3 represents the depth before the wiring was switched. The depth will be corrected to 10.6 ft (Probe 741-08-T2) if the field check indicates the switch was necessary.

Both Probes 741-08-03 (19.9 ft) and 743-03-T3 (18.5 ft) are located below the waste, and the minor infiltration seen in fall 2002 represents recharge that probably moved through the waste. The two probes indicate different water potentials (approximately –90 cm water versus –350 cm water), and this difference may reflect a different lithology or different moisture conditions between these two separate cluster areas. A soil moisture probe (Probe 743-03-237 [19.1 ft]) located within 3 ft of the tensiometer probe (Probe 743-03-T3 [18.5 ft]) indicates volumetric soil moisture contents of approximately 27%. This is reasonable moisture content for silt at -350 cm water. A volumetric moisture content of approximately 22 %, measured at soil moisture Probe 741-08-266 (20.0 ft) within 5 ft of tensiometer Probe 741-08-T3 (19.9 ft), would not be realistic for a silt at approximately –90 cm water but would be reasonable in a sand. It is also possible the two clusters represent wetter and drier areas within the SDA, based on the tensiometer data.

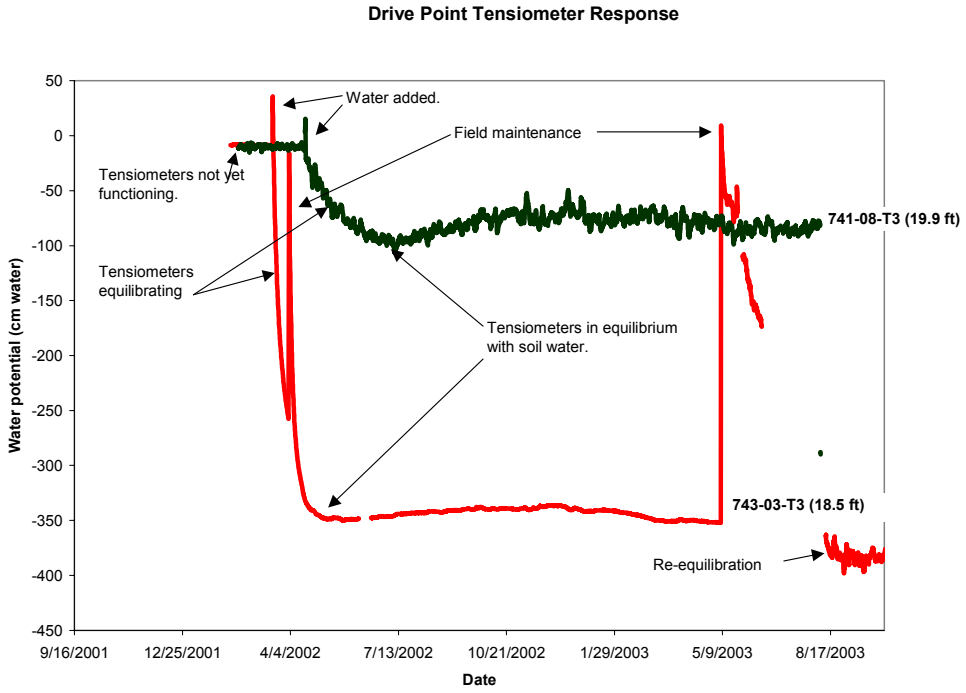

Figure 4-1. Calculated soil-water potential (relative to atmospheric) data from two probes at Clusters 741-08 and 743-03.

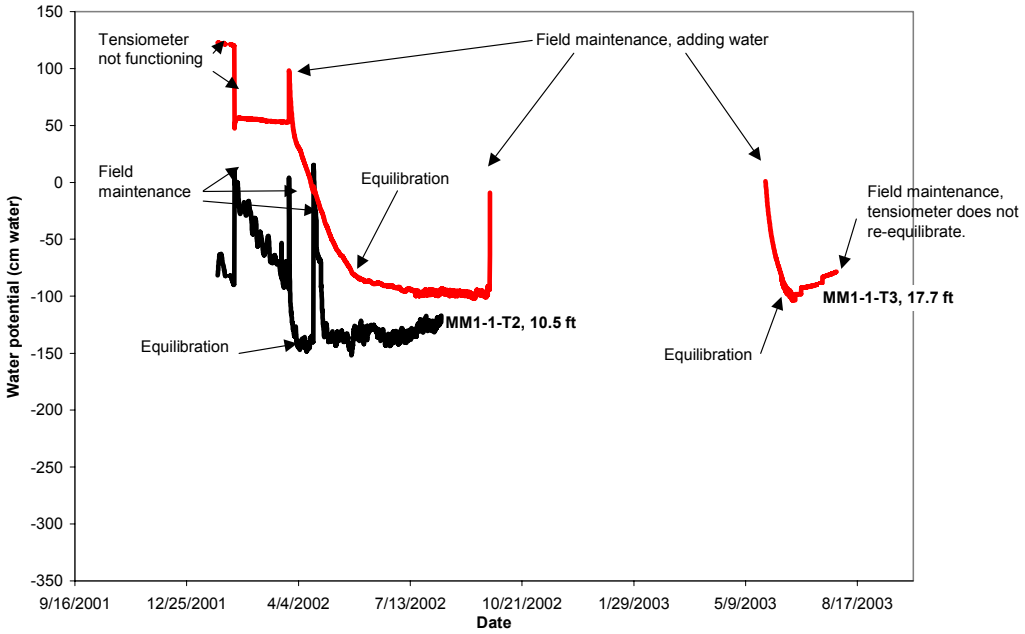

Figure 4-2. Calculated soil-water potential (relative to atmospheric) data from two locations at Cluster MM1-1.

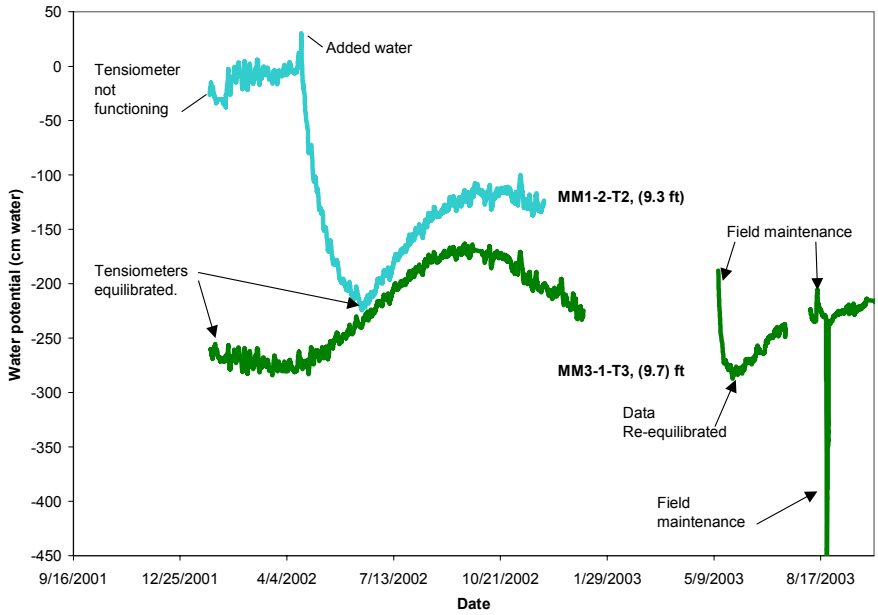

Figure 4-3. Calculated soil-water potential (relative to atmospheric) data from selected locations at Clusters MM1-2 and MM3-1.

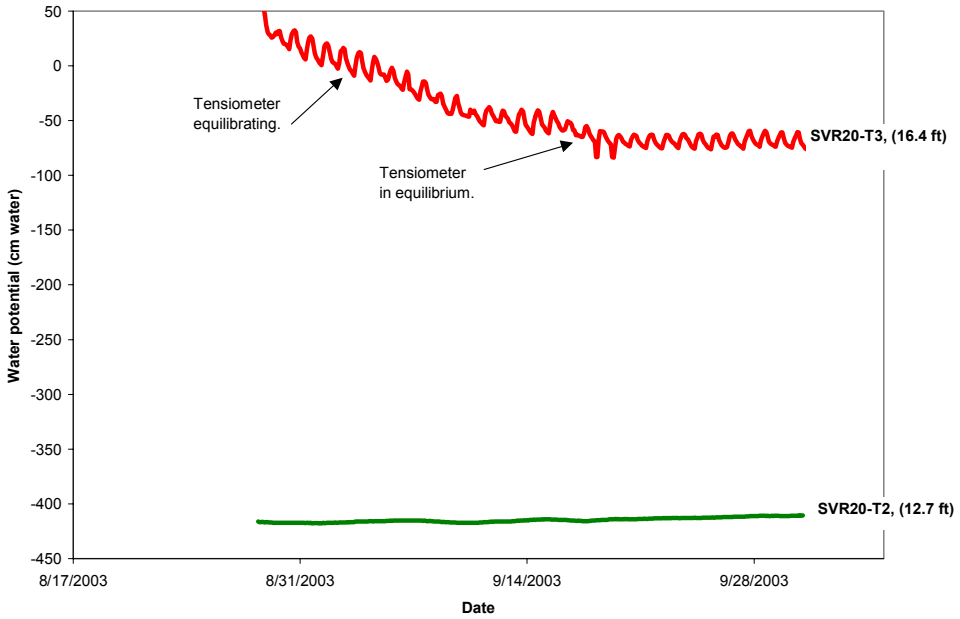

Figure 4-4. Calculated soil-water potential (relative to atmospheric) data from two locations at SVR-20.

Water potential data from two of the Cluster MM-1 tensiometer probes are shown in Figure 4-2. These tensiometer probes are located near the borrow pit, alongside the main east-west road through the SDA. Equilibrated water potentials from tensiometer Probes MM1-1-T2 (10.5 ft) and MM1-1-T3 (17.7 ft) show near-constant water potentials over the monitoring period. Probe MM1-1-T3 (17.7 ft) shows a rise in water potentials in July 2003 that is consistent with infiltration but could also be loss of water from the tensiometer cup. The data were interrupted by field maintenance and did not reequilibrate.

In contrast, tensiometer Probes MM1-2-T2 (9.3 ft) and MM3-1-T3 (9.7 ft) indicate infiltration occurred from late spring to fall of 2002, and drainage followed into December 2002 (see Figure 4-3). After a data gap, Probe MM3-1-T3 again shows infiltration from late spring to fall of 2003. Soil moisture Probes MM1-2-238 (6 ft) and MM3-1-242 (9.7 ft) (see Appendix C), located near these tensiometers (MM1-2-T2 [9.3 ft] and MM3-1-T3 [9.7 ft], respectively), also indicate infiltration occurred during these timeframes. The timing of infiltration may correspond with 0.74 in. of precipitation over a 4-day period in mid-April 2002 and 0.61 in. of precipitation over a 5-day period in April 2003 at the RWMC (NOAA 2004). Infiltration at these locations occurred in spite of less-than-average annual precipitation during the monitoring period (i.e., 4.53 in. in 2002 and 3.91 in. in 2003 [see Section 1.5], compared to an 8.71-in. annual average at the Central Facilities Area [Clawson, Start, and Ricks 1989]).

Approximately 1 month of water potential data for tensiometer Probes SVR-20-T2 (12.7 ft) and SVR-20-T3 (16.4 ft) is shown in Figure 4-4. Although one should be careful comparing water potential from different types of soil to each other, large differences in values can imply a degree of wetness in a general sense. The water potentials indicate that the deeper 16.4-ft tensiometer is very wet at approximately -50 cm of water and that the shallower 12.7-ft depth is drier at approximately -425 cm of water.

4.6.1 Instrument Performance

The majority of the tensiometers did not provide useable water potential data for 2002 and 2003. The tensiometer design is complex to ensure no radiological pathway to the surface when instrumentation is located in or near waste. However, the complexity of the design also provided many avenues for failure (e.g., valve failure or transducers that were not replaceable). The use of sonic drilling during installation also may have increased the potential for dewatering the porous stainless steel and damaging the instrument (e.g., loosening fittings, kinking tubing, and breaking seals).

Only eight out of 66 direct-push tensiometers installed in the SDA provided water potential data needed to characterize moisture movement through surficial sediment and waste. Table 4-1 lists the tensiometers, the working status of the transducers, and a recommendation to continue or discontinue the use of each direct-push tensiometer in the monitoring network. Troubleshooting is recommended for tensiometers that show potential for good performance. Recommendations are made to remove tensiometers from the monitoring network if the tensiometers have failed or if the tensiometers are located in soil that is too dry to allow continuous operation (such as the shallowest tensiometers). Plots of the raw data and a more detailed evaluation of the operability of the individual direct-push tensiometers are presented in Appendix D.

Table 4-1. Summary of monitoring recommendations for direct push tensiometers.

Cluster	Tensiometer	Depth (ft)	Transducer Status		Recommendation
			Soil Gas	Soil Water	
DU-08	DU-08-T1	5.3	Failed	Failed	Discontinue
	DU-08-T2	10.2	Working	Works sporadically	Continue
	DU-08-T3	16.4	Working	Failed	Discontinue
DU-10	DU-10-T1	4.0	Working	Failed	Discontinue
	DU-10-T2	6.7	Working	Working	Continue
	DU-10-T3	9.1	Working	Working	Continue
DU-14	DU-14-T1	3.7	Failed	Failed	Discontinue
	DU-14-T2	9.0	Failed	Failed	Discontinue
	DU-14-T3	15.3	Failed	Failed	Discontinue
743-03	743-03-T1	5.3	Worked previously	Some response to adding water	Continue
	743-03-T2	11.2	Failed	Failed	Discontinue
	743-03-T3	18.5	Some response	Working	Continue
743-08	743-08-T1	5.6	Working	May be working	Continue
	743-08-T2	13.0	Working	Some response	Continue
	743-08-T3	22.4	Failed	Failed	Discontinue
743-18	743-18-T1	5.5	Working	Working	Continue
	743-18-T2	14.9	Working	Failed	Discontinue
	743-18-T3	9.2	Working	Failed	Discontinue
741-08	741-08-T1	3.6	Working	Failed	Discontinue, too shallow
	741-08-T2	10.6	Works	Some response	Continue
	741-08-T3	19.9	Works	Some response	Continue
SVR-12	SVR12-T1	3.6	Works	Failed	Discontinue
	SVR12-T2	8.4	Works	Some response	Continue
	SVR12-T3	10.8	Works	Failed	Discontinue
SVR-20	SVR20-T1	8.3	Works	Some response	Continue
	SVR20-T2	12.7	Works	Works	Continue
	SVR20-T3	16.4	Works	Works	Continue

Table 4-1. (continued).

Cluster	Tensiometer	Depth (ft)	Transducer Status		Recommendation
			Soil Gas	Soil Water	
MM1-1	MM1-1-T1	5.6	Works	Works	Continue
	MM1-1-T2	10.5	Works	Failed	Discontinue
	MM1-1-T3	17.7	Some response	Some response	Continue
MM1-2	MM1-2-T1	5.6	Works	Failed	Discontinue
	MM1-2-T2	9.3	Works	Some response	Continue
	MM1-2-T3	14.0	Works	Some response	Continue
MM1-3	MM1-3-T1	5.1	Works	Some response	Continue
	MM1-3-T2	8.4	Works	Some response	Continue
	MM1-3-T3	11.7	Failed	Failed	Discontinue
MM2-1	MM2-1-T1	6.7	Some response	Failed	Discontinue
	MM2-1-T2	11.9	Some response	Some response	Continue
	MM2-1-T3	16.0	Some response	Some response	Continue
MM2-2	MM2-2-T1	5.0	Works	Some response	Continue
	MM2-2-T2	8.6	Works	Failed	Discontinue
	MM2-2-T3	9.2	Failed	Failed	Discontinue
MM2-3	MM2-3-T1	3.8	Works	Failed	Discontinue
	MM2-3-T2	5.1	Works	Failed	Discontinue
	MM2-3-T3	6.6	Works	Failed	Discontinue
MM3-1	MM3-1-T1	4.9	Failed	Failed	Discontinue
	MM3-1-T2	7.1	Works	Failed	Discontinue
	MM3-1-T3	9.7	Works	Works	Continue
MM3-2	MM3-2-T1	5.0	Works	Failed	Discontinue
	MM3-2-T2	6.6	Works	Some response	Continue
	MM3-2-T3	8.4	Works	Failed	Discontinue
MM3-3	MM3-3-T1	14.0	Works	Some response	Continue
	MM3-3-T2	4.6	Works	Some response	Continue
	MM3-3-T3	17.0	Failed	Failed	Discontinue
MM4-1	MM4-1-T1	5.7	Works	Some response	Continue
	MM4-1-T2	14.9	Works	Some response	Continue
	MM4-1-T3	18.5	Works	Some response	Continue

Table 4-1. (continued).

Cluster	Tensiometer	Depth (ft)	Transducer Status		Recommendation
			Soil Gas	Soil Water	
MM4-2	MM4-2-T1	4.9	Works	Failed	Discontinue
	MM4-2-T2	11.4	Failed	Some response	Continue
	MM4-2-T3	15.8	Failed	Failed	Discontinue
MM4-3	MM4-3-T1	3.6	Works	Failed	Discontinue
	MM4-3-T2	8.2	Works	Failed	Discontinue
	MM4-3-T3	9.5	Works	Some response	Continue
MM4-5	MM4-5-T1	4.1	Failed	Failed	Discontinue
	MM4-5-T2	9.7	Some response	Failed	Discontinue
	MM4-5-T3	13.5	Failed	May be working	Continue

4.7 Conclusions and Recommendations

Continuous water potential data from four locations in the SDA indicate that infiltration occurs through surficial sediment and through waste despite less-than-average precipitation during the last 2 years. The lack of working tensiometers over a depth profile prevents use of water potential data for hydraulic gradients or estimates of infiltration rates.

It is recommended that the tensiometers be monitored through FY 2004 to track infiltration and drainage from the spring 2004 snowmelt. If the performance of the direct-push tensiometers does not improve, it is further recommended that consideration be given to halting the collection of the direct-push tensiometer data at the end of FY 2004.

5. SOIL MOISTURE PROBE

5.1 Introduction

Applied Research Associates, Inc. (ARA) developed the capacitance-based soil moisture sensor and web-based data acquisition and control system that are part of the monitoring system installed at RWMC. This system was selected because it contains the following features:

- Direct contact of the sensor with the soil
- Use of higher frequency oscillation (150 MHz) in the capacitance-measuring circuit
- Combination of three sensors (moisture, resistivity, and temperature) in a single package that can be pushed into the soil
- Data-handling and data-processing capabilities.

Although Vertek markets the probe for ARA as a standard off-the-shelf item for obtaining real-time, in situ logs of SMR, in some respects, the probe is still in the development stage. For example, in 2003 ARA redesigned the SMR probe and renamed it the "SMRT" probe. The SMR probe is designed with electrode rings circling the tip (see Figure 5-1) for measuring SMR. The two inner rings (second and forth) determine the soil moisture content by measuring the frequency shift of a high-frequency excitation signal as it passes through the soil near the probe. Resistivity is measured by the two outer rings (first and fifth). Soil temperature is measured by the center ring (third).

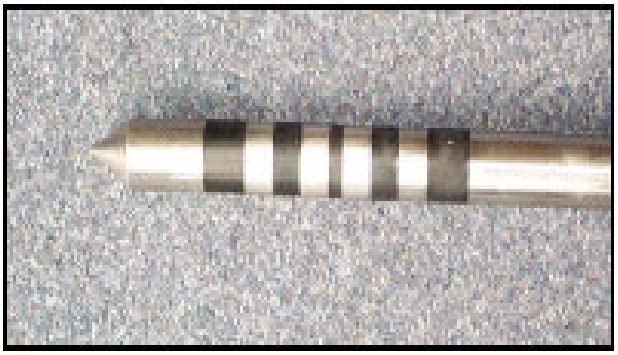

Figure 5-1. View showing the tip of the soil moisture, resistivity, and temperature probe with its electrode rings.

Seventy-eight of the SMR probes were pushed into soil and waste at RWMC in 2001. Target depths were at the top of the waste, near the bottom of the waste, and in sediment below the waste. The objective was to monitor infiltration that moved through the waste. Forty-eight of the 78 probes were functioning at least part of the time during FY 2003. Data collection from the probes is automated such that data are remotely collected at 2-hour intervals. Data are then transmitted from the dataloggers to a computer and placed in a shared file. From there, the data are pulled into an Excel spreadsheet for analysis. Data are collected as processed, meaning that calibration and other equations are applied to the data as they are collected.

5.2 Probe Calibration

The SMR probes were calibrated using moisture extremes by taking readings in air and water. Once installed, the probes cannot be recalibrated without pulling them out of the soil, which is not possible when the probes are installed in or through waste. Because the probes were not calibrated to the actual soil conditions, the reported moisture contents should be viewed as relative rather than absolute values. In addition, metal objects located near the probes can affect the measured moisture content. Soil temperature, resistivity, and pore-water salinity also can impact the moisture content.

5.3 Fiscal Year 2003 Radioactive Waste Management Complex Precipitation

Precipitation is important when considering potential infiltration. Although there are exceptions, low precipitation usually means low infiltration. At RWMC, the spring snowmelt has been shown to be the most significant infiltration event. The National Oceanic and Atmospheric Administration maintains precipitation records for the RWMC (NOAA 2004). On average, National Oceanic and Atmospheric Administration long-term records indicate that the INEEL receives 8.65 in. of precipitation annually (Clawson, Start, and Ricks 1989). The 2003 total precipitation at RWMC is less than half the average—4.28 in. (see Figure 1-3). The greatest monthly amount of precipitation occurred in April—just shy of 1.6 in. The maximum daily precipitation was 0.45 in. on April 28, 2003.

5.4 Summary of Soil Moisture and Soil Temperature Data Trends

Plots of the soil moisture and temperature data for the functioning SMR probes are shown in Appendix C. Trends in the moisture and temperature are discussed below and presented in Table 5-1 (for 2003) and in Appendix C. Table 5-1 presents all of the 78 probes that were installed and categorizes their functionality (e.g., usable, questionable, or nonfunctioning).

5.5 Moisture Data

Functioning SMR probes are installed in the subsurface at depths ranging from 1.67 to 19.86 ft. With the scant 2003 precipitation, infiltrating moisture at most sites should prove to be insignificant. However, heterogeneities in RWMC surficial soil promote preferential flow. Run-off water is known to collect in ditches along the roadways. These areas, at the expense of other flatter areas from which the water runs off, can receive substantial recharge even in years of drought. This means that if a SMR probe is located near a collection area and installed deep in the subsurface, it could indicate recharge while a shallow probe located in another area might not.

The SMR probes indicate that infiltration has occurred by showing an increasing moisture content that is reflected in a rising moisture trend. However, a slowly rising trend over a long period also could indicate that the probe may be impacted by other parameters (e.g., resistivity or salinity as well as temperature). A continued rising trend generally would not be expected as an indicator of recharge at RWMC. Rather, a rising trend and then a falling off a couple of weeks or months later is generally what has been observed in past moisture monitoring at RWMC. The fall-off would be the desired response to drying associated with decreased moisture following the moisture pulse. With long-term rising trends (for more than 1 year), resistivity readings might help to determine if infiltration is actually occurring as a result of a slowly moving wetting front, but at this point, the resistivity measurements are of no help. Another approach is to corroborate results with other moisture data (e.g., the tensiometer data). If the tensiometer data support the SMR data, it is a fairly safe conclusion that infiltration has occurred. Data

from any of the instruments are always stronger when they are corroborated by data from other independent measurements.

The SMR and tensiometer data indicate that infiltration has occurred at the MM1-2 cluster and perhaps at the PIT5-4 and PIT5-TW1 clusters. This is not surprising since Cluster MM1-2 is located near the haul road where water is known to pond. PIT5-4 and PIT5-TW1 also are located in areas where past observations indicate water ponds. Although we believe infiltration has occurred at these sites, the current quality of the SMR moisture data (e.g., temperature influences and calibration difficulties) does not allow a quantitative estimation of the amount of infiltration that has occurred.

Data plots for each of the functioning SMR probes (described below) with the trend discussion superimposed on the plots are shown in Appendix C. These are organized by borehole and probe depth.

The following provides a discussion of each of the SMR probes (and clusters), including long-term moisture trends (see Appendix C and Table 5-1):

- Cluster 741-08—Data appear to show a slightly rising trend in each of the three probes at this location (741-08-266, 741-08-267, and 741-08-268). However, two of the three trends are impacted by temperature. Probes 267 (4.4 ft bls) and 266 (19.86 ft bls) appear to be inversely correlated with the temperature measurements (see page C-3—Cluster 741-08—in Appendix C). These probes are located above the waste, in the waste, and near the bottom of the waste. Probe 268 (11.5 ft bls) indicates very low moisture, which could be reasonable given that this probe is located within the waste. If infiltration occurred at this location, it occurred between March and July and was slight. Since that time, the trend is flat.

- Cluster 743-03—Probe 743-03-235, installed at 3.36 ft bls, is significantly impacted by temperature. Even so, it appears to have a slightly rising trend over the long term as does its companion probe (743-03-237) that is installed deeper at this location. It is possible that a slight amount of infiltration occurred in this location, although it would be more convincing if the trends remained after removal of the temperature effect.

- Cluster 743-08—Data from Probes 743-08-247, 743-08-250, and 743-08-251 look similar to Cluster 743-03. Final trend on each probe seems to be slightly up, suggesting infiltration could have occurred, but again, the trends would be more convincing if they remained after removal of the temperature effect.

- Cluster 743-18—The trend for Probe 743-18-217 seems to be slightly up and then down, but the trend is cyclic and has the temperature influencing it; probably the true trend (after temperature influence is removed) is flat, indicating little or no infiltration has occurred at this location.

- Cluster MM1-2—Probe MM1-2-238 (6 ft bls) measurements indicate that infiltration has likely occurred in 2002 and 2003 at this location. The 2002 infiltration is supported by nearby tensiometer data.

- Cluster MM2-1—Probes MM 2-1-221, MM 2-1-231, and MM 2-1-241 are all potentially influenced by temperature. Their location is near the ditch by the haul road where water most likely ponded. Probe MM 2-1-221 seems to have a steady slightly rising trend but nothing corresponding to infiltration. However, perhaps Probe MM 2-1-241 and very likely Probe MM 2-1-231 have rising responses indicating possible infiltration in the March-April timeframe. Cluster MM2-2—Probes MM2-2-220 and MM2-2-222 (SMR probes) do not indicate that significant infiltration occurred at their locations, although it is possible that infiltration has occurred in the February-March timeframe at the 10.78-ft-bls (Probe MM2-2-224) location. However, data from this probe are noisy, but the recharge event seems to rise above the general noise in the data.

- Cluster MM2-3—Probe MM2-3-246 shows a jump around the middle of July. One might be tempted to believe the jump is in response to infiltration from a summer rainstorm because it jumps up rapidly and then falls off gradually. The problem with this assumption is that July precipitation data do not support such a storm. So, it is likely that something else, other than increased moisture content of the soil, is causing the jump, possibly instrument servicing. Neither of the other probes at this location (Probes MM2-3-215 and MM2-3-229) indicates infiltration.

- Cluster MM3-1—2002 tensiometer data indicate infiltration at 10.5 ft, and 2002 SMR Probe 242 (9.69 ft bls) data may indicate infiltration. Probe MM3-1-242 (at 9.69 ft) does not appear to show infiltration occurring in 2003. Temperature effects impact all probes at this location. If these effects were removed, infiltration might be more evident.

- Cluster MM3-2—Probes MM3-2-210 and MM3-2-216 are obviously impacted by temperature. The middle probe, Probe MM3-2-252, data are fairly flat.

- Cluster MM3-3—All probes at this location appear to have some degree of temperature effect. There does not appear to have been any infiltration at this location.

- Cluster PIT5-4—There is, perhaps, some infiltration at the 2.81-ft (Probe PIT5-4-289) and the 10.16-ft levels (Probe PIT5-4-285). To verify infiltration, the temperature effect needs to be removed. Probe PIT5-4-279 does not appear to indicate significant infiltration.

- Cluster PIT5-TW1—Temperature impacts all three probes at this location. The deeper two probes (Probes PIT5-TW1-282 and PIT5-TW1-291) appear to have rising trends, which might indicate infiltration. The shallow probe (Probe PIT5-TW1-290) may be indicating slight infiltration in February 2003.

- Cluster SVR-20—Little 2003 data. Cluster has only recently come back online. There is insufficient data to assess potential 2003 infiltration.

- The rest of the locations and probes have insufficient data to determine the potential of infiltration in their specific locations.

Table 5-1. Summary of soil moisture, resistivity, and temperature probes, depth, materials, temperature, and soil moisture.

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C)		Soil Moisture Content Volumetric (%)		Comments	Moisture Content Trend
					Maximum	Minimum	Maximum	Minimum		
741-08	267	4.40	Useful	Soil cover above waste	19.565 (8/21)	3.6739 (3/8)	22.427 (5/14)	15.4090 (9/1)	Moisture content seems to be inversely correlated to temperature. If moisture data can be believed (without removing temperature influences), the moisture content seems to be drying, which is consistent with Radioactive Waste Management Complex norms for this time of year.	The long-term trend is cyclic—upward as temperature trends down. Without removing the temperature component of the moisture data, it would be hard to predict the actual trend.
	268	11.50	Useful	Waste	16.086 (9/30)	9.0089 (4/17)	2.720 (7/26)	1.0977 (1/1)	No temperature dependence. Data are reasonable. Low-moisture content is consistent with dry waste with large void spaces. No significant moisture changes in waste near probe. Moisture minimum and maximum achieved on several dates.	Over time, slight upward trend, which could indicate some infiltration.
	266	19.86	Useful	Bottom of waste	12.815 (9/29)	9.5864 (6/19)	23.701 (5/3)	21.5080 (1/1)	Temperature and moisture seem to be slightly inversely correlated. Does not appear to be any real moisture changes near probe during quarter. Jump in temperature on 8/28 may reflect field servicing.	Basically flat for the last part of 2003. A flat trend suggests that the moisture conditions are not changing. Over time, though, the trend is slightly cyclic and appears to be increasing. Need to remove temperature effects from data.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C) Maximum	Temperature (°C) Minimum	Soil Moisture Content Volumetric (%) Maximum	Soil Moisture Content Volumetric (%) Minimum	Comments	Moisture Content Trend
743-03	235	3.36	Useful	Soil cover above waste	20.614 (8/25)	4.8863 (3/11)	35.432 (8/22)	25.7810 (8/22)	Temperature reflects probe's nearness to surface. Definite inverse correlation to temperature. Differences in moisture content would suggest that there was a wetting front passing the probe between 8/22 and 10/2. If the data are real, infiltration has occurred.	Cyclic. Current trend is up, but because of inverse correlation to temperature, trend cannot be trusted. Probably the true trend is flat or rising slightly, which would suggest that little or no infiltration is occurring.
	226	12.31	Nonfunctioning							
	237	19.09	Useful	Soil below waste	27.302 (1/1)	13.6040 (6/11)	62.141 (5/8)	25.7810 (8/22)	Differences in moisture content would suggest that there was a wetting front passing the probe between 8/22 and 10/2. If the data are real, infiltration has occurred. That the high temperature occurred in January suggests that there may be some problem with the temperature data.	Long-term trend appears to be rising slightly. Servicing of probe in early August resulted in dramatic drop in moisture values, which are probably more accurate. Trend continues gradual upward movement.
743-08	247	6.60	Useful	Soil cover above waste	22.449 (9/11)	21.0760 (9/30)	20.261 (9/28)	18.7600 (8/13)	First data 8/12. Doesn't appear to be influenced by temperature.	Trend is upward after sudden drop in moisture content (caused by servicing) in previous quarter.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C) Maximum	Temperature (°C) Minimum	Soil Moisture Content Volumetric (%) Maximum	Soil Moisture Content Volumetric (%) Minimum	Comments	Moisture Content Trend
	250	13.90	Useful	Waste	21.361 (9/29)	21.3060 (9/28)	14.538 (9/28)	14.4260 (9/30)	Not enough fourth-quarter data to analyze.	Not enough recent data to tell about fourth-quarter trends. Over the long term, though, there is a definite temperature influence on data. Although long-term trend is cyclic, the true trend appears to be rising, which suggests wetting may be occurring.
	251	22.28	Useful	Bottom of waste	N/A	N/A	N/A	N/A	Data from 9/10. Not enough data to give conclusions. Data appear to be influenced by temperature.	Trend appears to be up but not enough data to be sure. Trend also appears to have a temperature component, which must be removed.
743-18	217	6.47	Useful	Top of waste	20.028 (9/09)	18.6990 (9/30)	19.457 (9/13)	18.8610 (8/18)	The moisture data are influenced by temperature, which needs to be removed before the moisture data can be trusted. If the moisture data can be trusted, then infiltration could have occurred between 8/18 and 9/13. The minimum and maximum occur on more than one date; the dates given are representative.	The trend seems to be slightly up and then down, but the trend is cyclic and has the temperature influencing it so that it is hard to comment much about the actual moisture patterns. Probably the true trend is fairly flat, which would indicate little or no infiltration has occurred at this location.
	248	12.83	Nonfunctioning							
	236	19.2	Nonfunctioning							

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C) Maximum	Temperature (°C) Minimum	Soil Moisture Content Volumetric (%) Maximum	Soil Moisture Content Volumetric (%) Minimum	Comments	Moisture Content Trend
MM1-1	232	5.5	Nonfunctioning							
	227	11.58	Questionable							
	211	18.7	Questionable							
MM1-2	238	6.00	Useful	Soil	21.376 (8/21)	1.9718 (3/10)	18.582 (6/22)	16.9392 (3/10)	Data to 9/10 only. Moisture maximum occurred on June 22, which is about the time that it is expected to be highest. This is an indicator that infiltration occurred at this location. The minimum temperature and moisture content occurring on the same day probably results from the temperature influence.	The long-term trend is somewhat cyclic but does not appear to be influenced by temperature and is possibly responding to actual moisture changes in the soil suggesting that infiltration is occurring. Fourth quarter trend is slightly down then slightly up.
	214	10.75	Nonfunctioning							
	219	13.89	Questionable							
MM1-3	212	4.9	Questionable							
	240	9.75	Nonfunctioning							
	213	11.47	Questionable							
MM2-1	221	7.25	Questionable	Undetermined (no nearby Type A logging available)	3.633 (7/15)	–7.2372 (3/15)	36.930 (7/14)	32.6540 (2/24)	Probe not responding; last readings third quarter of 2003. Many temperature readings are negative. It does not seem reasonable that soil temperatures would be negative at 7.25 ft bls.	Long-term trend is cyclic, reflecting temperature influences. Actual trend (when temperature influences are removed) is probably flat or slightly up suggesting little to no infiltration is occurring.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C) Maximum	Temperature (°C) Minimum	Soil Moisture Content Volumetric (%) Maximum	Soil Moisture Content Volumetric (%) Minimum	Comments	Moisture Content Trend
	241	12.51	Questionable probe functioning until August 2003	Undetermined (no nearby Type A logging available)	12.056 (1/1)	8.8593 (4/5)	58.329 (7/15)	53.6870 (2/23)	Probe not responding; last readings third quarter of 2003. The high soil temperature occurred on 1/1, which is surprising.	Long-term trend is slightly cyclic, reflecting temperature influences. Actual trend is probably fairly flat suggesting little infiltration is occurring, although it is possible that infiltration has occurred in March or April.
	231	16.00	Questionable probe functioning until August 2003	Undetermined (no nearby Type A logging available)	11.742 (7/14)	3.8004 (5/8)	58.329 (7/15)	53.8660 (6/26)	Probe not responding; last readings third quarter of 2003.	The long-term trend appears to have a slight inverse temperature effect. Data may be trending up slightly. Infiltration may have occurred at this location in the March-April timeframe.
MM2-2	220	4.00	Questionable probe functioning until August 2003	Undetermined (no nearby Type A logging available)	16.742 (7/15)	–3.2507 (2/28)	67.150 (4/5)	61.0290 (7/11)	Probe not responding; last readings third quarter of 2003. The timing of the maximum moisture content is consistent with infiltration.	Moisture trend has an inverse temperature effect. If this were removed, trend may be flat or slightly rising. If it were rising, infiltration could be occurring.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C)		Soil Moisture Content Volumetric (%)		Comments	Moisture Content Trend
					Maximum	Minimum	Maximum	Minimum		
	222	9.14	Questionable probe functioning until August 2003	Undetermined (no nearby Type A logging available)	11.858 (9/12)	0.2555 (3/18)	70.749 (9/20)	51.4720 (3/14)	Probe not responding; last readings third quarter of 2003 and three readings in September. Maximum and minimum values may miss actual maximum and minimum values because half of July, all of August, and most of September data are missing.	The trend is cyclic reflecting temperature influences. However, actual trend may be rising slightly.
	224	10.78	Useful	Undetermined (no nearby Type A logging available)	10.950 (9/21)	2.2914 (8/23)	50.491 (9/28)	11.1130 (8/24)	The minimum and maximum values for temperature and moisture occurred at similar times—in August and September, which is surprising. Many data are missing.	The trend suggests there is much noise in the data. However, actual trend appears to be rising slightly. There is a possible infiltration event in the February-March timeframe. Each probe in this location seems to have a rising trend, which could indicate some water is moving through the system.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C) Maximum	Temperature (°C) Minimum	Soil Moisture Content Volumetric (%) Maximum	Soil Moisture Content Volumetric (%) Minimum	Comments	Moisture Content Trend
MM2-3	246	1.67	Useful	Undetermined (no nearby Type A logging available)	25.069 (7/8)	15.4880 (9/20)	33.935 (7/1)	24.5250 (9/28)	Large data gap between early July and 9/10. High temperature and moisture data are in July data, therefore, probably do not reflect the actual high-temperature or moisture content. Moisture data have temperature component, which needs to be removed for data to be useful. The large swing in temperature results from the probe's nearness to the land surface.	The cyclic trend results from the temperature influence on the moisture data, making it a slightly muted copy of the temperature trend. The large temperature variation influences the moisture trend to such an extent that it is hard to determine the actual moisture trend, which might be fairly flat.
	215	3.05	Useful	Undetermined (no nearby Type A logging available)	18.252 (7/15)	13.2800 (9/22)	33.041 (7/15)	29.8870 (9/25)	Data collected for first half of July, then missing until 9/10. Some spurious moisture points that are outside the overall moisture trend—13.413 (9/19), 27.871 (9/19), and 22.879 (9/25) among others. These were not recorded as the minimum because they fall outside the trend. Moisture contents are influenced by temperature.	The moisture trend is cyclic, a somewhat muted mirror of the temperature trend. In the fourth quarter, the moisture trend peaks and falls off exactly like the temperature. Probably the real moisture trend is somewhat flat, but this cannot be said definitively until the temperature influence is removed from the moisture data.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C) Maximum	Temperature (°C) Minimum	Soil Moisture Content Volumetric (%) Maximum	Soil Moisture Content Volumetric (%) Minimum	Comments	Moisture Content Trend
	229	6.98	Questionable probe functioning until August 2003	Undetermined (no nearby Type A logging available)	11.907 (7/15)	1.1497 (3/15)	10.790 (7/11)	7.8279 (1/1)	Probe not responding; last readings third quarter of 2003.	Long-term trend is cyclic, reflecting temperature influences. If the temperature influence is removed, the trend might be slightly upward.
MM3-1	245	4.47	Useful	Undetermined (no nearby Type A logging available)	22.840 (8/5)	1.8586 (3/3)	49.414 (7/1)	35.2470 (3/9)	Data for 7/1 through 7/15 and 8/5. Rest of data (through September removed because of negative restivities). Minimum and maximum values are of little value because of limited data set. Moisture has definite moisture influence.	Moisture trend is cyclic, reflecting the same curve as the temperature. If the temperature influence were removed, it is believed that the trend would be fairly flat, suggesting little or no infiltration.
	253	7.62	Useful	Undetermined (no nearby Type A logging available)	20.293 (8/20)	15.2400 (7/1)	14.650 (8/28)	8.3808 (2/23)	Data set is discontinuous because of removal of bad data. The moisture maximum occurs several times. Also, the maximum and minimum are not representative of entire data because some data were removed.	Cyclic, following muted temperature trend. True moisture trend appears to be rising but cannot be sure until the temperature influences are removed from the moisture data.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C) Maximum	Temperature (°C) Minimum	Soil Moisture Content Volumetric (%) Maximum	Soil Moisture Content Volumetric (%) Minimum	Comments	Moisture Content Trend
	242	9.69	Useful	Undetermined (no nearby Type A logging available)	19.878 (8/21)	2.6054 (3/11)	22.586 (8/20)	16.9160 (3/15)	Two data gaps in the file between 8/7 and 8/18 and 8/28 and 9/7. Minimum and maximum temperature and moisture content may not reflect true minimum and maximum. Minimum moisture content occurred frequently in early July. Maximum temperature and moisture occurred almost at the same time. Moisture content is muted reflection of temperature data.	Cyclic, following muted temperature trend. True moisture trend appears to be rising but cannot be sure until the temperature influences are removed from the moisture data. Possible spring 2002 infiltration event that is supported by nearby tensiometer data at the 10-ft level.
MM3-2	216	3.97	Useful	Undetermined (no nearby Type A logging available)	19.510 (8/5)	–1.9673 (3/2)	21.426 (8/22)	–11.0080 (7/19)	Much of August data missing from data set. Therefore, actual minimum and maximum may be different. Soil temperature impacts the moisture data.	Because the moisture trend is impacted by the soil temperature, it is difficult to tell the true trend. It appears to be slightly up.
	252	6.96	Useful	Undetermined (no nearby Type A logging available)	19.401 (8/28)	3.4334 (3/14)	15.227 (9/27)	12.6440 (7/26)	Data set is fairly continuous through the quarter. Therefore, the minimum and maximum are probably the true minimum and maximum. Data may not be impacted by soil temperature. If it is, it is very subtle.	Trend is fairly flat, perhaps slightly up. There is enough noise in the data to have sufficient scatter to make trend analysis difficult.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C)		Soil Moisture Content Volumetric (%)		Comments	Moisture Content Trend
					Maximum	Minimum	Maximum	Minimum		
	210	8.53	Useful	Undetermined (no nearby Type A logging available)	11.991 (8/22)	0.0697 (3/17)	27.904 (8/20)	21.0240 (3/18)	The data set includes data through 8/22. Soil temperature is impacting the moisture measurement. The maximum moisture occurred on 8/20, and if it could be believed, it would conclude that infiltration is occurring. However, this may not be true because the measurement reflects the rising soil temperature, not necessarily increasing moisture content.	The moisture trend is cyclic, reflecting the cyclical nature of the temperature. The true trend is probably flat.
MM3-3	254	7.46	Useful	Undetermined (no nearby Type A logging available)	22.474 (8/5)	1.2719 (3/12)	18.335 (8/5)	9.7065 (2/23)	Data set only includes data to August 5, so it is unlikely that the true maximum for temperature and moisture is captured. Soil temperature impacts the moisture data.	Cyclic, following temperature trend. Actual moisture content may be trending up slightly, but this is impossible to verify until temperature effects are removed from the moisture data.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C) Maximum	Temperature (°C) Minimum	Soil Moisture Content Volumetric (%) Maximum	Soil Moisture Content Volumetric (%) Minimum	Comments	Moisture Content Trend
	244	13.82	Useful	Undetermined (no nearby Type A logging available)	16.084 (9/14)	5.7843 (3/23)	8.803 (9/26)	4.3875 (3/20)	Missing data intervals include 8/7 through 8/18 and 8/28 through 9/7. Low-moisture content occurred several times during early July. High-moisture content also occurred several times in late September. The moisture content readings are influenced by soil temperature. The temperature influence must be removed before moisture content measurements can be trusted (provided the instrument is calibrated for existing soil conditions).	The moisture trend is a cyclic reflection of the temperature trend. The real moisture trend may be slightly up.
	225	17.00	Useful	Undetermined (no nearby Type A logging available)	8.042 (1/22)	4.4071 (5/9)	65.688 (6/29)	58.5490 (6/2)	Data include measurements through 7/15 and one reading on 8/5. The minimum moisture content occurred numerous times in early July. The probability of capturing the actual minimum and maximum measurements in the limited data set is unlikely. Moisture is probably influenced by the temperature but more subtly than some of the other probe measurements.	Moisture trend appears to be slightly cyclic in response to soil temperature. The trend at the middle of July 2003 appeared to be slightly down or flat, but because of the missing data, nothing can be said for the trend at the end of the quarter.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C) Maximum	Temperature (°C) Minimum	Soil Moisture Content Volumetric (%) Maximum	Soil Moisture Content Volumetric (%) Minimum	Comments	Moisture Content Trend
PIT5-4	289	2.81	Useful	Undetermined (no nearby Type A logging available)	28.217 (7/24)	0.3022 (3/6)	18.899 (4/23)	9.2151 (3/6)	Data set mostly complete, only missing data between 8/25 and 8/28. Minimum and maximum probably captured in data. Data appear to be influenced by temperature. Probe close to the surface so temperature reflects large swing. Because the soil is wetter on 9/21 than on 7/17, infiltration may have occurred. However, this is probably not the case, as the temperature is impacting moisture inversely. That is, when the temperature is high, moisture is low, or when the temperature is low, moisture is high. This is probably the effect of a dropping temperature.	The trend is inversely correlated to the temperature trend. Real trend may be flat, but there is also a possible infiltration event in the April-May timeframe. The timing of the maximum moisture content is consistent with infiltration.
	288	4.39	Nonfunctioning							
	279	8.18	Useful	Undetermined (no nearby Type A logging available)	20.398 (9/11)	5.7618 (3/19)	23.454 (3/6)	16.5370 (4/10)	Have entire data set. Data do not appear to be impacted by soil temperature, and suggest that slight wetting may be occurring.	Trend is slightly upward.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C)		Soil Moisture Content Volumetric (%)		Comments	Moisture Content Trend
					Maximum	Minimum	Maximum	Minimum		
	285	10.16	Useful	Undetermined (no nearby Type A logging available)	18.203 (9/17)	8.2643 (4/3)	27.049 (8/30)	19.8120 (3/16)	Only small data gap (8/25 through 8/28), otherwise, data set is intact. Minimum and maximum probably captured in data. Data appear to have only a slight temperature effect. It is interesting that the high occurred about a week after the low.	Trend ever so slightly reflects the cyclic nature of the temperature. The data seem to indicate a wetting event starting toward the end of May. When temperature is removed from moisture, wetting front will be revisited. The true moisture trend appears to be rising.
PIT5-TW1	290	2.85	Useful	Undetermined (no nearby Type A logging available)	26.512 (7/25)	0.1296 (3/6)	14.320 (11/18)	8.5118 (7/14)	Data set mostly complete, only missing data between 8/25 and 8/28. Minimum and maximum probably captured in data. Data appear to be inversely influenced by temperature, notice temperature high and moisture low close to the dates. Possible wetting event in early February 2003.	Moisture trend is probably fairly flat, but temperature influence needs to be removed. Slight infiltration may have occurred in early February 2003.
	291	8.22	Useful	Undetermined (no nearby Type A logging available)	17.808 (9/11)	6.0831 (3/15)	42.919 (8/17)	41.0410 (4/2)	Entire data set exists. The high-moisture content occurred several times in late August and September. The moisture data appear to be impacted by soil temperature to a slight extent.	Although the moisture trend is slightly cyclic, reflecting soil temperature influence, the true moisture trend appears to be moving upward at a slight pace.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C) Maximum	Temperature (°C) Minimum	Soil Moisture Content Volumetric (%) Maximum	Soil Moisture Content Volumetric (%) Minimum	Comments	Moisture Content Trend
	282	10.24	Useful	Undetermined (no nearby Type A logging available)	14.995 (9/22)	5.9485 (3/25)	99.906 (9/28)	4.8326 (5/28)	The low-moisture content is believed to be a bad reading. Obviously, the 99 moisture content is out of the reasonable range, but the trend for moisture data may be usable if the temperature influence was removed. Possible slight wetting in February 2003.	Long-term trend is cyclic because of temperature effects. If that were removed, the trend would be moving up slightly. Possible bump in trend signifies slight wetting in February.
MM4-1	287	6.3	Probably useful							
	286	14.67	Recently useful	Soil	N/A	N/A	47.540 (8/3)	N/A	—	Perhaps up, but not enough data to determine trend.
	272	16.72	Questionable							
	233	19.44	Questionable							
MM4-2	275	4.72	Recently useful	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A	Data available for the fourth quarter. Needs to be monitored further.	Moisture data seem to be trending upward, but this may simply be a reflection of temperature influence on the data. Data need to be monitored further before making a decision.
	273	12.08	Questionable		N/A	N/A	N/A	N/A		
	223	17.39	Questionable		N/A	N/A	N/A	N/A		
MM4-3	255	4.80	Recently useful	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A		Not enough data to do a trend analysis.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C)		Soil Moisture Content Volumetric (%)		Comments	Moisture Content Trend
					Maximum	Minimum	Maximum	Minimum		
	275	6.18	Recently useful	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A		Not enough data to do a trend analysis.
	218	9.11	Recently questionable		N/A	N/A	N/A	N/A		
MM4-4	257	4.17	Nonfunctioning		N/A	N/A	N/A	N/A		
	256	8.72	Questionable		N/A	N/A	N/A	N/A		
	274	10.86	Questionable		N/A	N/A	N/A	N/A		
	230	11.2	Questionable		N/A	N/A	N/A	N/A		
MM4-5	239	9.74	Questionable		N/A	N/A	N/A	N/A		
	234	13.88	Questionable	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A		Not enough data to do a trend analysis.
SVR-12	281	4.3	Questionable	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A		
	283	8.39	Questionable	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A		
	284	11.45	Questionable	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A		
SVR-20	260	4.43	Questionable	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A		

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C)		Soil Moisture Content Volumetric (%)		Comments	Moisture Content Trend
					Maximum	Minimum	Maximum	Minimum		
	258	17.44	Recently useful	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A	Insufficient FY 2003 data.	Early data appear to have an inverse temperature influence. Not enough FY 2003 data to determine a trend. Data noisy.
	259	13.79	Recently useful	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A	Insufficient FY 2003 data.	Early data appear to have an inverse temperature influence. Not enough FY 2003 data to determine a trend. Data noisy.
DU-8	265	6.14	Questionable		N/A	N/A	N/A	N/A		
	269	11.5	Questionable		N/A	N/A	N/A	N/A		
	270	17.86	Nonfunctioning		N/A	N/A	N/A	N/A		
DU-14	280	4.47	Recently useful	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A	Some data available from third quarter.	Third quarter trend seems to be flat.
	278	9.83	Questionable		N/A	N/A	N/A	N/A		
	276	15.2	Questionable		N/A	N/A	N/A	N/A		
DU-10	263	3.97	Recently useful	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A	The DU-10 probes have generated some data during the fourth quarter but not enough to interpret.	Not enough data to do a trend analysis.
	271	6.64	Recently useful	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A	The DU-10 probes have generated some data during the fourth quarter but not enough to interpret.	Not enough data to do a trend analysis.

Table 5-1. (continued).

Cluster	Probe	Probe Depth (ft)	Probe Functionality	Probe Location in Subsurface Material	Temperature (°C)		Soil Moisture Content Volumetric (%)		Comments	Moisture Content Trend
					Maximum	Minimum	Maximum	Minimum		
	277	6.72	Recently useful	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A	The DU-10 probes have generated some data during the fourth quarter but not enough to interpret.	Not enough data to do a trend analysis.
	264	9.25	Recently useful	Undetermined (no nearby Type A logging available)	N/A	N/A	N/A	N/A	The DU-10 probes have generated some data during the fourth quarter but not enough to interpret.	Not enough data to do a trend analysis.

N/A = not enough data to make reasonable picks

5.6 Summary of Temperature Data

Temperature extremes and the dates they occurred for each SMR probe location are presented in Table 5-1. Temperature data for the SMR probes reflected seasonal trends. However, timing of the trends appears to be dependent upon depth. The shallower the probe, the more nearly it matched surficial air temperatures. Deeper probes had significant lag times. Shallow probes, less than 6 ft, generally had a minimum temperature in early to late March and a maximum temperature in mid-July to late August. Deep probes, greater than 13 ft, generally had a low temperature in mid-May to early June and a maximum temperature in October to early November.

The range of temperature fluctuations is also depth dependant. The largest temperature swings are in the shallow probes (less than 4 ft deep), and the smallest temperature changes are in the deepest probes (greater than 15 ft deep). Temperature impacts moisture measurements for many of the probes. In some cases, the cyclic curves of the temperature and moisture mirror each other. In other cases, the high and low peaks are reflected in the moisture data. In still other cases, the temperature and moisture are inverses of each other. It is desirable to remove the temperature impacts on the moisture data. This is usually done by applying a correction equation to the raw moisture data.

5.7 Issues

Several issues have emerged as crucial for maintaining and obtaining quality data. They are listed in the following headings in order of importance.

5.7.1 Temperature Influence on Moisture Data

The 2003 data collected from the SMR probes were analyzed quarterly (Q1, Q2, and Q3) and presented in quarterly reports. The Q2 report discussed the cyclic nature of some of the moisture data, suggesting that soil temperature might be impacting the moisture measurements.

After reviewing all of the FY 2003 data, it is believed that many of the moisture measurements are impacted by soil temperature. A good example of moisture measurements that appear impacted by temperature can be seen in Probe MM3-1-245, installed at a depth of 4.47 ft bls (see Appendix C, p. C-10). The moisture (dark blue) and the temperature (red) traces parallel each other from early 2002 through July 2003. Time is on the x-axis, while moisture content and temperature are on the y-axis. Both traces are elevated during the summer, reaching a peak in August and then falling off to a low in February. While this is reasonable for the temperature, the moisture trend would not be expected to identically mirror the temperature trend. Near surface, moisture conditions are normally wettest in March and driest in September.

Other moisture data appear to be impacted by temperature as well, even though the impact is subtle. An example of a more subtle temperature impact on moisture can be seen in Probe MM2-3-229, installed at a depth of 6.98 ft bls (see Appendix C, p. C-9). Again, dark blue represents the moisture measurements, while the red is the temperature. Here, the traces do not parallel each other, but the peak moisture readings still correspond with the maximum temperature measurements.

In other cases, temperature can influence moisture readings inversely. Probe 743-03-235, installed at a depth of 3.36 ft bls (see Appendix C, p. C-4), is an example of an inverse relationship between moisture and soil temperature. Here, the moisture (dark blue) is at a minimum when the temperature (red) is at a maximum.

Literature provided by ARA, the SMR probe developer, acknowledges the temperature effects on soil moisture but suggests that unless the temperature significantly exceeds the range of 10°C to 30°C, the effect is expected to be negligible (Conklin et al. 1999). The ARA further states that they have found the soil moisture sensor to be sensitive to the known variation of dielectric permitivity with temperature (ARA 2003). The literature from ARA also provides an equation that should remove the temperature effects when it is applied to the raw data. The ARA tested the SMR probe in a variety of soils of differing textures, organic contents, and controlled moisture conditions to develop a calibration equation that relates the dielectric-proportional probe response to volumetric soil moisture. When contacted, the ARA representative provided the equation and indicated that if it did not remove the temperature influences, he was willing to work with the INEEL to develop a Site-specific equation that, when applied to the raw moisture readings, should remove the temperature effects. The difficulty is that no raw data are being collected. An attempt to back-calculate the raw data for equation application and potential use in development of the Site-specific equation has been made. However, it is strongly recommended that several dataloggers be programmed to collect the raw data as well as processed data for the next quarter. With both raw and processed data, the equation can be developed and tested for removing the temperature from the moisture data. When the equation is validated, it can be added to the processing.

5.7.2 Resistivity Measurements

The quarterly reports have been reporting restistivity values measured by the SMR probes. The Q2 report states that the trend in resistivity data should be opposite that of the moisture content data. That is, as the moisture content increases, the soil becomes more conductive, and resistance decreases. Further, the report states that the consistency between the resistivity and soil moisture data is not clear because the resistivity data exhibit significant variability. Variability in resistivity may result from the above moisture-temperature issue, from salinity changes, or from RWMC clays. The SMR probes were evaluated at the INEEL using RWMC soil. The conclusion was that the resistivity data proved to be so erratic as to be meaningless for INEEL applications. These observations lead to the recommendation to discontinue reporting resistivity data (therefore, that data are not included in this report). Should temperature effects be successfully removed from the SMR data, the utility of the resistivity data can be revisited.

5.7.3 Trend Reporting

Past practices have been to remove data from the data set that were considered bad (e.g., negative moisture and extreme temperatures). It is recognized that negative moisture cannot occur, but if trends and not absolute values are looked at, the trends of the negative moisture might be good while the actual values are not. In the future, it is our intent to look at the trends of the negative moisture values to determine if there is usable data that can be extracted.

5.7.4 Nonfunctioning Probes

During the fourth quarter (FY 2003) and continuing into FY 2004, the design engineer has worked with the SMR probes to resolve problems. Work included the following activities:

- SMR probes were individually interrogated to collect readings and determine functionality.
- All dataloggers have been reprogrammed with calibrations for the SMR probes that had corrupt calibrations.
- SMR probe communication wiring was reconfigured so that each probe is on an individual RS-485 driver. This corrected communication problems originating from star-patterned topology.

This work resulted in successfully bringing several clusters of SMR probes back online that had not been functioning for a long period. These probes are listed at the end of Table 5-1, with "N/A" designating their minimum and maximum temperature and moisture content values. Because they have just recently come back online, so little data were available that it was not considered meaningful to present minimum and maximum data points.

5.7.5 Salinity

Salinity increases or changes may be impacting the moisture content as well as the resistivity. It might prove beneficial to conduct laboratory tests to evaluate the salinity and resistivity impact on moisture content.

5.8 Recommendations

The following recommendations are critical to ensure integrity of the project and quality data:

- Collect raw and processed data from the SMR probes for FY 2004
- Develop and apply a temperature correction equation to the moisture probe measurements
- Calibrate SMR probes with the neutron probe in areas where Type A probes or neutron access tubes exist
- Perform controlled experiments to determine impact of soil resistivity and salinity on moisture measurements.

6. VISUAL PROBE

6.1 Introduction

Visual probes, as shown in Figures 1-1 and 1-2, are constructed from steel rods, stabilizers, tool joints, and Lexan tubes. The steel rods, stabilizers, and tool joints form a framework inside the Lexan tube that becomes sections of the visual probe. The first section of a visual probe has a drive point and is advanced into the ground using a sonic drill rig. Additional sections, 4 ft long, are added to the visual probe as needed to reach the required depth. The interior of the probe then provides access to the interior of the landfill or subsurface soil structure, and the waste or soil structure can be viewed through the clear Lexan tube. The *OU 7-13/14 Integrated Probing Project Type B Probes Visual Probe Design* (Clark 2001b) describes the construction and design specifications of the visual probes installed for this program.

Ten visual probes were placed in the SDA. Three each were placed in the organic sludge focus area (743), the DU focus area, and the Pit 9 focus area (P9). One was placed in the americium and neptunium focus area (741). The locations of the probes are shown in the figures in Appendix A, and the detailed data for each probe are contained in Appendix B (see Table B-1 in Appendix B).

6.2 Methods

The procedure for logging video probes is "Visual Probe Logging Procedure" (TPR-1671). This procedure uses a commercially available borehole camera and records the visual images on standard VHS videotapes. The borehole camera uses a small-diameter fiber-optic cable that is lowered down the visual probes. The end of the fiber-optic cable has a lens and light source, and the end can be articulated or bent up to approximately a horizontal position to see the side of the hole through the Lexan tube. The borehole camera was not used in FY 2003 to record images from the visual probes. The previous videotape borehole logs are available in the project files and the Hydrologic Data Repository.

In September 2002 and March 2003, the visual probes were logged with an optical televiewer by a technical services contractor. The optical televiewer is a visual logging tool that can take a picture of the entire 360-degree interior of the visual probe in thin horizontal slices. The horizontal slices are placed in a digital file to create a complete visual record of the interior of the probe. The optical televiewer uses a rotating mirror in the end of the tool to illuminate the wall of the borehole and take the circumferential pictures. The images are displayed by splitting the image longitudinally and laying the image out flat, similar to cutting a tube longitudinally and opening the tube up and placing it flat on a table with the interior surface facing up. All of the visual probes were logged with the optical televiewer, except for Cluster 743-18V and the visual probes in Pit 9 (see Figure A-4 in Appendix A). The visual probes in Pit 9 were not logged because construction activities for the retrieval demonstration prevented access to the probes. The images are available on CD in the project files; on a share drive, Hbb2/optical_televiewer; or in *Compilation of Analytical Notes and Data Analyses for the Integrated Probing Project 1999–2002* (Josten 2002). The images recorded in March 2003 are in Appendix E.

6.3 Results

Logging with the borehole camera evolved into an effective technique to observe and evaluate subsurface waste and soil structure. To start the logging efforts, technicians learned how to use and operate the borehole camera system and were challenged to find ways to produce steady images with a thin fiber-optic cable hanging down the inside of the visual probes. They gained experience operating the system and developed a way to stabilize the fiber-optic cable by running it through a PVC pipe that

lessened movement of the end of the cable and provided directional control. The borehole camera provides good microscale images of the borehole interior.

The optical televiewer provides a good macroscale image of the interior of the visual probes. The image of Probe 741-08-V shows the cover soil over the americium and neptunium focus area in Pit 10 (see Figure A-5 in Appendix A). Near the bottom of the log, a layer of yellow and translucent waste is shown, which is probably personal protective equipment. Probes 743-03-V, 743-08-V, and 743-18-V are in the organic sludge focus area in Pit 4. The log of Probe 743-03-V shows a change in soil texture between 5 and 7 ft and a distinct change in soil color below 7 ft that can be attributed to the presence of waste. The log for Probe 743-08-V has recorded some very distinct waste near the bottom of the hole that appears to be light blue in color and cloudy or translucent. It's difficult to determine what this waste could be, but it may be some translucent plastic sheeting the probe has penetrated. Discoloration of the Lexan also could be caused by carbon tetrachloride degradation of the polycarbonate. Probe 743-18-V cannot be logged because rust and corrosion on the inside of the probe collect on the clear plastic window of the optical televiewer and make it impossible to get a good image. Probes DU-08-V, DU-10-V, and DU-14-V are in the DU focus area in Pit 10. The log of Probe DU-08-V shows overburden soil down to a depth of about 7 ft, where a white object can be seen in the soil. Below this depth, the color changes to a lighter brown, and darker-colored objects and fragments can be seen to the bottom of the probe. Probe DU-10-V is a short probe and shows a distinct change in soil color at a depth of approximately 7 ft, which may be the overburden and waste interface. The log for Probe DU-14-V has dark areas showing up in the soil below a depth of 7 ft and below 10 ft down to the bottom of the probe. At about 1 ft more, several dark images are seen that may be fragments or large pieces of waste. The depths in the optical televiewer logs are based on the collar of the probe and have not been adjusted for probe stickup.

6.4 Conclusions

The visual probes are a useful tool to gain access to and record images of the subsurface soil and waste. The visual probes coupled with the optical televiewer provide information that can define waste and soil interfaces, changes in color in the waste and soil matrix, and images of waste fragments and pieces. The borehole camera provides images on a much smaller scale and is useful for examining smaller features and details in the borehole. The visual probes have provided a unique opportunity to physically see the soil and waste in selected parts of the SDA. While current plans for remedial activities do not include use of the visual probes, they can be used again if experience with ongoing activities indicates visual probes would be beneficial.

7. TYPE A PROBE

7.1 Methods

Forty-eight new Type A probes were installed during FY 2003. Much of the first half of the year was spent planning probe locations, using waste inventory records and surface geophysics data. New probes were installed in August–September and were logged beginning in September using a nuclear logging suite consisting of passive spectral gamma-ray, passive neutron, neutron-activated spectral gamma-ray, and moisture logging methods. Logging data from the first 37 new probes were received from the subcontractor near the end of FY. Preliminary analysis was conducted, which consisted of identifying contamination areas and comparing contamination type with waste inventory information. The investigation of quantitative analysis methods for estimating VOC chlorine mass continued throughout the year. This work focused on calibration of the neutron-activated spectral gamma-ray tool under variable conditions. At the beginning of FY 2004, a major effort was begun to collect and archive all the SDA surface and downhole geophysical data into a permanent on-Site archive.

7.2 Results

The following list of FY 2003–early FY 2004 logging program activities reflects an effort to capture and document the status and history of the program through the end of January 2004.

7.2.1 Comprehensive Logging and Surface Geophysics Data Analysis Summary—October to December 2002

Results and notes from previous unpublished analysis efforts pertaining to Type A probe selection, installation, logging, and interpretation were published in December 2002 in *Compilation of Analytical Notes and Data Analyses for the Integrated Probing Project 1999–2002* (Josten 2002). The report contains numerous summaries and discussions of probe planning and probing results for the first 148 Type A probes installed at the SDA. Appendix A of *Compilation of Analytical Notes and Data Analyses for the Integrated Probing Project 1999–2002* also contains a previously unpublished surface geophysics report for SDA Pits 4, 6, and 10.

7.2.2 Select and Screen New Fiscal Year 2003 Type A Probes—December 2002 to April 2003

Eight new study areas were identified for exploration with new Type A probes in FY 2003. The screening process for these study areas consisted of the following activities:

- Selecting waste shipments of interest using the INEEL WasteOScope database system
- Evaluating surface geophysics and selecting preliminary Type A probe locations
- Identifying inconsistencies or uncertainties between the waste inventory data and the surface geophysics
- Selecting those study areas and probe locations judged to have the best chance of achieving the program objective.

New high-resolution geophysical data were collected to support final probe selection (see Section 7.2.4). After several revisions and review by program management and participating federal and state agencies, 37 new probes were planned for eight study areas as summarized in Table 7-1 and Figure 7-1.

7.2.3 Technical Specifications for Fiscal Year 2003 Geophysical Logging—February to March 2003

A technical specification (SOW-561) describing subcontractor requirements for geophysical logging of the new probes was prepared. The technical specification was based on the specification used to procure logging services in previous SDA logging campaigns so that the data would be comparable to earlier results. Data processing, tool calibration, and data delivery requirements were refined to improve the long-term utility of the data. The new specification required vendor data submittals for the purpose of documenting work procedures, tool calibration certificates, tool designs, and data processing methodology. These items will be needed by the INEEL if detailed quantitative analysis is desired in the future.

7.2.4 Surface Geophysics Surveys—July to August 2003

The effort to select new FY 2003 study areas and Type A probe locations used surface geophysics data to attempt to identify the approximate position of targeted waste shipments. New high-resolution magnetic and time-domain electromagnetic surveys were conducted to support probe selection for Study Areas 1A, 1B, 1C, and 1D as shown in Figure 7-2. (Note that no probes were installed in Study Area 1C during the initial FY 2003 campaign [because of a scope reduction].)

Table 7-1. Summary of new Fiscal Year 2003 Type A probe study areas.

Study Area	Location	Target Waste Type	Number of Probes	Probes
1A	Trench 3	Enriched uranium	4	T3-UE-01, T3-EU-02, T3-EU-03, and T3-EU-04
1B	Trench 47	Irradiated fuel	4	T47-IF-1, T47-IF-2, T47-IF-3, and T47-IF-4
1D	Outside known pits and trenches	Undocumented disposals	9	UD-01, UD-03, UD-03B, UD-04, UD-05, UD-05B, UD-05C, UD-05D, and UD-05E
2	Trench 24	High-activity liquid	4	HAL-1, HAL-2, HAL-3, and HAL-4
3	Pit 5	Uranium and enriched uranium	8	P5-UEU-1, P5-UEU-2, P5-UEU-3, P5-UEU-4, P5-UEU-5, P5-UEU-6, P5-UEU-7, and P5-UEU-8
4	Pit 10	Plutonium in vicinity of Cluster 741-08	2	741-10 and 741-11
5	Pit 6	Plutonium	3	P6-PU-1, P6-PU-2, and P6-PU-3
6	Pit 10	Plutonium	3	P10-PU-1, P10-PU-2, and P10-PU-3

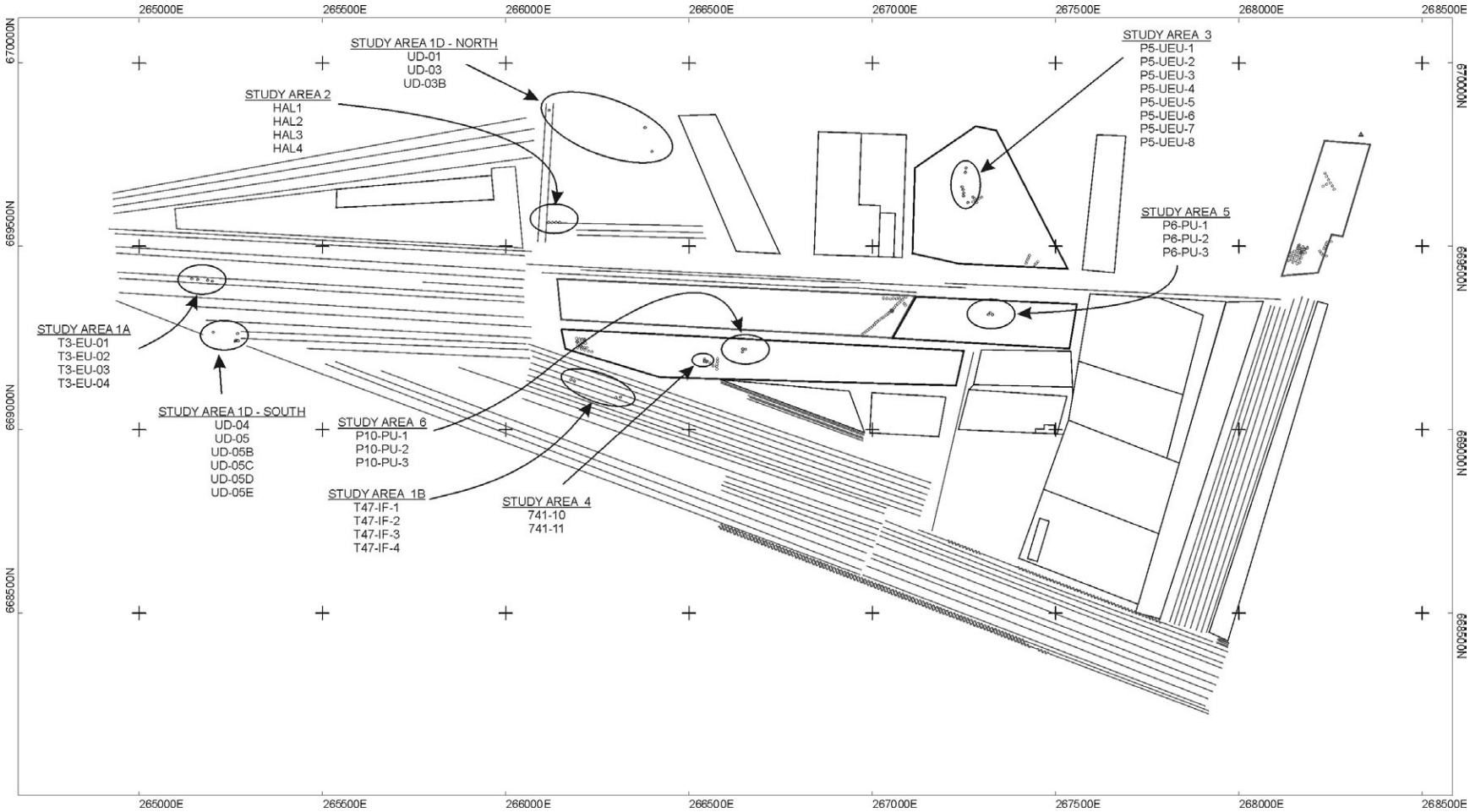

Figure 7-1. Index map for Fiscal Year 2003 Type A study areas and probes.

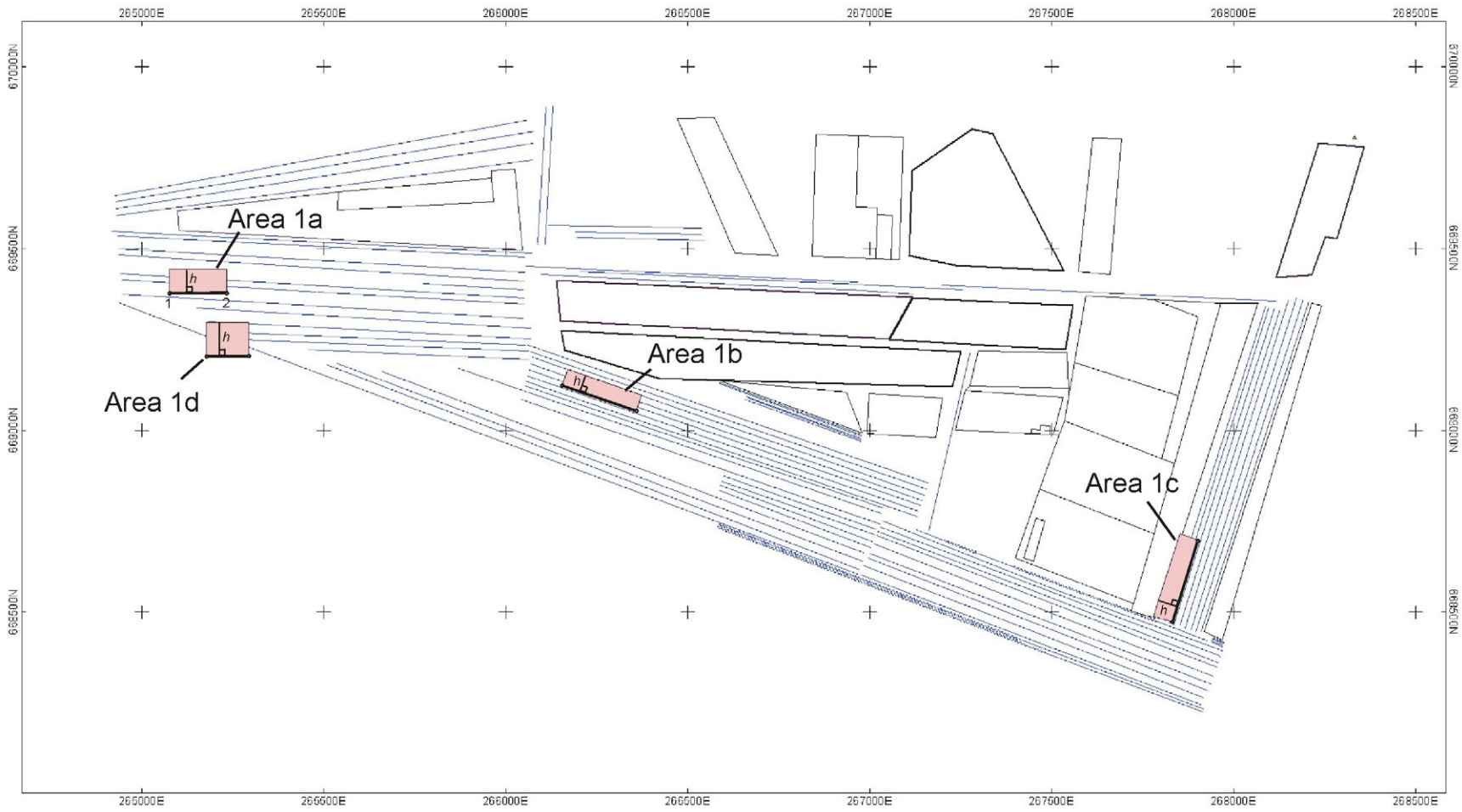

Figure 7-2. Index map Fiscal Year 2003 surface geophysics surveys used to support study area and probe selection.

Waste shipment manifests contain information regarding the types and quantities of waste containers and the composition of waste masses. Typically, the geophysical data serve to identify the presence or absence of metallic containers or massive metal objects and are therefore useful for identifying probe locations that are consistent with waste manifest information.

7.2.5 Analysis of Chlorine Logging Data for Organic Contamination in the Vadose Zone—July to October 2003

In FY 2002, the Organic Contamination in the Vadose Zone Project initiated a program to analyze Type A logging data for the purpose of quantifying VOC levels within SDA buried waste. The draft document produced from this effort, "Preliminary Estimate of Carbon Tetrachloride and Total Volatile Organic Carbon Compound Mass Remaining in Subsurface Disposal Area Pits (Draft),"[a] is still in technical review. The Organic Contamination in the Vadose Zone Project is resolving technical issues inherent to the problem of quantifying VOC levels using geophysical logging data. The FY 2003 efforts were focused on logging-tool calibration under highly heterogeneous subsurface conditions. Preliminary work has shown that hydrogen content and bulk density can have pronounced effects on the logging tool response to chlorine. Corrections for these effects are being sought.

7.2.6 Analysis of Moisture Logs—September to October 2003

Results from FY 2003 soil moisture logs in several new probes indicated volumetric soil moisture contents exceeding 30 vol% within the first few feet of the subsurface. The moisture content results were considered unusual because of recent excessively dry conditions at the SDA. A soil sampling effort was initiated to verify the moisture results.

Laboratory moisture measurements of the verification soil samples generally agreed with the logging results and serve to validate the moisture logging tool performance and calibration. Details of this moisture study may be obtained by INEEL internal correspondence.[b,c,d] Soil sampling results in weight percent are listed in Table 7-2, along with a computed value for the corresponding volume percent to facilitate comparison with moisture logging data. The conversion between weight percent and volume percent depends on the soil dry bulk density, which was taken as 1.44 g/cc based on previous SDA soil sampling data (McElroy an Hubbell 1990).

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a. INEEL, 2004, "Preliminary Estimate of Carbon Tetrachloride and Total Volatile Organic Carbon Compound Mass Remaining in Subsurface Disposal Area Pits (Draft)," INEEL/EXT-02-00140, Rev. B, Idaho National Engineering and Environmental Laboratory.

b. T. J. Meyer, INEEL, Memorandum to J. L. Casper, INEEL, "Soil Sampling for Nuclear Logging Soil Moisture Verification," September 4, 2003.

c. Carol Strong, INEEL, Memorandum to T. J. Meyer, INEEL, "Soil Sampling for Nuclear Logging Soil Moisture Verification," September 15, 2003.

d. Nicholas E. Josten, INEEL, Memorandum to T. J. Meyer, INEEL, "Summary of Soil Moisture Investigation on New SDA Probes," October 9, 2003.

Table 7-2. Summary of sampling and logging results.

Well_ID	Sample_ID	Depth	Soil Sampling Weight Percent	Soil Sampling Volume Percent	Nuclear Logging Volume Percent
P5-UEU-4	SMV00601M7	1	19.5	28.1	19.2
P5-UEU-4	SMV00701M7	2	22.2	32.0	32.2
P5-UEU-4	SMV00801M7	3	24.5	35.3	32.0
UD-01	SMV00301M7	1	13.4	19.3	16.2
UD-01	SMV00401M7	2	16.6	23.9	22.2
UD-01	SMV00501M7	3	19.3	27.8	22.3
HAL1	SMV00001M7	1	8.4	12.1	7.0
HAL1	SMV00101M7	2	7.9	11.4	8.5
HAL1	SMV00201M7	3	6.8	9.8	11.5

7.2.7 Analysis of Type A Logging Data for Areas 1A, 1B, 1D, 2, 3, 4, 5, and 6—September to November 2003

This report gives a brief summary of downhole logging results for the 37 new probes installed during FY 2003. These study areas are located in the western half of the SDA as shown in Figure 7-1. Table 7-3 gives a summary, by probehole, of the logged depths for each of the four logging tools employed. (Minimum and maximum logging depths are given in feet below ground surface.)

The man-made radionuclides are segregated into three groupings: cobalt, cesium, and europium; plutonium, americium, and neptunium; and uranium. These groupings characterize distinct waste streams. The other common waste constituent, chlorine, is shown in the chart summaries together with hydrogen because the logging tool response to these elements is known to be highly interdependent. A detection summary for the common man-made radionuclides and chlorine is presented in Table 7-4. (Value displayed corresponds to the highest apparent concentration observed in each probehole.)

Table 7-3. Logging completion summary for new Fiscal Year 2003 probes.

Study Area	Probe	Passive Neutron Minimum (ft bgs)	Passive Neutron Maximum (ft bgs)	Passive Gamma Minimum (ft bgs)	Passive Gamma Maximum (ft bgs)	N-Gamma Minimum (ft bgs)	N-Gamma Maximum (ft bgs)	Moisture Minimum (ft bgs)	Moisture Maximum (ft bgs)
1A	T3-EU-01	2.30	17.60	2.0	18.00	2.0	16.90	0.30	18.10
1A	T3-EU-02	2.30	20.90	2.0	21.40	2.0	20.30	0.30	21.40
1A	T3-EU-03	2.30	11.00	2.0	11.40	2.0	10.30	0.30	11.50
1A	T3-EU-04	2.30	12.60	2.0	12.20	2.0	11.90	0.30	13.10
1B	T47-IF-1	2.30	10.70	2.0	11.10	2.0	10.00	0.30	11.10
1B	T47-IF-2	2.30	9.90	2.0	10.30	2.0	9.30	0.20	10.40
1B	T47-IF-3	2.30	10.70	2.0	11.00	2.0	10.00	0.20	11.10
1B	T47-IF-4	2.30	8.80	2.0	9.20	2.0	8.20	0.20	9.30
1D	UD-01	2.24	9.58	2.0	10.02	2.0	8.95	0.25	10.13
1D	UD-03	2.25	3.65	2.0	4.04	2.0	3.03	0.25	4.13
1D	UD-03B	2.25	13.84	2.0	14.22	2.0	13.22	0.25	14.33
1D	UD-04	2.25	13.40	2.0	13.86	2.0	12.81	0.25	13.91
1D	UD-05	2.25	3.62	2.5	4.03	2.0	2.83	0.25	4.13
1D	UD-05B	2.25	4.13	2.0	4.49	2.0	3.48	0.25	4.60
1D	UD-05C	2.25	4.42	2.0	4.80	2.0	3.75	0.25	4.86
1D	UD-05D	2.25	4.56	2.0	4.92	2.0	3.92	0.25	5.00
2	HAL-1	2.30	19.20	2.0	19.70	2.0	18.60	0.30	19.70
2	HAL-2	2.30	21.60	2.0	22.00	2.0	21.00	0.20	22.10
2	HAL-3	2.30	7.80	2.0	8.20	2.0	7.10	0.30	8.20
2	HAL-4	2.30	12.00	2.0	12.50	2.0	11.40	0.30	12.50
3	P5-UEU-1	4.24	17.60	4.0	18.11	4.0	17.12	0.25	18.16
3	P5-UEU-2	4.23	17.30	4.0	17.76	4.0	16.68	0.25	17.75
3	P5-UEU-3	4.24	15.24	4.0	15.74	4.0	14.66	0.25	15.80
3	P5-UEU-4	4.25	16.80	4.0	17.27	4.0	16.18	0.25	17.29
3	P5-UEU-5	4.25	15.26	4.0	15.70	4.0	14.66	0.25	15.79
3	P5-UEU-6	4.24	15.06	4.0	15.51	4.0	14.46	0.25	15.57
3	P5-UEU-7	4.25	16.19	4.0	16.64	4.0	15.54	0.25	16.71
3	P5-UEU-8	4.25	11.26	4.0	11.72	4.0	10.64	0.25	11.74
4	741-10	4.24	19.20	4.0	19.67	4.0	18.56	0.25	19.69
4	741-11	4.25	19.32	4.0	19.73	4.0	18.66	0.25	19.76
5	P6-PU-1	4.25	19.59	4.0	19.89	4.0	18.82	0.25	19.92
5	P6-PU-2	4.25	19.43	4.0	20.06	4.0	19.02	0.25	20.05
5	P6-PU-3	4.25	7.38	4.0	7.80	4.0	6.74	0.25	7.88
6	P10-PU-1	4.24	5.10	4.0	5.54	4.0	4.48	0.25	5.58
6	P10-PU-2	4.24	9.60	4.0	10.07	4.0	8.97	0.25	10.10
6	P10-PU-3	4.25	19.86	4.0	20.31	4.0	19.26	0.24	20.50

Table 7-4. Contamination detection summary for new Fiscal Year 2003 probes.

Study Area	Probe	Cs-137 (pCi/g)	Co-60 (pCi/g)	Eu-154 (pCi/g)	Pu-239 (nCi/g)	Am-241 (nCi/g)	Np-237 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Chlorine (counts/ second)
1A	T3-EU-01	3.2	5.0	ND	ND	ND	ND	ND	ND	2.9
1A	T3-EU-02	5,504.8	1.0	ND	ND	ND	ND	26.5	1,235.7	8.0
1A	T3-EU-03	31.7	ND	ND	ND	ND	ND	3.4	178.8	2.0
1A	T3-EU-04	0.3	ND	ND	ND	ND	ND	ND	22.9	1.2
1B	T47-IF-1	1,942.9	3.4	14.3	ND	ND	ND	ND	ND	1.1
1B	T47-IF-2	2,295.5	13.2	4.8	ND	ND	ND	ND	ND	1.2
1B	T47-IF-3	3.2	24.6	ND	ND	ND	ND	ND	ND	ND
1B	T47-IF-4	8.9	0.2	ND	ND	ND	ND	ND	ND	1.4
1D	UD-01	ND	ND	ND	ND	ND	ND	ND	ND	2.3
1D	UD-03	ND	ND	ND	ND	ND	ND	ND	ND	ND
1D	UD-03B	ND	ND	ND	ND	ND	ND	ND	ND	1.1
1D	UD-04	42.1	157.7	ND	ND	ND	ND	ND	ND	1.3
1D	UD-05	ND	ND	ND	ND	ND	ND	ND	ND	0.9
1D	UD-05B	0.5	ND	ND	ND	ND	ND	ND	ND	ND
1D	UD-05C	0.3	ND	ND	ND	ND	ND	ND	ND	ND
1D	UD-05D	0.4	ND	ND	ND	ND	ND	ND	ND	ND
1D	UD-05E	1.9	ND	ND	ND	ND	ND	ND	ND	2.3
2	HAL-1	0.3	ND	ND	ND	ND	ND	ND	ND	0.6
2	HAL-2	6,773.5	228.0	5.5	ND	ND	ND	ND	ND	1.0
2	HAL-3	1.0	ND	ND	ND	ND	ND	ND	ND	ND
2	HAL-4	240.7	45.8	ND	ND	ND	ND	ND	ND	ND
3	P5-UEU-1	ND	0.3	0.8	3,074.7	872.5	12.2	ND	ND	38.7
3	P5-UEU-2	ND	ND	2.5	1,272.7	3,701.0	52.5	ND	363.8	4.9
3	P5-UEU-3	ND	ND	4.6	5,331.0	1,340.8	21.4	10.5	940.6	20.4
3	P5-UEU-4	ND	ND	4.6	31,924.9	7,469.7	96.5	26.4	2,102.5	34.6
3	P5-UEU-5	ND	ND	5.1	3,214.0	6,153.0	87.7	109.3	32,920.6	1.9
3	P5-UEU-6	ND	ND	10.5	2,399.7	4,114.9	62.3	ND	63.4	5.2
3	P5-UEU-7	ND	ND	1.8	1,180.1	1,842.6	26.4	2.8	ND	24.2
3	P5-UEU-8	1.7	ND	ND	219.0	ND	ND	ND	29.1	6.2
4	741-10	ND	ND	ND	ND	ND	ND	173.1	174.6	10.5
4	741-11	ND	ND	ND	ND	ND	ND	12.0	74.8	6.1
5	P6-PU-1	ND	ND	12.9	7,943.8	42,117.8	593.7	ND	573.8	5.3
5	P6-PU-2	ND	ND	1.0	1,590.9	1,129.6	12.1	ND	28.1	2.8
5	P6-PU-3	ND	ND	3.6	1,234.1	551.0	8.1	ND	ND	ND
6	P10-PU-1	ND	ND	ND	ND	ND	ND	ND	ND	1.3
6	P10-PU-2	ND	ND	ND	ND	ND	ND	ND	ND	14.6

Table 7-4. (continued).

Study Area	Probe	Cs-137 (pCi/g)	Co-60 (pCi/g)	Eu-154 (pCi/g)	Pu-239 (nCi/g)	Am-241 (nCi/g)	Np-237 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Chlorine (counts/ second)
6	P10-PU-3	ND	ND	ND	21.3	ND	ND	ND	ND	8.7
	MAX[a]	140.5	814.2	N/A	194,171.0	30,449.0	4,881.0	344.9	220,894.0	38.0
	PROBE	741-04	P9-FI-05	N/A	P9-20	743-08-02	DU-08	743-08	743-08	P9-03

a. Maximum observed value of radionuclide or element from previous Subsurface Disposal Area logging; no previous data available for Eu-154.

ND = nondetect

In general, logging results from the FY 2003 probes showed the same characteristics as have been observed in previous SDA logging. The same common radionuclide groupings—plutonium, americium, and neptunium; U-235 and U-238; and cesium and cobalt—that had been observed were prevalent throughout the new probes as well. The apparent radionuclide concentrations also were comparable, except that very high levels of Cs-137 were detected in several probes. Chlorine was widely detected throughout all the study areas, a finding that has been characteristic of all the SDA logging performed to date.

The following items are considered noteworthy:

- The logging data suggest the presence of enriched uranium in Probes P5-UEU-7, 741-10, and 741-11.
- High levels of Cs-137 and Co-60 were observed in Probes T3-EU-02, T47-IF-1, T47-IF-2, HAL-2, and HAL-4. The spectral gamma-ray detector was saturated by the high gamma-ray flux in HAL-2, and it was not possible to identify the peak contamination depth.
- Eu-154 was identified in many of the FY 2003 probeholes, where it was commonly associated with plutonium, americium, and neptunium contamination zones.
- High levels of natural potassium, uranium, and thorium were observed sporadically throughout the FY 2003 probes. As yet, no pattern or explanation has been proposed for these anomalies.

7.2.8 Analysis of Azimuthal Logging Data—December 2003 to January 2004

Azimuthal logging was conducted in 13 probes during November–December 2003 (see Table 7-5). Azimuthal logging is conducted with a hyper-pure germanium, gamma-ray detector contained within a slotted shield. During logging, the tool (and therefore the slot) is rotated through 360 degrees of azimuth, and a gamma-ray spectrum is acquired at 22.5-degree increments. The purpose of azimuthal logging is to detect heterogeneous radionuclide distributions as indicated by variation in gamma-ray flux with azimuthal direction. Logging depth is held constant during the azimuthal survey. In some cases, azimuthal surveys were conducted at multiple depths in a probehole. Fifty-seven azimuthal surveys were conducted during the November–December logging effort.

Table 7-5. Azimuthal logging data acquisition summary.

Study Area	Location	Target Waste Type	Probe	Probe Depth
1A	Trench 3	Enriched uranium	T3-EU-02	8.0
1A	Trench 3	Enriched uranium	T3-EU-03	8.0
1B	Trench 47	Irradiated fuel	T47-IF-1	8.0
1B	Trench 47	Irradiated fuel	T47-IF-2	8.0 and 10.0
2	Trench 24	Liquid waste	HAL-2	12.0 and 21.0
2	Trench 24	Liquid waste	HAL-4	12.0
3	Pit 5	Uranium and enriched uranium	P5-UEU-1	8.0, 8.5, 9.0, 9.5, 10.0, 10.5, 11.0, 11.5, 12.0, 12.5, 13.0, 13.5, 14.0, 14.5, 15.0, 15.5, and 16.0
3	Pit 5	Uranium and enriched uranium	P5-UEU-4	6.0, 7.0, 8.0, 9.0, 9.5, 10.0, 11.0, 12.0, 13.0, and 14.0
3	Pit 5	Uranium and enriched uranium	P5-UEU-5	11.0, 12.0, and 13.0
3	Pit 5	Uranium and enriched uranium	P5-UEU-7	10.0, 11.0, 12.0, 13.0, and 14.0
5	Pit 6	Plutonium waste	P6-PU-1	6.0, 7.0, 8.0, 9.0, 10.0, 11.0, and 12.0
5	Pit 6	Plutonium waste	P6-PU-2	9.0, 10.0, 11.0, 12.0, 13.0, and 14.0
5	Pit 6	Plutonium waste	P6-PU-3	7.74

Table 7-6 lists interpreted azimuthal peaks for the logs obtained during the FY 2003 logging campaign. The nuclides causing the azimuthal peaks and the quality of the peak are indicated along with the interpreted azimuth direction. The azimuthal peak characteristics may be used to precisely position additional Type A or Type B probes to investigate contaminants of interest.

Azimuthal logs were collected at 0.5-ft intervals from 8 to 16 ft in Probe P5-UEU-1. These logs provide useful insight into the heterogeneity of the SDA subsurface since they make it possible to observe the change in position of the radionuclide source with depth. The Probe P5-UEU-1 data reveal that approximate homogenous conditions occur at a few depths, but most depths indicate heterogeneous conditions (i.e., the waste containing the radionuclide source is not uniformly distributed about the probehole). The data also show that the direction, radionuclide mixture, and apparent radionuclide concentrations change gradually with depth. Heterogeneity may be caused by nonuniform radionuclide distribution or nonuniform density distribution in the vicinity of the probehole.

Table 7-6. Azimuthal logging data results summary.

Probe	Probe Depth	Azimuth (degrees)	Nuclide	Peak Quality
T3-EU-02	8.0	169	U-238	Fair
T3-EU-03	8.0	None	U-238	Poor
T47-IF-1	8.0	290	Cesium and minor cobalt	Good
T47-IF-2	8.0	290	Cesium and minor cobalt	Good
T47-IF-2	10.0	124	Cesium and minor cobalt	Good
HAL-2	12.0	191	Cesium and minor cobalt	Good
HAL-2	21.0	90	Cesium and minor cobalt	Fair
HAL-4	12.0	90	Cesium and cobalt	Fair
P5-UEU-1	9.0	280	Plutonium	Good
P5-UEU-1	14.5	45	Plutonium	Fair
P5-UEU-4	9.0	11	Plutonium and americium	Good
P5-UEU-4	10.0	90	Plutonium and americium	Good
P5-UEU-4	12.0	0	Americium	Poor
P5-UEU-4	14.0	135	U-238	Poor
P5-UEU-5	12.0	236	Plutonium, americium, and neptunium	Fair
P5-UEU-7	11.0	68	Plutonium	Fair
P6-PU-1	8.0	34	Americium, neptunium, and plutonium	Good
P6-PU-1	8.0	68	U-238	Poor
P6-PU-1	10.0	90	Plutonium	Fair
P6-PU-2	10.0	168	Americium	Fair
P6-PU-2	10.0	338	Americium	Poor
P6-PU-2	13.0	260	Plutonium	Fair
P6-PU-3	7.7	185	Plutonium and neptunium	Good

7.2.9 Long-Count Spectral Gamma-Ray Data—December 2003 to January 2004

Four special passive spectral gamma-ray logging measurements were collected in Probes P6-PU-1 and P6-PU-2. These measurements used 3,000-second count times in order to increase the sensitivity to target radionuclides compared with standard 300-second counts (see Table 7-7). The purpose of these measurements was to investigate evidence for downward migration of radionuclides from waste stream contamination zones to the underlying soil. For each probe, one measurement was obtained at the waste-soil interface, and a second measurement was made 1 ft deeper into the underburden.

Table 7-7. Estimated detection limits.

Radionuclide	Energy (keV)	Detection Limit @ 300 seconds[a] (pCi/g)	Detection Limit @ 3,000 seconds[b] (pCi/g)
Np-237	312	1	0.32
Pu-239	375	25,000	7,906.00
Am-241	662	43,000	13,598.00
Am-241	722	90,000	28,460.00
U-238	1,001	10	3.16

a. Based on minimum detection limits calculated for low-contamination zones in Probe P6-PU-1.
b. Scaled based on square root of count time.

The long-count measurements showed that, with a single exception, no radionuclides were detectable at the deeper measurement point. The single exception was Am-241, which was detected at just above the detection limit in Probe P6-PU-1. Overall, the measurements suggest that contaminant migration into soil beneath the waste zone is extremely limited.

7.2.10 Idaho National Engineering and Environmental Laboratory Geophysical Database Compilation—October 2003 to January 2004

Beginning in October 2003, the OU 7-13/14 Remedial Investigation/Feasibility Study Project initiated a comprehensive effort to consolidate, organize, and archive all the existing surface and downhole geophysical data for the SDA. At present, the data are archived by the program in hard-copy format only. Over the preceding years, several informal databases were developed to support data analysis, but the database formats are inconsistent and do not contain all the data that have been collected at the SDA. The database compilation effort will result in the permanent storage of these data in an INEEL database where they will be readily accessible for future uses.

Two separate databases have been developed in prototype form: one for geophysical logging data collected from 1999 to 2003 and one for surface geophysics data collected between 1992 and 2003. The logging database has been populated with data from the first 148 probes installed and logged at the SDA. The database will contain analysis results, calibration records, and raw data files for every measurement since the inception of the Type A logging program in 1999. All new logging data will be archived in this database.

The surface geophysics database has been populated with data from 41 geophysical surveys. Twelve additional datasets have been recovered from informal archives and are ready for transfer to the new database. Five known surveys have not yet been recovered in electronic format. The database contains magnetic and electromagnetic survey data collected using a variety of different equipment and methods. Details concerning equipment and data acquisition methods will be stored with the data.

The "Geophysics Logging and Surface Information System Configuration Management Plan for the OU 7-13/14 Project (Draft)"[e] contains the database specifications, quality assurance/quality control results, and maintenance plans for these new databases.

e. PLN-1568, 2004, "Geophysics Logging and Surface Information System Configuration Management Plan for the OU 7-13/14 Project (Draft)," Rev. B, Idaho National Engineering and Environmental Laboratory.

7.3 Discussion

The process of using WasteOScope (the SDA waste inventory database) and surface geophysics data for selecting probe locations in order to investigate specific items of waste inventory has been shown to be effective in most cases, but not all. In particular, the method of using geophysical anomalies to guide probe installation for targets that are known to have metal containers has proven to be effective in most cases. On the other hand, experience shows that the intensity of geophysical anomalies clearly is not correlated with contamination levels.

Newly identified study areas and logging results are consistent with logging results obtained from previous logging campaigns. The mixtures and amounts of radionuclides observed in the new study areas are within the same range as those previously observed, with a few exceptions. Exceptions include the detection of high cesium-cobalt levels in Area 2 and the identification of widespread Eu-154 in many new study areas. It is likely that Eu-154 also occurs in many previously logged SDA probeholes as well; its apparent absence is attributable to the circumstance that this radionuclide either was not targeted for analysis by the previous subcontractor or was missed because of gamma-ray interference with another radionuclide.

Two innovative data collection efforts yielded important results. In one effort, azimuthal data were measured at 6-in. depth intervals within several probes. These data clearly illustrated the heterogeneous character of radionuclide distribution, showing that both apparent concentration and position of radionuclide sources change continually with depth. In the second effort, long-count, high-sensitivity gamma-ray spectra were obtained within the soil zone underlying waste in two probes. These data showed that vertical migration of radionuclides into the underlying soil is not a vigorous process.

Logging data acquisition, data processing, and analysis methods have been refined so that the OU 7-13/14 program can now very quickly and efficiently explore the SDA subsurface to obtain useful qualitative information regarding the nature of waste-zone contamination in selected areas. Significant progress also has been made toward consolidating and archiving the extensive amounts of surface and probehole geophysics data that have been collected at the SDA over the last 10 years. These efforts will ensure that new data may be obtained and that old data will be available to address future issues that arise during remediation efforts.

Quantitative analysis of surface and probehole geophysics data continues to be a challenge. The uncertainty is almost always traceable to the highly heterogeneous character of the SDA waste seam. The most promising progress on quantitative methods has been related to chlorine distribution, perhaps because chlorine contamination seems to be much more widespread and spatially continuous than radionuclide contamination.

7.4 Conclusions

The combined use of WasteOScope inventory data and surface geophysics was generally successful for locating subsurface contamination within the SDA. In most cases, the contamination was consistent with the expected waste inventory.

Logging data within 37 new probes installed during FY 2003 show contamination mixtures and levels similar to previous SDA logging with the following exceptions:

- Very high cesium-cobalt levels were observed in Area 2
- Eu-154 was identified as a common constituent in many of the new study areas.

Measurement of azimuthal data at 6-inch depth intervals in two probes showed that both apparent concentration and position of radionuclide sources change continually with depth, supporting the conclusion that radionuclide contamination in the SDA is highly heterogeneous.

High-sensitivity measurements within underburden soil in two probes showed that downward vertical migration of radionuclides is very limited.

7.5 Recommendations

Additional long-count measurements at selected locations should be considered as a means to directly evaluate the downward migration of radionuclides and VOCs into the vadose zone beneath the SDA waste pits and trenches.

The geophysical database compilation effort should be completed in order to ensure that these valuable data sets are available in the future.

Data acquisition and data analysis summaries should be formalized to document the FY 2003–2004 Type A logging activities in more detail.

Quantitative analysis methods for Type A logging data, particularly methods related to quantifying subsurface VOCs, should continue to be developed. The current development program promises to produce useful insight into the problems inherent to highly heterogeneous environments, which will likely apply to other quantitative issues.

8. REFERENCES

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Appendix A

Maps of Surveyed Probe Locations in the Subsurface Disposal Area

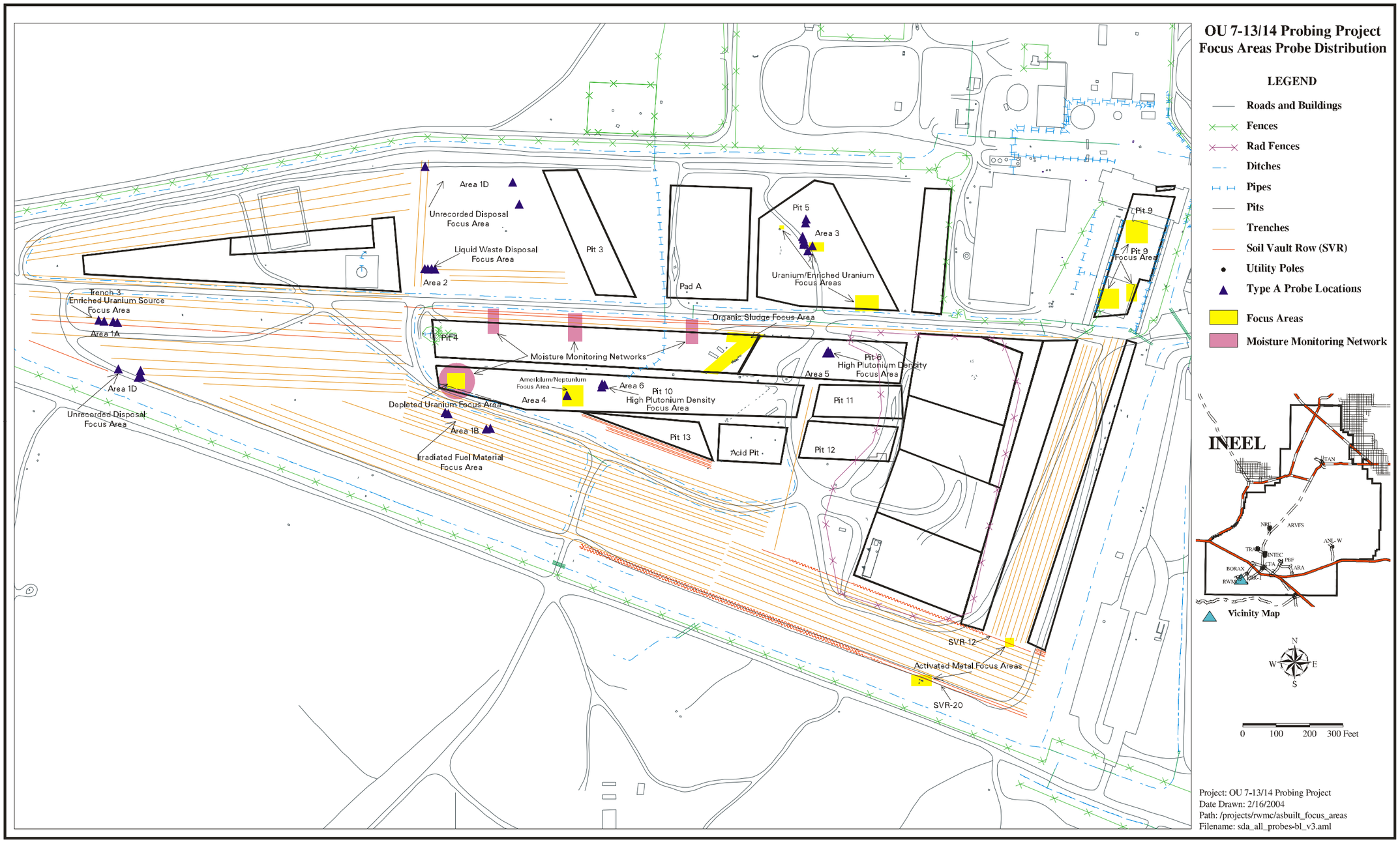


Figure A-1. Subsurface Disposal Area focus areas and moisture monitoring networks.

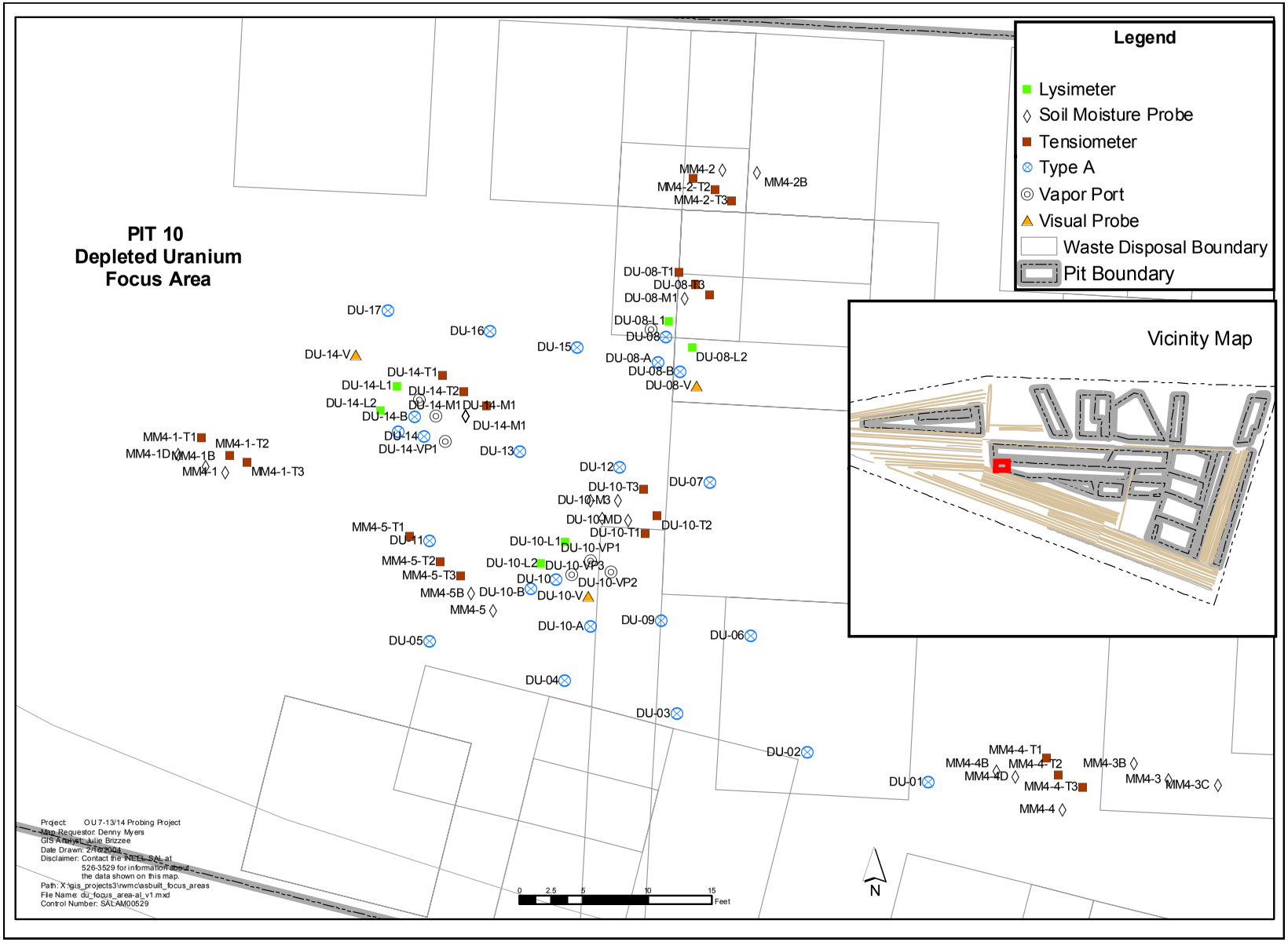


Figure A-2. Probe clusters installed in and around the depleted uranium focus area in the west end of Pit 10.

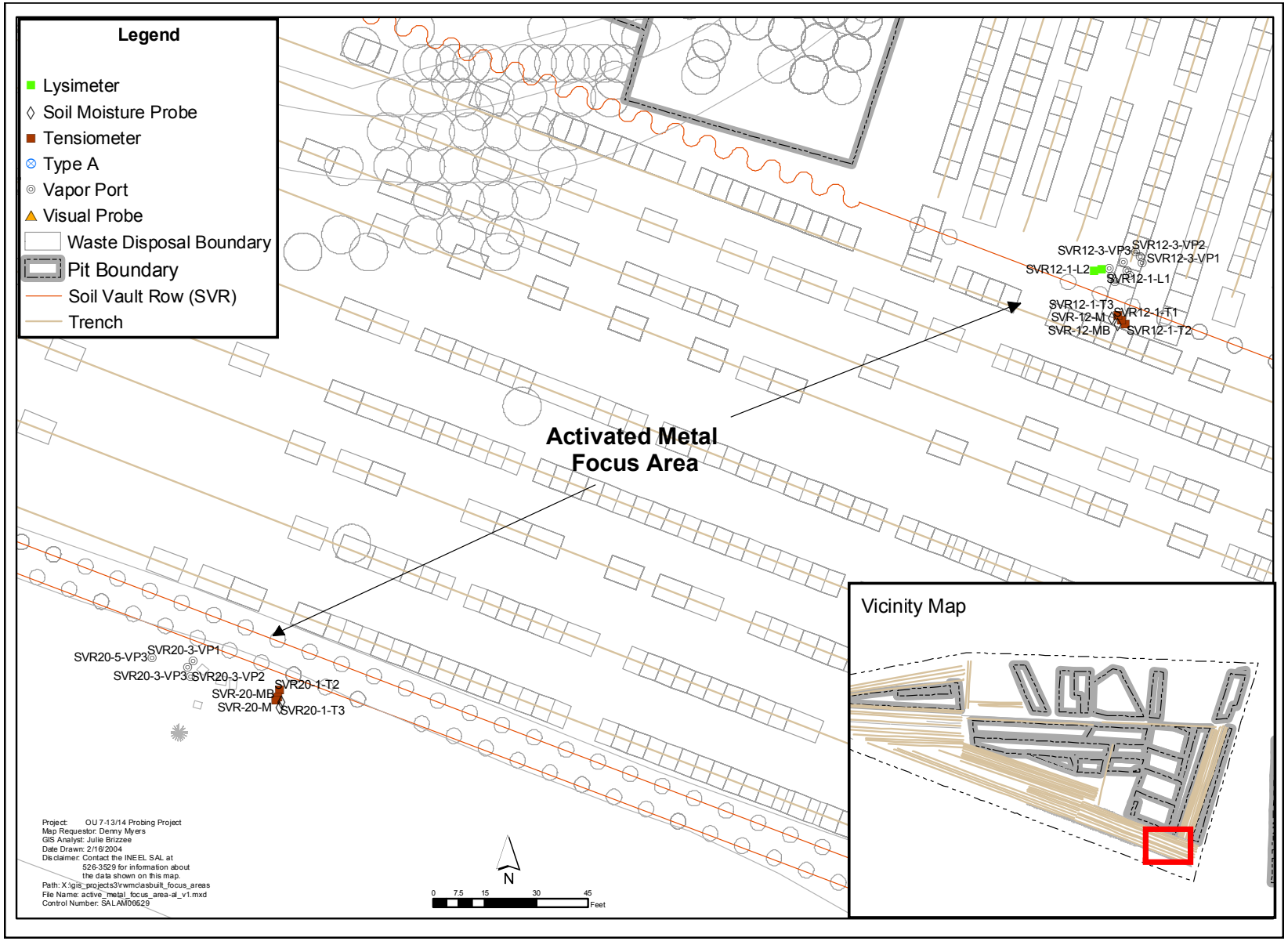


Figure A-3. Probes installed in the activated metal focus area.

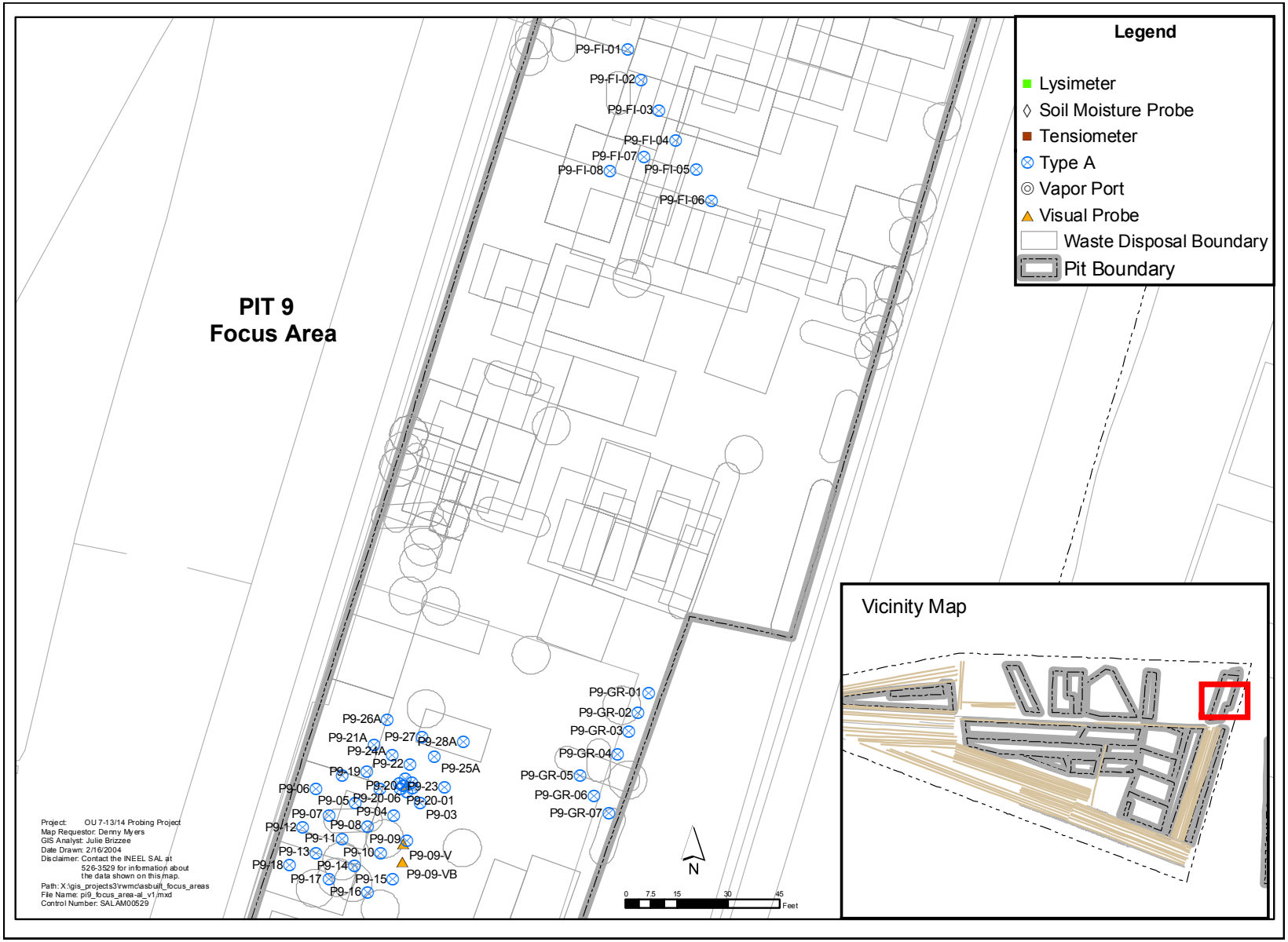


Figure A-4. Probes installed in the Pit 9 study area.

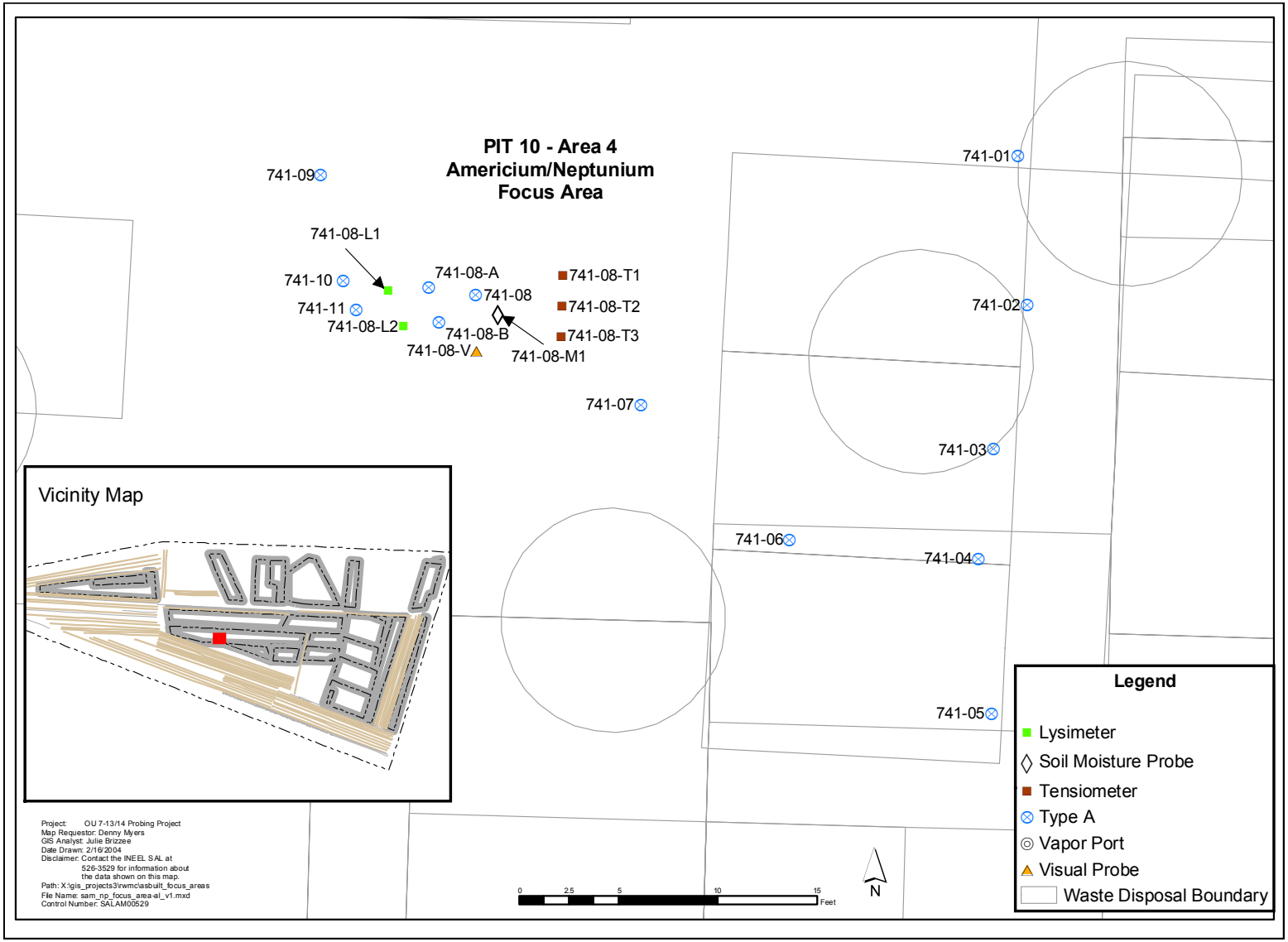


Figure A-5. Probes installed in the americium and neptunium focus area in the central part of Pit 10.

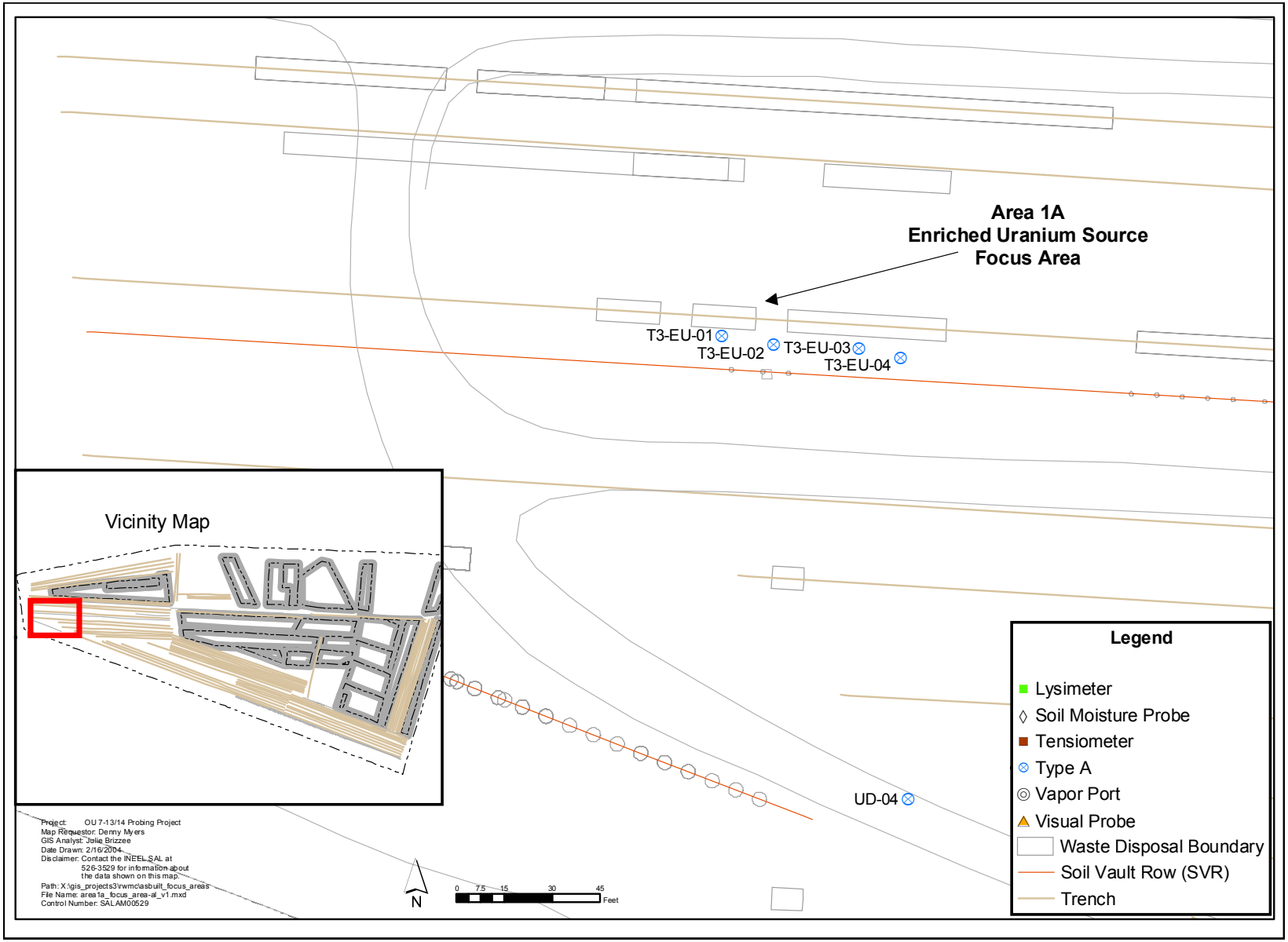


Figure A-6. Probes installed in the enriched uranium source focus area.

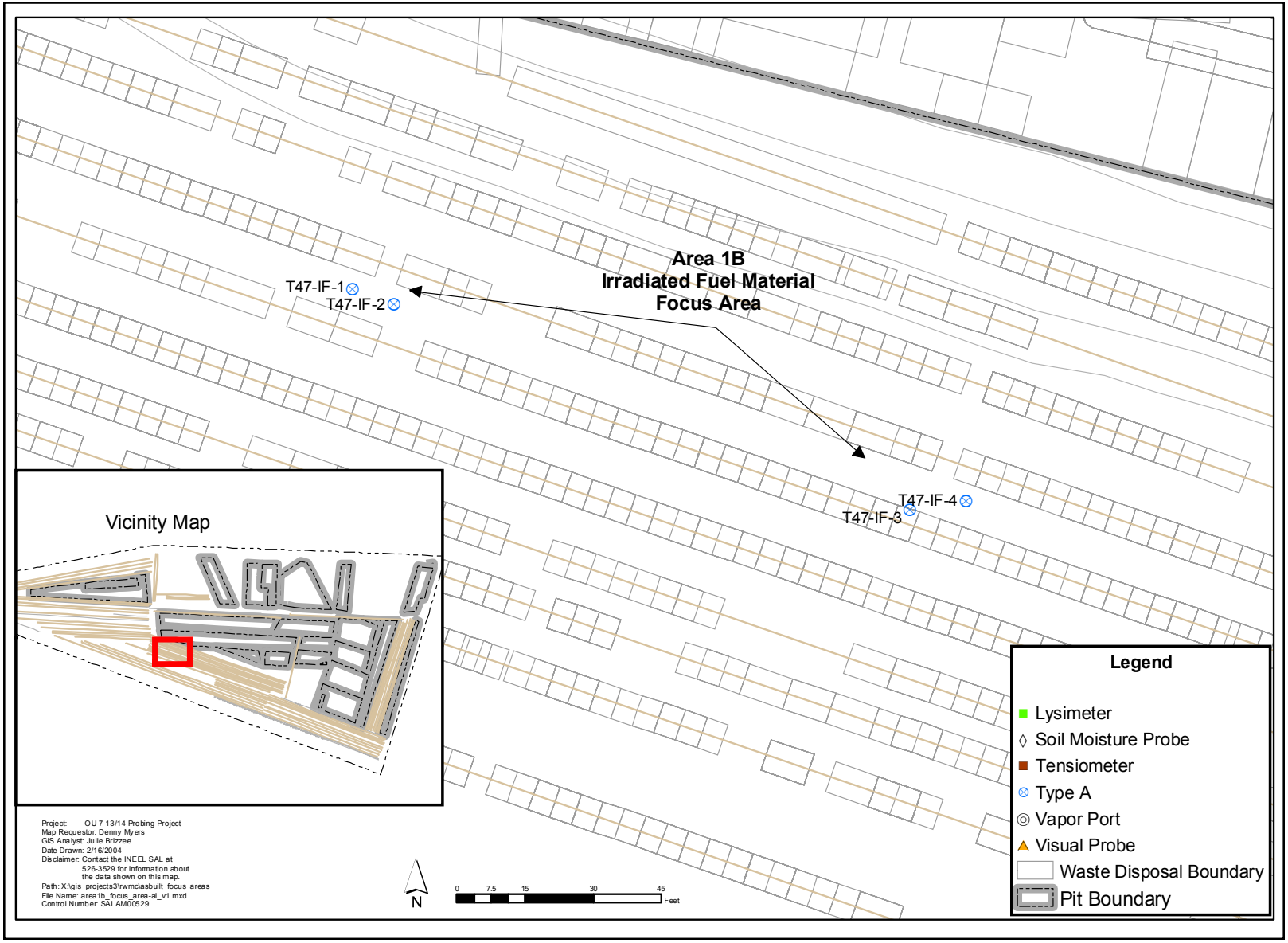


Figure A-7. Probes installed in the irradiated fuel material focus area.

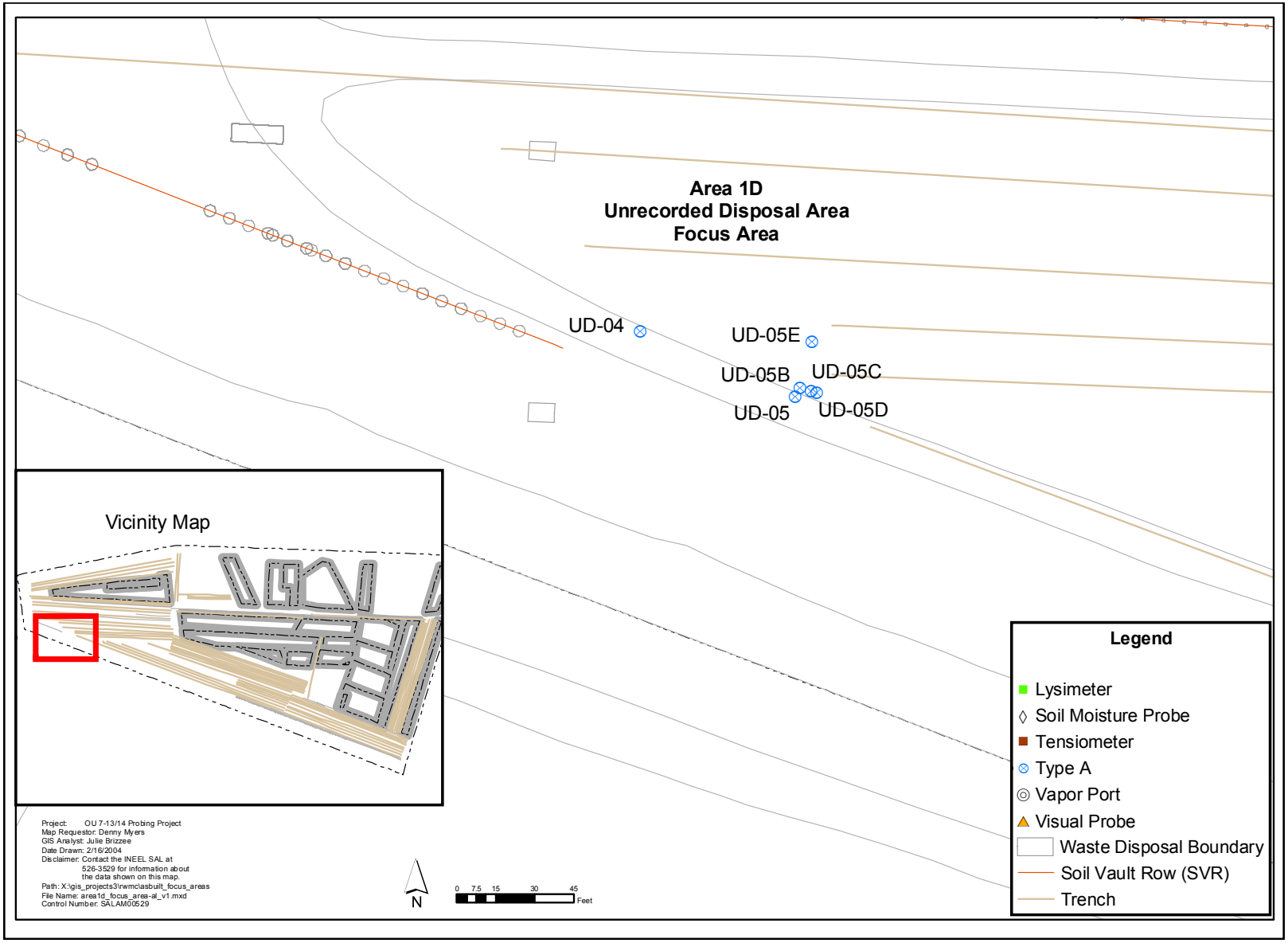


Figure A-8. Probes installed in the unrecorded disposal area focus area.

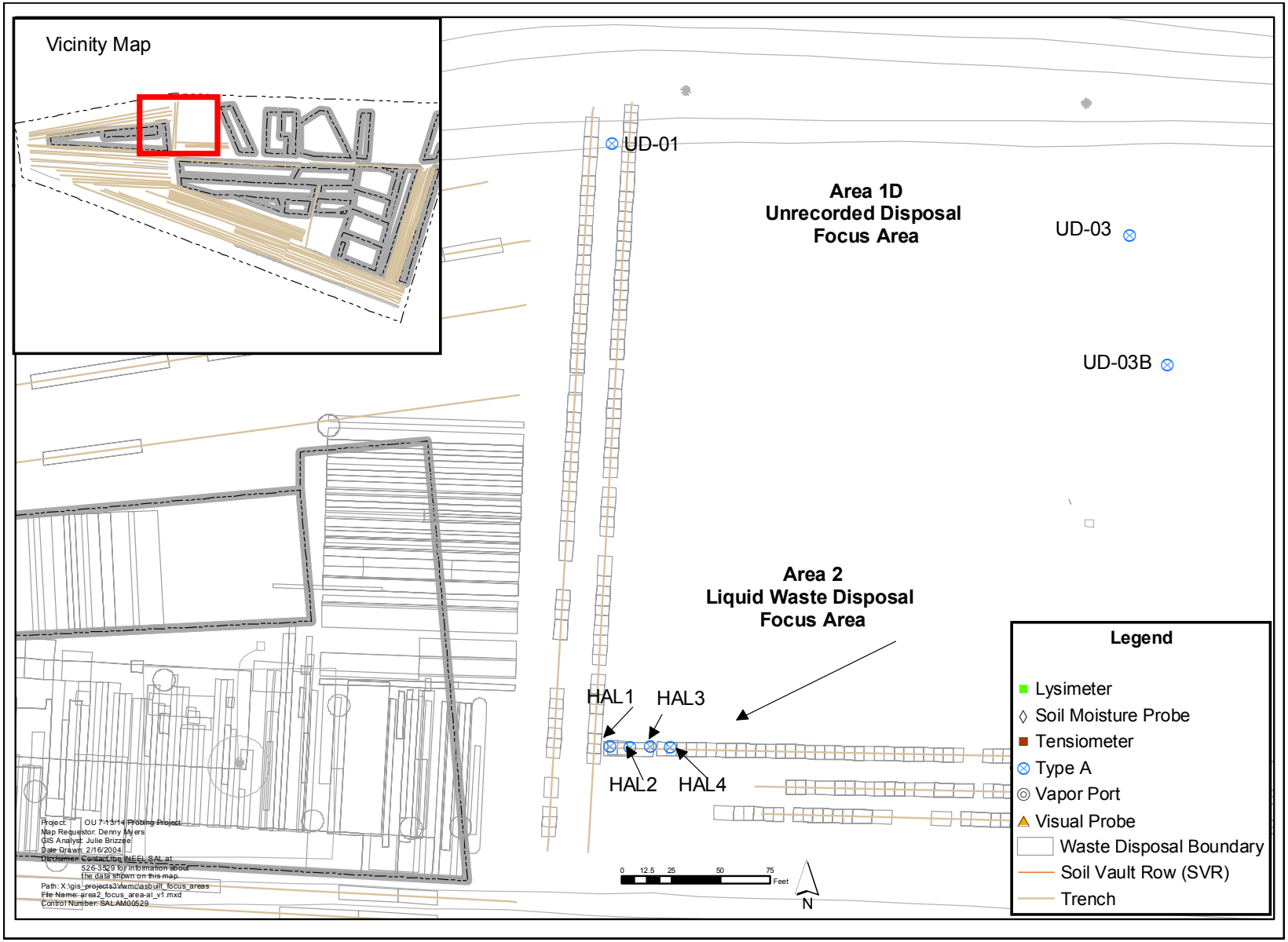


Figure A-9. Probes installed in the unrecorded disposal area focus area and in the liquid waste disposal focus area.

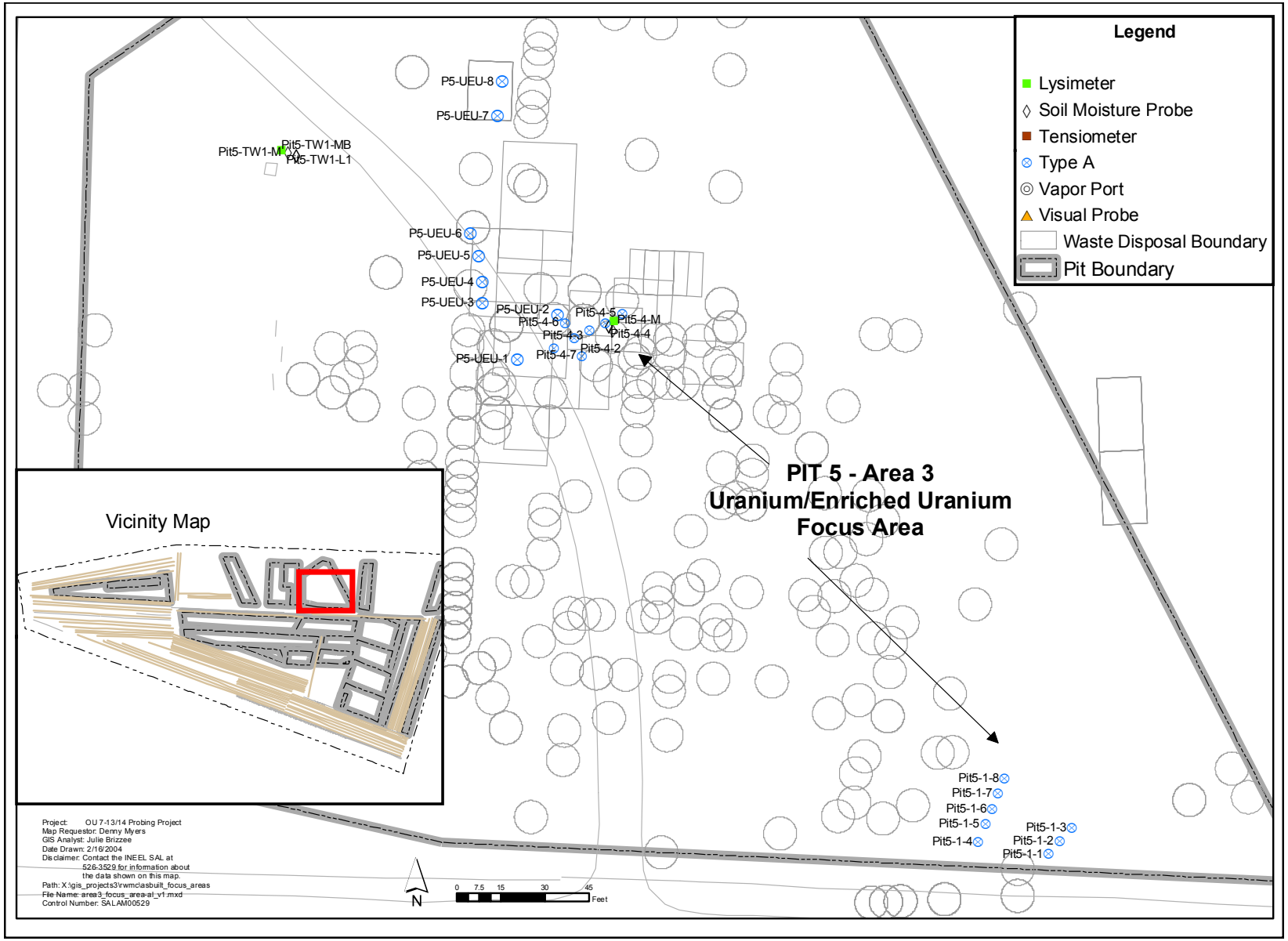


Figure A-10. Probes installed in the uranium and enriched uranium focus area in Pit 5.

Figure A-11. Probes installed in the high plutonium density focus area in Pit 6.

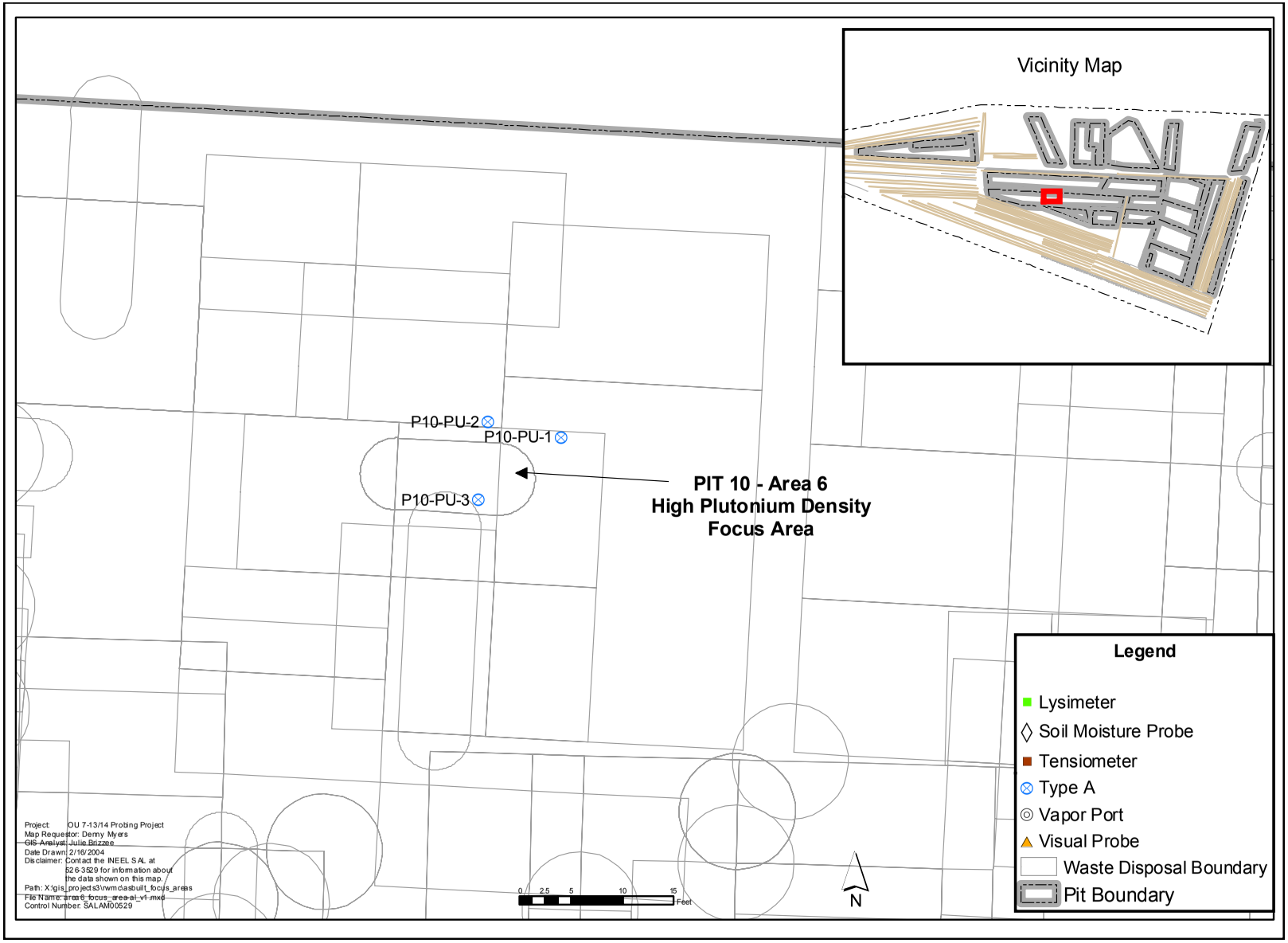


Figure A-12. Probes installed in the high plutonium density focus area in Pit 10.

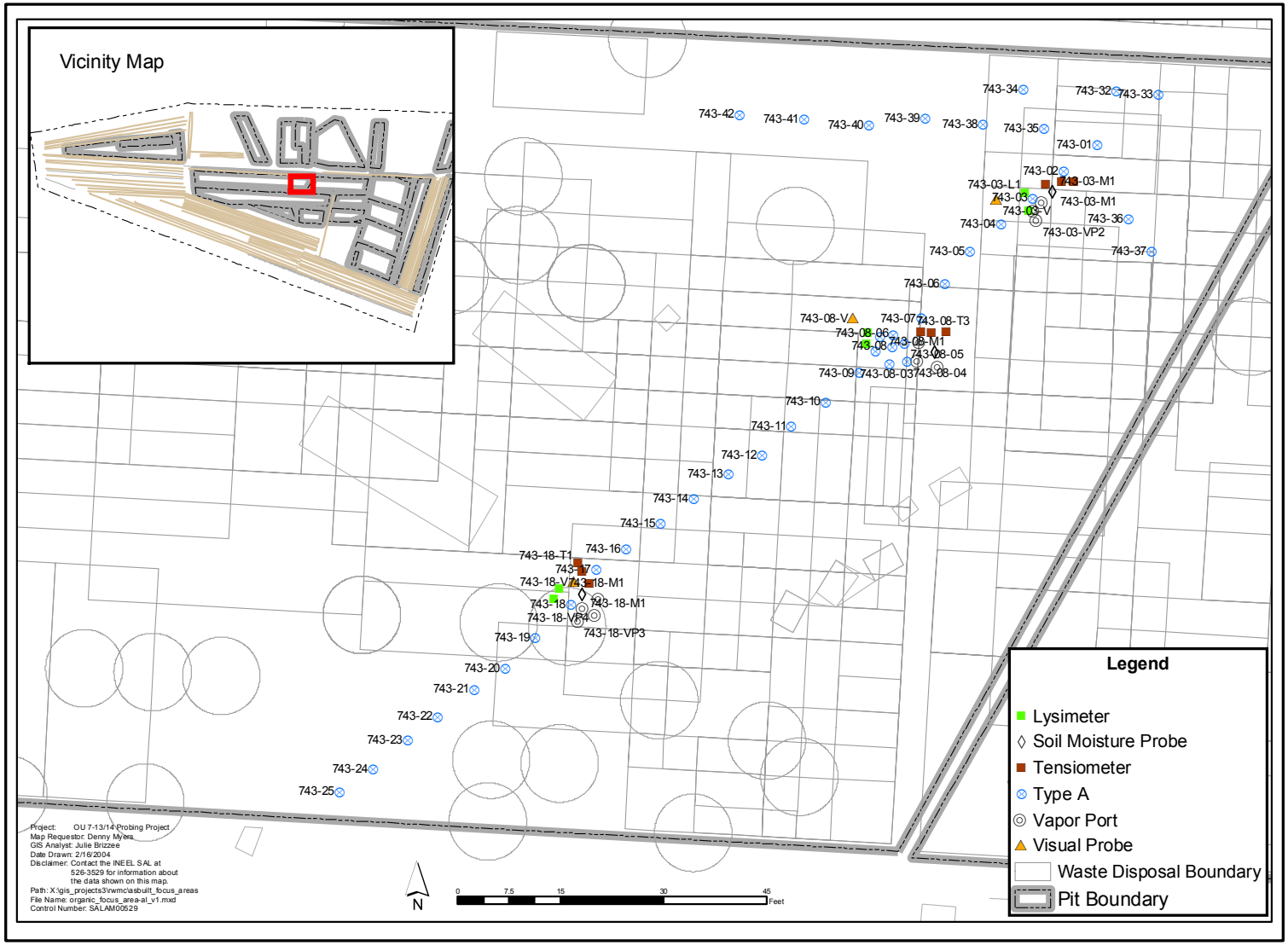


Figure A-13. Probes installed in the high plutonium density focus area in Pit 2.

Appendix B

Tabular Listing of Probe Attributes

Table B-1. Probe attributes.

Integrated Probing Project Focus Area	IPP Cluster	Common Probe Name	Official_Name	Alias Probe Name	Well_ID	Probe Type	Installation Date (mm/dd/yyyy)	Northing (ft) (NAD27)	Easting (ft) (NAD27)	Surface Elevation (ft) (NGVD29)	Probe Depth (ft) (from surface)	Sensor/Port Bottom Depth from Surface (ft)	Sensor/Port Bottom Elevation (ft) (NGVD29)	Probe Stick Up (in.)	Soil Mstr Prb Sensor ID	Tensio-Gross Matric Pot Sensor ID	Tensio-Amb Pres Sensor ID	No. Sensors/ Ports per Probe	P/F Initial Pres. Test	Functional
Americium/Neptunium	741-01	741-01	RWMC-SCI-S-741-01	741-1	1451	Type A	8/28/2000	669192.3394	266577.0655	5,012.54	5.9	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Americium/Neptunium	741-02	741-02	RWMC-SCI-S-741-02	741-2	1452	Type A	8/28/2000	669184.8187	266577.5322	5,012.52	18.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Americium/Neptunium	741-03	741-03	RWMC-SCI-S-741-03	741-3	1453	Type A	8/24/2000	669177.5579	266575.8486	5,012.49	20.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Americium/Neptunium	741-04	741-04	RWMC-SCI-S-741-04	741-4	1454	Type A	8/24/2000	669172.0506	266575.096	5,012.42	24.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Americium/Neptunium	741-05	741-05	RWMC-SCI-S-741-05	741-5	1455	Type A	8/23/2000	669164.2625	266575.7358	5,012.39	6.4	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Americium/Neptunium	741-06	741-06	RWMC-SCI-S-741-06	741-6	1456	Type A	8/23/2000	669172.9898	266565.6077	5,012.41	18.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Americium/Neptunium	741-07	741-07	RWMC-SCI-S-741-07	741-7	1457	Type A	8/21/2000	669179.7867	266558.0987	5,012.35	6.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Americium/Neptunium	741-08	741-08	RWMC-SCI-S-741-08	741-8	1458	Type A	8/22/2000	669185.2928	266549.7728	5,012.24	22.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Americium/Neptunium	741-08	741-08-A	RWMC-SCI-S-741-08-A	741-8-A	1459	Type A	7/2/2001	669185.7087	266547.4306	5,012.27	20.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Americium/Neptunium	741-08	741-08-B	RWMC-SCI-S-741-08-B	741-8-B	1460	Type A	7/3/2001	669183.9639	266547.9219	5,012.3	21.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Americium/Neptunium	741-09	741-09	RWMC-SCI-S-741-09	741-9	1461	Type A	8/22/2000	669191.3788	266541.9946	5,012.06	14.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Americium/Neptunium	741-10	741-10	RWMC-1950		1950	Type A	6/30/2003	669186.06	266543.09	5,012	20.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Americium/Neptunium	741-11	741-11	RWMC-1951		1951	Type A	6/30/2003	669184.56	266543.79	5,012.1	20.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-01	743-01	RWMC-SCI-S-743-01	743-1	1462	Type A	10/17/2000	669353.1956	267082.3598	5,011.18	17.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-02	743-02	RWMC-SCI-S-743-02	743-2	1463	Type A	10/17/2000	669349.2787	267077.5497	5,010.94	20.7	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-03	743-03	RWMC-SCI-S-743-03	743-3	1464	Type A	10/16/2000	669345.3478	267073.0392	5,011.02	19.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-04	743-04	RWMC-SCI-S-743-04	743-4	1465	Type A	10/16/2000	669341.5913	267068.4112	5,011.06	25.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-05	743-05	RWMC-SCI-S-743-05	743-5	1466	Type A	10/12/2000	669337.5395	267063.9136	5,011.08	27.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-06	743-06	RWMC-SCI-S-743-06	743-6	1467	Type A	10/12/2000	669332.9574	267060.1284	5,011	26.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-07	743-07	RWMC-SCI-S-743-07	743-7	1468	Type A	10/12/2000	669327.8961	267056.6863	5,010.82	25.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-08	743-08	RWMC-SCI-S-743-08	743-8	1469	Type A	10/12/2000	669323.7015	267052.4853	5,011.01	25.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-08	743-08-01	RWMC-SCI-S-743-08-01	743-8-1	1470	Type A	4/24/2001	669325.2804	267050.703	5,010.93	25.6	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-08	743-08-02	RWMC-SCI-S-743-08-02	743-8-2	1471	Type A	4/24/2001	669323.024	267050.0948	5,010.91	25.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-08	743-08-03	RWMC-SCI-S-743-08-03	743-8-3	1472	Type A	4/24/2001	669321.325	267052.1107	5,010.85	26.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-08	743-08-04	RWMC-SCI-S-743-08-04	743-8-4	1473	Type A	4/25/2001	669321.5919	267054.7452	5,010.75	25.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-08	743-08-05	RWMC-SCI-S-743-08-05	743-8-5	1474	Type A	4/25/2001	669324.1071	267054.2933	5,010.89	25.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-08	743-08-06	RWMC-SCI-S-743-08-06	743-8-6	1475	Type A	4/25/2001	669325.4034	267052.6881	5,010.89	25.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-09	743-09	RWMC-SCI-S-743-09	743-9	1476	Type A	10/11/2000	669319.8912	267047.7597	5,010.86	24.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-10	743-10	RWMC-SCI-S-743-10		1477	Type A	10/11/2000	669315.6876	267042.8318	5,011.02	25.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-11	743-11	RWMC-SCI-S-743-11		1478	Type A	10/11/2000	669312.1216	267037.8055	5,011.06	25.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-12	743-12	RWMC-SCI-S-743-12		1479	Type A	10/10/2000	669307.8943	267033.5049	5,011.22	25.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-13	743-13	RWMC-SCI-S-743-13		1480	Type A	10/2/2000	669305.194	267028.5962	5,011.5	25.6	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-14	743-14	RWMC-SCI-S-743-14		1481	Type A	10/2/2000	669301.6006	267023.4588	5,011.81	23.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-15	743-15	RWMC-SCI-S-743-15		1482	Type A	9/28/2000	669298.0901	267018.7367	5,012.14	21.9	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-16	743-16	RWMC-SCI-S-743-16		1483	Type A	9/28/2000	669294.2152	267013.7148	5,012.29	16.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-17	743-17	RWMC-SCI-S-743-17		1484	Type A	9/27/2000	669291.3466	267009.3815	5,012.47	20.7	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-18	743-18	RWMC-SCI-S-743-18		1485	Type A	9/25/2000	669286.1225	267005.5783	5,012.67	21.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-19	743-19	RWMC-SCI-S-743-19		1486	Type A	9/11/2000	669281.4003	267000.4348	5,012.79	4.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-20	743-20	RWMC-SCI-S-743-20		1487	Type A	9/7/2000	669276.8783	266996.0225	5,012.87	16.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-21	743-21	RWMC-SCI-S-743-21		1488	Type A	9/6/2000	669273.8238	266991.4852	5,012.79	14.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-22	743-22	RWMC-SCI-S-743-22		1489	Type A	9/5/2000	669269.8914	266986.2118	5,012.78	21.4	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-23	743-23	RWMC-SCI-S-743-23		1490	Type A	8/31/2000	669266.4174	266981.8544	5,012.84	8.4	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-24	743-24	RWMC-SCI-S-743-24		1491	Type A	8/31/2000	669262.2263	266976.8187	5,012.79	23.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-25	743-25	RWMC-SCI-S-743-25		1492	Type A	8/31/2000	669259.0241	266971.8635	5,012.94	17.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-32	743-32	RWMC-SCI-S-743-32		1493	Type A	12/11/2000	669360.8453	267085.1497	5,011.1	12.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-33	743-33	RWMC-SCI-S-743-33		1494	Type A	12/11/2000	669360.41	267091.3504	5,011.18	12.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes

Table B-1. (continued).

Integrated Probing Project Focus Area	IPP Cluster	Common Probe Name	Official_Name	Alias Probe Name	Well_ID	Probe Type	Installation Date (mm/dd/yyyy)	Northing (ft) (NAD27)	Easting (ft) (NAD27)	Surface Elevation (ft) (NGVD29)	Probe Depth (ft) (from surface)	Sensor/Port Bottom Depth from Surface (ft)	Sensor/Port Bottom Elevation (ft) (NGVD29)	Probe Stick Up (in.)	Soil Mstr Prb Sensor ID	Tensio-Gross Matric Pot Sensor ID	Tensio-Amb Pres Sensor ID	No. Sensors/ Ports per Probe	P/F Initial Pres. Test	Functional
Organic Sludge	743-34	743-34	RWMC-SCI-S-743-34		1495	Type A	12/11/2000	669361.2448	267071.6978	5,011.16	11.9	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-35	743-35	RWMC-SCI-S-743-35		1496	Type A	12/11/2000	669355.4775	267074.5822	5,011.1	16.4	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-36	743-36	RWMC-SCI-S-743-36		1497	Type A	12/13/2000	669342.2995	267087.0058	5,010.86	25.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-37	743-37	RWMC-SCI-S-743-37		1498	Type A	12/13/2000	669337.5791	267090.3483	5,010.74	25.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-38	743-38	RWMC-SCI-S-743-38		1499	Type A	12/12/2000	669356.105	267065.7669	5,011.17	15.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-39	743-39	RWMC-SCI-S-743-39		1500	Type A	12/12/2000	669356.9531	267057.34	5,011.14	19.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-40	743-40	RWMC-SCI-S-743-40		1501	Type A	12/12/2000	669356.0709	267049.0327	5,011.14	18.4	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-41	743-41	RWMC-SCI-S-743-41		1502	Type A	12/12/2000	669356.7895	267039.58	5,011.14	21.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Organic Sludge	743-42	743-42	RWMC-SCI-S-743-42		1503	Type A	12/12/2000	669357.5646	267030.2029	5,011.11	22.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-01	DU-01	RWMC-SCI-S-DU-01	DU1	1504	Type A	8/15/2000	669211.1707	266234.8183	5,010.83	14.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-02	DU-02	RWMC-SCI-S-DU-02	DU2	1505	Type A	8/15/2000	669213.5708	266225.3	5,011.04	14.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-03	DU-03	RWMC-SCI-S-DU-03	DU3	1506	Type A	8/15/2000	669216.5446	266215.1599	5,011.22	14.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-04	DU-04	RWMC-SCI-S-DU-04	DU4	1507	Type A	8/14/2000	669219.1281	266206.4795	5,011.2	14.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-05	DU-05	RWMC-SCI-S-DU-05	DU5	1508	Type A	8/14/2000	669222.1592	266195.8783	5,011.21	18.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-06	DU-06	RWMC-SCI-S-DU-06	DU6	1509	Type A	8/16/2000	669222.6042	266220.9177	5,011.15	18.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-07	DU-07	RWMC-SCI-S-DU-07	DU7	1510	Type A	8/16/2000	669234.551	266217.7122	5,011.51	14.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-08	DU-08	RWMC-SCI-S-DU-08	DU8	1511	Type A	8/16/2000	669245.8865	266214.3102	5,011.78	18.7	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-08	DU-08-A	RWMC-SCI-S-DU-08-A	DU8A	1512	Type A	6/28/2001	669243.9573	266213.6498	5,011.77	18.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-08	DU-08-B	RWMC-SCI-S-DU-08-B	DU8B	1513	Type A	6/28/2001	669243.1779	266215.4429	5,011.71	17.6	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-09	DU-09	RWMC-SCI-S-DU-09	DU9	1514	Type A	12/14/2000	669223.7424	266213.9709	5,011.33	18.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-10	DU-10	RWMC-SCI-S-DU-10	DU10	1515	Type A	12/14/2000	669226.9858	266205.8061	5,011.42	17.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-10	DU-10-A	RWMC-SCI-S-DU-10-A	DU10A	1516	Type A	6/28/2001	669223.3645	266208.3956	5,011.4	17.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-10	DU-10-B	RWMC-SCI-S-DU-10-B	DU10B	1517	Type A	7/2/2001	669226.2649	266203.7837	5,011.4	17.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-11	DU-11	RWMC-SCI-S-DU-11	DU11	1518	Type A	12/14/2000	669230.0245	266195.904	5,011.59	18.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-12	DU-12	RWMC-SCI-S-DU-12	DU12	1519	Type A	12/14/2000	669235.6588	266210.7058	5,011.59	18.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-13	DU-13	RWMC-SCI-S-DU-13	DU13	1520	Type A	12/14/2000	669237.0252	266202.9283	5,011.62	18.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-14	DU-14	RWMC-SCI-S-DU-14	DU14	1521	Type A	12/14/2000	669238.1388	266195.4606	5,011.71	17.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-14	DU-14-A	RWMC-SCI-S-DU-14-A	DU14A	1522	Type A	6/28/2001	669238.4737	266193.5134	5,011.76	17.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-14	DU-14-B	RWMC-SCI-S-DU-14-B	DU14B	1523	Type A	6/28/2001	669239.6982	266194.6868	5,011.78	17.6	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-15	DU-15	RWMC-SCI-S-DU-15	DU15	1524	Type A	12/18/2000	669245.1424	266207.414	5,011.73	17.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-16	DU-16	RWMC-SCI-S-DU-16	DU16	1525	Type A	12/18/2000	669246.3733	266200.6459	5,011.77	16.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Depleted Uranium	DU-17	DU-17	RWMC-SCI-S-DU-17	DU17	1526	Type A	12/18/2000	669247.9685	266192.6534	5,011.84	20.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-01	RWMC-SCI-S-P9-01	P901	1527	Type A	12/22/1999	669485.9779	268151.0205	5,009.47	13.9	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-02	RWMC-SCI-S-P9-02	P902	1528	Type A	12/20/1999	669482.1713	268162.059	5,009.17	15.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-03	RWMC-SCI-S-P9-03	P903	1529	Type A	12/14/1999	669478.1627	268173.6943	5,009.46	11.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-04	RWMC-SCI-S-P9-04	P904	1530	Type A	12/20/1999	669474.6121	268166.1917	5,009.47	16.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-05	RWMC-SCI-S-P9-05	P905	1531	Type A	12/21/1999	669478.2158	268154.8668	5,009.15	16.9	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-06	RWMC-SCI-S-P9-06	P906	1532	Type A	12/22/1999	669482.1367	268143.3256	5,009.34	14.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-07	RWMC-SCI-S-P9-07	P907	1533	Type A	12/21/1999	669474.4906	268147.2058	5,009.18	15.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-08	RWMC-SCI-S-P9-08	P908	1534	Type A	12/1/1999	669471.2567	268158.4925	5,009.22	13.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-09	RWMC-SCI-S-P9-09	P909	1535	Type A	12/15/1999	669467.0099	268169.9308	5,009.47	11.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-10	RWMC-SCI-S-P9-10	P910	1536	Type A	12/16/1999	669463.4635	268162.3107	5,009.33	9.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-11	RWMC-SCI-S-P9-11	P911	1537	Type A	12/21/1999	669467.6154	268150.996	5,009.06	15.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-12	RWMC-SCI-S-P9-12	P912	1538	Type A	12/21/1999	669470.9882	268139.4149	5,009.28	16.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-13	RWMC-SCI-S-P9-13	P913	1539	Type A	12/21/1999	669463.6127	268143.2715	5,009.35	15.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-14	RWMC-SCI-S-P9-14	P914	1540	Type A	12/20/1999	669459.7611	268154.5727	5,009.26	14.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-15	RWMC-SCI-S-P9-15	P915	1541	Type A	12/16/1999	669455.7291	268165.807	5,009.34	13.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes

Table B-1. (continued).

Integrated Probing Project Focus Area	IPP Cluster	Common Probe Name	Official_Name	Alias Probe Name	Well_ID	Probe Type	Installation Date (mm/dd/yyyy)	Northing (ft) (NAD27)	Easting (ft) (NAD27)	Surface Elevation (ft) (NGVD29)	Probe Depth (ft) (from surface)	Sensor/Port Bottom Depth from Surface (ft)	Sensor/Port Bottom Elevation (ft) (NGVD29)	Probe Stick Up (in.)	Soil Mstr Prb Sensor ID	Tensio-Gross Matric Pot Sensor ID	Tensio-Amb Pres Sensor ID	No. Sensors/ Ports per Probe	P/F Initial Pres. Test	Functional
Pit 9		P9-16	RWMC-SCI-S-P9-16	P916	1542	Type A	12/16/1999	669451.8749	268158.4599	5,009.13	13.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-17	RWMC-SCI-S-P9-17	P917	1543	Type A	12/15/1999	669455.9118	268146.9532	5,009.08	14.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-18	RWMC-SCI-S-P9-18	P918	1544	Type A	12/15/1999	669459.9743	268135.4982	5,009.32	18.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-19	RWMC-SCI-S-P9-19	P919	1545	Type A	12/22/1999	669487.0609	268158.0836	5,009.27	15.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-20	RWMC-SCI-S-P9-20	P920	1546	Type A	12/22/1999	669483.1684	268168.9775	5,009.38	12.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-20-01	RWMC-SCI-S-P9-20-01	9-20-1	1547	Type A	5/10/2001	669482.1154	268168.0574	5,009.54	13.9	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-20-02	RWMC-SCI-S-P9-20-02	9-20-2	1548	Type A	5/10/2001	669483.9592	268167.7035	5,009.49	11.6	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-20-03	RWMC-SCI-S-P9-20-03	9-20-3	1549	Type A	5/10/2001	669485.1669	268169.369	5,009.65	12.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-20-04	RWMC-SCI-S-P9-20-04	9-20-4	1550	Type A	5/10/2001	669484.036	268171.4369	5,009.57	12.6	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-20-05	RWMC-SCI-S-P9-20-05	9-20-5	1551	Type A	5/10/2001	669482.4702	268171.6347	5,009.6	12.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-20-06	RWMC-SCI-S-P9-20-06	9-20-6	1552	Type A	5/10/2001	669481.5244	268169.9325	5,009.56	12.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-21A	RWMC-SCI-S-P9-21A	P9-2-01-A	1553	Type A	10/26/2000	669495.0708	268160.2349	5,009.68	13.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-22	RWMC-SCI-S-P9-22	P9-2-2	1554	Type A	10/30/2000	669489.3656	268170.917	5,009.48	12.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-23	RWMC-SCI-S-P9-23	P9-2-3	1555	Type A	10/31/2000	669482.6617	268180.9586	5,009.6	11.4	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-24A	RWMC-SCI-S-P9-24A	P9-2-4-A	1556	Type A	10/26/2000	669492.1547	268165.578	5,009.5	12.7	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-25A	RWMC-SCI-S-P9-25A	P9-2-5	1557	Type A	10/31/2000	669491.5	268178.0	5,009.7	11.4	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-26A	RWMC-SCI-S-P9-26A	P9-2-6-A	1558	Type A	10/30/2000	669502.4694	268164.2634	5,009.87	11.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-27	RWMC-SCI-S-P9-27	P9-2-7	1559	Type A	10/30/2000	669497.4277	268174.2893	5,009.44	11.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-28A	RWMC-SCI-S-P9-28A	P9-2-8-A	1560	Type A	10/31/2000	669496.0009	268186.3336	5,009.86	10.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-FI-01	RWMC-SCI-S-P9-FI-01		1561	Type A	12/7/2000	669698.8678	268234.7273	5,008.71	10.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-FI-02	RWMC-SCI-S-P9-FI-02		1562	Type A	12/5/2000	669689.9741	268238.6067	5,008.74	12.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-FI-03	RWMC-SCI-S-P9-FI-03		1563	Type A	12/5/2000	669680.8554	268243.8193	5,008.55	16.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-FI-04	RWMC-SCI-S-P9-FI-04		1564	Type A	12/6/2000	669672.0627	268248.7197	5,009.13	13.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-FI-05	RWMC-SCI-S-P9-FI-05		1565	Type A	12/6/2000	669663.6765	268254.6839	5,009.69	13.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-FI-06	RWMC-SCI-S-P9-FI-06		1566	Type A	12/6/2000	669654.5612	268259.0632	5,009.74	17.9	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-FI-07	RWMC-SCI-S-P9-FI-07		1567	Type A	12/5/2000	669667.655	268239.1956	5,008.98	16.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-FI-08	RWMC-SCI-S-P9-FI-08		1568	Type A	12/5/2000	669663.2329	268229.4437	5,009.09	16.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-GR-01	RWMC-SCI-S-P9-GR-01		1569	Type A	11/30/2000	669510.298	268240.6388	5,008.99	13.7	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-GR-02	RWMC-SCI-S-P9-GR-02		1570	Type A	11/30/2000	669504.5965	268237.6337	5,009.01	13.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-GR-03	RWMC-SCI-S-P9-GR-03		1571	Type A	11/29/2000	669498.9076	268234.9612	5,008.99	13.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-GR-04	RWMC-SCI-S-P9-GR-04		1572	Type A	11/29/2000	669492.347	268231.6581	5,008.92	11.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-GR-05	RWMC-SCI-S-P9-GR-05		1573	Type A	11/29/2000	669486.2059	268220.6166	5,009.14	11.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-GR-06	RWMC-SCI-S-P9-GR-06		1574	Type A	11/29/2000	669480.4259	268224.762	5,008.87	11.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 9		P9-GR-07	RWMC-SCI-S-P9-GR-07		1575	Type A	11/28/2000	669475.0791	268229.0018	5,008.61	12.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-1	Pit5-1-1	RWMC-SCI-S-Pit5-1-1	P5-1-1	1576	Type A	5/7/2001	669448.8353	267443.2229	5,007.57	7.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-1	Pit5-1-2	RWMC-SCI-S-Pit5-1-2	P5-1-2	1577	Type A	5/7/2001	669453.1402	267446.9243	5,007.79	7.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-1	Pit5-1-3	RWMC-SCI-S-Pit5-1-3	P5-1-3	1578	Type A	5/7/2001	669457.3461	267451.3706	5,008.22	9.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-1	Pit5-1-4	RWMC-SCI-S-Pit5-1-4	P5-1-4	1579	Type A	5/7/2001	669452.6776	267419.2663	5,007.78	8.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-1	Pit5-1-5	RWMC-SCI-S-Pit5-1-5	P5-1-5	1580	Type A	5/7/2001	669458.7556	267421.6117	5,008.41	3.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-1	Pit5-1-6	RWMC-SCI-S-Pit5-1-6	P5-1-6	1581	Type A	5/8/2001	669463.8279	267424.0541	5,008.68	11.7	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-1	Pit5-1-7	RWMC-SCI-S-Pit5-1-7	P5-1-7	1582	Type A	5/8/2001	669469.2347	267425.8985	5,008.94	16.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-1	Pit5-1-8	RWMC-SCI-S-Pit5-1-8	P5-1-8	1583	Type A	5/8/2001	669474.4652	267428.2785	5,009.07	13.6	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-4	Pit5-4-1	RWMC-SCI-S-Pit5-4-1	P5-4-1	1584	Type A	5/3/2001	669621.1443	267274.3401	5,012.36	16.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-4	Pit5-4-2	RWMC-SCI-S-Pit5-4-2	P5-4-2	1585	Type A	5/3/2001	669624.5183	267281.6703	5,012.6	16.4	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-4	Pit5-4-3	RWMC-SCI-S-Pit5-4-3	P5-4-3	1586	Type A	5/3/2001	669627.0981	267286.6077	5,012.45	16.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-4	Pit5-4-4	RWMC-SCI-S-Pit5-4-4	P5-4-4	1587	Type A	5/3/2001	669629.8868	267292.1084	5,012.28	12.7	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-4	Pit5-4-5	RWMC-SCI-S-Pit5-4-5	P5-4-5	1588	Type A	5/3/2001	669632.9446	267297.8206	5,011.93	10.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes

Table B-1. (continued).

Integrated Probing Project Focus Area	IPP Cluster	Common Probe Name	Official_Name	Alias Probe Name	Well_ID	Probe Type	Installation Date (mm/dd/yyyy)	Northing (ft) (NAD27)	Easting (ft) (NAD27)	Surface Elevation (ft) (NGVD29)	Probe Depth (ft) (from surface)	Sensor/Port Bottom Depth from Surface (ft)	Sensor/Port Bottom Elevation (ft) (NGVD29)	Probe Stick Up (in.)	Soil Mstr Prb Sensor ID	Tensio-Gross Matric Pot Sensor ID	Tensio-Amb Pres Sensor ID	No. Sensors/ Ports per Probe	P/F Initial Pres. Test	Functional
Uranium/Enriched U	Pit5-4	Pit5-4-6	RWMC-SCI-S-Pit5-4-6	P5-4-6	1589	Type A	5/3/2001	669629.8717	267278.2644	5,012.6	16.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	Pit5-4	Pit5-4-7	RWMC-SCI-S-Pit5-4-7	P5-4-7	1590	Type A	5/3/2001	669618.7022	267284.2188	5,012.65	14.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	P5-UEU-1	P5-UEU-1	RWMC-1979		1979	Type A	6/9/2003	669617.33	267262.01	5,012.7	18.9	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	P5-UEU-2	P5-UEU-2	RWMC-1980		1980	Type A	6/9/2003	669632.44	267275.89	5,012.6	19.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	P5-UEU-3	P5-UEU-3	RWMC-1981		1981	Type A	6/9/2003	669636.39	267250.14	5,012.3	16.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	P5-UEU-4	P5-UEU-4	RWMC-1982		1982	Type A	6/9/2003	669643.51	267250.19	5,012.2	17.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	P5-UEU-5	P5-UEU-5	RWMC-1983		1983	Type A	6/9/2003	669652.62	267248.79	5,012.1	16.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	P5-UEU-6	P5-UEU-6	RWMC-1984		1984	Type A	6/9/2003	669660.28	267246.01	5,012	16.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	P5-UEU-7	P5-UEU-7	RWMC-1985		1985	Type A	6/5/2003	669700.09	267255.15	5,012	13.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Uranium/Enriched U	P5-UEU-8	P5-UEU-8	RWMC-1986		1986	Type A	6/5/2003	669711.91	267256.88	5,012	16.1	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Enriched Uranium Source	T3-EU-01	T3-EU-01	RWMC-1952		1952	Type A	6/11/2003	669409.95	265145.02	5,012.5	18.4	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Enriched Uranium Source	T3-EU-02	T3-EU-02	RWMC-1953		1953	Type A	6/11/2003	669407.31	265161.08	5,012.7	21.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Enriched Uranium Source	T3-EU-03	T3-EU-03	RWMC-1954		1954	Type A	6/11/2003	669406.04	265188.21	5,013	11.9	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Enriched Uranium Source	T3-EU-04	T3-EU-04	RWMC-1955		1955	Type A	6/12/2003	669403.11	265201	5,013.1	13.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Irradiated Fuel Material	T47-IF-1	T47-IF-1	RWMC-1956		1956	Type A	6/10/2003	669133.84	266179.3	5,010.2	11.6	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Irradiated Fuel Material	T47-IF-2	T47-IF-2	RWMC-1957		1957	Type A	6/10/2003	669130.56	266188.33	5,010.2	10.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Irradiated Fuel Material	T47-IF-3	T47-IF-3	RWMC-1958		1958	Type A	6/10/2003	669085.37	266301.94	5,010.8	11.6	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Irradiated Fuel Material	T47-IF-4	T47-IF-4	RWMC-1959		1959	Type A	6/10/2003	669087.38	266314.25	5,010.7	9.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Liquid Waste Disposal	HAL1	HAL1	RWMC-1960		1960	Type A	6/16/2003	669563.46	266118.28	5,016.7	20.0	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Liquid Waste Disposal	HAL2	HAL2	RWMC-1961		1961	Type A	6/16/2003	669563.08	266128.19	5,016.7	22.4	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Liquid Waste Disposal	HAL3	HAL3	RWMC-1962		1962	Type A	6/16/2003	669563.46	266138.51	5,016.7	8.7	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Liquid Waste Disposal	HAL4	HAL4	RWMC-1963		1963	Type A	6/16/2003	669563.17	266148.6	5,016.6	12.9	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 10 High Pu Density	P10-PU-1	P10-PU-1	RWMC-1964		1964	Type A	6/25/2003	669217.04	266654.96	5,013.7	5.9	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 10 High Pu Density	P10-PU-2	P10-PU-2	RWMC-1965		1965	Type A	6/25/2003	669218.57	266647.84	5,013.6	10.4	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 10 High Pu Density	P10-PU-3	P10-PU-3	RWMC-1966		1966	Type A	6/25/2003	669211.01	266646.92	5,013.3	20.7	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 6 High Pu Density	P6-PU-1	P6-PU-1	RWMC-1967		1967	Type A	6/23/2003	669312.5	267318.09	5,009.9	20.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 6 High Pu Density	P6-PU-2	P6-PU-2	RWMC-1968		1968	Type A	6/23/2003	669312.22	267329.01	5,010.2	20.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Pit 6 High Pu Density	P6-PU-3	P6-PU-3	RWMC-1969		1969	Type A	6/19/2003	669317.23	267323.12	5,010.2	8.3	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Unrecorded Disposal	UD-01	UD-01	RWMC-1970		1970	Type A	7/10/2003	669869.03	266119.31	5,010.6	10.7	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Unrecorded Disposal	UD-03	UD-03	RWMC-1971		1971	Type A	7/9/2003	669822.25	266381.09	5,013.6	4.6	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Unrecorded Disposal	UD-03	UD-03B	RWMC-1972		1972	Type A	7/9/2003	669756.67	266400.36	5,016.2	14.9	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Unrecorded Disposal	UD-04	UD-04	RWMC-1973		1973	Type A	7/1/2003	669264.11	265203.41	5,012.9	14.4	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Unrecorded Disposal	UD-05	UD-05	RWMC-1974		1974	Type A	7/1/2003	669239.24	265263.22	5,012.2	4.7	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Unrecorded Disposal	UD-05	UD-05B	RWMC-1975		1975	Type A	7/2/2003	669242.43	265265.1	5,012.4	5.2	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Unrecorded Disposal	UD-05	UD-05C	RWMC-1976		1976	Type A	7/2/2003	669241.35	265269.33	5,012.2	5.5	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Unrecorded Disposal	UD-05	UD-05D	RWMC-1977		1977	Type A	7/2/2003	669240.38	265271.65	5,012.2	5.6	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Unrecorded Disposal	UD-05	UD-05E	RWMC-1978		1978	Type A	7/7/2003	669260.02	265269.83	5,012.1	10.8	N.A.	N.A.	N.R.	N.A.	N.A.	N.A.	N.A.	N.A.	Yes
Americium/Neptunium	741-08	741-08-T1	RWMC-SCI-S-741-08-T1	741-8-T1	1591	Tensiometer	10/16/2001	669186.2854	266554.1736	5,012.29	4.4	3.60	5,008.7	6	N.A.	1561	1560	1	N.A.	Yes
Americium/Neptunium	741-08	741-08-T2	RWMC-SCI-S-741-08-T2	741-8-T2	1592	Tensiometer	10/11/2001	669184.7439	266554.151	5,012.29	11.4	10.55	5,001.7	14	N.A.	1581	1580	1	N.A.	Yes
Americium/Neptunium	741-08	741-08-T3	RWMC-SCI-S-741-08-T3	741-8-T3	1593	Tensiometer	10/11/2001	669183.2288	266554.1048	5,012.28	20.7	19.91	4,992.4	14.5	N.A.	1541	1540	1	N.A.	Yes
Organic Sludge	743-03	743-03-T1	RWMC-SCI-S-743-03-T1	743-3-T1	1594	Tensiometer	10/8/2001	669347.8137	267078.8834	5,011	6.1	5.30	5,005.7	10	N.A.	1501	1500	1	N.A.	Maybe
Organic Sludge	743-03	743-03-T2	RWMC-SCI-S-743-03-T2	743-3-T2	1595	Tensiometer	10/8/2001	669347.7317	267077.1402	5,010.96	12.0	11.22	4,999.7	6	N.A.	1521	1520	1	N.A.	No
Organic Sludge	743-03	743-03-T3	RWMC-SCI-S-743-03-T3	743-3-T3	1596	Tensiometer	10/8/2001	669347.437	267074.8395	5,010.95	19.3	18.49	4,992.5	7	N.A.	1491	1490	1	N.A.	Maybe
Organic Sludge	743-08	743-08-T1	RWMC-SCI-S-743-08-T1	743-8-T1	1597	Tensiometer	10/4/2001	669325.9349	267056.608	5,010.81	6.4	5.55	5,005.3	7	N.A.	1531	1530	1	N.A.	Yes
Organic Sludge	743-08	743-08-T2	RWMC-SCI-S-743-08-T2	743-8-T2	1598	Tensiometer	10/4/2001	669325.7545	267058.1448	5,010.83	13.8	12.99	4,997.8	6	N.A.	1171	1170	1	N.A.	Yes
Organic Sludge	743-08	743-08-T3	RWMC-SCI-S-743-08-T3	743-8-T3	1599	Tensiometer	10/4/2001	669325.9163	267060.2409	5,010.82	23.2	22.39	4,988.4	6	N.A.	1421	1420	1	N.A.	No
Organic Sludge	743-18	743-18-T1	RWMC-SCI-S-743-18-T1		1600	Tensiometer	10/3/2001	669292.2535	267006.5374	5,012.43	6.3	5.47	5,007.0	8	N.A.	1111	1110	1	N.A.	Yes

Table B-1. (continued).

Integrated Probing Project Focus Area	IPP Cluster	Common Probe Name	Official_Name	Alias Probe Name	Well_ID	Probe Type	Installation Date (mm/dd/yyyy)	Northing (ft) (NAD27)	Easting (ft) (NAD27)	Surface Elevation (ft) (NGVD29)	Probe Depth (ft) (from surface)	Sensor/Port Bottom Depth from Surface (ft)	Sensor/Port Bottom Elevation (ft) (NGVD29)	Probe Stick Up (in.)	Soil Mstr Prb Sensor ID	Tensio-Gross Matric Pot Sensor ID	Tensio-Amb Pres Sensor ID	No. Sensors/ Ports per Probe	P/F Initial Pres. Test	Functional
Organic Sludge	743-18	743-18-T2	RWMC-SCI-S-743-18-T2		1601	Tensiometer	10/3/2001	669291.0782	267007.0528	5,012.47	15.7	14.91	4,997.6	41	N.A.	1401	1400	1	N.A.	Yes
Organic Sludge	743-18	743-18-T3	RWMC-SCI-S-743-18-T3		1602	Tensiometer	10/3/2001	669289.3083	267008.1787	5,012.59	10.0	9.16	5,003.4	43	N.A.	1471	1470	1	N.A.	Yes
Depleted Uranium	DU-08	DU-08-T1	RWMC-SCI-S-DU-08-T1	DU-8-T1	1603	Tensiometer	9/19/2001	669250.9371	266215.3599	5,012	6.1	5.30	5,006.7	10	N.A.	1231	1230	1	N.A.	No
Depleted Uranium	DU-08	DU-08-T2	RWMC-SCI-S-DU-08-T2	DU-8-T2	1604	Tensiometer	9/19/2001	669250.0285	266216.5908	5,011.95	11.0	10.22	5,001.7	18	N.A.	1081	1080	1	N.A.	Yes
Depleted Uranium	DU-08	DU-08-T3	RWMC-SCI-S-DU-08-T3	DU-8-T3	1605	Tensiometer	9/19/2001	669249.1896	266217.7026	5,011.89	17.2	16.39	4,995.5	11	N.A.	1021	1020	1	N.A.	Yes
Depleted Uranium	DU-10	DU-10-T1	RWMC-SCI-S-DU-10-T1		1606	Tensiometer	9/24/2001	669230.575	266212.7144	5,011.45	4.8	4.03	5,007.4	13	N.A.	1321	1320	1	N.A.	Yes
Depleted Uranium	DU-10	DU-10-T2	RWMC-SCI-S-DU-10-T2		1607	Tensiometer	9/24/2001	669231.9841	266213.6032	5,011.46	7.5	6.74	5,004.7	14	N.A.	1371	1370	1	N.A.	Yes
Depleted Uranium	DU-10	DU-10-T3	RWMC-SCI-S-DU-10-T3		1608	Tensiometer	9/20/2001	669234.0463	266212.5997	5,011.49	9.9	9.10	5,002.4	10	N.A.	1241	1240	1	N.A.	Yes
Depleted Uranium	DU-14	DU-14-T1	RWMC-SCI-S-DU-14-T1		1609	Tensiometer	9/19/2001	669242.8947	266196.9003	5,011.82	4.5	3.72	5,008.1	29	N.A.	1191	1190	1	N.A.	No
Depleted Uranium	DU-14	DU-14-T2	RWMC-SCI-S-DU-14-T2		1610	Tensiometer	9/18/2001	669241.6471	266198.6118	5,011.81	9.8	8.95	5,002.9	12	N.A.	1071	1070	1	N.A.	No
Depleted Uranium	DU-14	DU-14-T3	RWMC-SCI-S-DU-14-T3		1611	Tensiometer	9/18/2001	669240.5856	266200.3542	5,011.78	16.1	15.30	4,996.5	24	N.A.	1181	1180	1	N.A.	No
Moisture Monitoring	MM1-1	MM1-1-T1	RWMC-SCI-S-MM1-1-T1		1612	Tensiometer	10/9/2001	669396.9846	266921.5022	5,010.78	6.4	5.60	5,005.2	6.5	N.A.	1311	1310	1	N.A.	Yes
Moisture Monitoring	MM1-1	MM1-1-T2	RWMC-SCI-S-MM1-1-T2		1613	Tensiometer	10/9/2001	669397.438	266919.9781	5,010.78	11.3	10.49	5,000.3	5.5	N.A.	1201	1200	1	N.A.	Yes
Moisture Monitoring	MM1-1	MM1-1-T3	RWMC-SCI-S-MM1-1-T3		1614	Tensiometer	10/9/2001	669397.7532	266918.3039	5,010.77	18.5	17.72	4,993.0	7	N.A.	1511	1510	1	N.A.	Maybe
Moisture Monitoring	MM1-2	MM1-2-T1	RWMC-SCI-S-MM1-2-T1		1615	Tensiometer	10/9/2001	669378.6859	266918.8127	5,010.7	6.4	5.55	5,005.1	16	N.A.	1631	1630	1	N.A.	Yes
Moisture Monitoring	MM1-2	MM1-2-T2	RWMC-SCI-S-MM1-2-T2		1616	Tensiometer	10/9/2001	669378.9073	266917.3765	5,010.7	10.1	9.26	5,001.4	8	N.A.	1621	1620	1	N.A.	Yes
Moisture Monitoring	MM1-2	MM1-2-T3	RWMC-SCI-S-MM1-2-T3		1617	Tensiometer	10/9/2001	669379.1485	266915.9302	5,010.72	14.8	13.97	4,996.7	6.5	N.A.	1641	1640	1	N.A.	Yes
Moisture Monitoring	MM1-3	MM1-3-T1	RWMC-SCI-S-MM1-3-T1		1618	Tensiometer	10/10/2001	669349.4213	266911.7513	5,011.61	5.9	5.14	5,006.5	12	N.A.	1591	1590	1	N.A.	Yes
Moisture Monitoring	MM1-3	MM1-3-T2	RWMC-SCI-S-MM1-3-T2		1619	Tensiometer	10/9/2001	669349.4785	266910.3017	5,011.55	9.2	8.43	5,003.1	6	N.A.	1551	1550	1	N.A.	Yes
Moisture Monitoring	MM1-3	MM1-3-T3	RWMC-SCI-S-MM1-3-T3		1620	Tensiometer	10/9/2001	669349.3988	266908.4566	5,011.57	12.5	11.72	4,999.8	12	N.A.	1651	1650	1	N.A.	No
Moisture Monitoring	MM2-1	MM2-1-T1	RWMC-SCI-S-MM2-1-T1		1621	Tensiometer	10/2/2001	669416.5083	266578.8293	5,010.64	7.5	6.66	5,004.0	15	N.A.	1381	1380	1	N.A.	Maybe
Moisture Monitoring	MM2-1	MM2-1-T2	RWMC-SCI-S-MM2-1-T2		1622	Tensiometer	10/2/2001	669416.4948	266577.1102	5,010.67	12.7	11.91	4,998.8	10	N.A.	1431	1430	1	N.A.	Maybe
Moisture Monitoring	MM2-1	MM2-1-T3	RWMC-SCI-S-MM2-1-T3		1623	Tensiometer	10/2/2001	669416.7224	266575.4264	5,010.65	16.8	15.97	4,994.7	16	N.A.	1461	1460	1	N.A.	Maybe
Moisture Monitoring	MM2-2	MM2-2-T1	RWMC-SCI-S-MM2-2-T1		1624	Tensiometer	10/2/2001	669389.3593	266576.4192	5,011.03	5.7	4.93	5,006.1	14.5	N.A.	1451	1450	1	N.A.	Yes
Moisture Monitoring	MM2-2	MM2-2-T2	RWMC-SCI-S-MM2-2-T2		1625	Tensiometer	10/2/2001	669389.4834	266574.8163	5,011.04	9.4	8.58	5,002.5	16.5	N.A.	1411	1410	1	N.A.	Yes
Moisture Monitoring	MM2-2	MM2-2-T3	RWMC-SCI-S-MM2-2-T3		1626	Tensiometer	10/2/2001	669389.6187	266573.2103	5,011.05	10.0	9.22	5,001.8	30	N.A.	1441	1440	1	N.A.	No
Moisture Monitoring	MM2-3	MM2-3-T1	RWMC-SCI-S-MM2-3-T1		1627	Tensiometer	10/3/2001	669360.5511	266573.0209	5,011.49	4.6	3.78	5,007.7	16	N.A.	1271	1270	1	N.A.	Yes
Moisture Monitoring	MM2-3	MM2-3-T2	RWMC-SCI-S-MM2-3-T2		1628	Tensiometer	10/2/2001	669360.7175	266571.4435	5,011.51	5.9	5.14	5,006.4	12	N.A.	1391	1390	1	N.A.	Maybe
Moisture Monitoring	MM2-3	MM2-3-T3	RWMC-SCI-S-MM2-3-T3		1629	Tensiometer	10/2/2001	669361.1873	266569.4641	5,011.57	7.4	6.55	5,005.0	7	N.A.	1481	1480	1	N.A.	Yes
Moisture Monitoring	MM3-1	MM3-1-T1	RWMC-SCI-S-MM3-1-T1		1630	Tensiometer	9/26/2001	669429.5959	266330.6438	5,010.62	5.7	4.89	5,005.7	15	N.A.	1341	1340	1	N.A.	No
Moisture Monitoring	MM3-1	MM3-1-T2	RWMC-SCI-S-MM3-1-T2		1631	Tensiometer	9/26/2001	669429.6464	266328.8968	5,010.62	7.9	7.08	5,003.5	10	N.A.	1301	1300	1	N.A.	Yes
Moisture Monitoring	MM3-1	MM3-1-T3	RWMC-SCI-S-MM3-1-T3		1632	Tensiometer	9/26/2001	669429.7159	266327.3362	5,010.68	10.5	9.74	5,000.9	11.5	N.A.	1361	1360	1	N.A.	Yes
Moisture Monitoring	MM3-2	MM3-2-T1	RWMC-SCI-S-MM3-2-T1		1633	Tensiometer	9/27/2001	669402.9053	266329.7716	5,010.96	5.8	4.97	5,006.0	14	N.A.	1281	1280	1	N.A.	Yes
Moisture Monitoring	MM3-2	MM3-2-T2	RWMC-SCI-S-MM3-2-T2		1634	Tensiometer	9/27/2001	669403.105	266328.1229	5,011.01	7.4	6.55	5,004.5	7	N.A.	1151	1150	1	N.A.	Yes
Moisture Monitoring	MM3-2	MM3-2-T3	RWMC-SCI-S-MM3-2-T3		1635	Tensiometer	9/27/2001	669403.0102	266326.6971	5,011	9.2	8.43	5,002.6	6	N.A.	1251	1250	1	N.A.	Yes
Moisture Monitoring	MM3-3	MM3-3-T1	RWMC-SCI-S-MM3-3-T1		1636	Tensiometer	10/1/2001	669384.4102	266325.6803	5,011.41	14.8	13.99	4,997.4	6	N.A.	1331	1330	1	N.A.	Yes
Moisture Monitoring	MM3-3	MM3-3-T2	RWMC-SCI-S-MM3-3-T2		1637	Tensiometer	9/27/2001	669384.5581	266324.1303	5,011.35	5.4	4.55	5,006.8	19	N.A.	1141	1140	1	N.A.	Yes
Moisture Monitoring	MM3-3	MM3-3-T3	RWMC-SCI-S-MM3-3-T3		1638	Tensiometer	9/27/2001	669384.9325	266322.5959	5,011.35	17.8	17.01	4,994.3	12.5	N.A.	1051	1050	1	N.A.	No
Moisture Monitoring	MM4-1	MM4-1-T1	RWMC-SCI-S-MM4-1-T1		1639	Tensiometer	9/18/2001	669238.0404	266178.1451	5,011.59	6.5	5.72	5,005.9	5	N.A.	1121	1120	1	N.A.	Yes
Moisture Monitoring	MM4-1	MM4-1-T2	RWMC-SCI-S-MM4-1-T2		1640	Tensiometer	9/17/2001	669236.6776	266180.375	5,011.58	15.7	14.87	4,996.7	8	N.A.	1161	1160	1	N.A.	Yes
Moisture Monitoring	MM4-1	MM4-1-T3	RWMC-SCI-S-MM4-1-T3		1641	Tensiometer	9/17/2001	669236.1844	266181.6675	5,011.59	19.3	18.51	4,993.1	10	N.A.	1131	1130	1	N.A.	Yes
Moisture Monitoring	MM4-2	MM4-2-T1	RWMC-SCI-S-MM4-2-T1		1642	Tensiometer	9/20/2001	669258.3396	266216.4445	5,011.94	5.7	4.89	5,007.1	15	N.A.	1101	1100	1	N.A.	Yes
Moisture Monitoring	MM4-2	MM4-2-T2	RWMC-SCI-S-MM4-2-T2		1643	Tensiometer	9/20/2001	669257.3659	266218.1425	5,011.96	12.2	11.39	5,000.6	4	N.A.	1091	1090	1	N.A.	No
Moisture Monitoring	MM4-2	MM4-2-T3	RWMC-SCI-S-MM4-2-T3		1644	Tensiometer	9/20/2001	669256.4863	266219.478	5,011.94	16.6	15.80	4,996.1	9	N.A.	1041	1040	1	N.A.	No
Moisture Monitoring	MM4-4	MM4-4-T1	RWMC-SCI-S-MM4-4-T1		1645	Tensiometer	9/24/2001	669213.1273	266244.0338	5,011	4.4	3.60	5,007.4	6	N.A.	1351	1350	1	N.A.	Yes
Moisture Monitoring	MM4-4	MM4-4-T2	RWMC-SCI-S-MM4-4-T2		1646	Tensiometer	9/24/2001	669211.779	266244.9191	5,010.96	9.0	8.22	5,002.7	8.5	N.A.	1291	1290	1	N.A.	Yes
Moisture Monitoring	MM4-4	MM4-4-T3	RWMC-SCI-S-MM4-4-T3		1647	Tensiometer	9/24/2001	669210.8231	266246.8188	5,010.95	10.3	9.45	5,001.5	6	N.A.	1261	1260	1	N.A.	Yes

Table B-1. (continued).

Integrated Probing Project Focus Area	IPP Cluster	Common Probe Name	Official_Name	Alias Probe Name	Well_ID	Probe Type	Installation Date (mm/dd/yyyy)	Northing (ft) (NAD27)	Easting (ft) (NAD27)	Surface Elevation (ft) (NGVD29)	Probe Depth (ft) (from surface)	Sensor/Port Bottom Depth from Surface (ft)	Sensor/Port Bottom Elevation (ft) (NGVD29)	Probe Stick Up (in.)	Soil Mstr Prb Sensor ID	Tensio-Gross Matric Pot Sensor ID	Tensio-Amb Pres Sensor ID	No. Sensors/ Ports per Probe	P/F Initial Pres. Test	Functional
Moisture Monitoring	MM4-5	MM4-5-T1	RWMC-SCI-S-MM4-5-T1		1648	Tensiometer	9/17/2001	669230.3753	266194.3873	5,011.51	4.9	4.14	5,007.4	24	N.A.	1001	1000	1	N.A.	No
Moisture Monitoring	MM4-5	MM4-5-T2	RWMC-SCI-S-MM4-5-T2		1649	Tensiometer	9/17/2001	669228.3685	266196.7444	5,011.5	10.5	9.72	5,001.8	24	N.A.	1031	1030	1	N.A.	Maybe
Moisture Monitoring	MM4-5	MM4-5-T3	RWMC-SCI-S-MM4-5-T3		1650	Tensiometer	9/17/2001	669227.2864	266198.3332	5,011.46	14.3	13.51	4,997.9	12	N.A.	1011	1010	1	N.A.	No
Activated Metal	SVR12-1	SVR12-1-T1	RWMC-SCI-S-SVR12-1-T1		1651	Tensiometer	10/11/2001	668437.8866	267865.1923	5,010.52	4.4	3.60	5,006.9	6	N.A.	1571	1570	1	N.A.	Yes
Activated Metal	SVR12-1	SVR12-1-T2	RWMC-SCI-S-SVR12-1-T2		1652	Tensiometer	10/11/2001	668438.9841	267864.1269	5,010.56	9.2	8.43	5,002.1	6	N.A.	1601	1600	1	N.A.	Yes
Activated Metal	SVR12-1	SVR12-1-T3	RWMC-SCI-S-SVR12-1-T3		1653	Tensiometer	10/11/2001	668440.3709	267862.9415	5,010.62	11.6	10.83	4,999.8	10.5	N.A.	1611	1610	1	N.A.	Yes
Activated Metal	SVR20-1	SVR20-1-T1	RWMC-SCI-S-SVR20-1-T1		1654	Tensiometer	9/12/2001	668331.1177	267618.41	5,010.25	9.1	8.26	5,002.0	8	N.A.	1211	1210	1	N.A.	Yes
Activated Metal	SVR20-1	SVR20-1-T2	RWMC-SCI-S-SVR20-1-T2		1655	Tensiometer	9/12/2001	668329.4563	267617.9502	5,010.23	13.5	12.68	4,997.6	22	N.A.	1061	1060	1	N.A.	Yes
Activated Metal	SVR20-1	SVR20-1-T3	RWMC-SCI-S-SVR20-1-T3		1656	Tensiometer	9/12/2001	668328.0981	267617.2649	5,010.18	17.2	16.39	4,993.8	11	N.A.	1221	1220	1	N.A.	Yes
Moisture Monitoring	MM1-1	MM1-1	RWMC-SCI-S-MM1-1		1657	Soil Moisture Probe	4/12/2001	669402.3743	266918.451	5,010.56	18.7	17.79	4,992.8	50	SMRT200011	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM1-1	MM1-1B	RWMC-SCI-S-MM1-1B		1658	Soil Moisture Probe	4/18/2001	669402.4548	266921.0786	5,010.5	12.5	11.58	4,998.9	27	SMRT200027	N.A.	N.A.	2	N.A.	Yes
Moisture Monitoring	MM1-1	MM1-1B	RWMC-SCI-S-MM1-1B		1658	Soil Moisture Probe	4/18/2001	669402.4548	266921.0786	5,010.5	12.5	5.50	5,005.0	27	SMRT200032	N.A.	N.A.	2	N.A.	No
Moisture Monitoring	MM1-2	MM1-2	RWMC-SCI-S-MM1-2		1659	Soil Moisture Probe	4/12/2001	669377.0694	266915.608	5,010.84	14.8	13.89	4,997.0	20	SMRT200019	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM1-2	MM1-2B	RWMC-SCI-S-MM1-2B		1660	Soil Moisture Probe	4/18/2001	669376.498	266917.8192	5,010.89	11.6	10.75	5,000.1	18	SMRT200014	N.A.	N.A.	2	N.A.	No
Moisture Monitoring	MM1-2	MM1-2B	RWMC-SCI-S-MM1-2B		1660	Soil Moisture Probe	4/18/2001	669376.498	266917.8192	5,010.89	11.6	6.00	5,004.9	18	SMRT200038	N.A.	N.A.	2	N.A.	Yes
Moisture Monitoring	MM1-3	MM1-3	RWMC-SCI-S-MM1-3		1661	Soil Moisture Probe	4/16/2001	669347.6477	266910.0807	5,011.65	12.4	11.47	5,000.2	39	SMRT200013	N.A.	N.A.	1	N.A.	Maybe
Moisture Monitoring	MM1-3	MM1-3B	RWMC-SCI-S-MM1-3B		1662	Soil Moisture Probe	4/17/2001	669347.9299	266907.6306	5,011.54	10.6	9.75	5,001.8	18	SMRT200040	N.A.	N.A.	2	N.A.	No
Moisture Monitoring	MM1-3	MM1-3B	RWMC-SCI-S-MM1-3B		1662	Soil Moisture Probe	4/17/2001	669347.9299	266907.6306	5,011.54	10.6	4.90	5,006.6	18	SMRT200012	N.A.	N.A.	2	N.A.	Yes
Moisture Monitoring	MM2-1	MM2-1	RWMC-SCI-S-MM2-1		1663	Soil Moisture Probe	3/28/2001	669420.2873	266576.9636	5,010.59	16.9	16.00	4,994.6	36	SMRT200031	N.A.	N.A.	1	N.A.	Maybe
Moisture Monitoring	MM2-1	MM2-1B	RWMC-SCI-S-MM2-1B		1664	Soil Moisture Probe	4/18/2001	669420.3779	266574.1169	5,010.5	13.4	12.51	4,998.0	24	SMRT200041	N.A.	N.A.	2	N.A.	Yes
Moisture Monitoring	MM2-1	MM2-1B	RWMC-SCI-S-MM2-1B		1664	Soil Moisture Probe	4/18/2001	669420.3779	266574.1169	5,010.5	13.4	7.25	5,003.3	24	SMRT200021	N.A.	N.A.	2	N.A.	No
Moisture Monitoring	MM2-2	MM2-2	RWMC-SCI-S-MM2-2		1665	Soil Moisture Probe	3/28/2001	669391.6421	266575.4524	5,011.01	11.7	10.78	5,000.2	22	SMRT200024	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM2-2	MM2-2B	RWMC-SCI-S-MM2-2B		1666	Soil Moisture Probe	4/18/2001	669392.1493	266572.3754	5,011.06	10.0	9.14	5,001.9	37	SMRT200022	N.A.	N.A.	2	N.A.	Yes
Moisture Monitoring	MM2-2	MM2-2B	RWMC-SCI-S-MM2-2B		1666	Soil Moisture Probe	4/18/2001	669392.1493	266572.3754	5,011.06	10.0	4.00	5,007.1	37	SMRT200020	N.A.	N.A.	2	N.A.	No
Moisture Monitoring	MM2-3	MM2-3	RWMC-SCI-S-MM2-3		1667	Soil Moisture Probe	3/28/2001	669359.5639	266570.8298	5,011.48	3.9	3.05	5,008.4	34	SMRT200015	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM2-3	MM2-3B	RWMC-SCI-S-MM2-3B		1668	Soil Moisture Probe	4/23/2001	669359.175	266562.0775	5,011.5	7.9	6.98	5,004.5	53	SMRT200029	N.A.	N.A.	2	N.A.	No
Moisture Monitoring	MM2-3	MM2-3B	RWMC-SCI-S-MM2-3B		1668	Soil Moisture Probe	4/23/2001	669359.175	266562.0775	5,011.5	7.9	1.67	5,009.8	53	SMRT200046	N.A.	N.A.	2	N.A.	Yes
Moisture Monitoring	MM3-1	MM3-1	RWMC-SCI-S-MM3-1		1669	Soil Moisture Probe	3/22/2001	669434.1759	266325.1384	5,010.73	10.6	9.69	5,001.0	33	SMRT200042	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM3-1	MM3-1B	RWMC-SCI-S-MM3-1B		1670	Soil Moisture Probe	5/14/2001	669434.2584	266327.4258	5,010.67	8.4	7.62	5,003.0	32	SMRT200053	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM3-1	MM3-1C	RWMC-SCI-S-MM3-1C		1671	Soil Moisture Probe	5/14/2001	669433.8944	266329.6281	5,010.65	5.3	4.47	5,006.2	18	SMRT200045	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM3-2	MM3-2	RWMC-SCI-S-MM3-2		1672	Soil Moisture Probe	3/26/2001	669402.1929	266322.2538	5,011.05	9.4	8.53	5,002.5	47	SMRT200010	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM3-2	MM3-2B	RWMC-SCI-S-MM3-2B		1673	Soil Moisture Probe	5/14/2001	669401.2171	266328.273	5,011.07	7.8	6.96	5,004.1	28	SMRT200052	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM3-2	MM3-2C	RWMC-SCI-S-MM3-2C		1674	Soil Moisture Probe	5/14/2001	669401.432	266326.1641	5,011.03	4.8	3.97	5,007.1	24	SMRT200016	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM3-3	MM3-3	RWMC-SCI-S-MM3-3		1675	Soil Moisture Probe	3/26/2001	669382.595	266319.5107	5,011.36	17.9	17.00	4,994.4	24	SMRT200025	N.A.	N.A.	1	N.A.	Maybe
Moisture Monitoring	MM3-3	MM3-3B	RWMC-SCI-S-MM3-3B		1676	Soil Moisture Probe	5/14/2001	669382.8536	266324.0746	5,011.36	13.8	13.82	4,997.5	22	SMRT200044	N.A.	N.A.	2	N.A.	Yes
Moisture Monitoring	MM3-3	MM3-3B	RWMC-SCI-S-MM3-3B		1676	Soil Moisture Probe	5/14/2001	669382.8536	266324.0746	5,011.36	13.8	7.46	5,003.9	22	SMRT200054	N.A.	N.A.	2	N.A.	Yes
Americium/Neptunium	741-08	741-08-M1	RWMC-SCI-S-741-08-M1	741-8-M1	1677	Soil Moisture Probe	7/9/2001	669184.3289	266550.9499	5,012.23	20.7	19.86	4,992.4	34	SMRT200066	N.A.	N.A.	3	N.A.	Yes
Americium/Neptunium	741-08	741-08-M1	RWMC-SCI-S-741-08-M1	741-8-M1	1677	Soil Moisture Probe	7/9/2001	669184.3289	266550.9499	5,012.23	20.7	11.50	5,000.7	34	SMRT200068	N.A.	N.A.	3	N.A.	Yes
Americium/Neptunium	741-08	741-08-M1	RWMC-SCI-S-741-08-M1	741-8-M1	1677	Soil Moisture Probe	7/9/2001	669184.3289	266550.9499	5,012.23	20.7	4.14	5,008.1	34	SMRT200067	N.A.	N.A.	3	N.A.	Yes
Organic Sludge	743-03	743-03-M1	RWMC-SCI-S-743-03-M1	743-3-M1	1678	Soil Moisture Probe	4/24/2001	669346.3134	267075.9356	5,010.87	20.0	19.09	4,991.8	20	SMRT200037	N.A.	N.A.	3	N.A.	Yes
Organic Sludge	743-03	743-03-M1	RWMC-SCI-S-743-03-M1	743-3-M1	1678	Soil Moisture Probe	4/24/2001	669346.3134	267075.9356	5,010.87	20.0	12.31	4,998.6	20	SMRT200026	N.A.	N.A.	3	N.A.	No
Organic Sludge	743-03	743-03-M1	RWMC-SCI-S-743-03-M1	743-3-M1	1678	Soil Moisture Probe	4/24/2001	669346.3134	267075.9356	5,010.87	20.0	3.36	5,007.5	20	SMRT200035	N.A.	N.A.	3	N.A.	Yes
Organic Sludge	743-08	743-08-M1	RWMC-SCI-S-743-08-M1	743-8-M1	1679	Soil Moisture Probe	4/30/2001	669322.9373	267058.6362	5,010.77	23.1	22.28	4,988.5	17	SMRT200051	N.A.	N.A.	3	N.A.	Yes
Organic Sludge	743-08	743-08-M1	RWMC-SCI-S-743-08-M1	743-8-M1	1679	Soil Moisture Probe	4/30/2001	669322.9373	267058.6362	5,010.77	23.1	13.90	4,996.9	17	SMRT200050	N.A.	N.A.	3	N.A.	Yes
Organic Sludge	743-08	743-08-M1	RWMC-SCI-S-743-08-M1	743-8-M1	1679	Soil Moisture Probe	4/30/2001	669322.9373	267058.6362	5,010.77	23.1	6.60	5,004.2	17	SMRT200047	N.A.	N.A.	3	N.A.	Yes
Organic Sludge	743-18	743-18-M1	RWMC-SCI-S-743-18-M1		1680	Soil Moisture Probe	4/30/2001	669287.7573	267007.2816	5,012.65	20.0	19.20	4,993.5	18	SMRT200036	N.A.	N.A.	3	N.A.	No
Organic Sludge	743-18	743-18-M1	RWMC-SCI-S-743-18-M1		1680	Soil Moisture Probe	4/30/2001	669287.7573	267007.2816	5,012.65	20.0	12.83	4,999.8	18	SMRT200048	N.A.	N.A.	3	N.A.	No

Table B-1. (continued).

Integrated Probing Project Focus Area	IPP Cluster	Common Probe Name	Official_Name	Alias Probe Name	Well_ID	Probe Type	Installation Date (mm/dd/yyyy)	Northing (ft) (NAD27)	Easting (ft) (NAD27)	Surface Elevation (ft) (NGVD29)	Probe Depth (ft) (from surface)	Sensor/Port Bottom Depth from Surface (ft)	Sensor/Port Bottom Elevation (ft) (NGVD29)	Probe Stick Up (in.)	Soil Mstr Prb Sensor ID	Tensio-Gross Matric Pot Sensor ID	Tensio-Amb Pres Sensor ID	No. Sensors/ Ports per Probe	P/F Initial Pres. Test	Functional
Organic Sludge	743-18	743-18-M1	RWMC-SCI-S-743-18-M1		1680	Soil Moisture Probe	4/30/2001	669287.7573	267007.2816	5,012.65	20.0	6.47	5,006.2	18	SMRT200017	N.A.	N.A.	3	N.A.	Yes
Depleted Uranium	DU-10	DU-10-M1	RWMC-SCI-S-DU-10-M1		1681	Soil Moisture Probe	7/11/2001	669231.7283	266209.3744	5,011.48	10.1	9.25	5,002.2	18	SMRT200064	N.A.	N.A.	1	N.A.	Yes
Depleted Uranium	DU-10	DU-10-M2	RWMC-SCI-S-DU-10-M2		1682	Soil Moisture Probe	7/11/2001	669233.2108	266208.5057	5,011.5	7.4	6.64	5,004.9	16	SMRT200071	N.A.	N.A.	1	N.A.	Maybe
Depleted Uranium	DU-10	DU-10-M3	RWMC-SCI-S-DU-10-M3		1683	Soil Moisture Probe	7/11/2001	669233.1322	266210.6299	5,011.54	4.8	3.97	5,007.6	24	SMRT200063	N.A.	N.A.	1	N.A.	Yes
Depleted Uranium	DU-10	DU-10-MD	RWMC-SCI-S-DU-10-MD		1684	Soil Moisture Probe	8/20/2001	669231.6206	266211.4367	5,011.42	7.5	6.72	5,004.7	15	SMRT200077	N.A.	N.A.	1	N.A.	Yes
Depleted Uranium	DU-14	DU-14-M1	RWMC-SCI-S-DU-14-M1	DU-14-M	1685	Soil Moisture Probe	7/16/2001	669239.7633	266198.7496	5,011.65	16.0	15.20	4,996.5	16	SMRT200076	N.A.	N.A.	3	N.A.	Yes
Depleted Uranium	DU-14	DU-14-M1	RWMC-SCI-S-DU-14-M1	DU-14-M	1685	Soil Moisture Probe	7/16/2001	669239.7633	266198.7496	5,011.65	16.0	9.83	5,001.8	16	SMRT200078	N.A.	N.A.	3	N.A.	Yes
Depleted Uranium	DU-14	DU-14-M1	RWMC-SCI-S-DU-14-M1	DU-14-M	1685	Soil Moisture Probe	7/16/2001	669239.7633	266198.7496	5,011.65	16.0	4.47	5,007.2	16	SMRT200080	N.A.	N.A.	3	N.A.	Yes
Depleted Uranium	DU-08	DU-08-M1	RWMC-SCI-S-DU-08-M1	DU-8-M1	1686	Soil Moisture Probe	7/10/2001	669248.9361	266215.8332	5,011.87	18.7	17.86	4,994.0	22	SMRT200070	N.A.	N.A.	3	N.A.	Maybe
Depleted Uranium	DU-08	DU-08-M1	RWMC-SCI-S-DU-08-M1	DU-8-M1	1686	Soil Moisture Probe	7/10/2001	669248.9361	266215.8332	5,011.87	18.7	11.50	5,000.4	22	SMRT200069	N.A.	N.A.	3	N.A.	Yes
Depleted Uranium	DU-08	DU-08-M1	RWMC-SCI-S-DU-08-M1	DU-8-M1	1686	Soil Moisture Probe	7/10/2001	669248.9361	266215.8332	5,011.87	18.7	6.14	5,005.7	22	SMRT200065	N.A.	N.A.	3	N.A.	Maybe
Moisture Monitoring	MM4-1	MM4-1	RWMC-SCI-S-MM4-1		1687	Soil Moisture Probe	3/12/2001	669235.4023	266180.0387	5,011.49	20.3	19.44	4,992.0	24	SMRT200033	N.A.	N.A.	1	N.A.	Maybe
Moisture Monitoring	MM4-1	MM4-1B	RWMC-SCI-S-MM4-1B		1688	Soil Moisture Probe	7/16/2001	669235.8225	266178.4303	5,011.44	15.5	14.67	4,996.8	20	SMRT200086	N.A.	N.A.	2	N.A.	Maybe
Moisture Monitoring	MM4-1	MM4-1B	RWMC-SCI-S-MM4-1B		1688	Soil Moisture Probe	7/16/2001	669235.8225	266178.4303	5,011.44	15.5	6.30	5,005.1	20	SMRT200087	N.A.	N.A.	2	N.A.	Yes
Moisture Monitoring	MM4-1	MM4-1D	RWMC-SCI-S-MM4-1D		1689	Soil Moisture Probe	8/21/2001	669236.7409	266176.3155	5,011.46	17.6	16.72	4,994.7	18.5	SMRT200072	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM4-2	MM4-2	RWMC-SCI-S-MM4-2		1690	Soil Moisture Probe	3/7/2001	669258.9432	266218.7203	5,011.98	18.3	17.39	4,994.6	28	SMRT200023	N.A.	N.A.	1	N.A.	Maybe
Moisture Monitoring	MM4-2	MM4-2B	RWMC-SCI-S-MM4-2B		1691	Soil Moisture Probe	7/10/2001	669258.7354	266221.4269	5,012	12.9	12.08	4,999.9	15	SMRT200073	N.A.	N.A.	2	N.A.	Yes
Moisture Monitoring	MM4-2	MM4-2B	RWMC-SCI-S-MM4-2B		1691	Soil Moisture Probe	7/10/2001	669258.7354	266221.4269	5,012	12.9	4.72	5,007.3	15	SMRT200075	N.A.	N.A.	2	N.A.	Yes
Moisture Monitoring	MM4-3	MM4-3	RWMC-SCI-S-MM4-3		1692	Soil Moisture Probe	3/1/2001	669211.3526	266253.5317	5,011.02	10.0	9.11	5,001.9	40	SMRT200018	N.A.	N.A.	1	N.A.	Maybe
Moisture Monitoring	MM4-3	MM4-3B	RWMC-SCI-S-MM4-3B		1693	Soil Moisture Probe	5/21/2001	669212.7012	266250.8084	5,011.01	6.2	6.18	5,004.8	22	SMRT200043	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM4-3	MM4-3C	RWMC-SCI-S-MM4-3C		1694	Soil Moisture Probe	6/12/2001	669210.9613	266257.3024	5,011.06	5.6	4.80	5,006.3	14	SMRT200055	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM4-4	MM4-4	RWMC-SCI-S-MM4-4		1695	Soil Moisture Probe	3/7/2001	669209.0315	266245.2221	5,011	11.2	10.28	5,000.7	26	SMRT200030	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM4-4	MM4-4B	RWMC-SCI-S-MM4-4B		1696	Soil Moisture Probe	6/12/2001	669212.0612	266240.1197	5,010.92	9.5	8.72	5,002.2	13.5	SMRT200056	N.A.	N.A.	2	N.A.	Yes
Moisture Monitoring	MM4-4	MM4-4B	RWMC-SCI-S-MM4-4B		1696	Soil Moisture Probe	6/12/2001	669212.0612	266240.1197	5,010.92	9.5	4.17	5,006.8	13.5	SMRT200057	N.A.	N.A.	2	N.A.	Yes
Moisture Monitoring	MM4-4	MM4-4D	RWMC-SCI-S-MM4-4D		1697	Soil Moisture Probe	8/20/2001	669211.6526	266241.6027	5,010.91	11.8	10.86	5,000.1	43	SMRT200074	N.A.	N.A.	1	N.A.	Yes
Moisture Monitoring	MM4-5	MM4-5	RWMC-SCI-S-MM4-5		1698	Soil Moisture Probe	3/8/2001	669224.5536	266200.8799	5,011.44	14.8	13.88	4,997.6	24	SMRT200034	N.A.	N.A.	1	N.A.	Maybe
Moisture Monitoring	MM4-5	MM4-5B	RWMC-SCI-S-MM4-5B		1699	Soil Moisture Probe	7/16/2001	669225.8529	266199.2026	5,011.4	10.6	9.75	5,001.7	19	SMRT200039	N.A.	N.A.	2	N.A.	No
Moisture Monitoring	MM4-5	MM4-5B	RWMC-SCI-S-MM4-5B		1699	Soil Moisture Probe	7/16/2001	669225.8529	266199.2026	5,011.4	10.6	4.39	5,007.0	19	SMRT200088	N.A.	N.A.	2	N.A.	No
Uranium/Enriched U	Pit5-4	Pit5-4-M	RWMC-SCI-S-Pit5-4-M	P5-4-M	1700	Soil Moisture Probe	8/14/2001	669627.1706	267294.7684	5,012.24	11.0	10.16	5,002.1	28.5	SMRT200085	N.A.	N.A.	1	N.A.	Yes
Uranium/Enriched U	Pit5-4	Pit5-4-MB	RWMC-SCI-S-Pit5-4-MB	P5-4-MB	1701	Soil Moisture Probe	8/14/2001	669628.6126	267293.2669	5,012.24	9.0	8.18	5,004.1	22.5	SMRT200079	N.A.	N.A.	2	N.A.	Yes
Uranium/Enriched U	Pit5-4	Pit5-4-MB	RWMC-SCI-S-Pit5-4-MB	P5-4-MB	1701	Soil Moisture Probe	8/14/2001	669628.6126	267293.2669	5,012.24	9.0	2.81	5,009.4	22.5	SMRT200089	N.A.	N.A.	2	N.A.	Yes
Uranium/Enriched U	Pit5-TW1	Pit5-TW1-M	RWMC-SCI-S-Pit5-TW1-M	P5-TW1-M	1702	Soil Moisture Probe	8/14/2001	669687.7006	267183.8481	5,011.67	11.1	10.24	5,001.4	27.5	SMRT200082	N.A.	N.A.	1	N.A.	Yes
Uranium/Enriched U	Pit5-TW1	Pit5-TW1-MB	RWMC-SCI-S-Pit5-TW1-MB	P5-TW1-MB	1703	Soil Moisture Probe	8/15/2001	669686.6167	267186.7229	5,011.71	9.0	8.22	5,003.5	22	SMRT200091	N.A.	N.A.	2	N.A.	Yes
Uranium/Enriched U	Pit5-TW1	Pit5-TW1-MB	RWMC-SCI-S-Pit5-TW1-MB	P5-TW1-MB	1703	Soil Moisture Probe	8/15/2001	669686.6167	267186.7229	5,011.71	9.0	2.85	5,008.9	22	SMRT200090	N.A.	N.A.	2	N.A.	Yes
Activated Metal	SVR-12	SVR-12-M	RWMC-SCI-S-SVR-12-M	SVR12-M	1704	Soil Moisture Probe	7/25/2001	668439.5962	267861.3319	5,010.54	12.3	11.45	4,999.1	13	SMRT200084	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR-12	SVR-12-MB	RWMC-SCI-S-SVR-12-MB	SVR12-MB	1705	Soil Moisture Probe	7/25/2001	668437.7899	267862.917	5,010.56	9.2	8.39	5,002.2	20	SMRT200083	N.A.	N.A.	2	N.A.	Yes
Activated Metal	SVR-12	SVR-12-MB	RWMC-SCI-S-SVR-12-MB	SVR12-MB	1705	Soil Moisture Probe	7/25/2001	668437.7899	267862.917	5,010.56	9.2	4.30	5,006.3	20	SMRT200081	N.A.	N.A.	2	N.A.	Yes
Activated Metal	SVR-20	SVR-20-M	RWMC-SCI-S-SVR-20-M	SVR20-M	1706	Soil Moisture Probe	9/6/2001	668326.134	267618.407	5,010.24	18.2	17.44	4,992.8	28.5	SMRT200058	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR-20	SVR-20-MB	RWMC-SCI-S-SVR-20-MB	SVR20-MB	1707	Soil Moisture Probe	9/6/2001	668327.7527	267619.0035	5,010.2	14.6	13.79	4,996.4	18.5	SMRT200059	N.A.	N.A.	2	N.A.	Yes
Activated Metal	SVR-20	SVR-20-MB	RWMC-SCI-S-SVR-20-MB	SVR20-MB	1707	Soil Moisture Probe	9/6/2001	668327.7527	267619.0035	5,010.2	14.6	4.43	5,005.8	18.5	SMRT200060	N.A.	N.A.	2	N.A.	Yes
Organic Sludge	743-03	743-03-VP1	RWMC-SCI-S-743-03-VP1	743-3-VP1	1708	Vapor Port	4/26/2001	669344.6353	267074.2661	5,010.92	18.6	17.96	4,993.0	6	N.A.	N.A.	N.A.	1	N.A.	Yes
Organic Sludge	743-03	743-03-VP2	RWMC-SCI-S-743-03-VP2	743-3-VP2	1709	Vapor Port	4/26/2001	669342.0827	267073.4532	5,010.95	13.9	13.25	4,997.7	6	N.A.	N.A.	N.A.	1	N.A.	Yes
Organic Sludge	743-03	743-03-VP3	RWMC-SCI-S-743-03-VP3	743-3-VP3	1710	Vapor Port	4/26/2001	669343.4013	267072.9552	5,010.86	5.4	4.78	5,006.1	4	N.A.	N.A.	N.A.	1	N.A.	Yes
Organic Sludge	743-08	743-08-VP1	RWMC-SCI-S-743-08-VP1	743-8-VP1	1711	Vapor Port	4/25/2001	669321.6213	267056.1074	5,010.85	20.8	20.19	4,990.7	6	N.A.	N.A.	N.A.	1	N.A.	Yes
Organic Sludge	743-08	743-08-VP2	RWMC-SCI-S-743-08-VP2	743-8-VP2	1712	Vapor Port	4/25/2001	669320.6977	267059.0568	5,010.7	14.0	13.38	4,997.3	6	N.A.	N.A.	N.A.	1	N.A.	Yes
Organic Sludge	743-08	743-08-VP3	RWMC-SCI-S-743-08-VP3	743-8-VP3	1713	Vapor Port	4/26/2001	669324.2567	267056.286	5,010.78	5.5	4.88	5,005.9	6	N.A.	N.A.	N.A.	1	N.A.	Yes
Organic Sludge	743-18	743-18-VP1	RWMC-SCI-S-743-18-VP1		1714	Vapor Port	5/1/2001	669285.6036	267007.282	5,012.64	20.6	20.00	4,992.6	6	N.A.	N.A.	N.A.	1	N.A.	Yes

Table B-1. (continued).

Integrated Probing Project Focus Area	IPP Cluster	Common Probe Name	Official_Name	Alias Probe Name	Well_ID	Probe Type	Installation Date (mm/dd/yyyy)	Northing (ft) (NAD27)	Easting (ft) (NAD27)	Surface Elevation (ft) (NGVD29)	Probe Depth (ft) (from surface)	Sensor/Port Bottom Depth from Surface (ft)	Sensor/Port Bottom Elevation (ft) (NGVD29)	Probe Stick Up (in.)	Soil Mstr Prb Sensor ID	Tensio-Gross Matric Pot Sensor ID	Tensio-Amb Pres Sensor ID	No. Sensors/ Ports per Probe	P/F Initial Pres. Test	Functional
Organic Sludge	743-18	743-18-VP3	RWMC-SCI-S-743-18-VP3		1715	Vapor Port	5/2/2001	669283.7124	267006.5188	5,012.63	8.2	7.61	5,005.0	6	N.A.	N.A.	N.A.	1	N.A.	Yes
Organic Sludge	743-18	743-18-VP4	RWMC-SCI-S-743-18-VP4		1716	Vapor Port	5/2/2001	669284.6499	267009.0883	5,012.72	15.2	14.57	4,998.2	2.5	N.A.	N.A.	N.A.	1	N.A.	Yes
Depleted Uranium	DU-10	DU-10-VP1	RWMC-SCI-S-DU-10-VP1		1717	Vapor Port	6/20/2001	669228.522	266208.4549	5,011.42	12.1	11.55	4,999.9	17.5	N.A.	N.A.	N.A.	1	N.A.	Yes
Depleted Uranium	DU-10	DU-10-VP2	RWMC-SCI-S-DU-10-VP2		1718	Vapor Port	6/19/2001	669227.3514	266206.9651	5,011.5	10.6	10.00	5,001.5	11.5	N.A.	N.A.	N.A.	1	N.A.	Yes
Depleted Uranium	DU-10	DU-10-VP3	RWMC-SCI-S-DU-10-VP3		1719	Vapor Port	6/20/2001	669227.5343	266210.076	5,011.39	6.8	6.19	5,005.2	11.5	N.A.	N.A.	N.A.	1	N.A.	Yes
Depleted Uranium	DU-14	DU-14-VP1	RWMC-SCI-S-DU-14-VP1		1720	Vapor Port	7/12/2001	669237.7332	266197.1223	5,011.62	16.6	16.05	4,995.6	6	N.A.	N.A.	N.A.	1	N.A.	Yes
Depleted Uranium	DU-14	DU-14-VP2	RWMC-SCI-S-DU-14-VP2		1721	Vapor Port	7/12/2001	669239.7467	266196.3637	5,011.73	12.3	11.73	5,000.0	12	N.A.	N.A.	N.A.	1	N.A.	Yes
Depleted Uranium	DU-14	DU-14-VP3	RWMC-SCI-S-DU-14-VP3		1722	Vapor Port	7/12/2001	669240.9956	266195.0839	5,011.76	5.5	4.88	5,006.9	6	N.A.	N.A.	N.A.	1	N.A.	Yes
Depleted Uranium	DU-08	DU-08-VP2	RWMC-SCI-S-DU-08-VP2	DU-8-VP2	1723	Vapor Port	6/20/2001	669246.4988	266213.1949	5,011.77	16.4	15.84	4,995.9	8.5	N.A.	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR12-1	SVR12-1-VP1	RWMC-SCI-S-SVR12-1-VP1		1724	Vapor Port	8/1/2001	668450.4658	267862.1056	5,010.35	12.3	11.73	4,998.6	12	N.A.	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR12-1	SVR12-1-VP2	RWMC-SCI-S-SVR12-1-VP2		1725	Vapor Port	7/31/2001	668452.0695	267860.9307	5,010.53	8.2	7.59	5,002.9	16	N.A.	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR12-1	SVR12-1-VP3	RWMC-SCI-S-SVR12-1-VP3		1726	Vapor Port	7/31/2001	668454.2537	267860.3751	5,010.5	3.3	2.67	5,007.8	8	N.A.	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR12-2	SVR12-2-VP1	RWMC-SCI-S-SVR12-2-VP1		1727	Vapor Port	7/26/2001	668452.1714	267866.5194	5,010.53	12.5	11.90	4,998.6	10	N.A.	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR12-2	SVR12-2-VP2	RWMC-SCI-S-SVR12-2-VP2		1728	Vapor Port	7/26/2001	668453.5916	267865.7126	5,010.57	8.3	7.67	5,002.9	15	N.A.	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR12-2	SVR12-2-VP3	RWMC-SCI-S-SVR12-2-VP3		1729	Vapor Port	7/31/2001	668456.1357	267864.4257	5,010.57	3.2	2.59	5,008.0	9	N.A.	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR12-3	SVR12-3-VP1	RWMC-SCI-S-SVR12-3-VP1		1730	Vapor Port	7/25/2001	668455.6777	267870.0603	5,010.5	12.4	11.82	4,998.7	11	N.A.	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR12-3	SVR12-3-VP2	RWMC-SCI-S-SVR12-3-VP2		1731	Vapor Port	7/26/2001	668457.6083	267869.5506	5,010.55	8.2	7.59	5,003.0	16	N.A.	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR12-3	SVR12-3-VP3	RWMC-SCI-S-SVR12-3-VP3		1732	Vapor Port	7/26/2001	668459.0461	267868.0609	5,010.63	3.1	2.50	5,008.1	10	N.A.	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR20-3	SVR20-3-VP1	RWMC-SCI-S-SVR20-3-VP1		1733	Vapor Port	9/5/2001	668339.8013	267593.2085	5,009.78	6.9	6.34	5,003.4	22	N.A.	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR20-3	SVR20-3-VP2	RWMC-SCI-S-SVR20-3-VP2		1734	Vapor Port	9/5/2001	668337.8749	267591.552	5,009.94	13.5	12.94	4,997.0	22	N.A.	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR20-3	SVR20-3-VP3	RWMC-SCI-S-SVR20-3-VP3		1735	Vapor Port	9/5/2001	668335.0207	267592.5306	5,009.8	15.6	14.96	4,994.8	10	N.A.	N.A.	N.A.	1	N.A.	Yes
Activated Metal	SVR20-5	SVR20-5-VP3	RWMC-SCI-S-SVR20-5-VP3		1736	Vapor Port	9/10/2001	668340.6212	267581.1257	5,009.53	17.8	17.17	4,992.4	17	N.A.	N.A.	N.A.	1	N.A.	Yes
~~Organic Sludge~~	~~743-18~~	~~743-18-Abandoned~~	~~RWMC-SCI-S-743-18-Abandoned~~	743-18-VP aband	1737	~~Vapor Port~~	~~5/1/2001~~	~~669287.001~~	~~267009.6275~~	~~5,012.63~~	~~14.9~~	14.28	4,998.4	~~6~~	N.A.	N.A.	N.A.	~~1~~	N.A.	No
Americium/Neptunium	741-08	741-08-L1	RWMC-SCI-S-741-08-L1	741-8-L1	1738	Lysimeter	7/3/2001	669185.592	266545.4039	5,012.12	15.3	15.24	4,996.9	5.0	N.A.	N.A.	N.A.	1	N.A.	
Americium/Neptunium	741-08	741-08-L2	RWMC-SCI-S-741-08-L2	741-8-L2	1739	Lysimeter	7/3/2001	669183.7481	266546.1344	5,012.13	7.9	7.78	5,004.3	3.0	N.A.	N.A.	N.A.	1	N.A.	
Organic Sludge	743-03	743-03-L1	RWMC-SCI-S-743-03-L1	743-3-L1	1740	Lysimeter	6/5/2001	669346.1438	267071.7195	5,011.04	12.9	12.80	4,998.2	15.0	N.A.	N.A.	N.A.	1	N.A.	
Organic Sludge	743-03	743-03-L2	RWMC-SCI-S-743-03-L2	743-3-L2	1741	Lysimeter	6/6/2001	669343.6017	267072.3239	5,010.88	9.9	9.80	5,001.1	11.0	N.A.	N.A.	N.A.	1	N.A.	
Organic Sludge	743-08	743-08-L1	RWMC-SCI-S-743-08-L1	743-8-L1	1742	Lysimeter	8/15/2001	669324.1261	267048.7195	5,010.97	23.4	23.28	4,987.7	18.0	N.A.	N.A.	N.A.	1	N.A.	
Organic Sludge	743-08	743-08-L2	RWMC-SCI-S-743-08-L2	743-8-L2	1743	Lysimeter	8/15/2001	669325.7622	267048.8873	5,010.9	9.1	8.99	5,001.9	13.0	N.A.	N.A.	N.A.	1	N.A.	
Organic Sludge	743-18	743-18-L1	RWMC-SCI-S-743-18-L1		1744	Lysimeter	6/7/2001	669288.611	267003.8742	5,012.53	12.2	12.10	5,000.4	15.0	N.A.	N.A.	N.A.	1	N.A.	
Organic Sludge	743-18	743-18-L2	RWMC-SCI-S-743-18-L2		1745	Lysimeter	6/7/2001	669287.1871	267003.0568	5,012.59	12.9	12.85	4,999.7	6.0	N.A.	N.A.	N.A.	1	N.A.	
Depleted Uranium	DU-10	DU-10-L1	RWMC-SCI-S-DU-10-L1		1746	Lysimeter	6/19/2001	669229.9197	266206.4872	5,011.44	9.9	9.76	5,001.7	25.0	N.A.	N.A.	N.A.	1	N.A.	
Depleted Uranium	DU-10	DU-10-L2	RWMC-SCI-S-DU-10-L2		1747	Lysimeter	6/19/2001	669228.2671	266204.639	5,011.46	7.1	7.03	5,004.4	12.0	N.A.	N.A.	N.A.	1	N.A.	
Depleted Uranium	DU-14	DU-14-L1	RWMC-SCI-S-DU-14-L1		1748	Lysimeter	8/21/2001	669242.0537	266193.3945	5,011.7	16.1	15.95	4,995.8	21.0	N.A.	N.A.	N.A.	1	N.A.	
Depleted Uranium	DU-14	DU-14-L2	RWMC-SCI-S-DU-14-L2		1749	Lysimeter	8/20/2001	669240.175	266192.1064	5,011.73	8.0	7.91	5,003.8	26.0	N.A.	N.A.	N.A.	1	N.A.	
Depleted Uranium	DU-08	DU-08-L1	RWMC-SCI-S-DU-08-L1	DU-8-L1	1750	Lysimeter	6/20/2001	669247.1048	266214.5963	5,011.8	16.2	16.10	4,995.7	16.0	N.A.	N.A.	N.A.	1	N.A.	
Depleted Uranium	DU-08	DU-08-L2	RWMC-SCI-S-DU-08-L2	DU-8-L2	1751	Lysimeter	7/10/2001	669245.0918	266216.375	5,011.76	14.2	14.08	4,997.7	19.0	N.A.	N.A.	N.A.	1	N.A.	
Uranium/Enriched U	Pit5-4	Pit5-4-L1	RWMC-SCI-S-Pit5-4-L1	P5-4-L1	1752	Lysimeter	8/14/2001	669630.5854	267294.9199	5,012.16	10.7	10.55	5,001.6	15.5	N.A.	N.A.	N.A.	1	N.A.	
Uranium/Enriched U	Pit5-TW1	Pit5-TW1-L1	RWMC-SCI-S-Pit5-TW1-L1	P5-TW1-L1	1753	Lysimeter	8/14/2001	669688.5597	267181.6481	5,011.71	12.3	12.16	4,999.6	17.5	N.A.	N.A.	N.A.	1	N.A.	
Activated Metal	SVR12-1	SVR12-1-L1	RWMC-SCI-S-SVR12-1-L1		1754	Lysimeter	8/13/2001	668453.81	267858.2382	5,010.57	11.2	11.14	4,999.4	8.5	N.A.	N.A.	N.A.	1	N.A.	
Activated Metal	SVR12-1	SVR12-1-L2	RWMC-SCI-S-SVR12-1-L2		1755	Lysimeter	8/13/2001	668453.6388	267856.1485	5,010.53	5.9	5.76	5,004.8	6.0	N.A.	N.A.	N.A.	1	N.A.	
Americium/Neptunium	741-08	741-08-V	RWMC-SCI-S-741-08-V	741-8-V	1756	Visual Probe	8/30/2001	669182.5026	266549.8354	5,012.21	13.5	N.A.	N.A.	6.0	N.A.	N.A.	N.A.	N.A.	P	Yes
Organic Sludge	743-03	743-03-V	RWMC-SCI-S-743-03-V	743-3-V	1757	Visual Probe	8/27/2001	669345.1972	267067.7101	5,011.07	13.6	N.A.	N.A.	4.5	N.A.	N.A.	N.A.	N.A.	P	Yes
Organic Sludge	743-08	743-08-V	RWMC-SCI-S-743-08-V	743-8-V	1758	Visual Probe	8/29/2001	669327.7911	267046.7721	5,010.93	13.6	N.A.	N.A.	5.0	N.A.	N.A.	N.A.	N.A.	P	Yes
Organic Sludge	743-18	743-18-V	RWMC-SCI-S-743-18-V	743-18-V1	1759	Visual Probe	7/19/2001	669289.5603	267005.9621	5,012.58	12	N.A.	N.A.	37.5	N.A.	N.A.	N.A.	N.A.	F	No
Depleted Uranium	DU-08	DU-08-V	RWMC-SCI-S-DU-08-V	DU-8-V1	1760	Visual Probe	9/25/2001	669242.1426	266216.6866	5,011.66	17.6	N.A.	N.A.	5.0	N.A.	N.A.	N.A.	N.A.	P	Yes
Depleted Uranium	DU-10	DU-10-V	RWMC-SCI-S-DU-10-V		1761	Visual Probe	6/14/2001	669225.6578	266208.257	5,011.46	7	N.A.	N.A.	33.0	N.A.	N.A.	N.A.	N.A.	F	No

Table B-1. (continued).

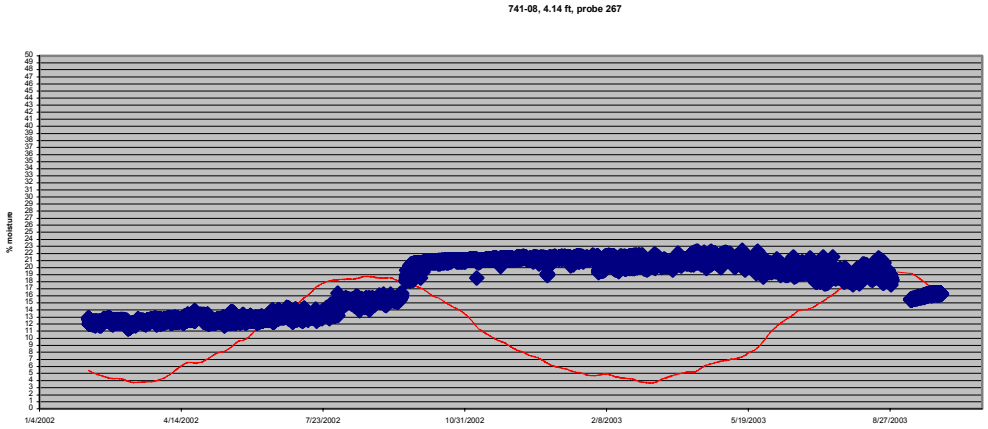
Integrated Probing Project Focus Area	IPP Cluster	Common Probe Name	Official_Name	Alias Probe Name	Well_ID	Probe Type	Installation Date (mm/dd/yyyy)	Northing (ft) (NAD27)	Easting (ft) (NAD27)	Surface Elevation (ft) (NGVD29)	Probe Depth (ft) (from surface)	Sensor/Port Bottom Depth from Surface (ft)	Sensor/Port Bottom Elevation (ft) (NGVD29)	Probe Stick Up (in.)	Soil Mstr Prb Sensor ID	Tensio-Gross Matric Pot Sensor ID	Tensio-Amb Pres Sensor ID	No. Sensors/ Ports per Probe	P/F Initial Pres. Test	Functional
Depleted Uranium	DU-14	DU-14-V	RWMC-SCI-S-DU-14-V		1762	Visual Probe	9/18/2001	669244.5292	266190.1832	5,011.77	10.5	N.A.	N.A.	41.5	N.A.	N.A.	N.A.	N.A.	F	No
Pit 9		P9-20-V	RWMC-SCI-S-P9-20-V		1763	Visual Probe	10/25/2001	669483.2232	268170.0508	5,009.6	12.6	N.A.	N.A.	17.0	N.A.	N.A.	N.A.	N.A.	P	Yes
Pit 9		P9-09-V	RWMC-SCI-S-P9-09-V		1764	Visual Probe	10/23/2001	669466.1012	268168.8692	5,009.64	6.7	N.A.	N.A.	40.0	N.A.	N.A.	N.A.	N.A.	F	No
Pit 9		P9-09-VB	RWMC-SCI-S-P9-09-VB		1765	Visual Probe	11/1/2001	669460.7171	268168.4894	5,009.6	10.9	N.A.	N.A.	37.0	N.A.	N.A.	N.A.	N.A.	P	Yes

Probe coordinates given in this table have been compiled from numerous surveys.

Appendix C

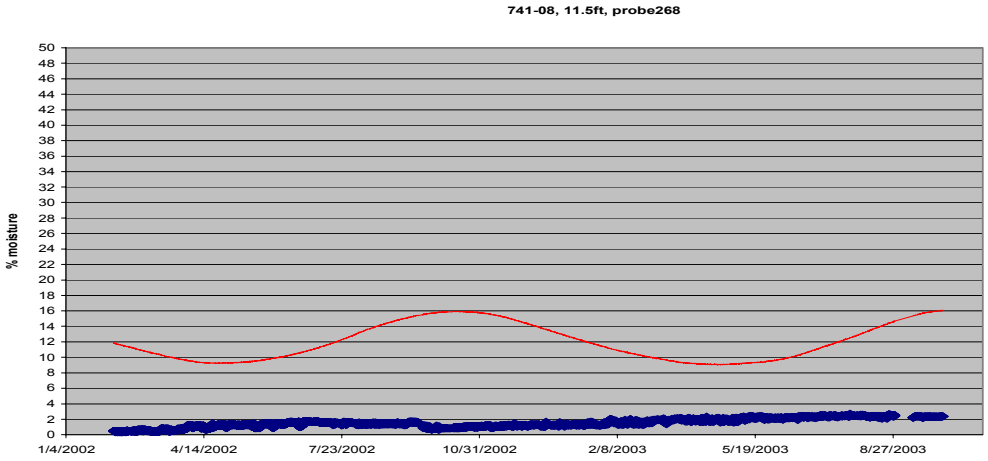
Soil Moisture Probe Data

Cluster 741-08



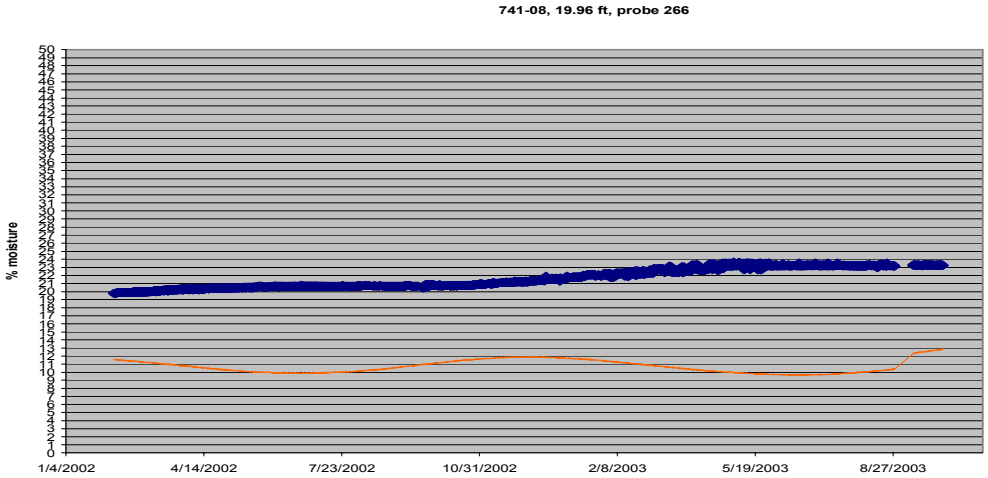
Moisture Trend (Probe 267)

Cyclic—upward as temperature trends down. Need to remove temperature effects from moisture data.



Moisture Trend (Probe 268)

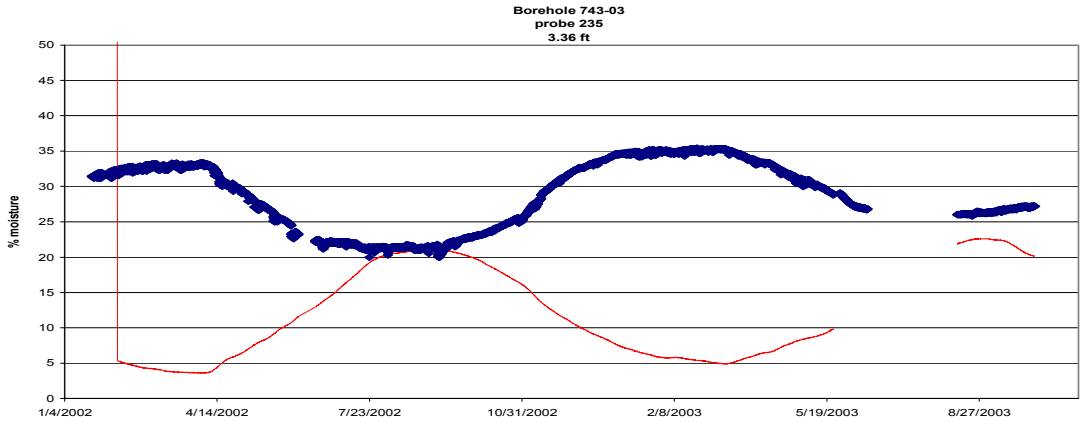
Over time, slight upward trend.



Moisture Trend (Probe 266)

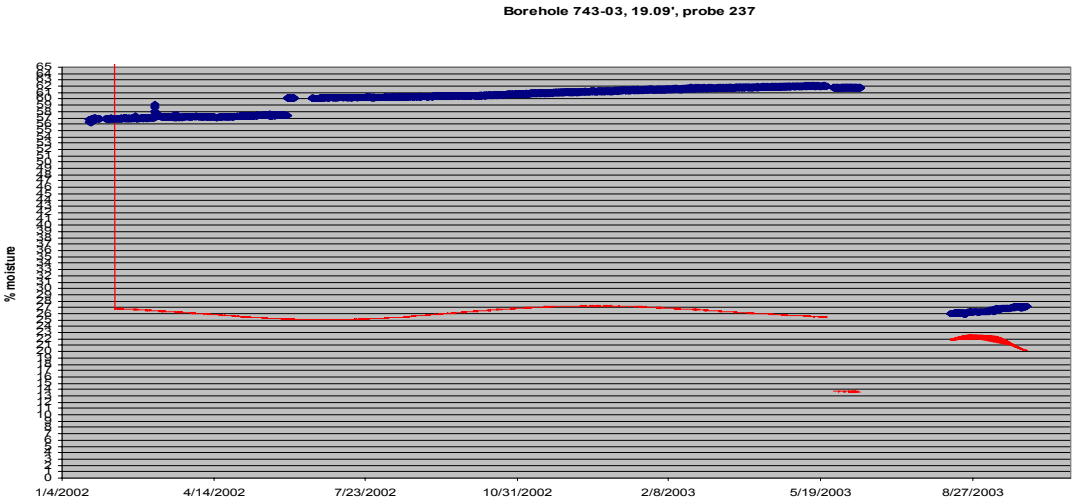
Basically flat. Overtime, though, trend appears to be slightly cyclic. Need to remove temperature effects from data.

Cluster 743-03



Moisture Trend (Probe 235)

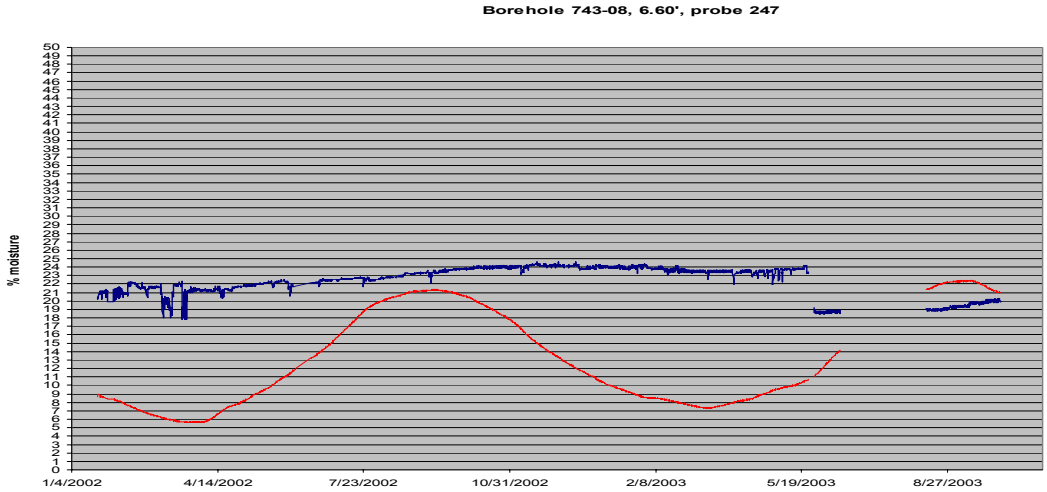
Cyclic. Current trend is up, but because of inverse correlation to temperature, trend cannot be trusted. Probably the true trend is flat.



Moisture Trend (Probe 237)

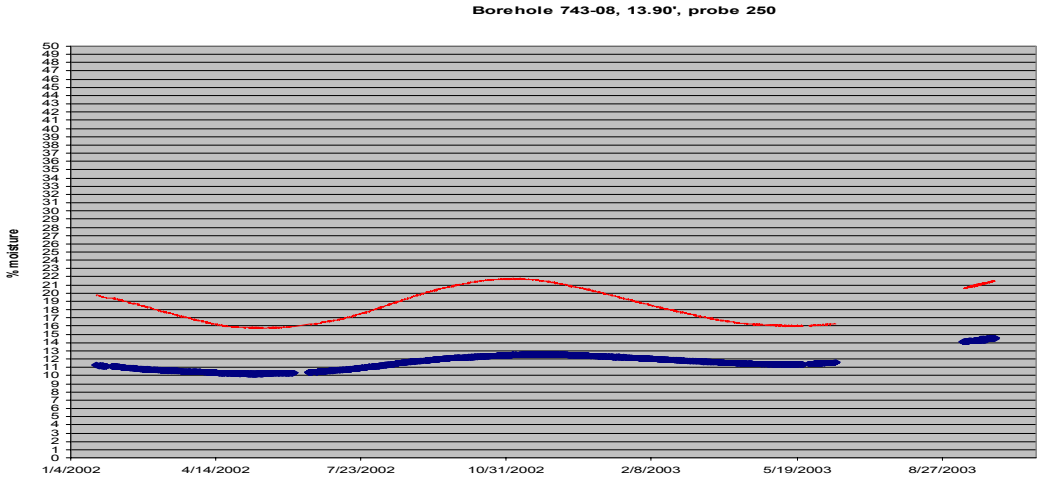
Trend for most of the year is gradually upward. Servicing of probe in early August resulted in dramatic drop in moisture values to values that are probably more accurate. Trend continues gradual upward movement.

Cluster 743-08



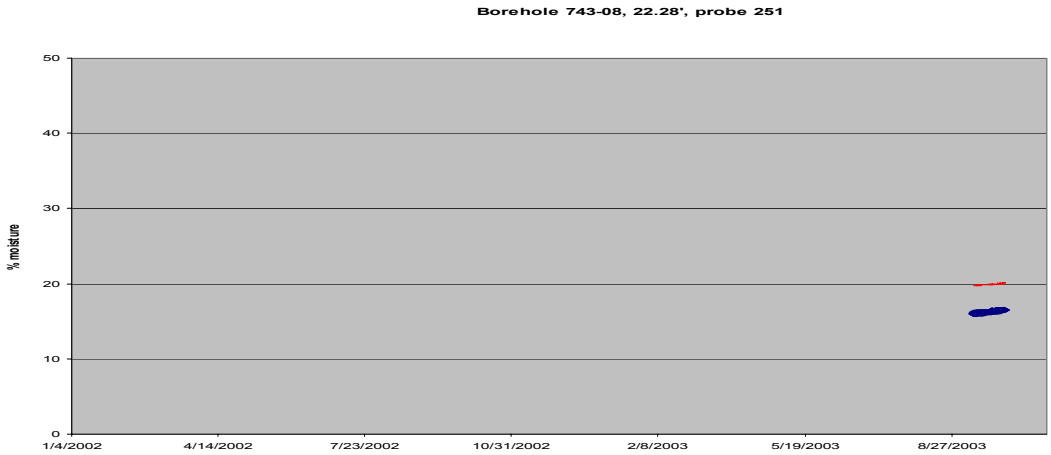
Moisture Trend (Probe 247)

Trend is upward after sudden drop in moisture content after servicing during first part of fourth quarter (see arrow).



Moisture Trend (Probe 250)

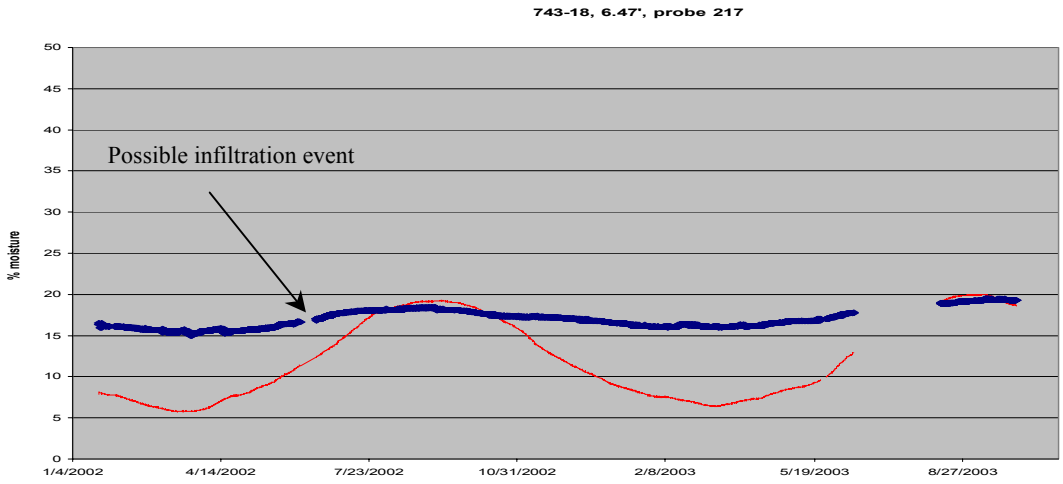
Over the long term, there is a definite temperature influence on data. Long-term trend is cyclic showing maximum and minimums for temperature and moisture on about the same dates.

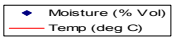


Moisture Trend (Probe 251)

Trend appears to be slightly upward, but there is not enough data for a long-term trend.

Cluster 743-18

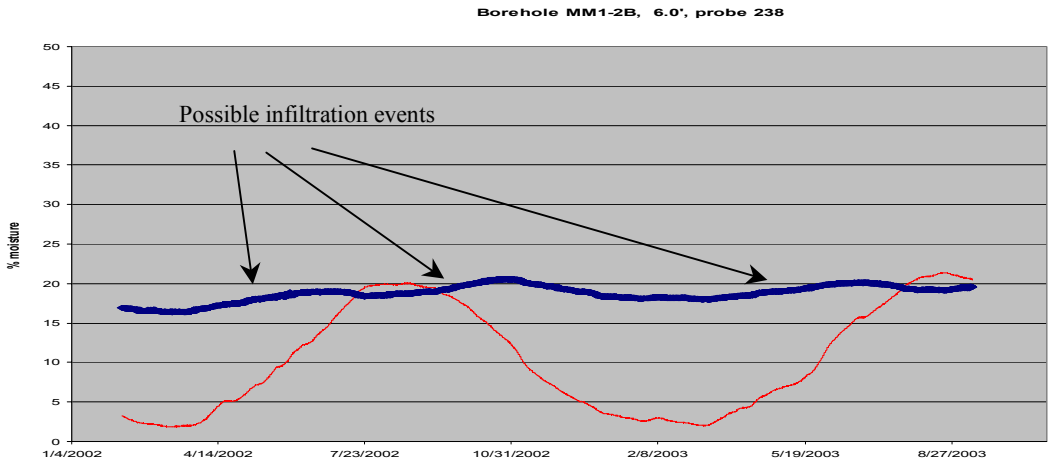


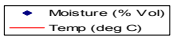


Moisture Trend
(Probe 217)

Long-term trend appears to be cyclic. Trend appears to have a temperature component, which should be removed. Real trend is probably flat or slightly up.

Cluster MM1-2

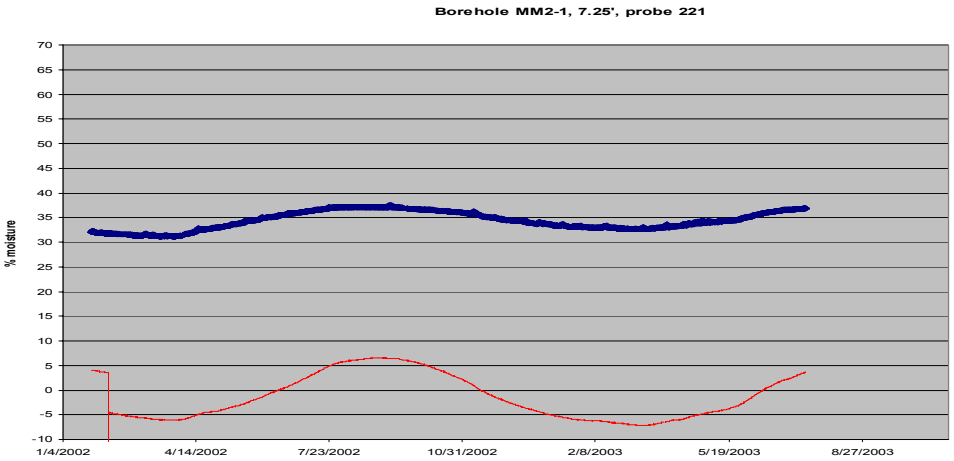




Moisture Trend (Probe 238)

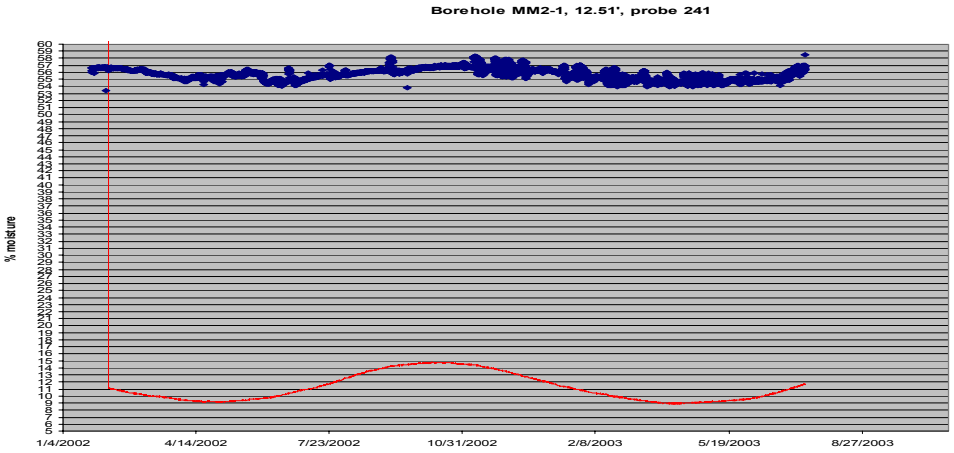
Data to 9/10 only. Long-term moisture trend is somewhat cyclic but does not appear to be related to temperature. The fluctuations could be related to possible wetting fronts moving through the soil profile. Tensiometer data indicate infiltration in early 2002.

Cluster MM2-1



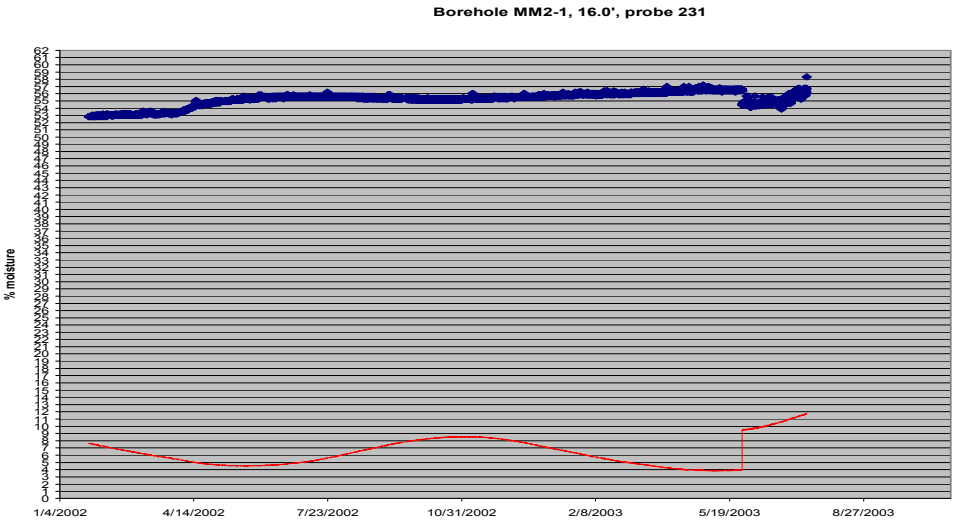
Moisture Trend (Probe 221)

Probe not responding; last readings third quarter 2003. Long-term trend is cyclic reflecting temperature influences. Real trend is probably flat.



Moisture Trend (Probe 241)

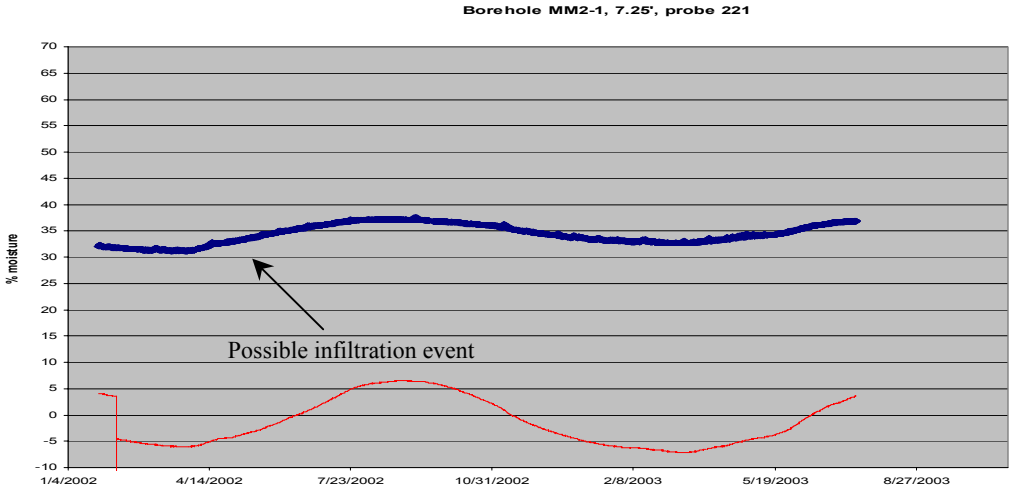
Probe not responding; last readings third quarter 2003. Long-term trend is slightly cyclic reflecting temperature influence. Real trend is probably flat or rising slightly.



Moisture Trend (Probe 231)

Probe not responding; last readings third quarter 2003. Drop in data reflects servicing. Long-term trend seems to be slightly upward, which might indicate some infiltration has occurred at this location.

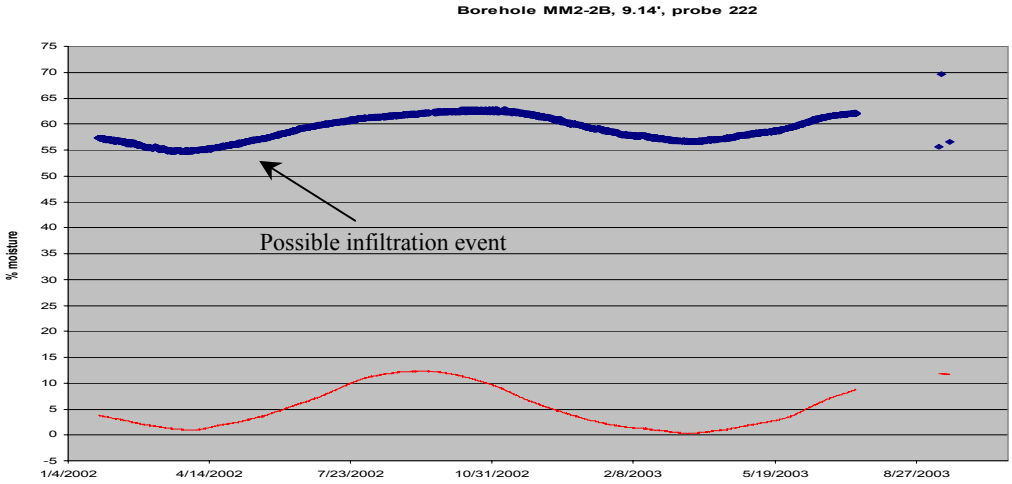
Cluster MM2-2



Moisture (% Vol)
Temp (deg C)

Moisture Trend (Probe 220)

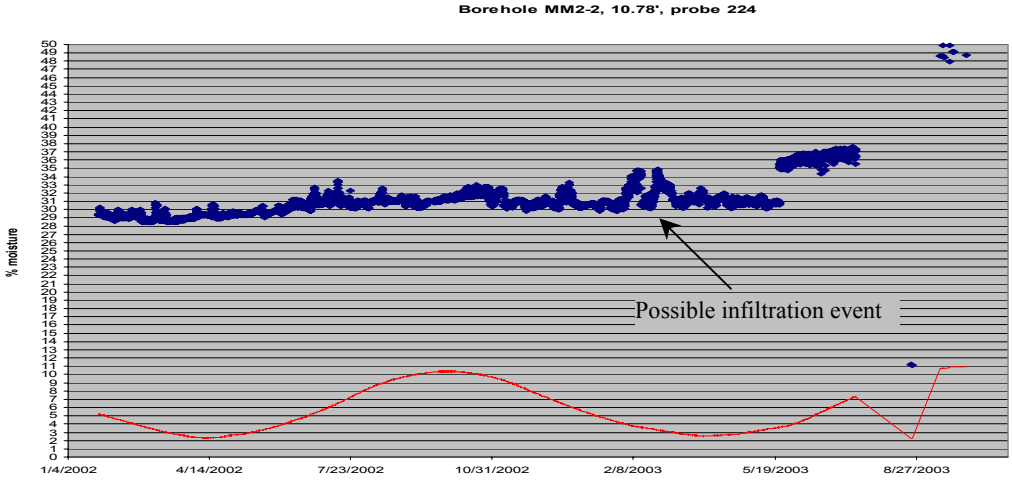
Probe not responding; last readings third quarter 2003. Long-term trend is cyclic reflecting temperature influences. Real trend is probably fairly flat or slightly rising.



Moisture (% Vol)
Temp (deg C)

Moisture Trend (Probe 222)

Probe not responding. Long-term trend is cyclic, reflecting temperature influences. Long-term trend without temperature influence is probably rising.

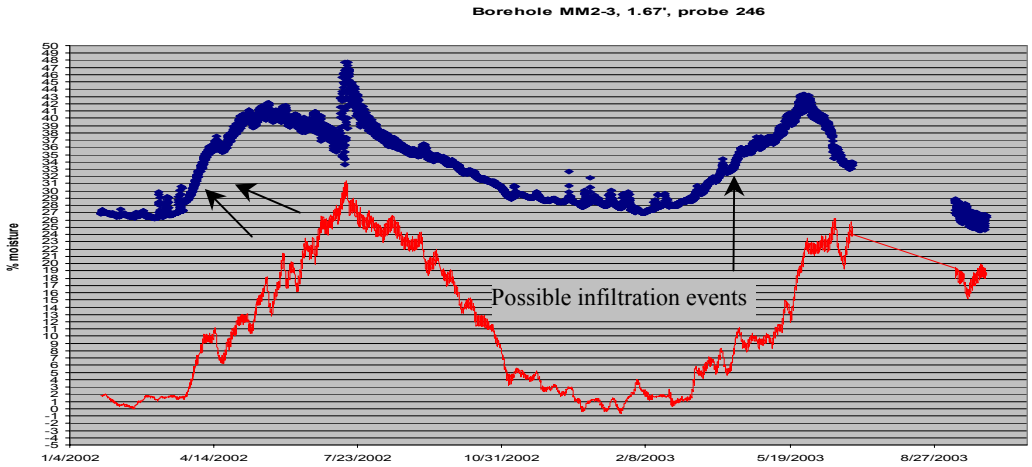


Moisture (% Vol)
Temp (deg C)

Moisture Trend (Probe 224)

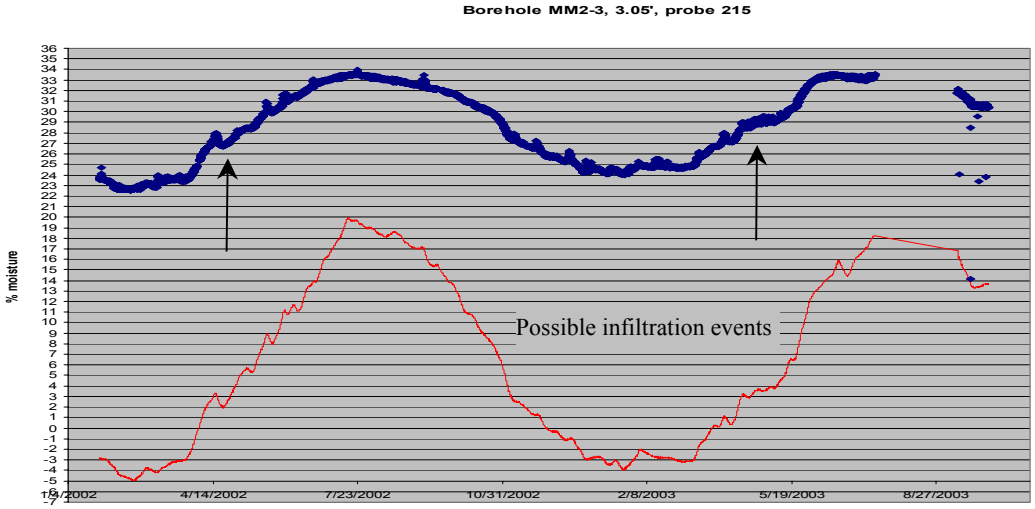
Fourth-quarter data are problematic. Break in data reflects servicing. Overall, long–term trend (minus fourth quarter points) appears to be fairly flat to rising slightly, but data are noisy. Recharge may have occurred in February-Marrch timeframe.

Cluster MM2-3



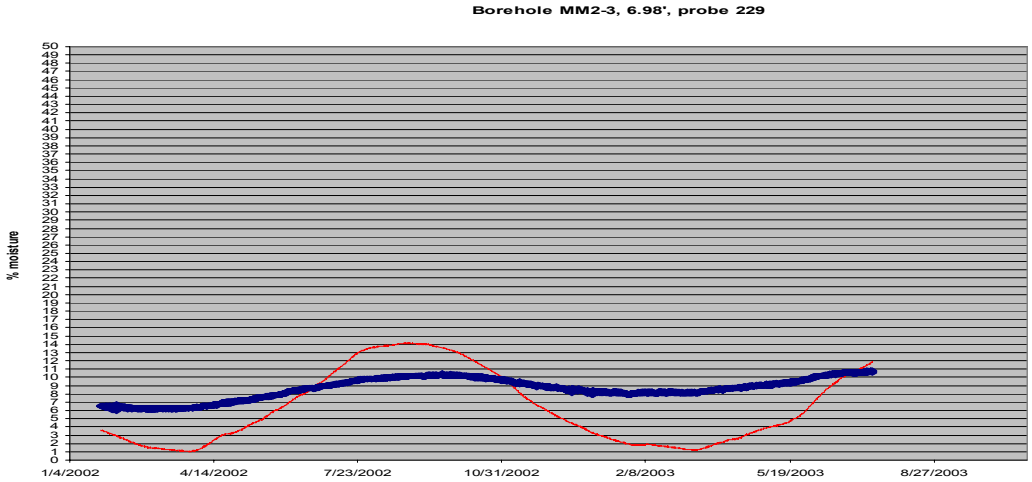
Moisture Trend (Probe 246)

The cyclic trend results from the temperature influence on the moisture data, making it a slightly muted copy of the temperature trend. If the temperature influence was removed, the trend might be fairly flat.



Moisture Trend (Probe 215)

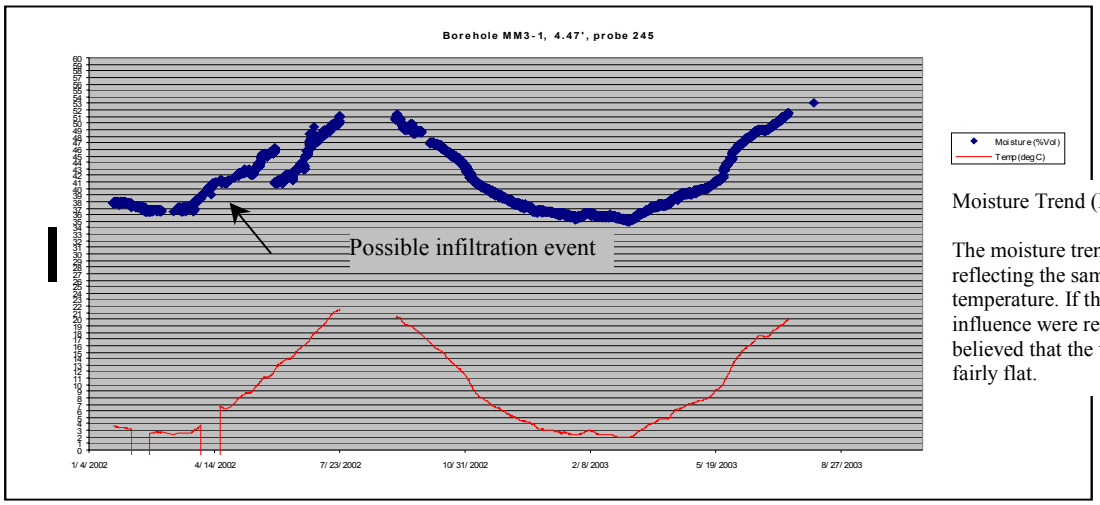
The moisture trend is cyclic, a somewhat muted mirror of the temperature trend. In the fourth quarter, the moisture trend peaks and falls off exactly like the temperature. Probably the real moisture trend is somewhat flat, but this cannot be said definitively until the temperature influence is removed from the moisture data.



Moisture Trend (Probe 229)

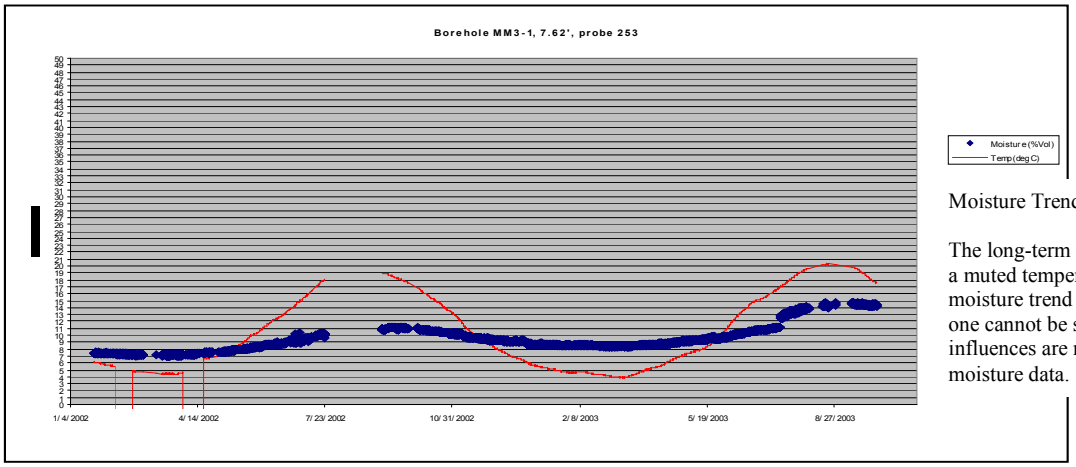
Long-term trend is cyclic, reflecting temperature influences. If the temperature influence is removed, the trend might be slightly upward.

Cluster MM3-1



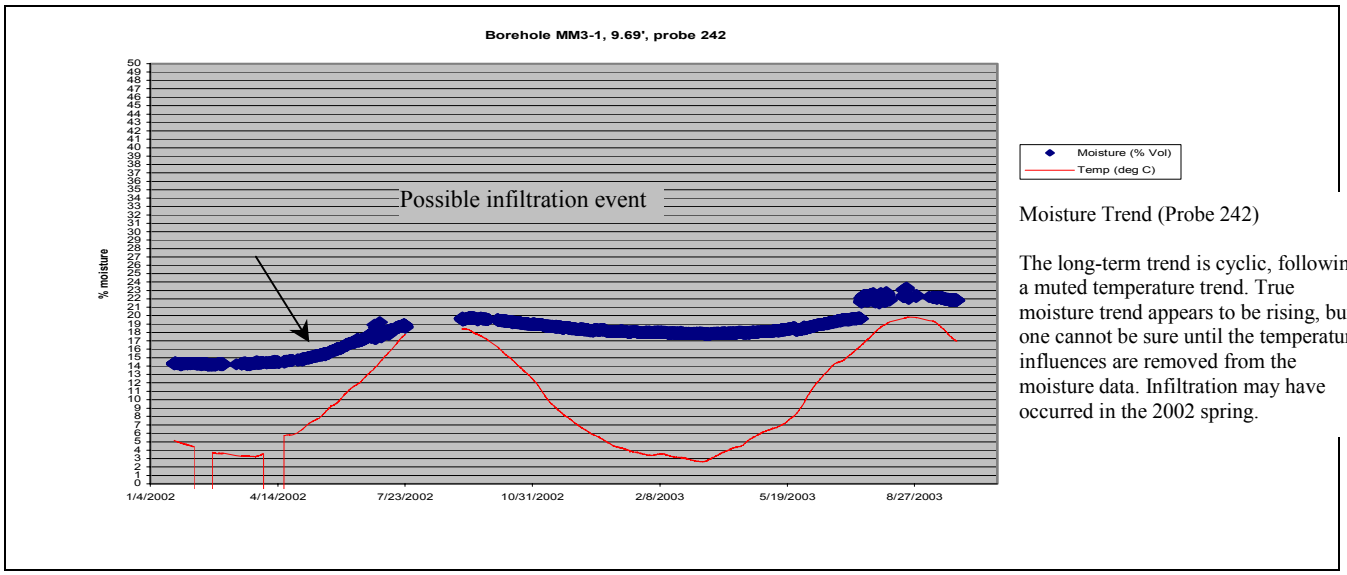
Moisture Trend (Probe 245)

The moisture trend is cyclic reflecting the same curve as the temperature. If the temperature influence were removed, it is believed that the trend would be fairly flat.



Moisture Trend (Probe 253)

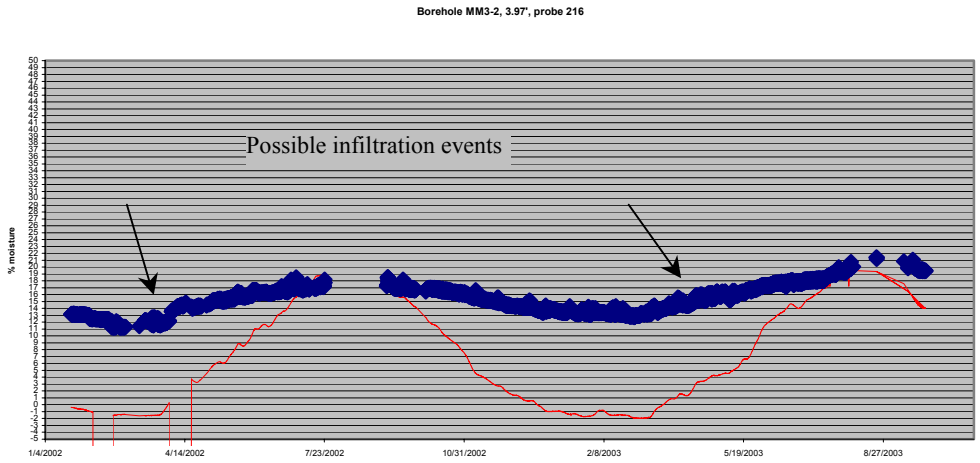
The long-term trend is cyclic, following a muted temperature trend. True moisture trend appears to be rising, but one cannot be sure until the temperature influences are removed from the moisture data.



Moisture Trend (Probe 242)

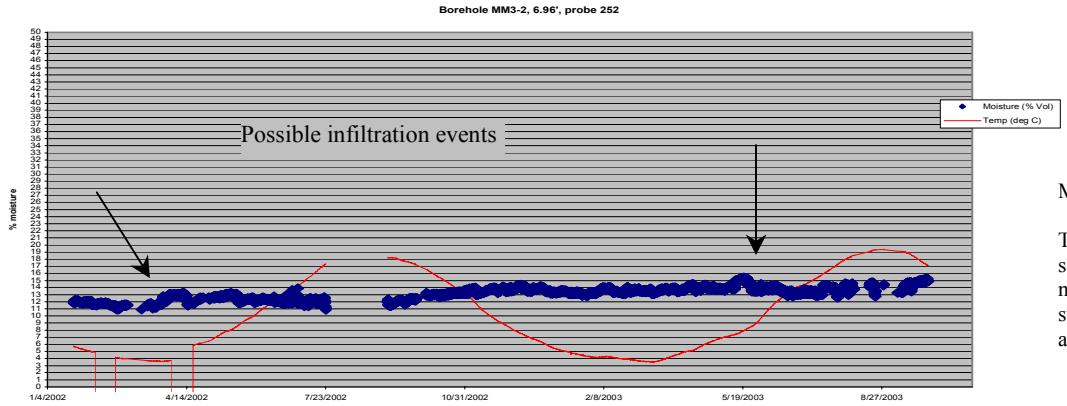
The long-term trend is cyclic, following a muted temperature trend. True moisture trend appears to be rising, but one cannot be sure until the temperature influences are removed from the moisture data. Infiltration may have occurred in the 2002 spring.

Cluster MM3-2



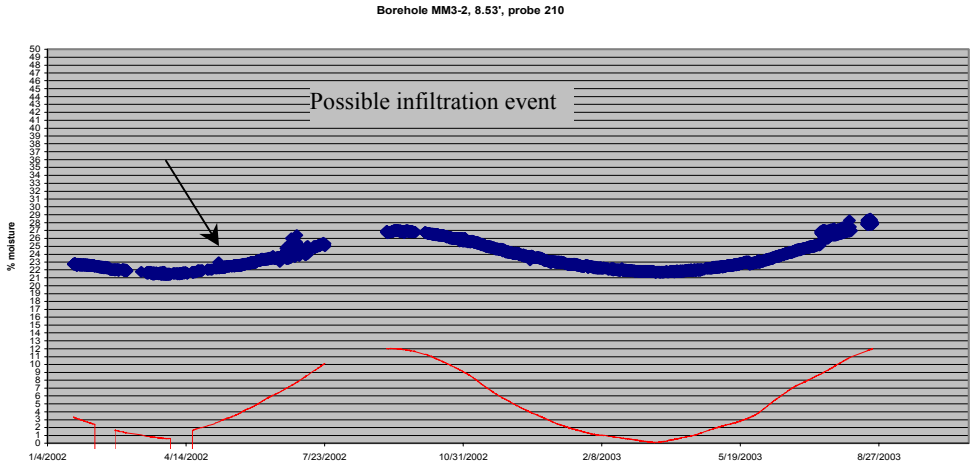
Moisture Trend (Probe 216)

Because the moisture trend is impacted by the soil temperature, it is difficult to tell the true trend. It appears to be slightly up.



Moisture Trend (Probe 252)

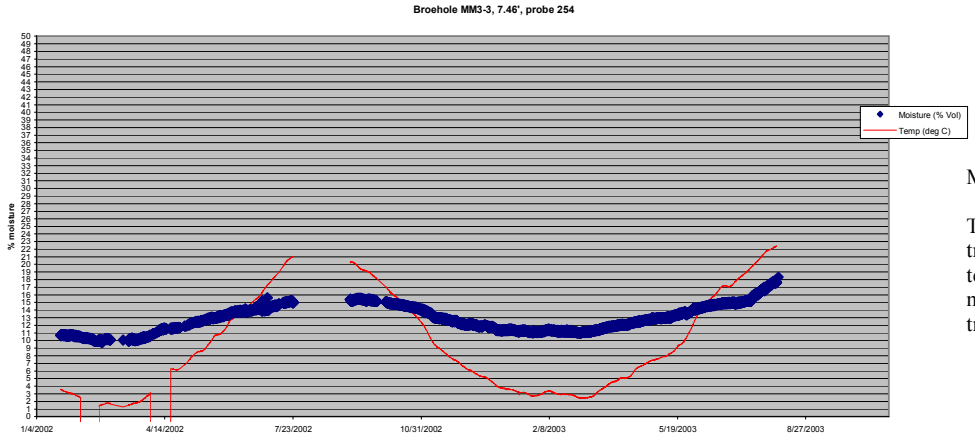
The trend is fairly flat, perhaps slightly up. There is enough noise in the data to have sufficient scatter to make trend analysis slightly uncertain.



Moisture trend (Probe 210)

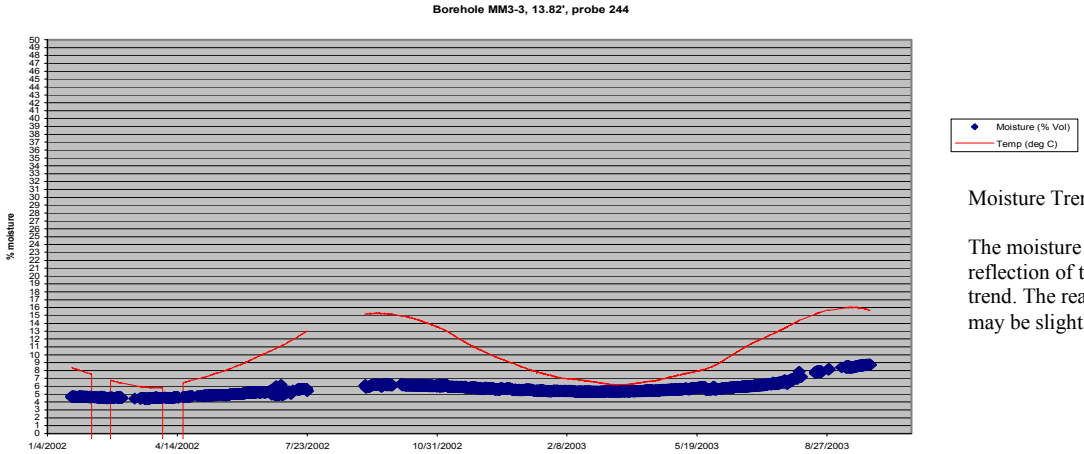
The moisture trend is cyclic, reflecting the cyclical nature of the temperature. Probably the true trend is fairly flat, maybe slightly up.

Cluster MM3-3



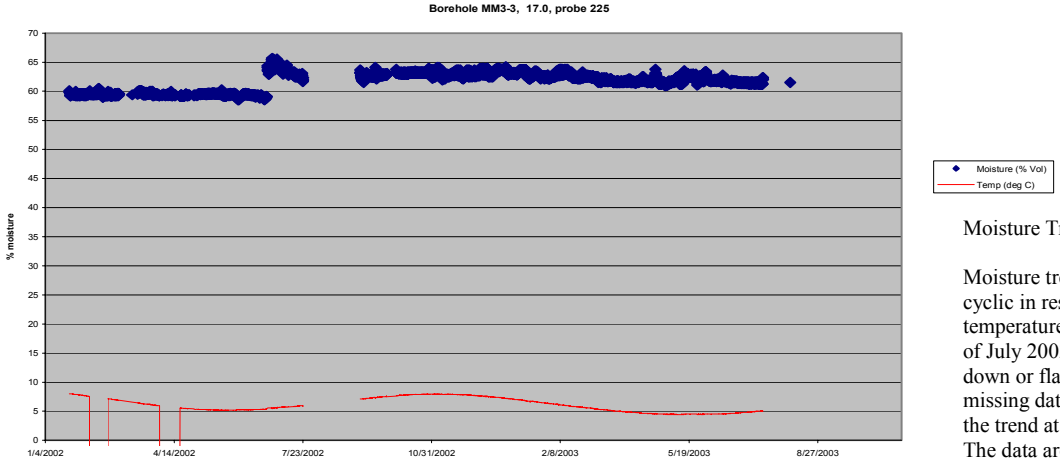
Moisture Trend (Probe 254)

The long-term moisture trend is cyclic, following the temperature trend. Actual moisture content may be trending up.



Moisture Trend (Probe 244)

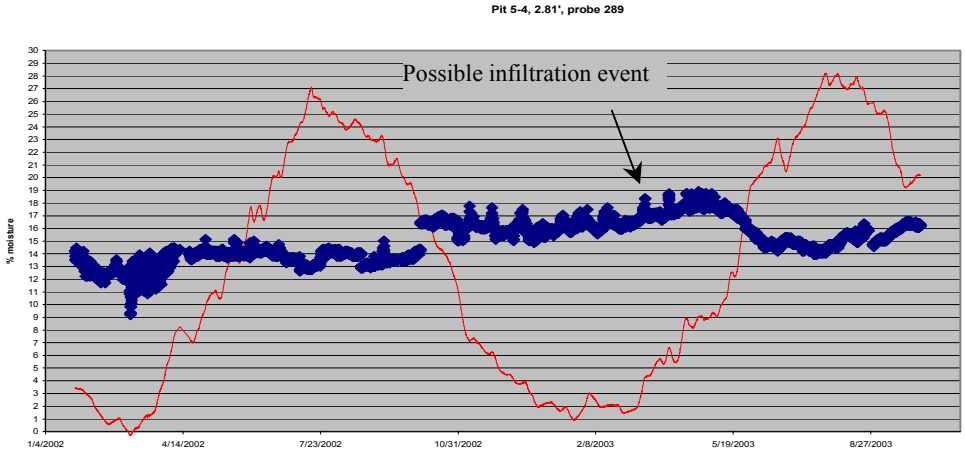
The moisture trend is a cyclic reflection of the temperature trend. The real moisture trend may be slightly up.



Moisture Trend (Probe 225)

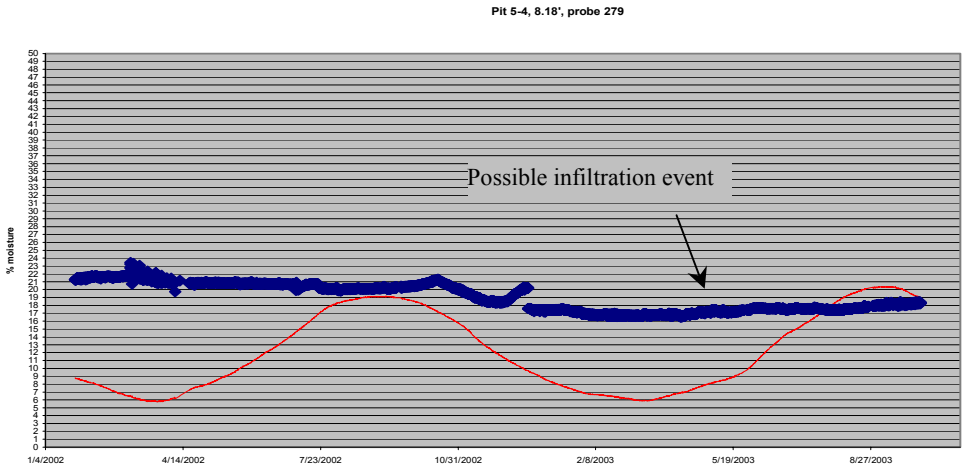
Moisture trend appears to be slightly cyclic in response to soil temperature. The trend at the middle of July 2003 appeared to be slightly down or flat, but because of the missing data, nothing can be said for the trend at the end of the quarter. The data are fairly noisy.

Cluster PIT5-4



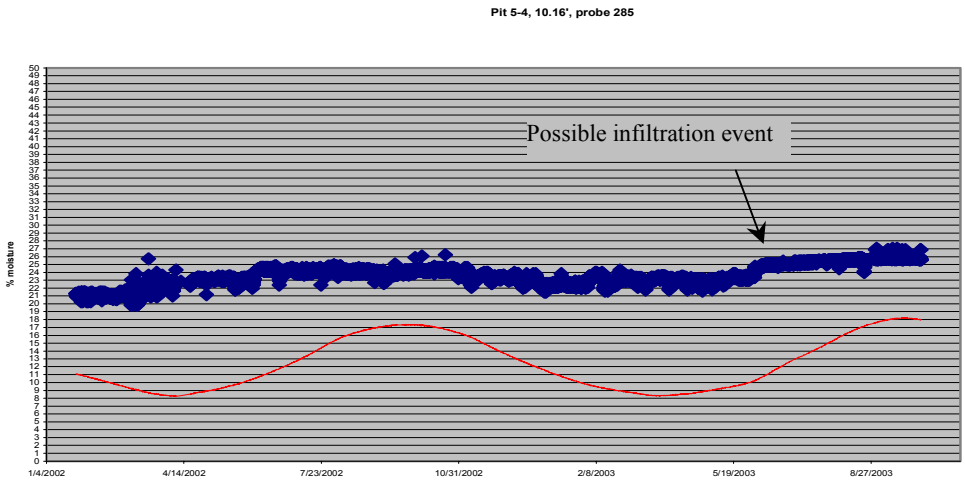
Moisture Trend (Probe 289)

Trend is inversely correlated to temperature trend. Real trend is probably fairly flat. However, there may be an infiltration event in April and May. Temperature influence needs to be removed from data to be sure.



Moisture Trend (Probe 279)

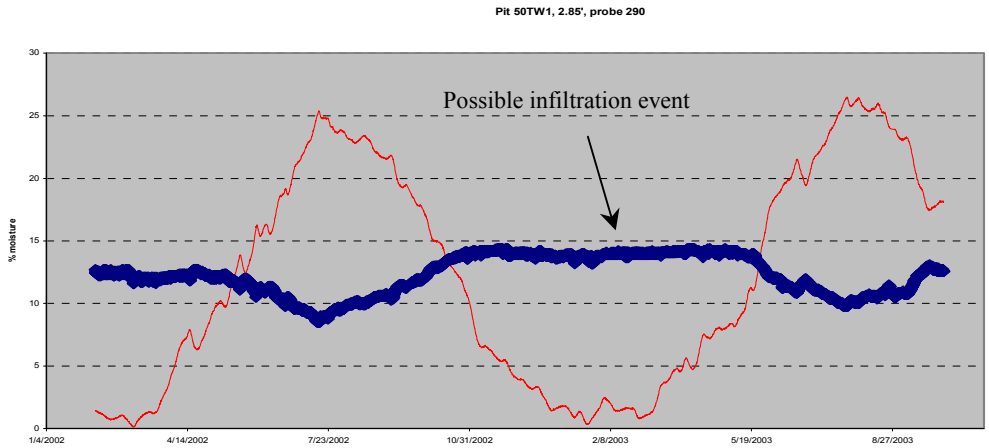
Trend is slightly upward.



Moisture Trend (Probe 285)

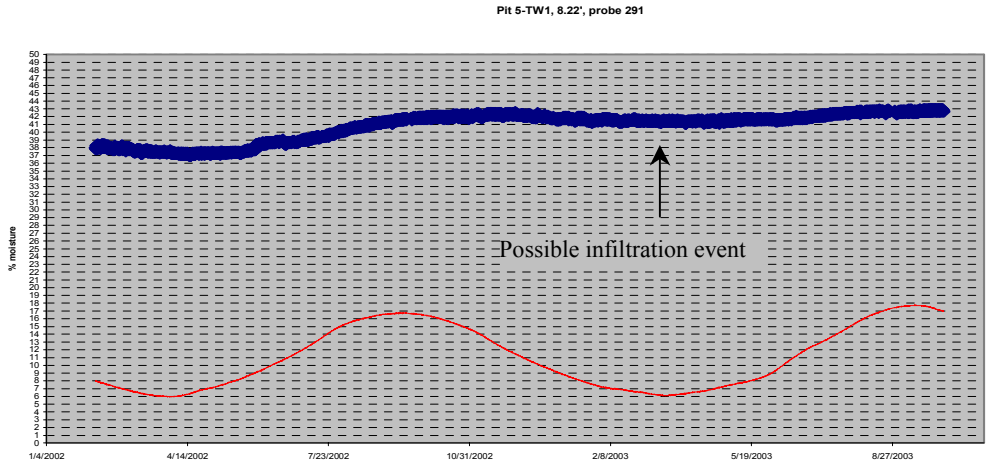
Trend ever so slightly has the cyclic trend of the temperature. True trend appears to be rising. This should be verified by removing temperature influence and reanalyzing data. Infiltration event may have occurred toward the end of May.

Cluster PIT5-TW1



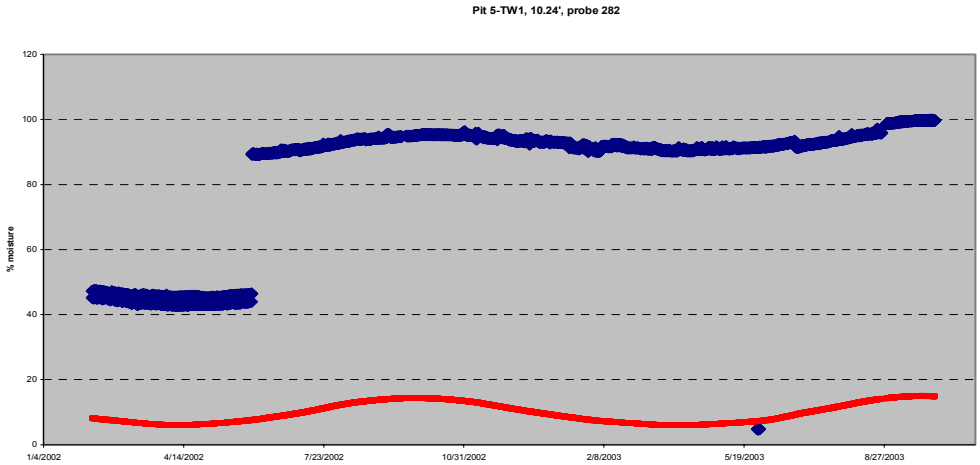
Moisture Trend (Probe 290)

Moisture trend is probably fairly flat but need to remove temperature. Slight infiltration may have occurred in early February 2003.



Moisture Trend (Probe 291)

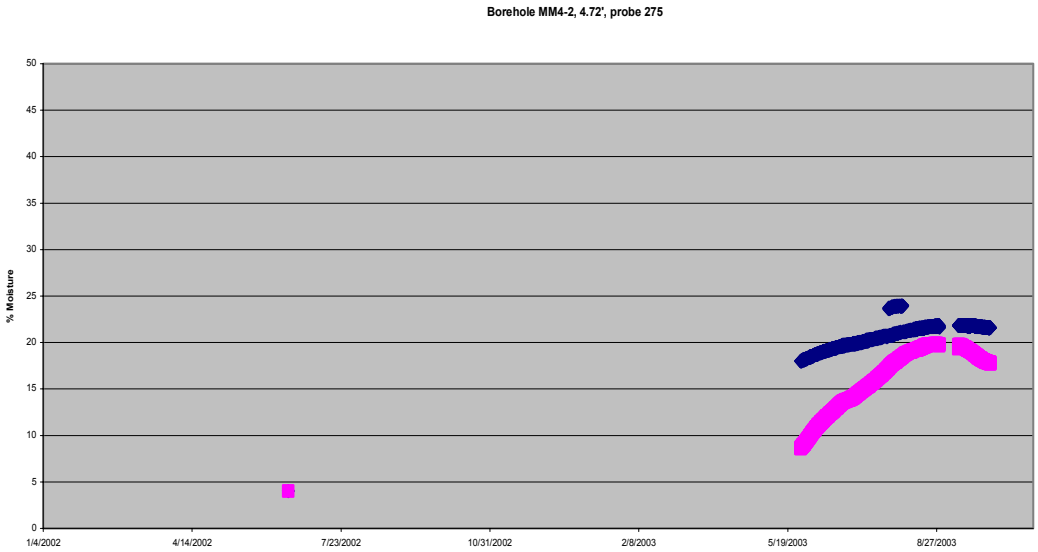
Although the moisture trend is slightly cyclic, reflecting soil temperature influence, the true moisture trend appears to be moving upward at a slight pace.



Moisture Trend (Probe 282)

Long-term trend is cyclical, reflecting temperature influence. Actual trend may be increasing. Possible slight wetting event in early February 2003.

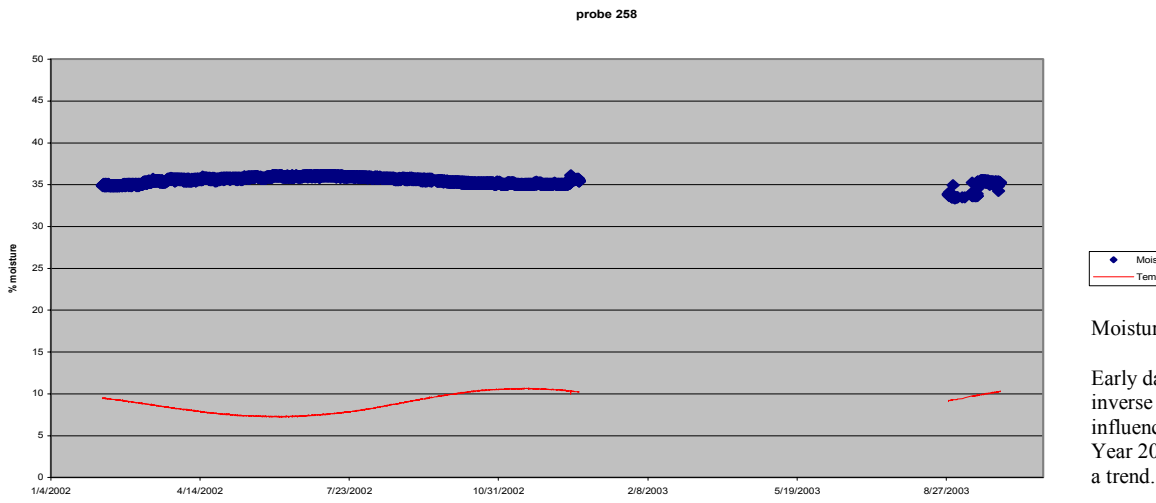
Cluster MM4-2



Moisture Trend (Probe 275)

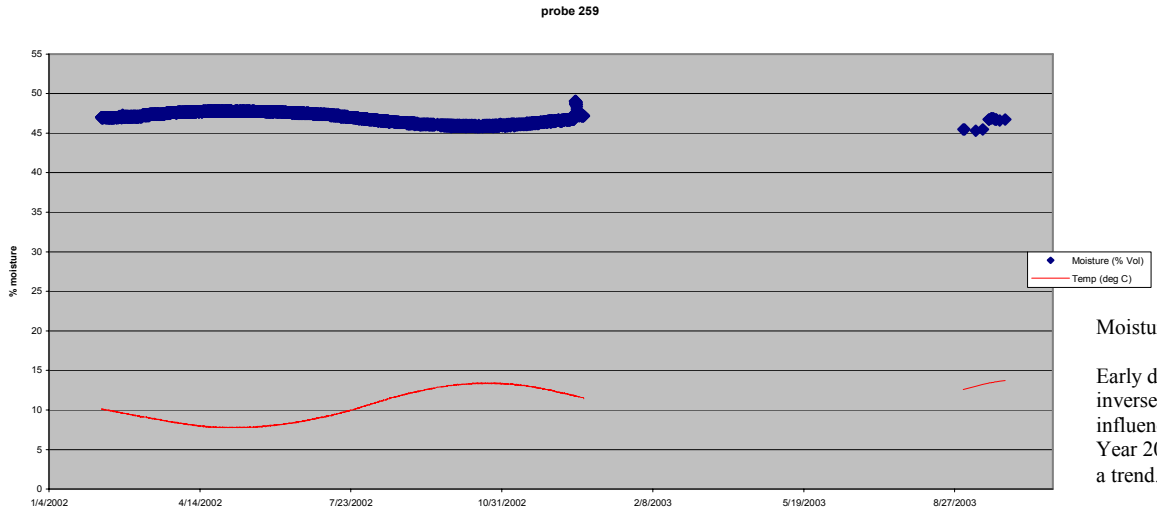
Moisture data seem to be trending upward, but this may simply be a reflection of temperature influence on the data. Data need to be monitored further before making a decision.

Cluster SVR-20



Moisture Trend (Probe 258)

Early data appear to have an inverse temperature influence. Not enough Fiscal Year 2003 data to determine a trend.



Moisture Trend (Probe 259)

Early data appear to have an inverse temperature influence. Not enough Fiscal Year 2003 data to determine a trend.

Appendix D

Charts of Plotted Data from Tensiometers with Performance Evaluation and Recommendations

Appendix D

Charts of Plotted Data from Tensiometers with Performance Evaluation and Recommendations

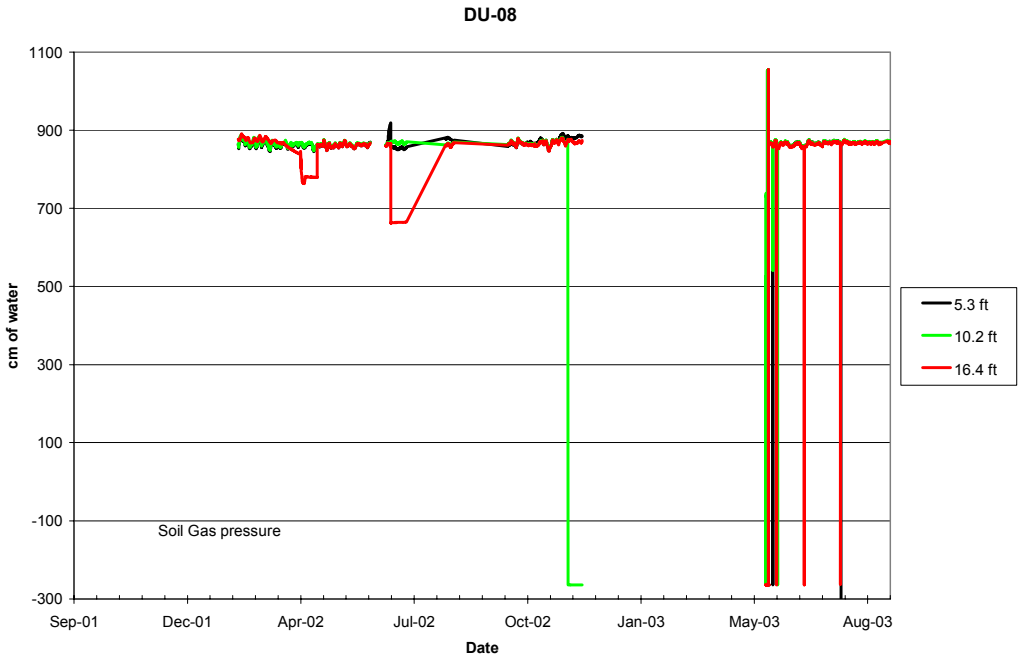
D1. KEY TO APPENDIX

The following plots show the raw soil gas and soil-water potential data:

- Soil gas pressure—The top graph is the raw soil-water pressure from the upper sensor. It is presented as recorded with no modification.

- Soil-water potential (absolute)—The bottom graph is the raw (absolute) soil-water pressure as recorded by the lower transducer, with no modification.

Comments at the base of each set of plots refer to the instrumentation by depth. It is recommended that sensors highlighted with red be discontinued because of failure of sensor or failure of tensiometer (lack of seal or unable to fill with water). Sensors highlighted with blue are instruments that have shown some evidence of working. Troubleshooting on these instruments should be continued. Sensors highlighted with green are working.



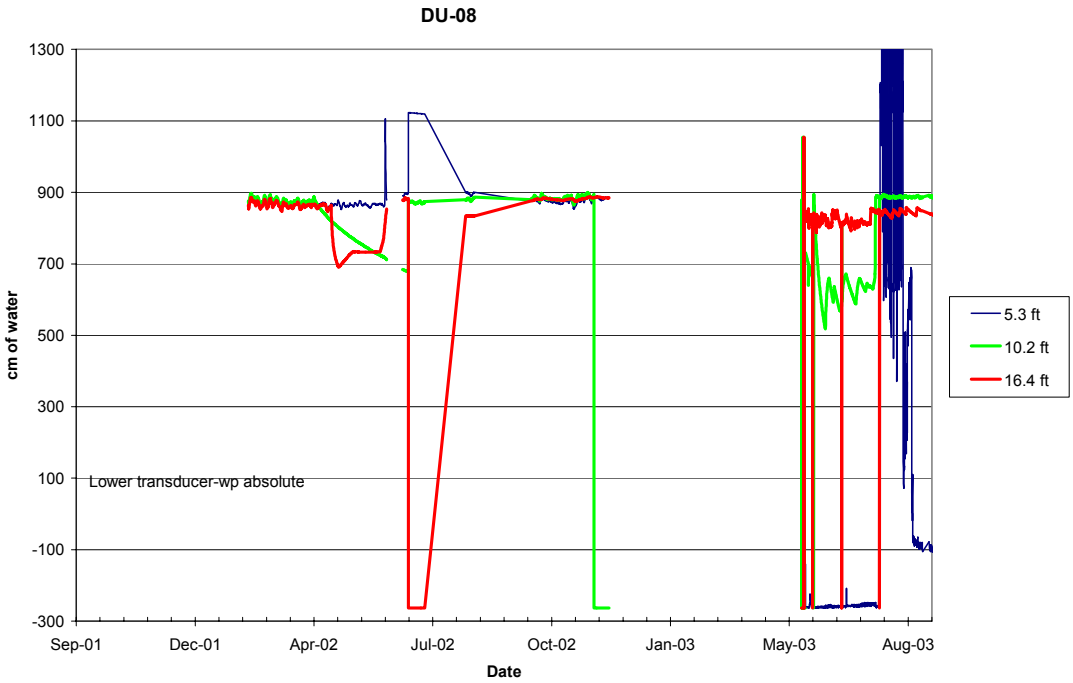
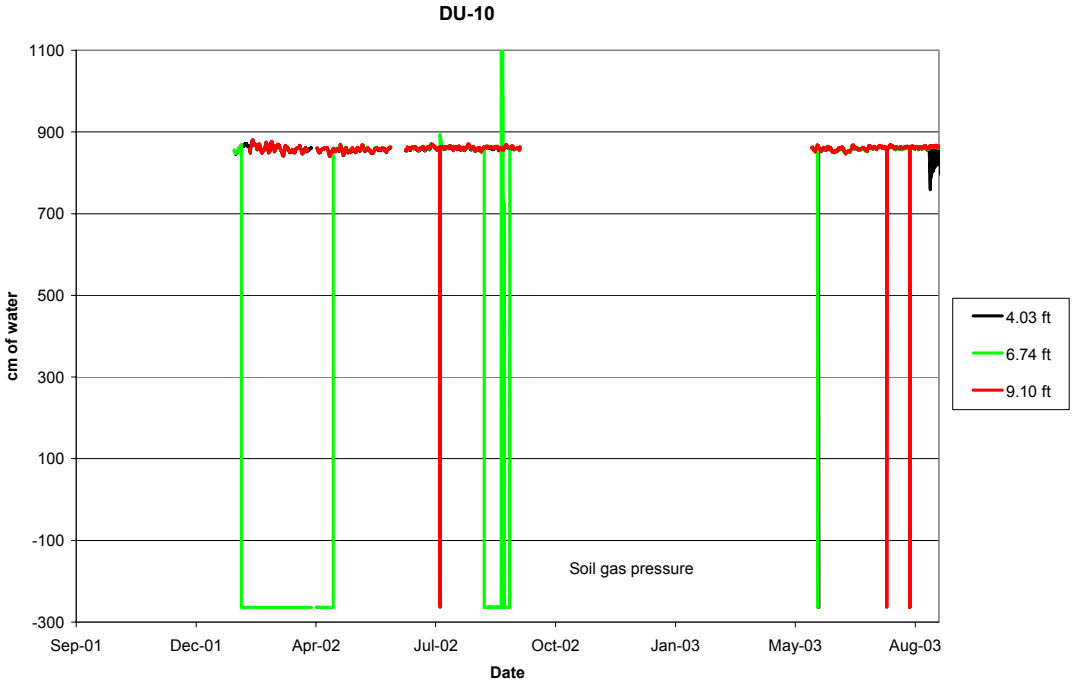


Figure D-1. Cluster DU-08.

T1, 5.3 ft: Soil gas pressure not working, absolute wp transducer not operating, spool valve not operating.
T2, 10.2 ft: Soil gas pressure working, absolute wp transducer works sporadically.
T3, 16.4 ft: Soil gas pressure working, absolute wp transducer has not responded to refilling.



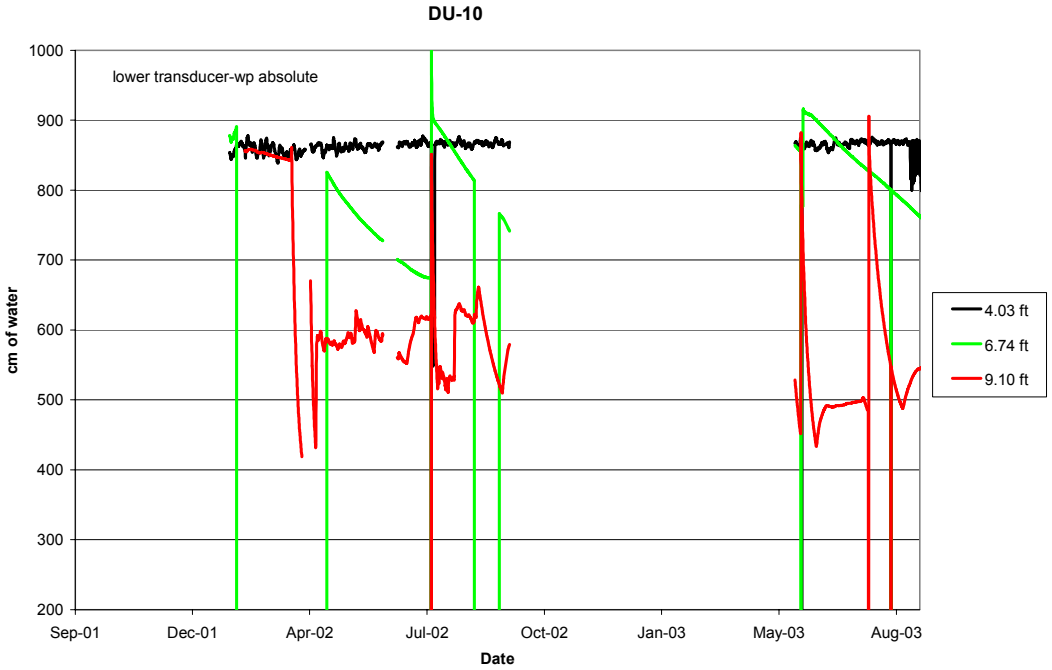
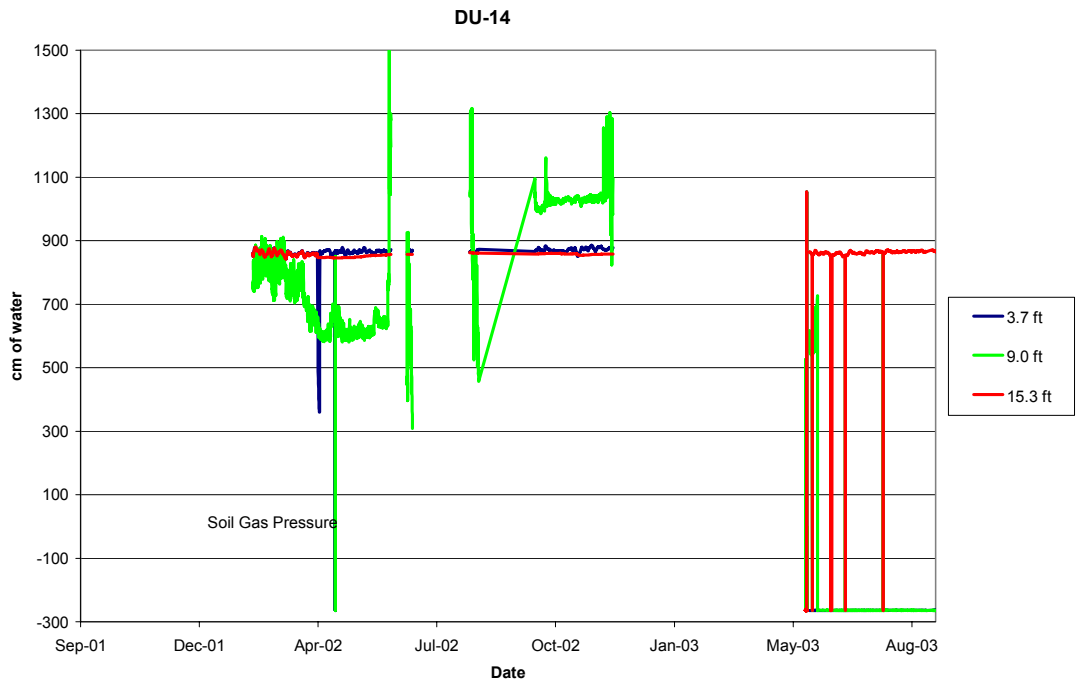


Figure D-2. Cluster DU-10.

T1, 4 ft: Soil gas pressure working, absolute wp transducer has not worked.
T2, 6.7 ft: Soil gas pressure working, absolute wp transducer has responded to refilling.
T3, 9.1 ft: Soil gas pressure working, absolute wp transducer data are variable, but sensor appears to be working in September 2003.



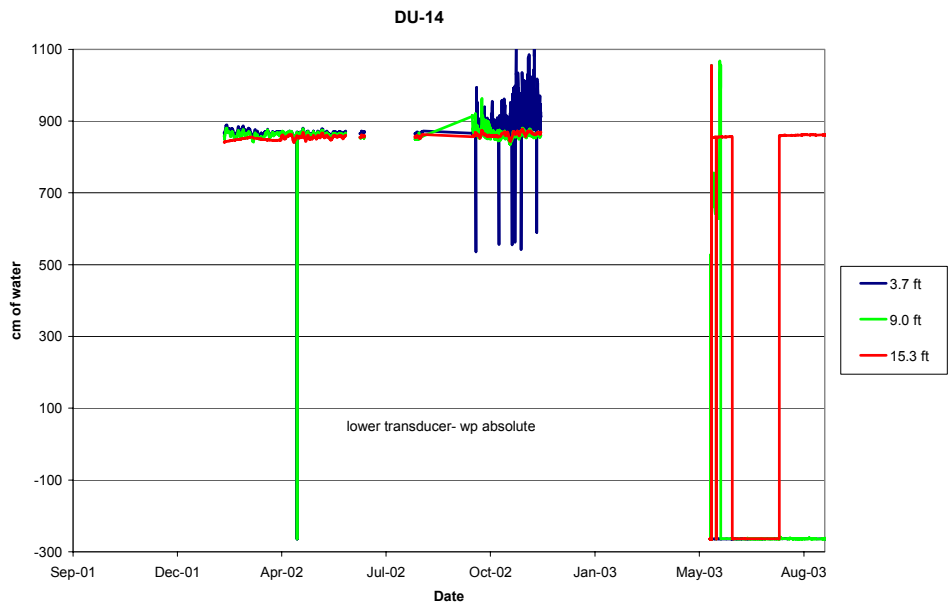
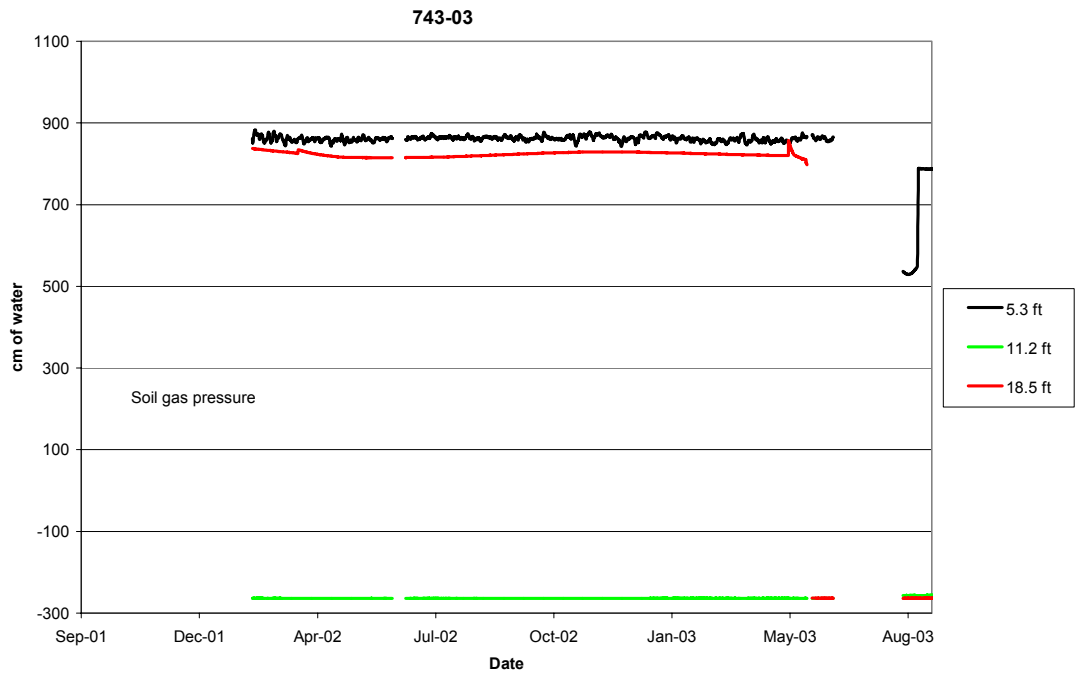


Figure D-3. Cluster DU-14.

T1, 3.7 ft: Soil gas pressure and absolute wp transducer not working (–273).
T2, 9 ft: Soil gas pressure not working, absolute wp transducer shows loss of signal, also no response to refilling, could not field calibrate.
T3, 15.3 ft: Soil gas pressure does not appear to be working (data are flat in fall 2003), absolute wp transducer not able to yield good data because spool valve is not working, cannot fill with water.



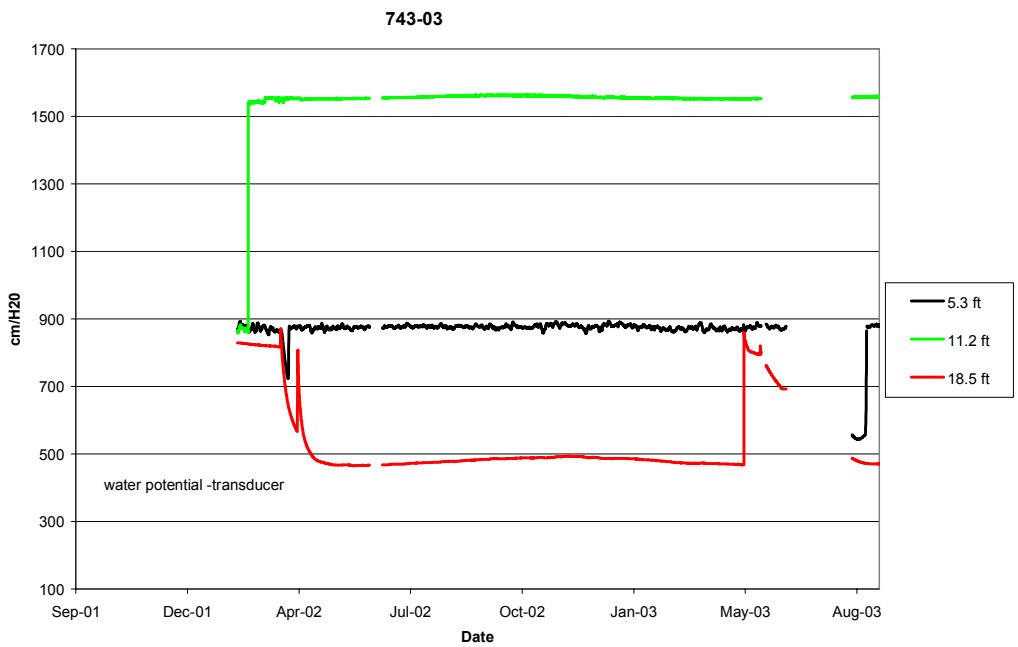


Figure D-4. 743-03.

T1, 5.3 ft: Soil gas pressure not currently working, absolute wp transducer has responded to refilling with water in the past. Soil gas pressure and wp wires may be reversed.
T2, 11.2 ft: Soil gas pressure not working (–273), absolute wp transducer not working, out of range.
T3, 18.5 ft: Soil gas pressure appears isolated from atmosphere in early measurements, not giving a signal in later measurements. Absolute wp transducer working.

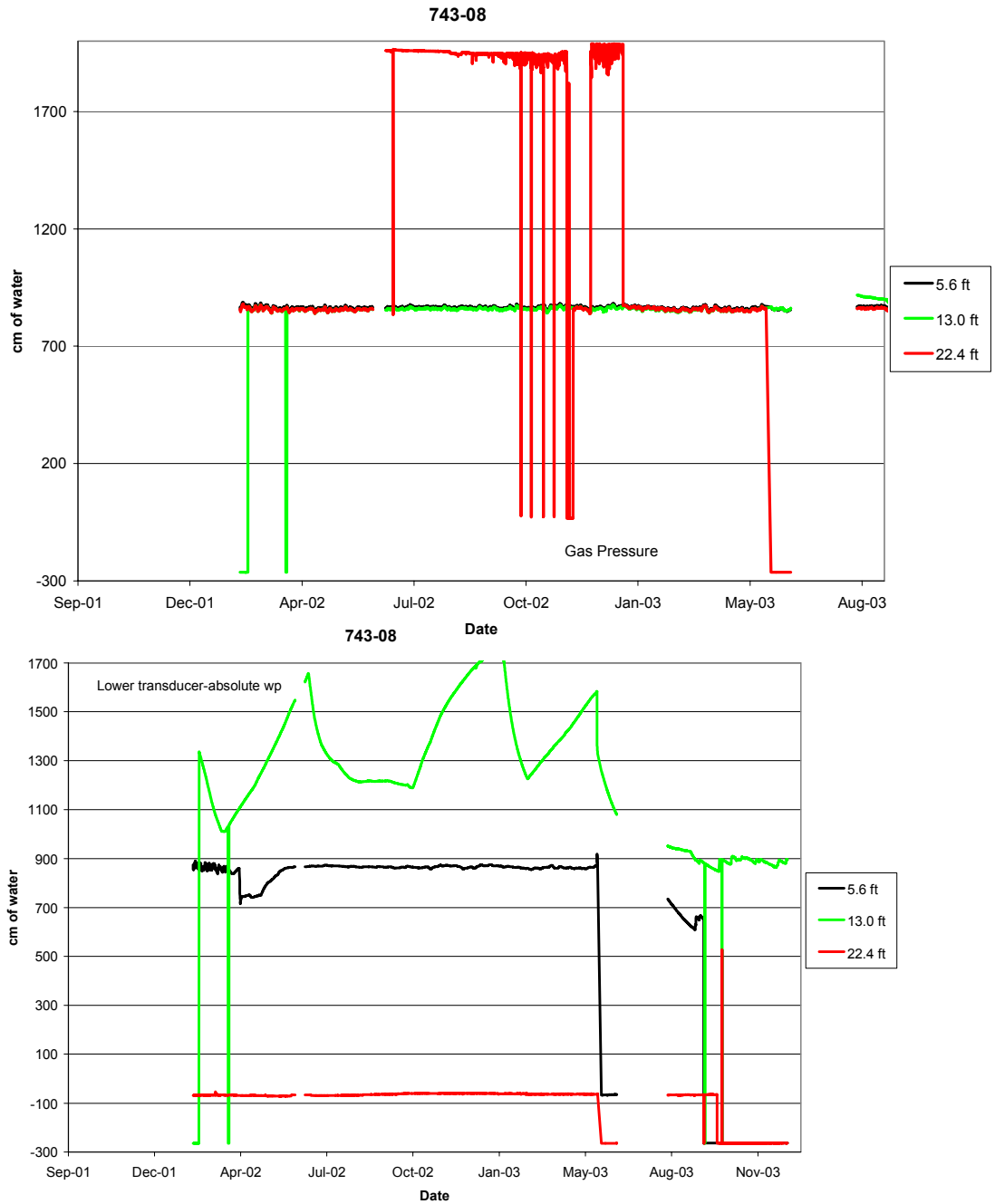
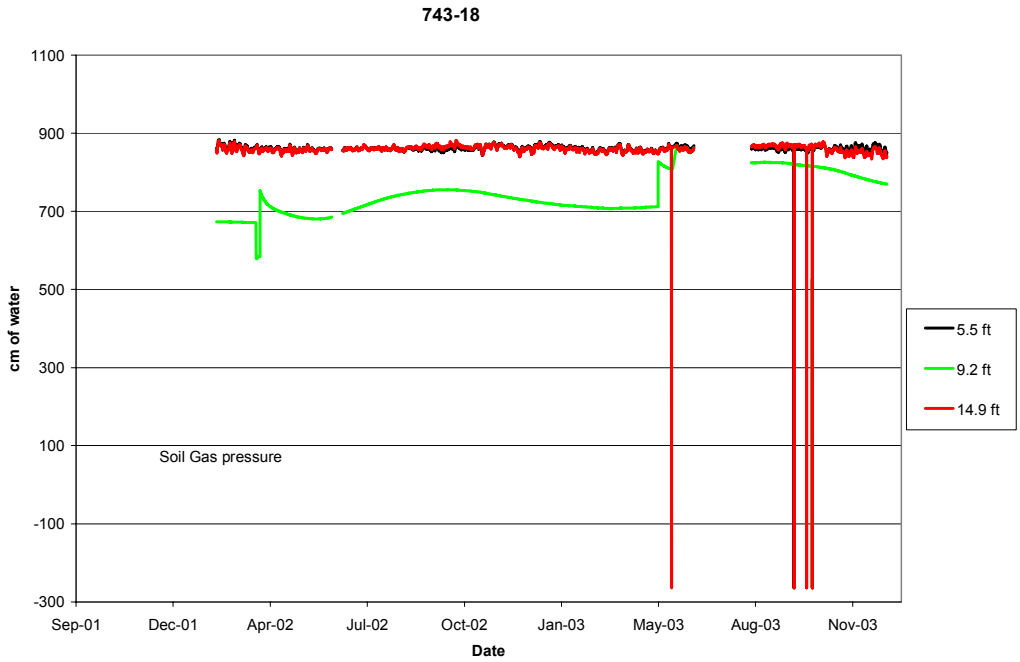


Figure D-5. 743-08.

T1, 5.6 ft: Soil gas pressure working, absolute wp transducer may be working.
T2, 13 ft: Soil gas pressure working, absolute wp transducer beginning to track barometric pressure, try refilling.
T3, 22.4 ft: Soil gas pressure working, absolute wp transducer has never responded, wires are pulled loose.



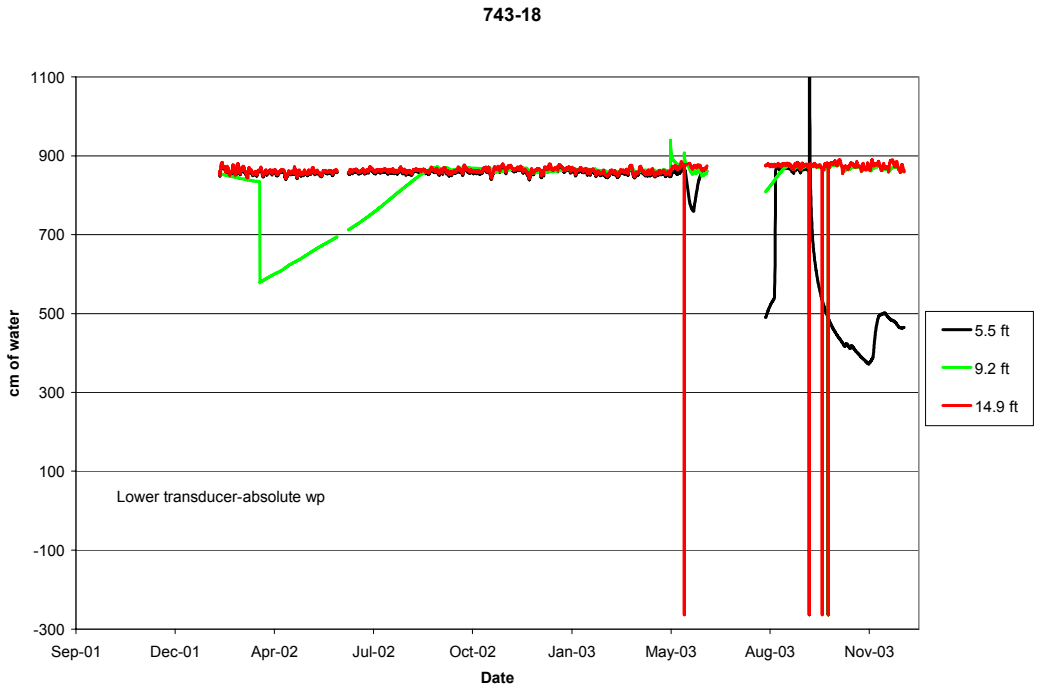
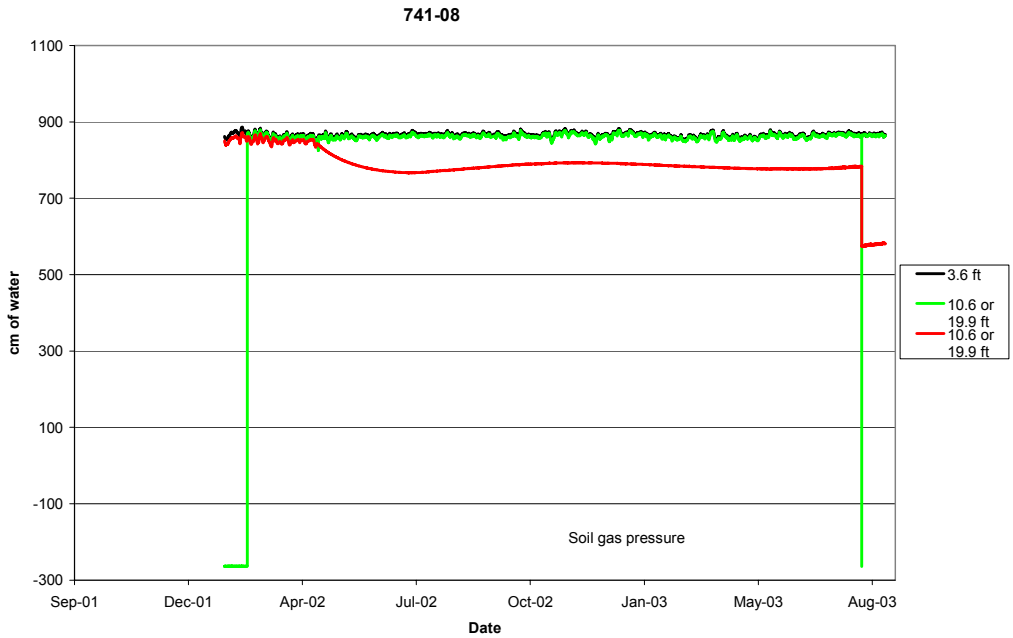


Figure D-6. 743-18.

T1, 5.5 ft: Soil gas pressure working, absolute wp transducer responded to refilling.
T3, 9.2 ft: Soil gas pressure appears to be isolated from atmosphere, absolute wp transducer not responding.
T2, 14.9 ft: Soil gas pressure working, discontinue absolute wp transducer, spool valve stuck open.



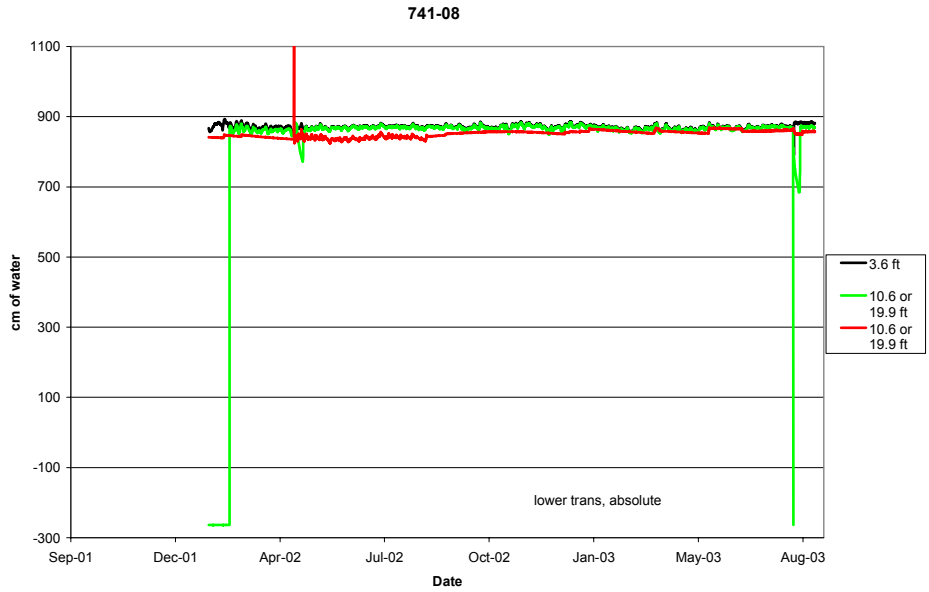
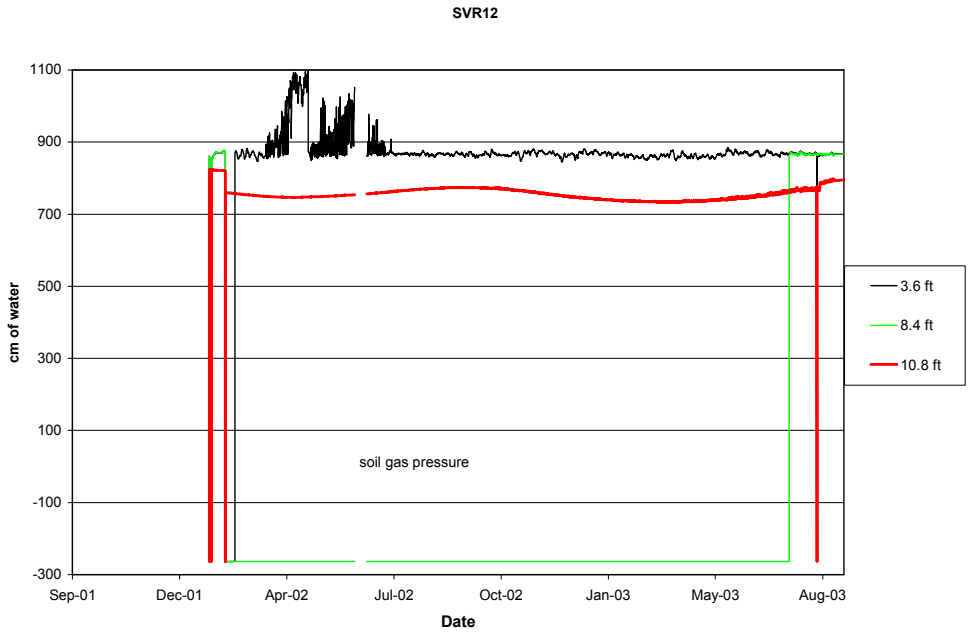


Figure D-7. 741-08.

T1, 3.6 ft: Soil gas pressure working, absolute wp transducer not working.
Note: Wires between the 10.6- and 19.9-ft depths were switched in September 2003, and the switch needs to be double-checked in the field. Therefore, the following two tensiometers are not referred to by depth.
Green line: Soil gas pressure works, absolute wp transducer shows response to refilling.
Red line: Wires for soil gas pressure and absolute wp transducer may be switched. If wires are switched, soil gas pressure (lower figure) works, but absolute wp transducer (upper figure) worked until fall 2003, needs troubleshooting.



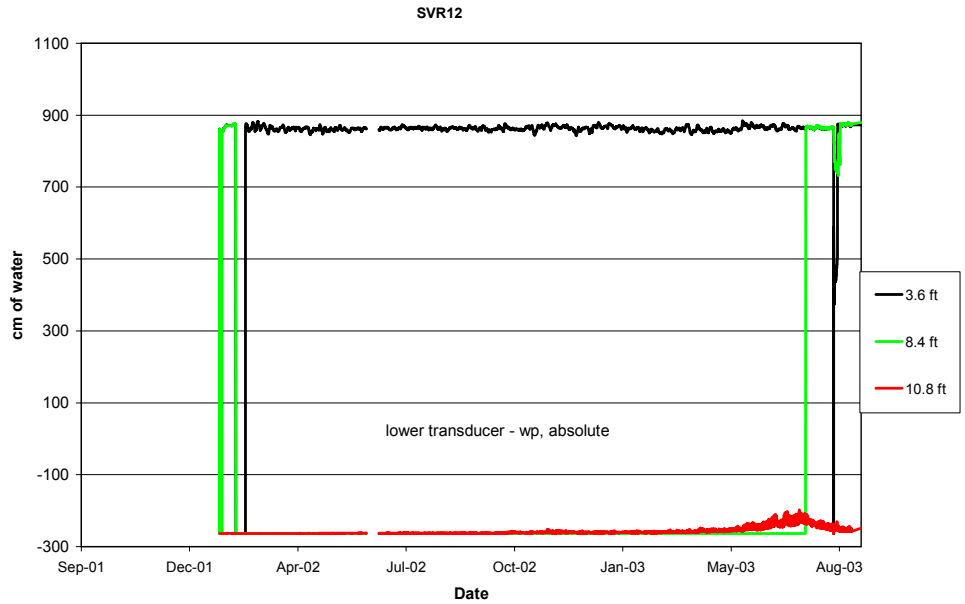
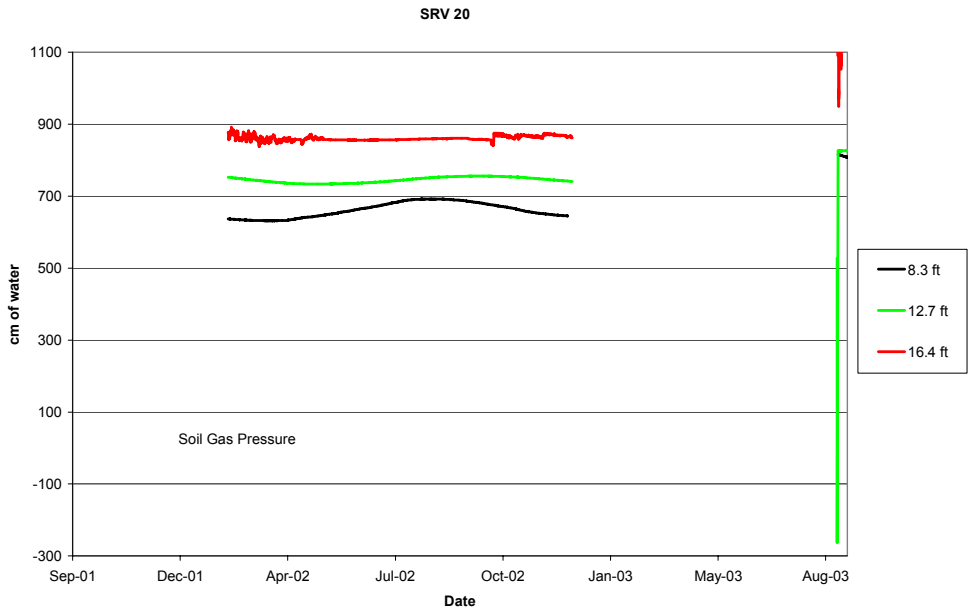


Figure D-8. SVR-12.

T1, 3.6 ft: Soil gas pressure works, absolute wp transducer has not responded to refilling.
T2, 8.4 ft: Soil gas pressure currently working after not working for over 1 year, absolute wp transducer appears to respond to refilling.
T3, 10.8 ft: Soil gas pressure appears to be isolated from atmosphere, absolute wp transducer is not operable (field checked).



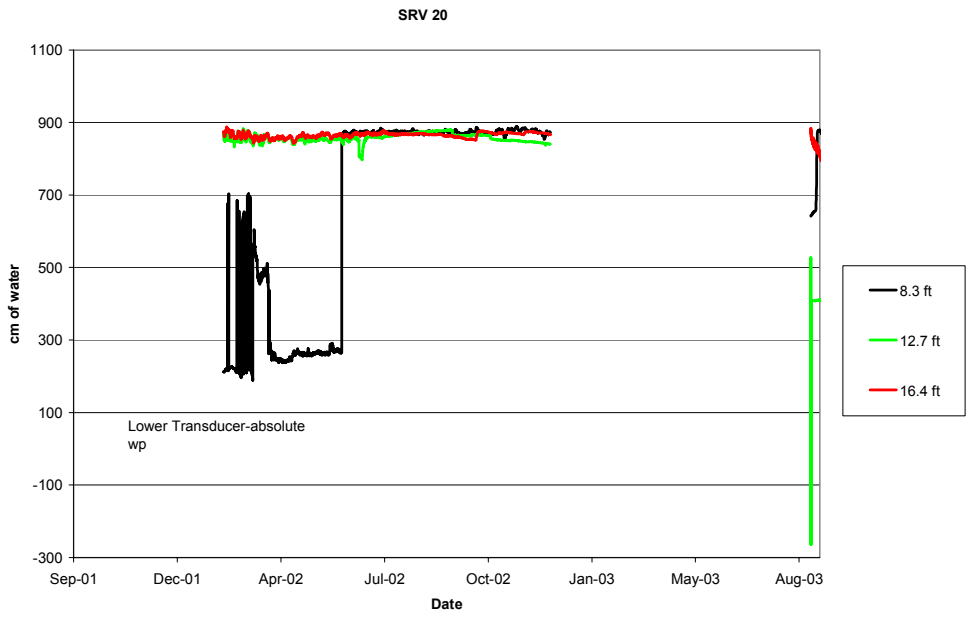
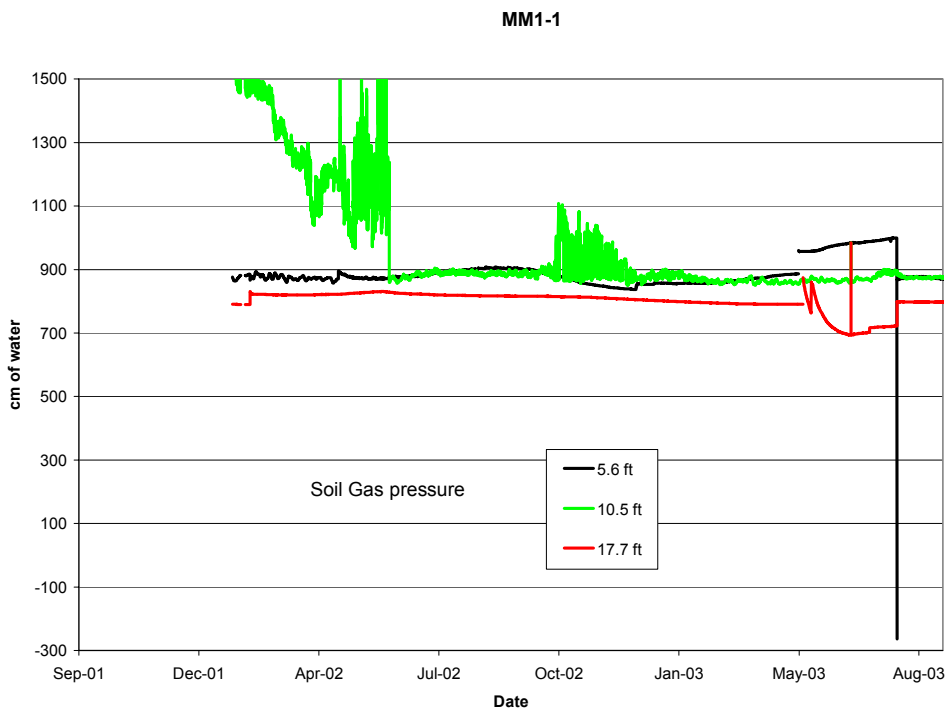


Figure D-9. SVR-20.

T1, 8.3 ft: Soil gas pressure appears to be isolated from atmospheric pressure, absolute wp transducer has responded in the past.
T2, 12.7 ft: Soil gas pressure appears to be isolated from atmospheric pressure, absolute wp transducer appears to be working.
T3, 16.4 ft: Soil gas pressure working, isolated from atmospheric pressure, absolute wp transducer is working.



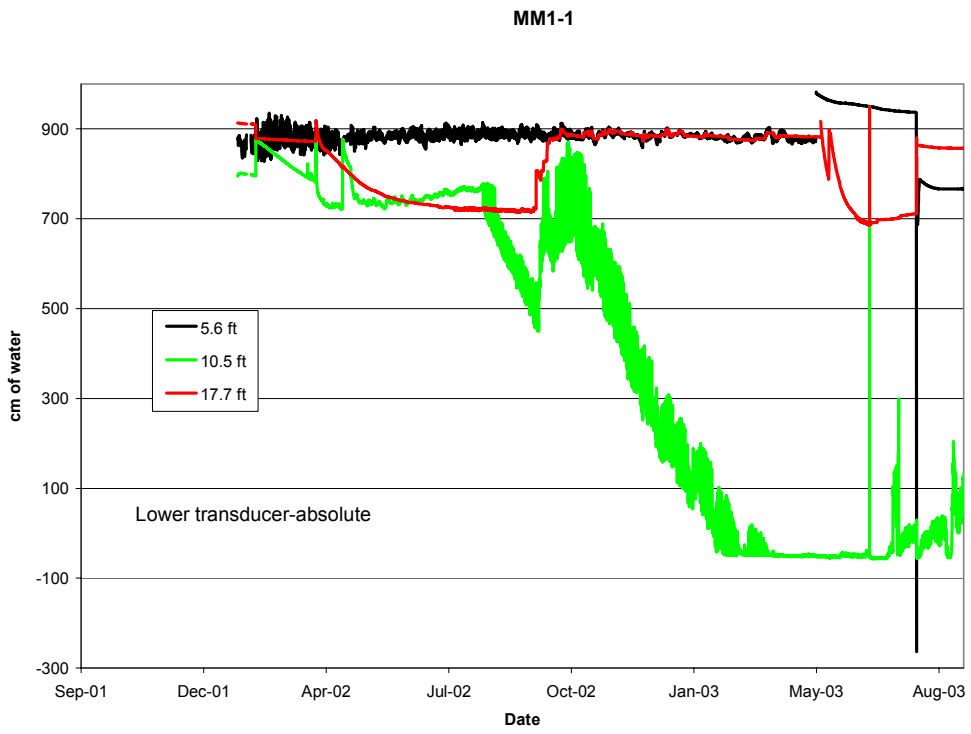
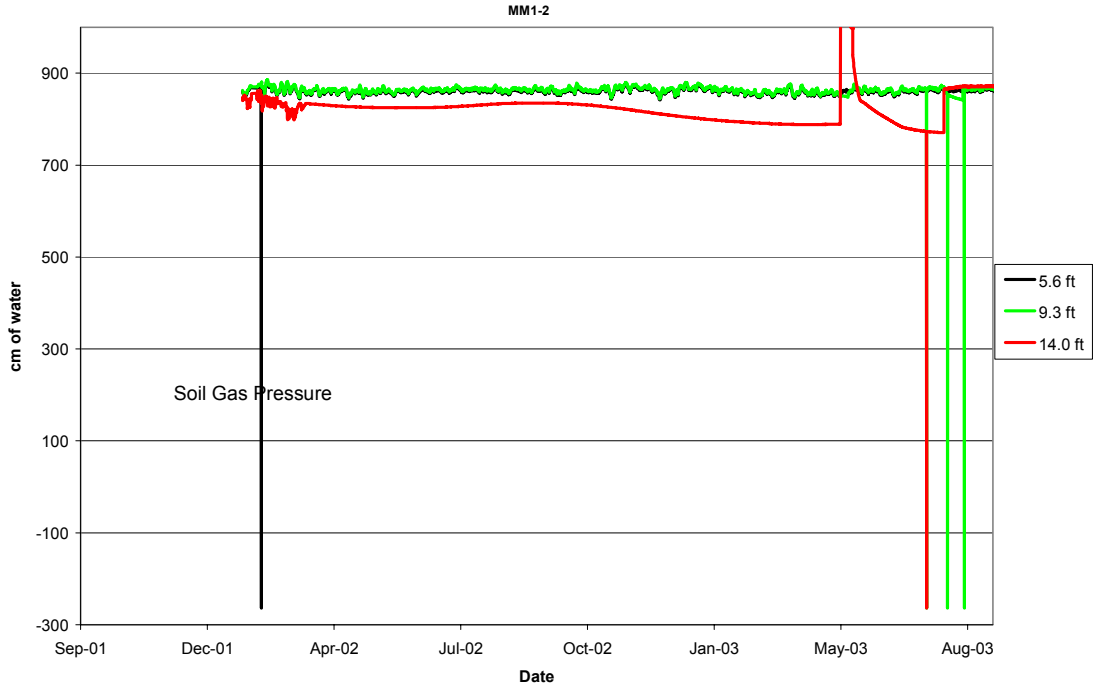


Figure D-10. MM1-1.

T1, 5.6 ft: Soil gas pressure works, lower transducer started working July 29, 2003.
T2, 10.5 ft: Soil gas pressure works after mid-2002, lower transducer has failed.
T3, 17.7 ft: Soil gas pressure appears isolated from atmosphere, lower transducer working until July 29, 2003.



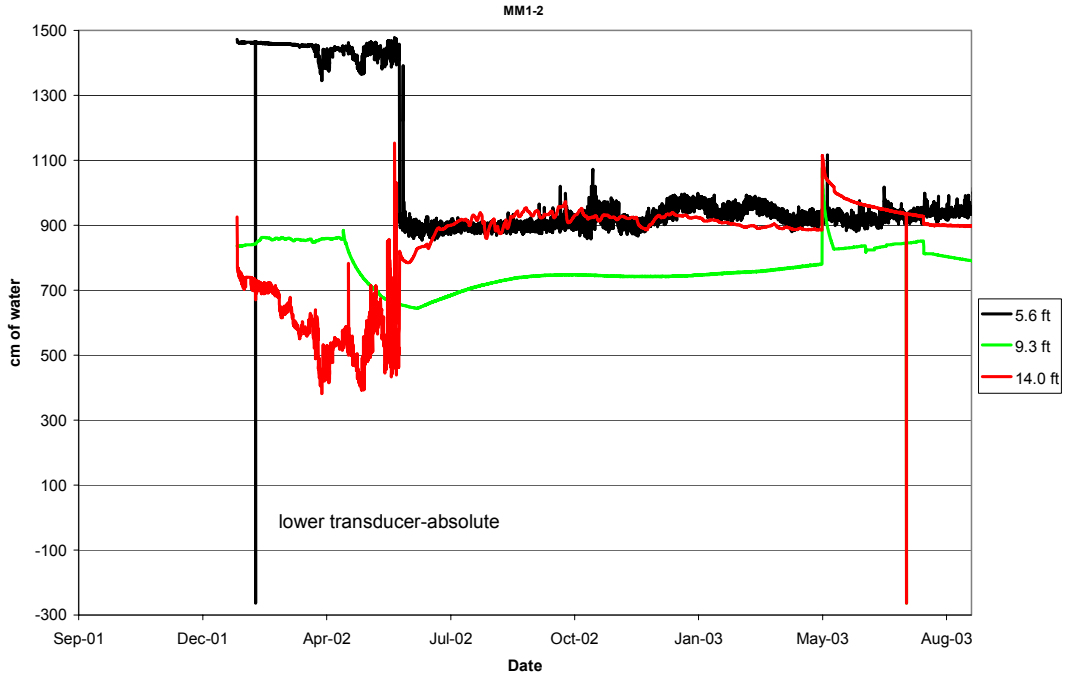
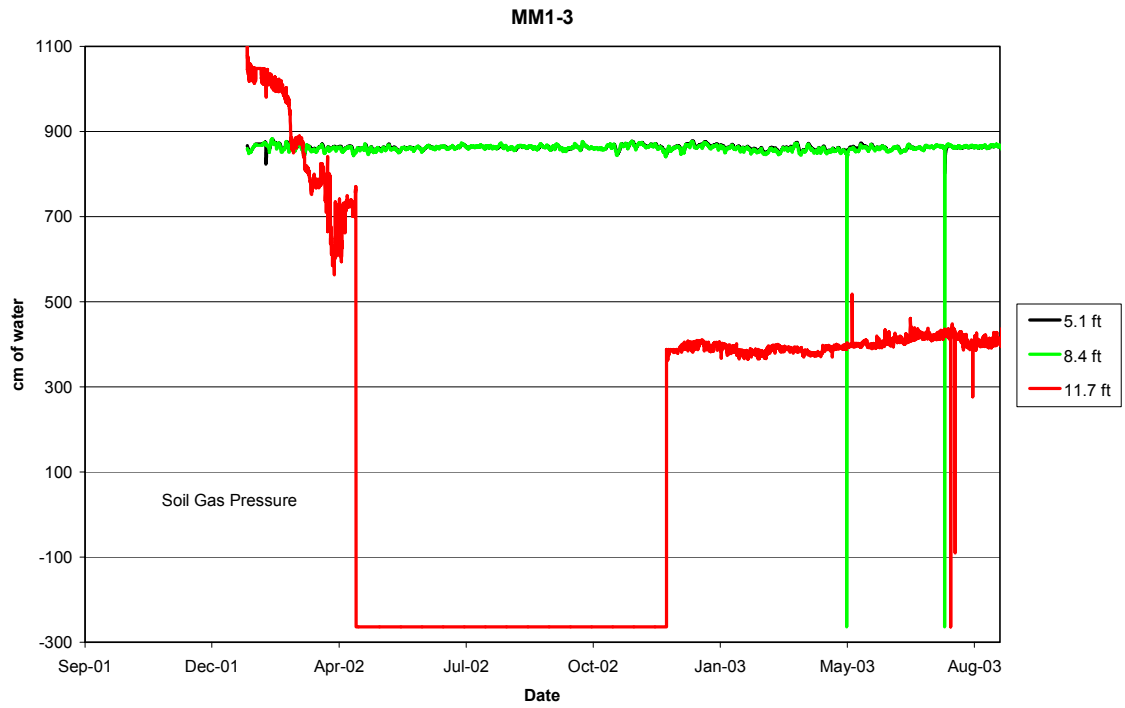


Figure D-11. MM1-2.

T1, 5.6 ft: Soil gas pressure working, lower transducer leaked, couldn't calibrate.
T2, 9.3 ft: Soil gas pressure working, lower transducer worked earlier.
T3, 14 ft: Soil gas pressure isolated from atmosphere but responds to calibration, lower transducer is questionable, continue to troubleshoot.



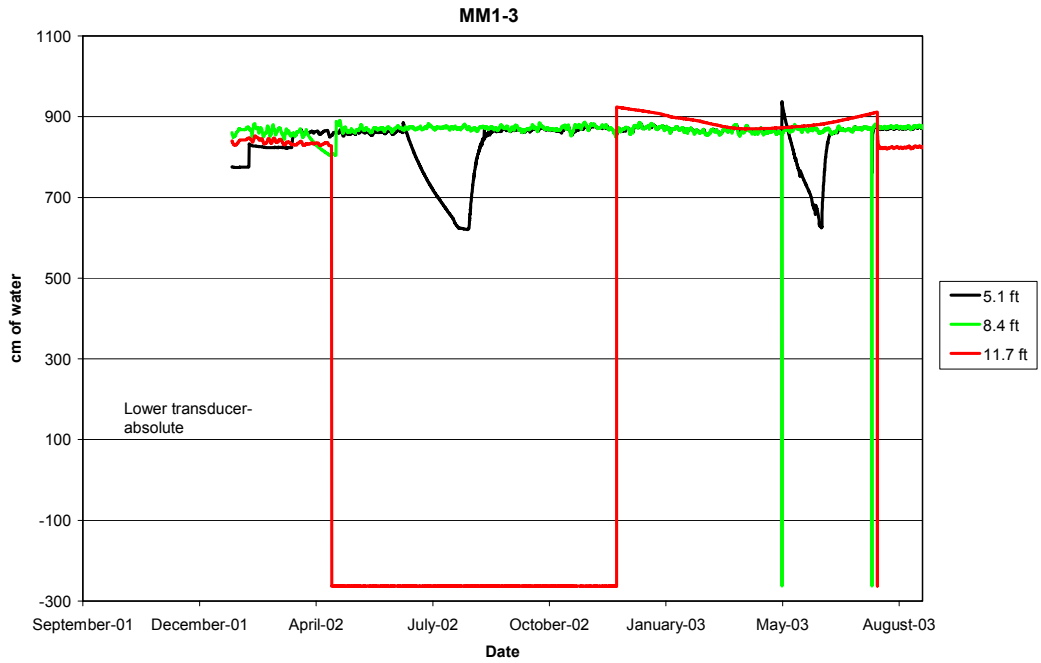
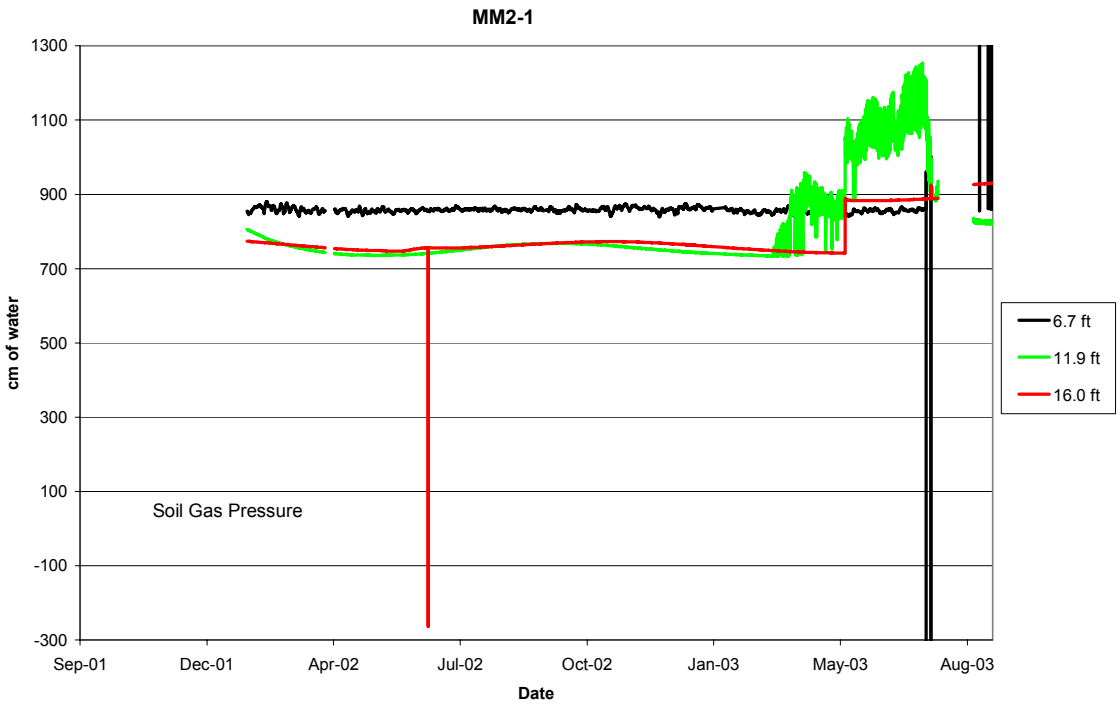


Figure D-12. MM1-3.

T1, 5.1 ft: Soil gas pressure works, absolute wp transducer works sporadically.
T2, 8.4 ft: Soil gas pressure works, absolute wp transducer showed early signs of working.
T3, 11.7 ft: Soil gas pressure and absolute wp transducer not working. Water came out of line when applied vacuum to calibrate, so may be saturated.



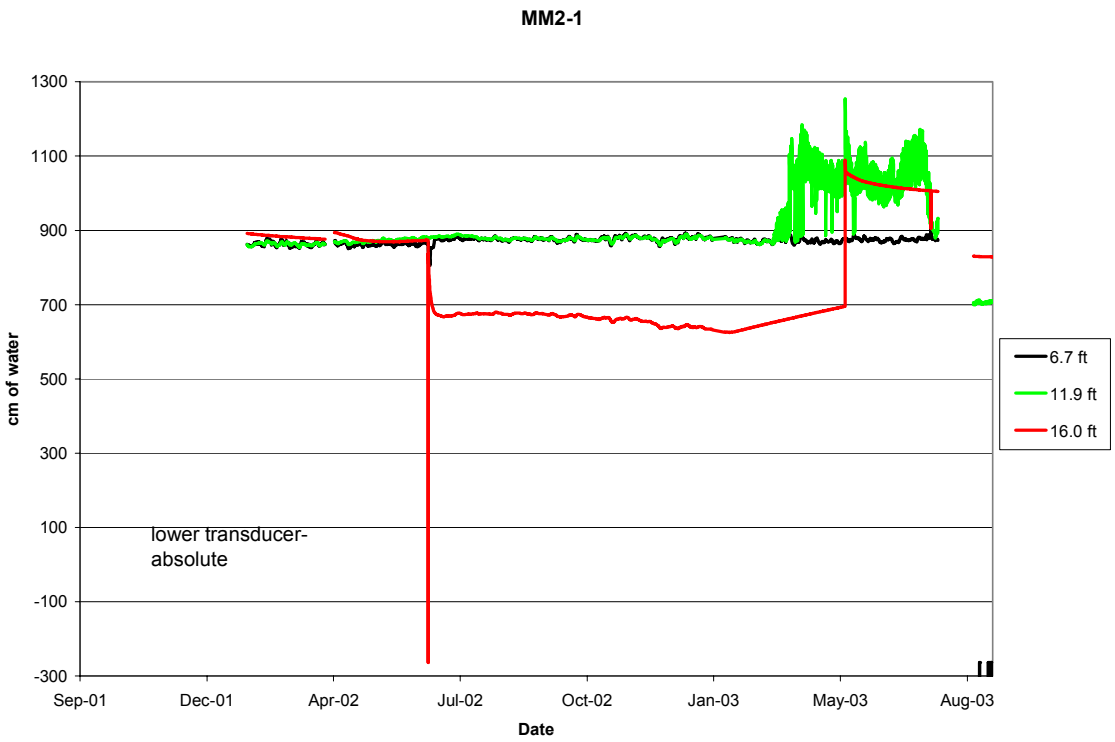
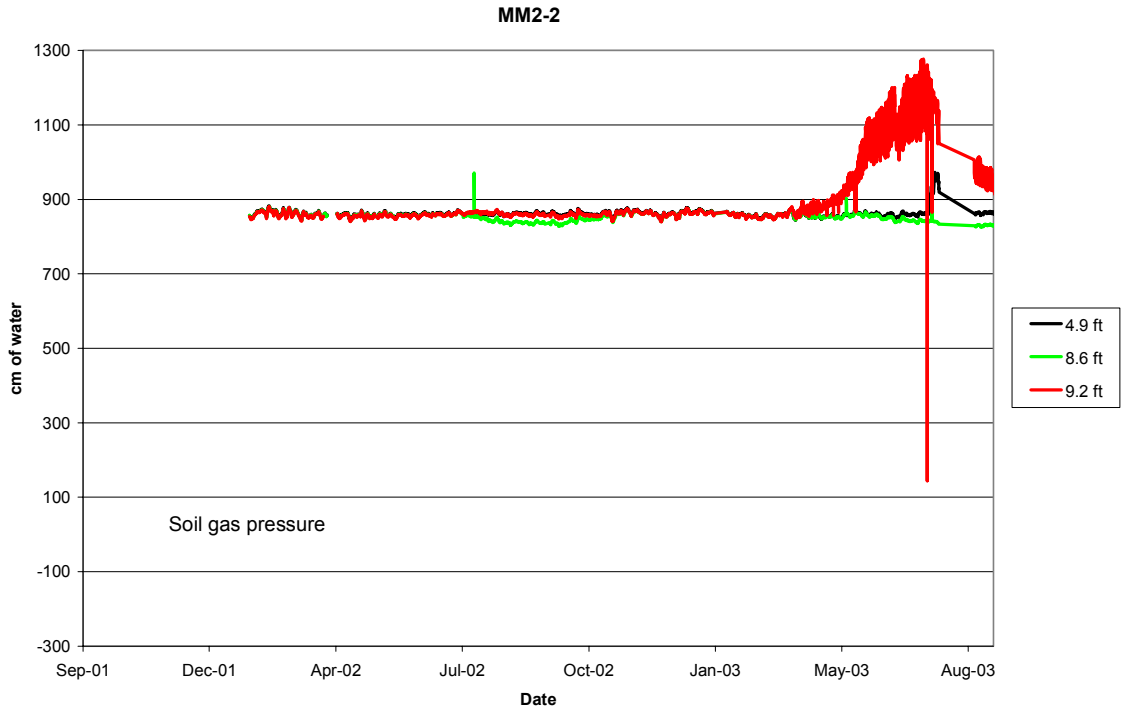


Figure D-13. MM2-1.

T1, 6.7 ft: Soil gas pressure working till fall 2003, absolute wp transducer won't hold vacuum.
T2, 11.9 ft: Soil gas pressure and absolute wp transducers may be working by fall 2003.
T3, 16 ft: Soil gas pressure not working in fall, not clear if absolute wp transducer is currently working.



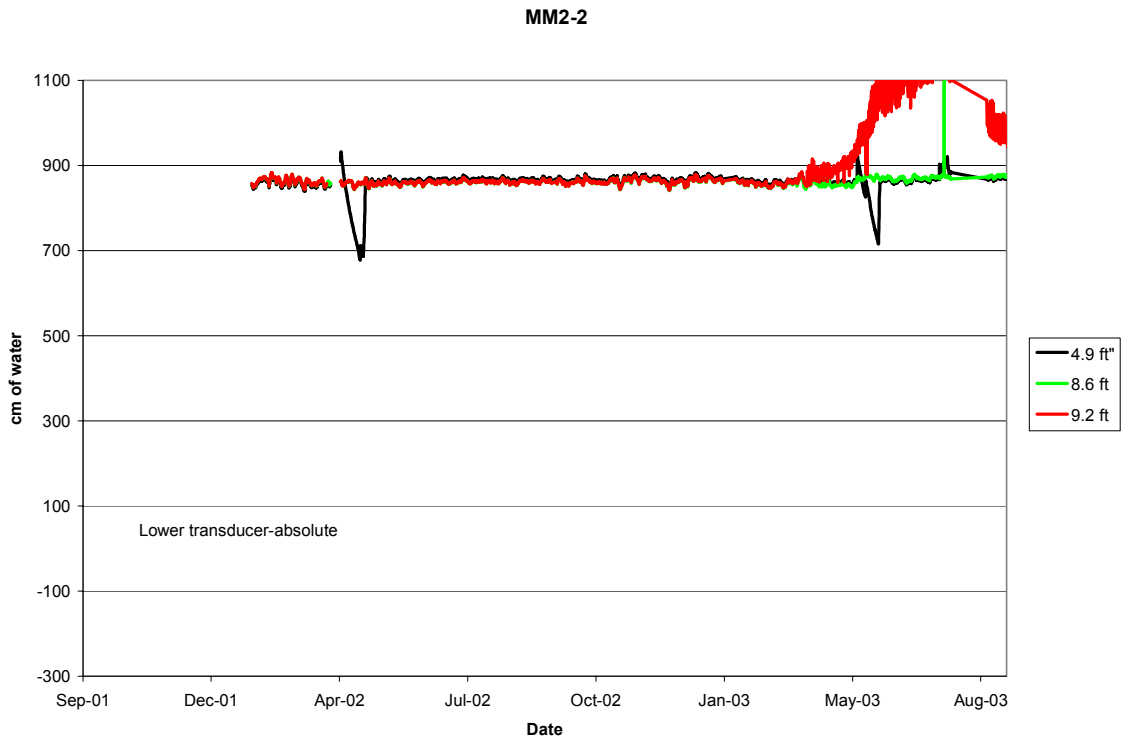
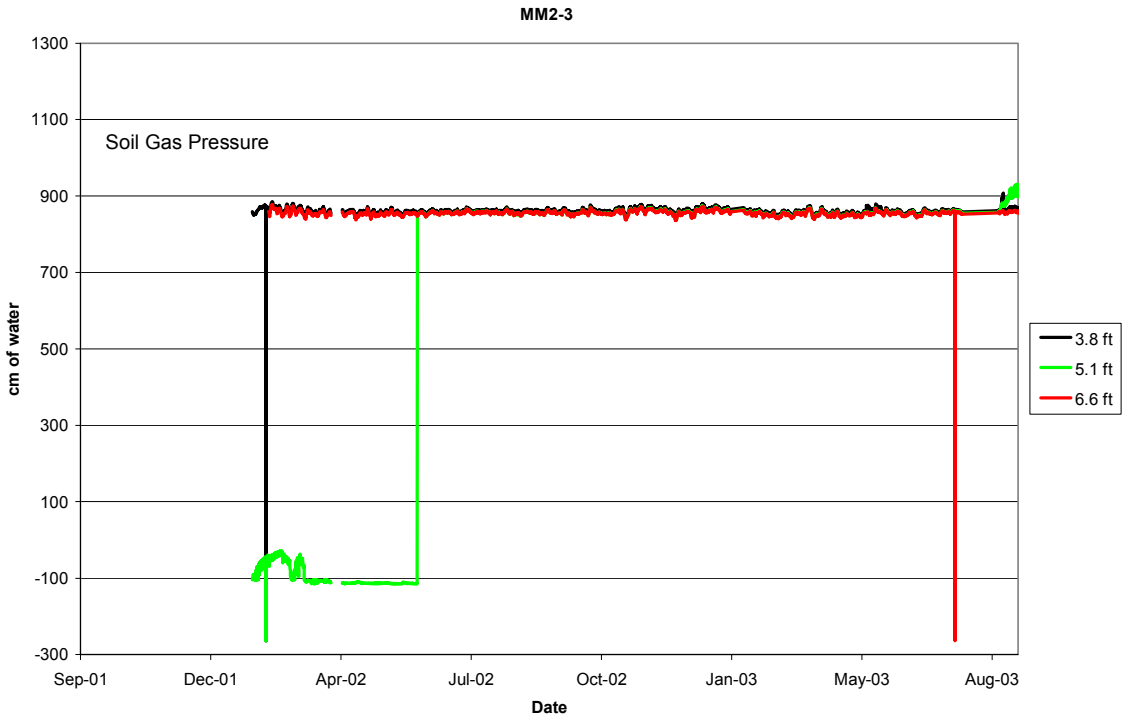


Figure D-14. MM2-2.

T1, 5 ft: Soil gas pressure is tracking well, absolute wp transducer started to work several times.
T2, 8.6 ft: Soil gas pressure tracks well, absolute wp transducer has shown no signs of working.
T3, 9.2 ft: Soil gas pressure and absolute wp transducer have electrical problems, lower transducer has shown no sign of working.



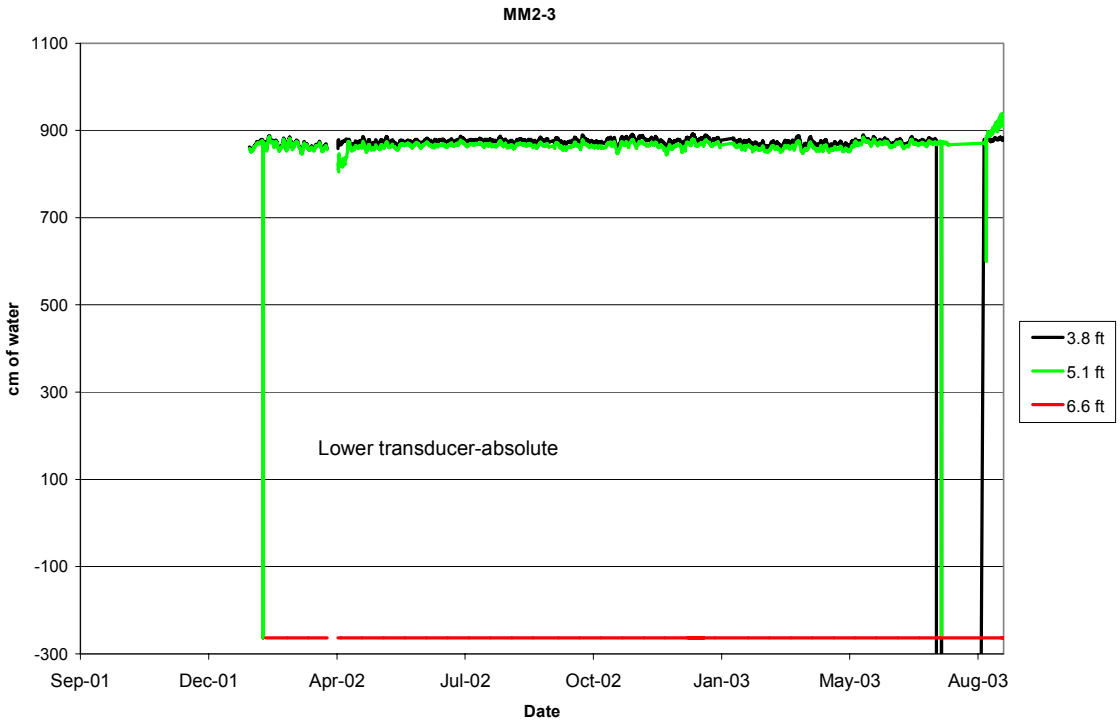
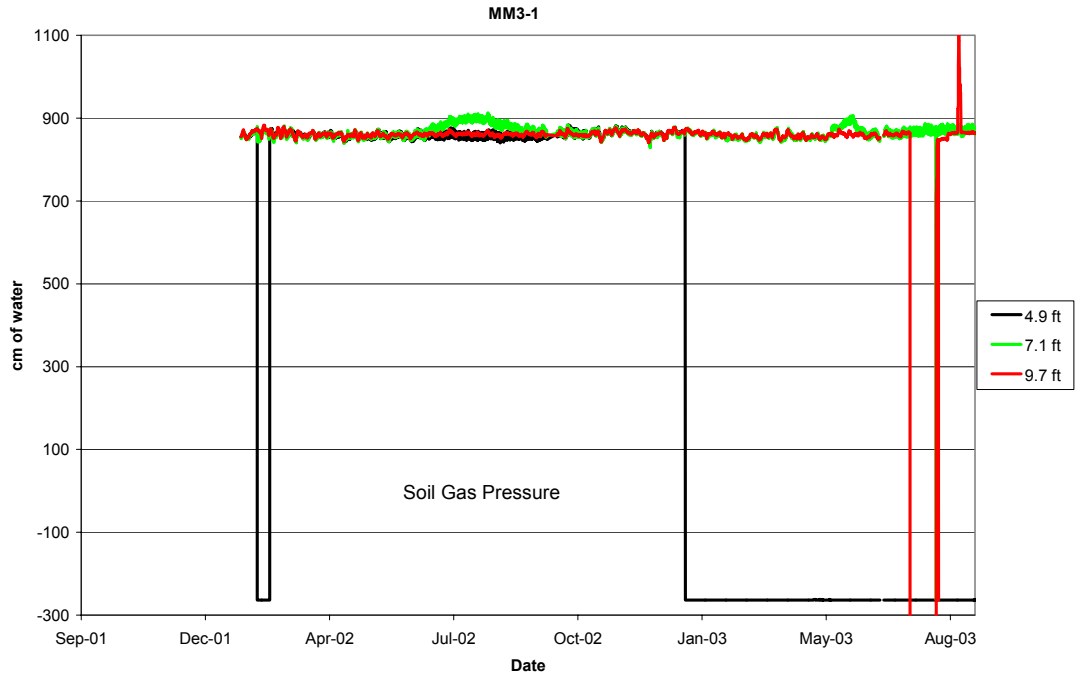


Figure D-15. MM2-3.

T1, 3.8 ft: Soil gas pressure looks good, absolute wp transducer has shown no signs of working.
T2, 5.1 ft: Soil gas pressure tracks well until August 2003, absolute wp transducer shows no sign of working.
T3, 6.6 ft: Soil gas pressure tracks well, absolute wp transducer has failed.



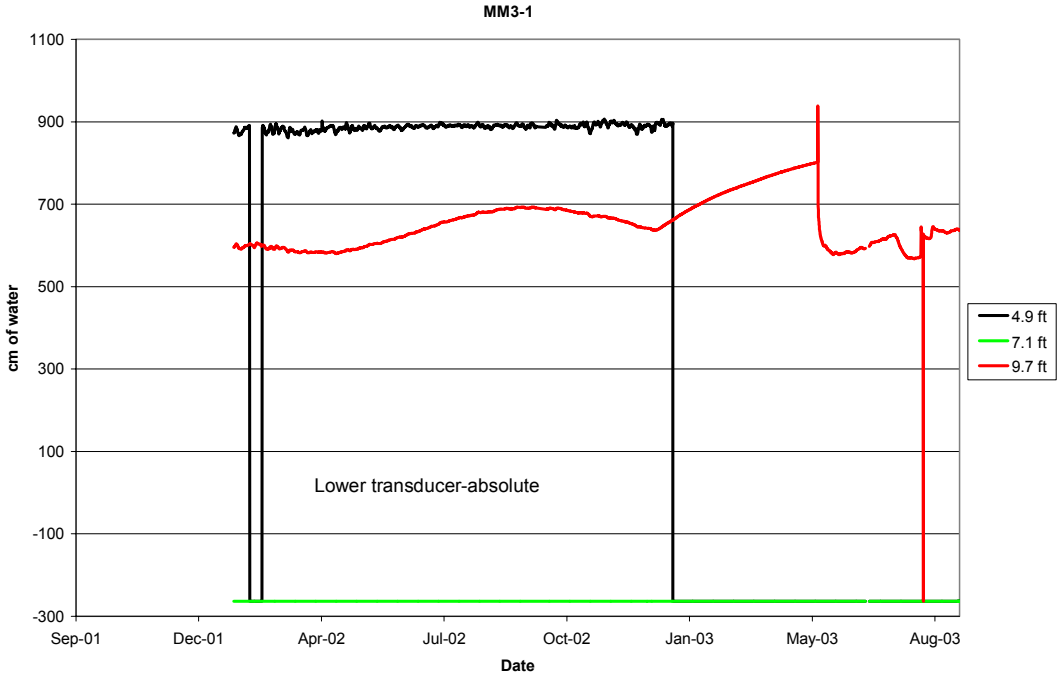
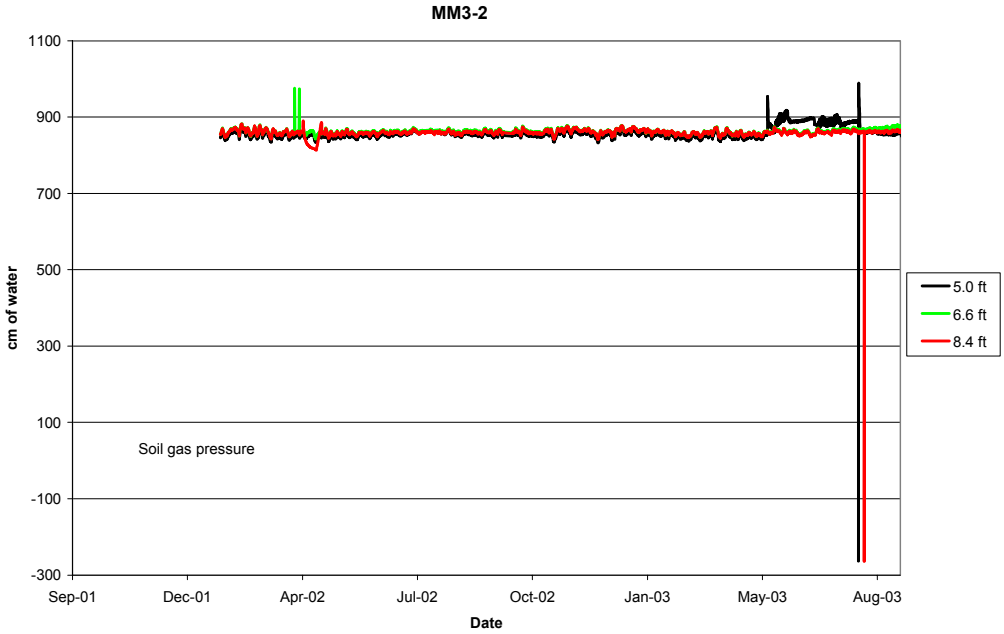


Figure D-16. MM3-1.

T1, 4.9 ft: Soil gas pressure no signal, absolute wp transducer no signal and spool valve not working.
T2, 7.1 ft: Soil gas pressure working, absolute wp transducer no signal (–273).
T3, 9.7 ft: Soil gas pressure working, absolute wp transducer working.



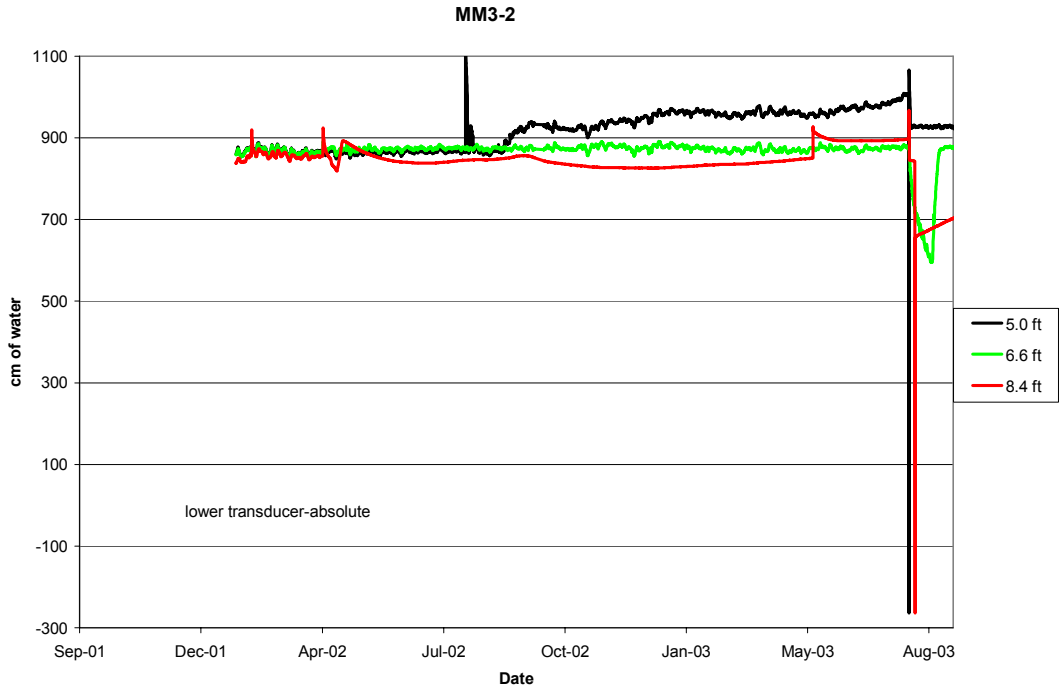
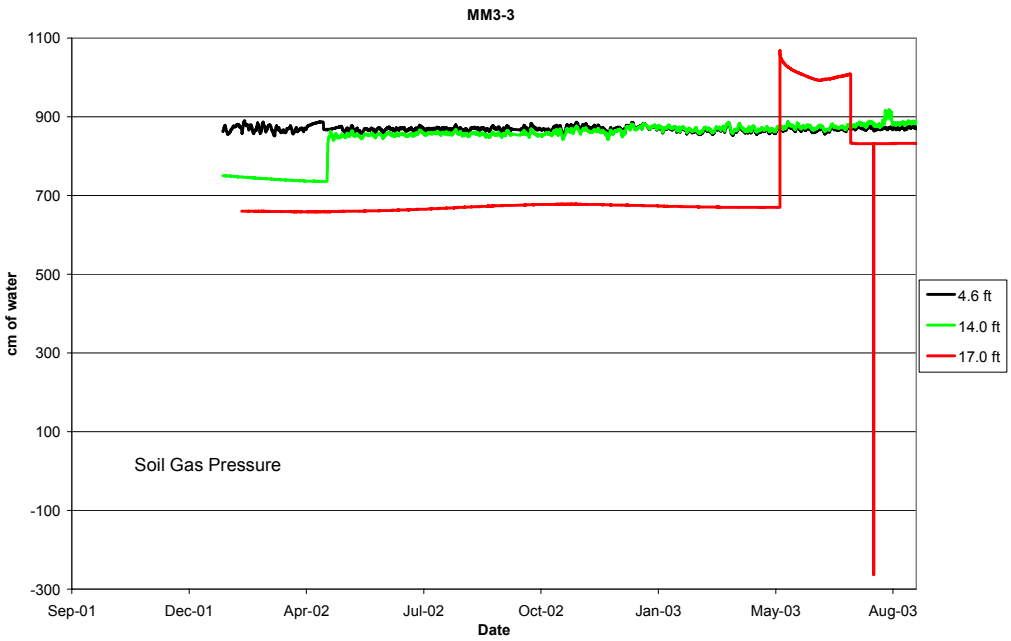


Figure D-17. MM3-2.

T1, 5 ft: Soil gas pressure working, absolute wp transducer shows no sign of holding vacuum.
T2, 6.6 ft: Soil gas pressure working, absolute wp transducer showed signs of working in fall 2003.
T3, 8.4 ft: Soil gas pressure working, absolute wp transducer not working, tubing pulled out during field operations.



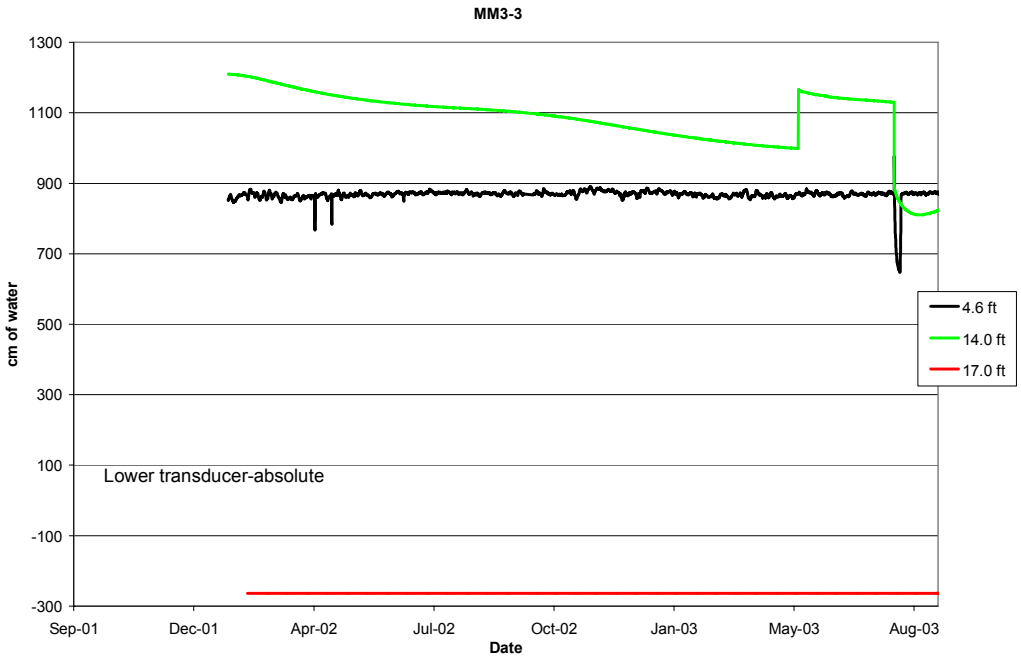
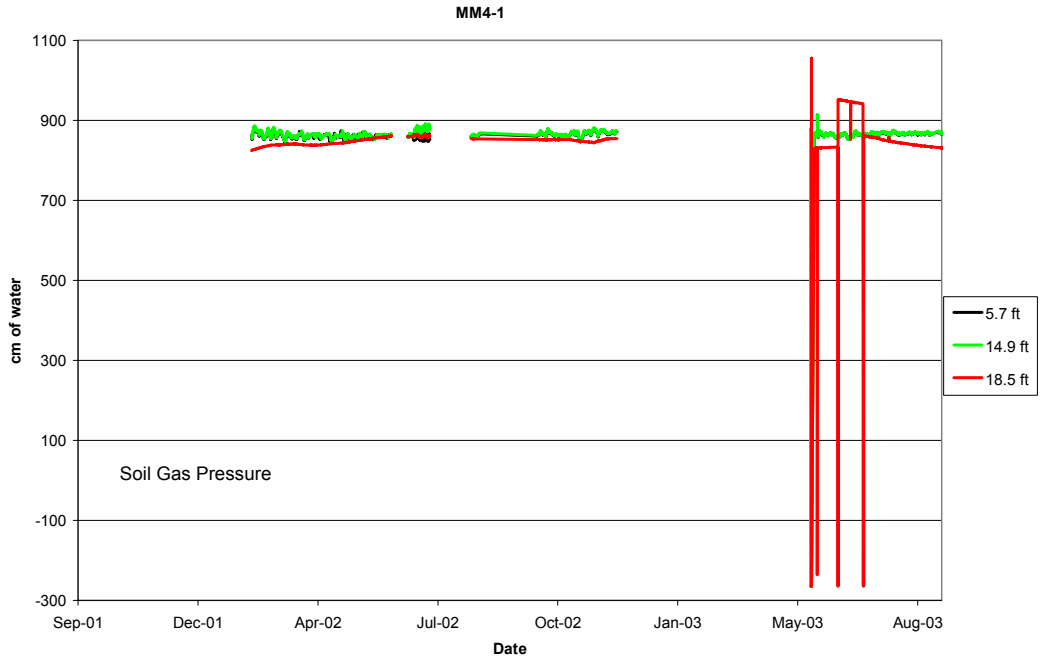


Figure D-18. MM3-3.

T1, 14 ft: Soil gas pressure working, absolute wp transducer possibly coming into range.
T2, 4.6 ft: Soil gas pressure working, absolute wp transducer showed signs of working in summer 2003.
T3, 17 ft: Soil gas pressure range is not consistent, absolute wp transducer—no signal, 273.



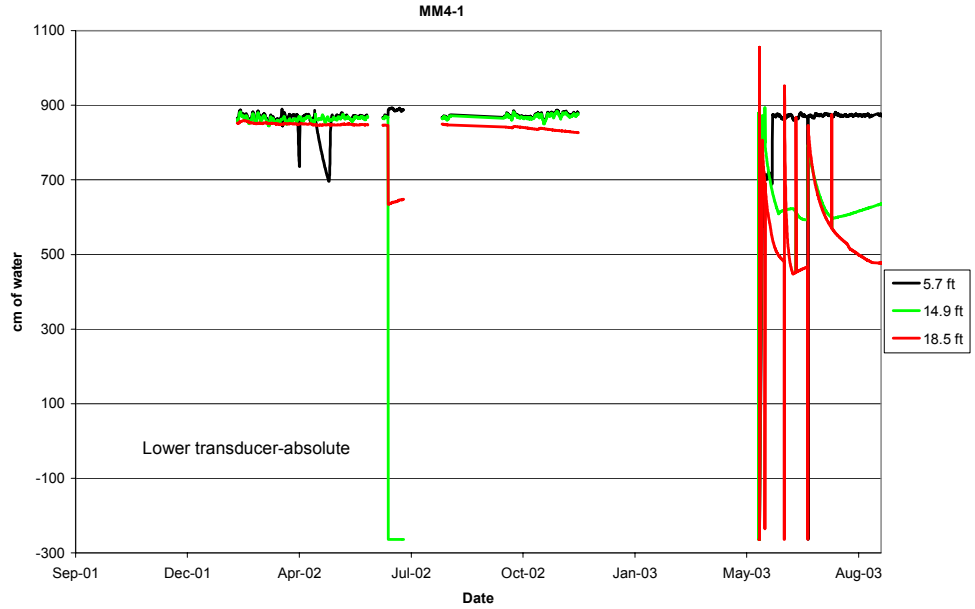
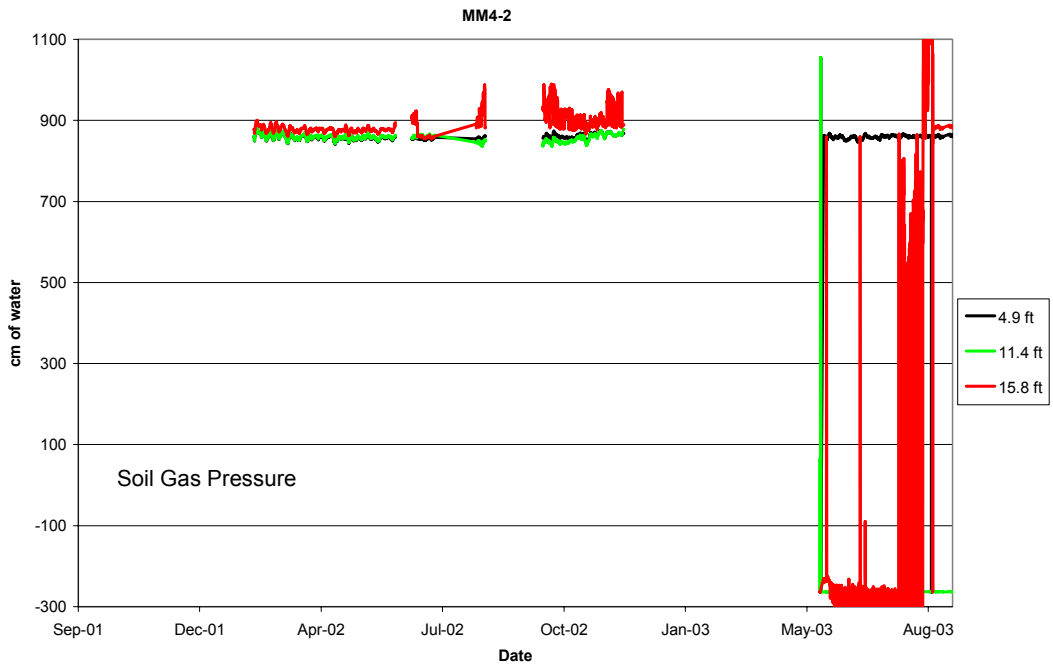


Figure D-19. MM4-1.

T1, 5.7 ft: Soil gas pressure working, absolute wp transducer works sporadically.
T2, 14.9 ft: Soil gas pressure working, absolute wp transducer working sporadically.
T3, 18.5 ft: Soil gas pressure working but hydraulically disconnected from the atmosphere, absolute wp transducer working sporadically.



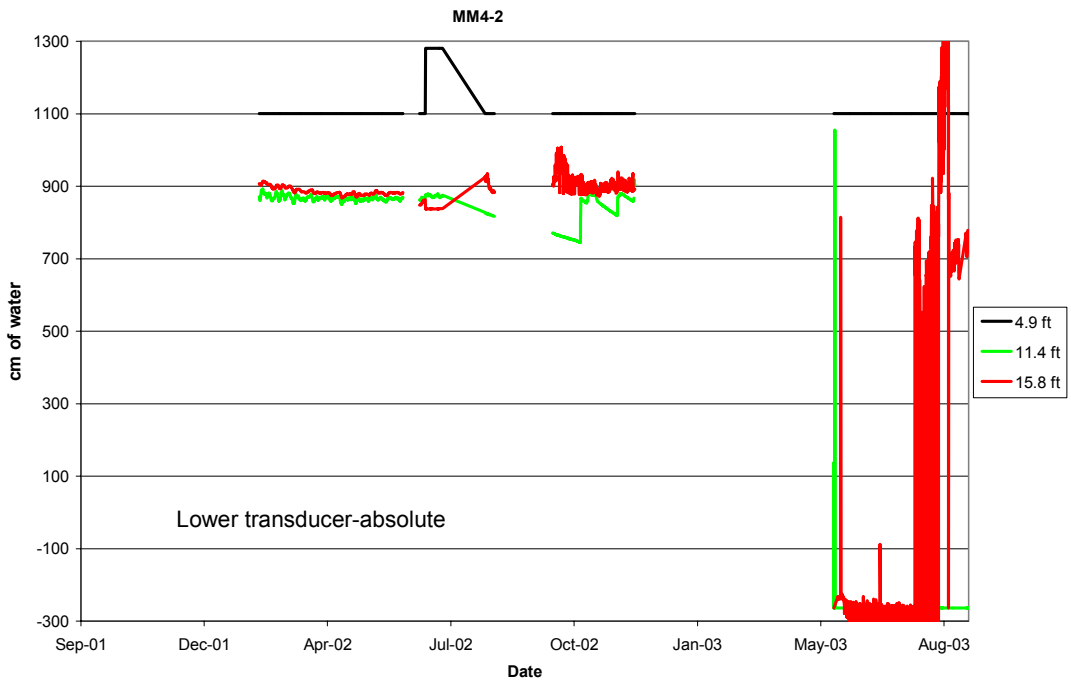
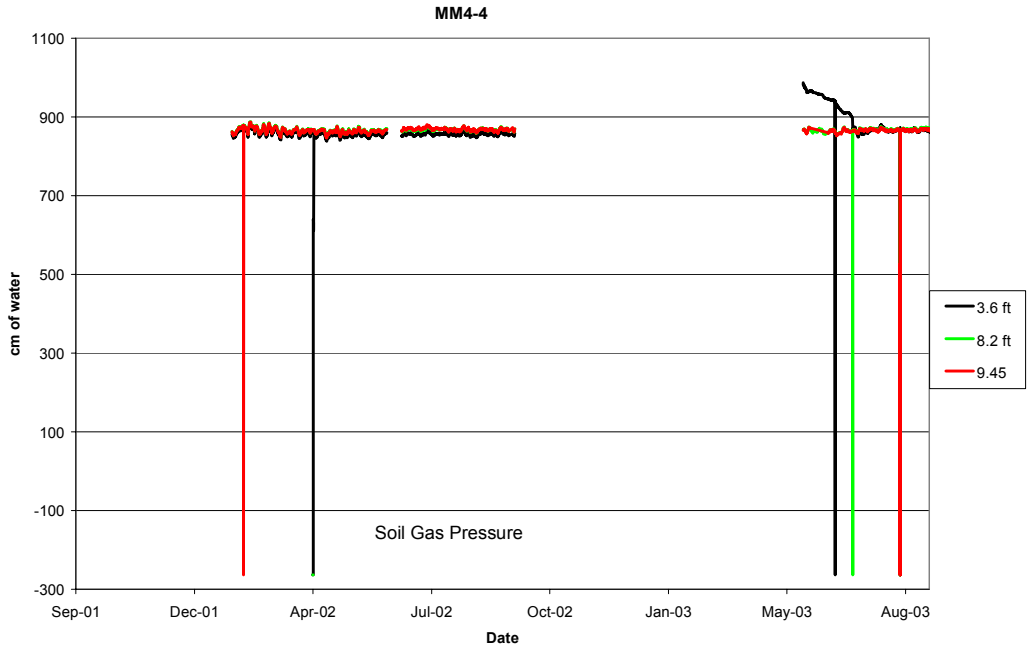


Figure D-20. MM4-2.

T1, 4.9 ft: Soil gas pressure working, absolute wp transducer gives out-of-range readings.
T2, 11.4 ft: Soil gas pressure no longer working (–273), absolute wp transducer—currently no signal (–273) but has worked in past.
T3, 15.8 ft: Soil gas pressure working sporadically, absolute wp transducer is not consistent.



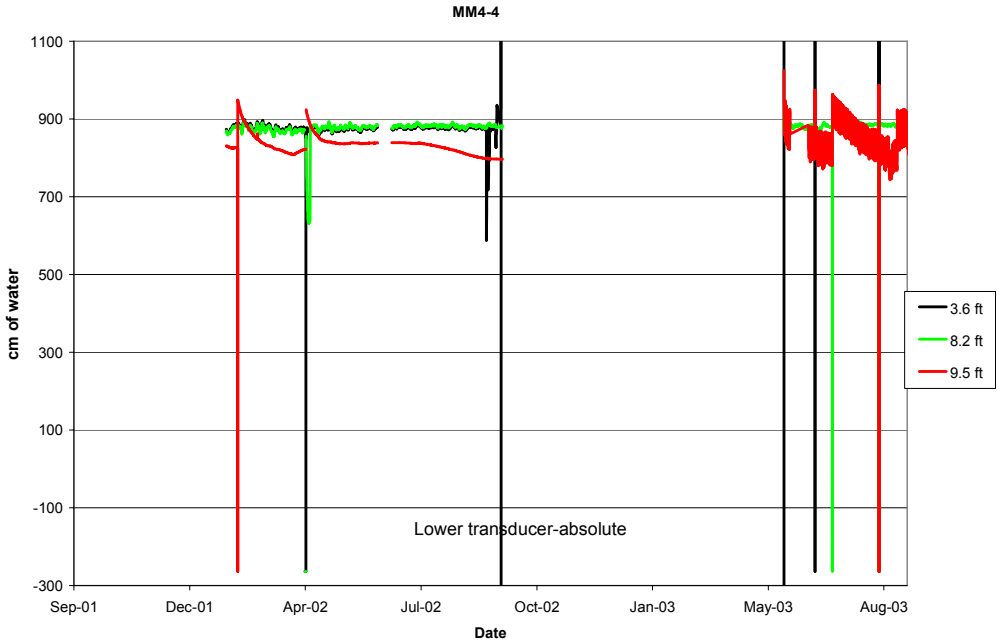
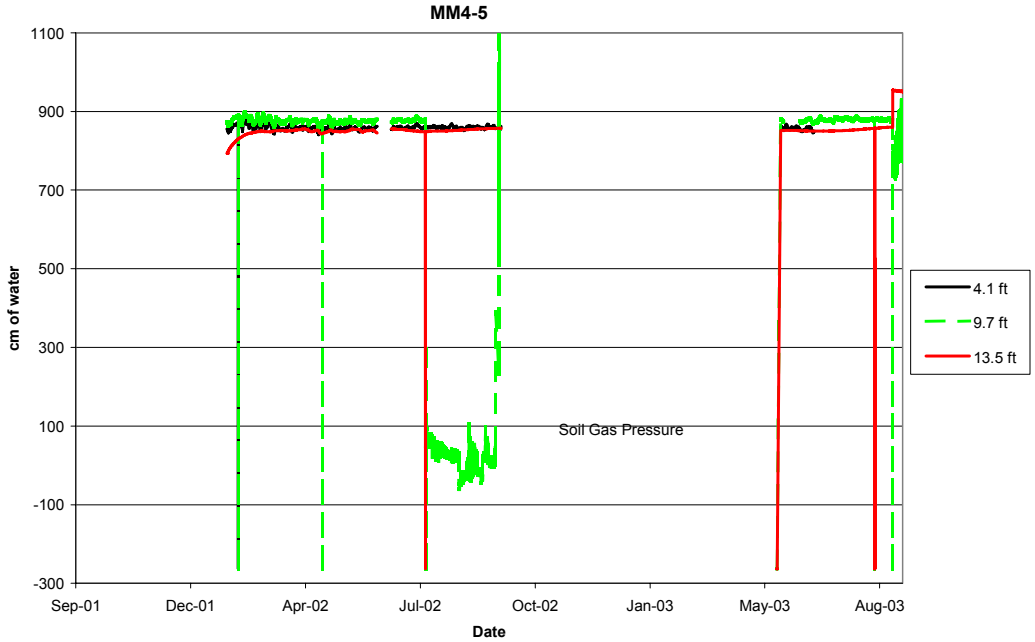


Figure D-21. MM4-4.

T1, 3.6 ft: Soil gas pressure working, absolute wp transducer out of range.
T2, 8.2 ft: Soil gas pressure working, absolute wp transducer shows no sign of working.
T3, 9.5 ft: Soil gas pressure working, absolute wp transducer worked sporadically and has electrical problem, may be loose wire.



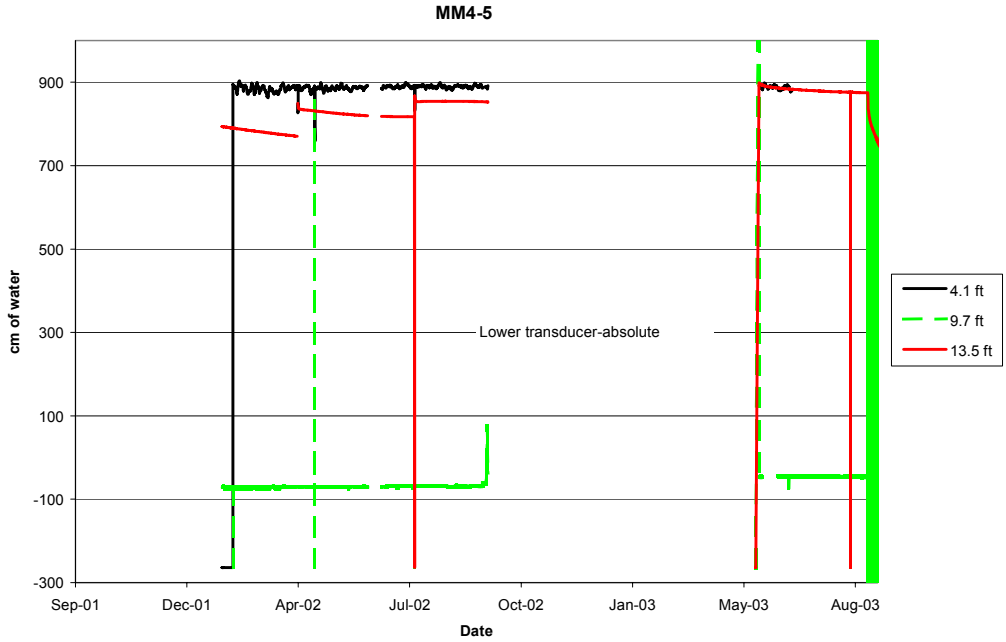


Figure D-22. MM4-5.

T1, 4.1 ft: No soil gas pressure and absolute wp transducer data since June 2003.
T2, 9.7 ft: Soil gas pressure has worked, absolute wp transducer does not respond.
T3, 13.5 ft: Soil gas pressure lost calibration, absolute wp transducer appears to be working.

Appendix E

Optical Televiewer Digital Images

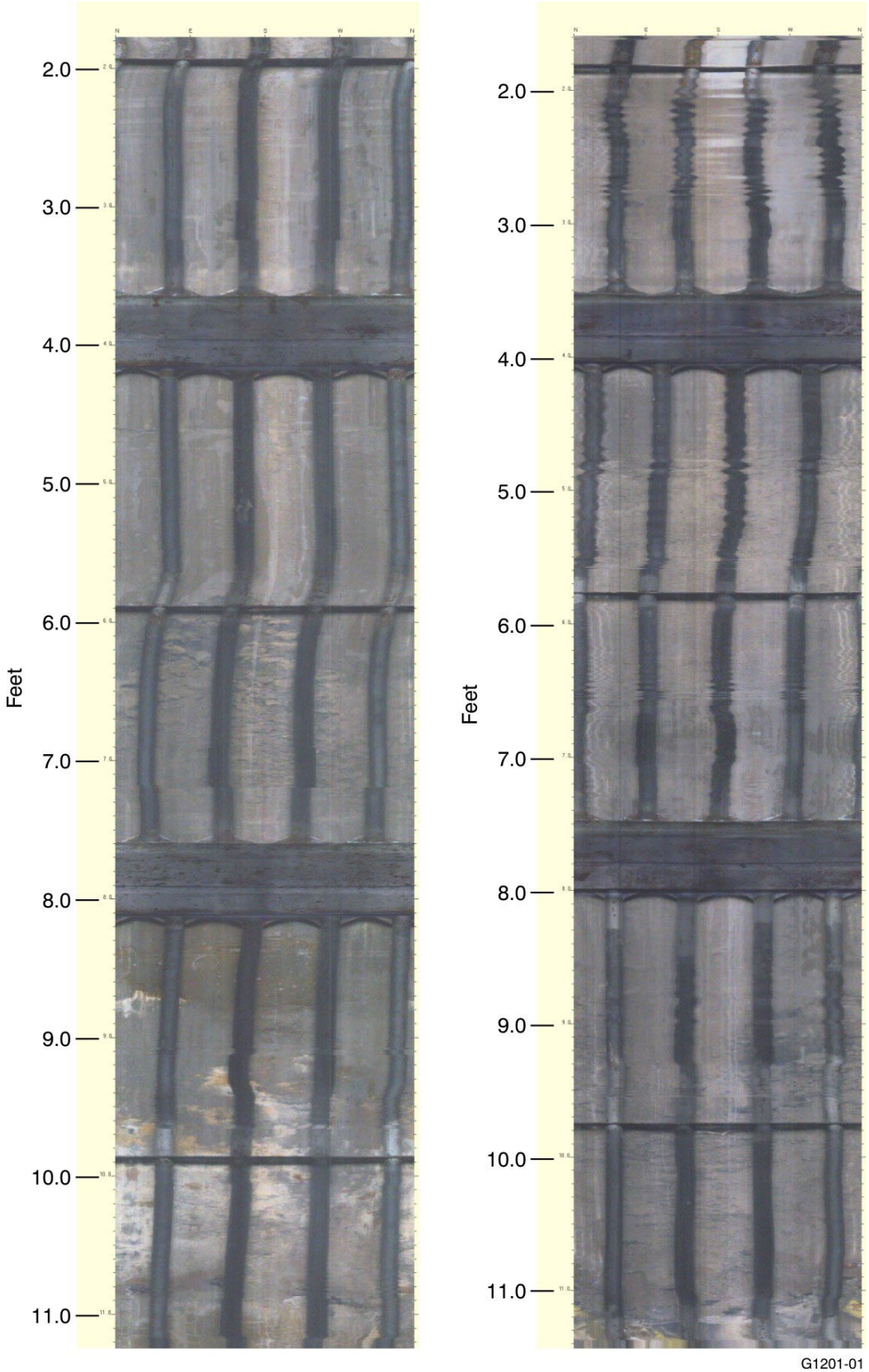


Figure E-1. Visual probe Clusters 743-03 and 741-8.

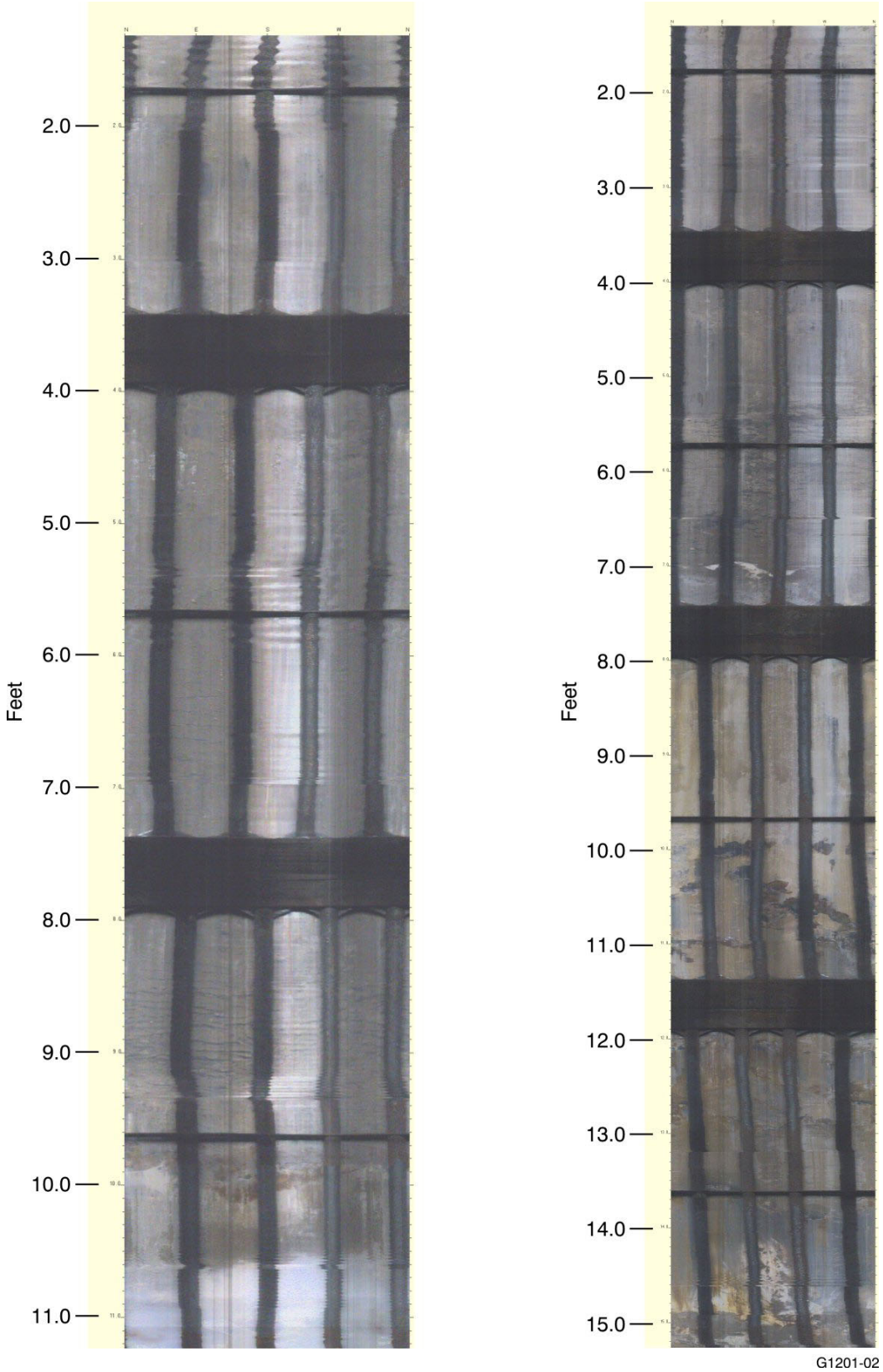


Figure E-2. Visual probe Clusters 743-08 and DU-8.

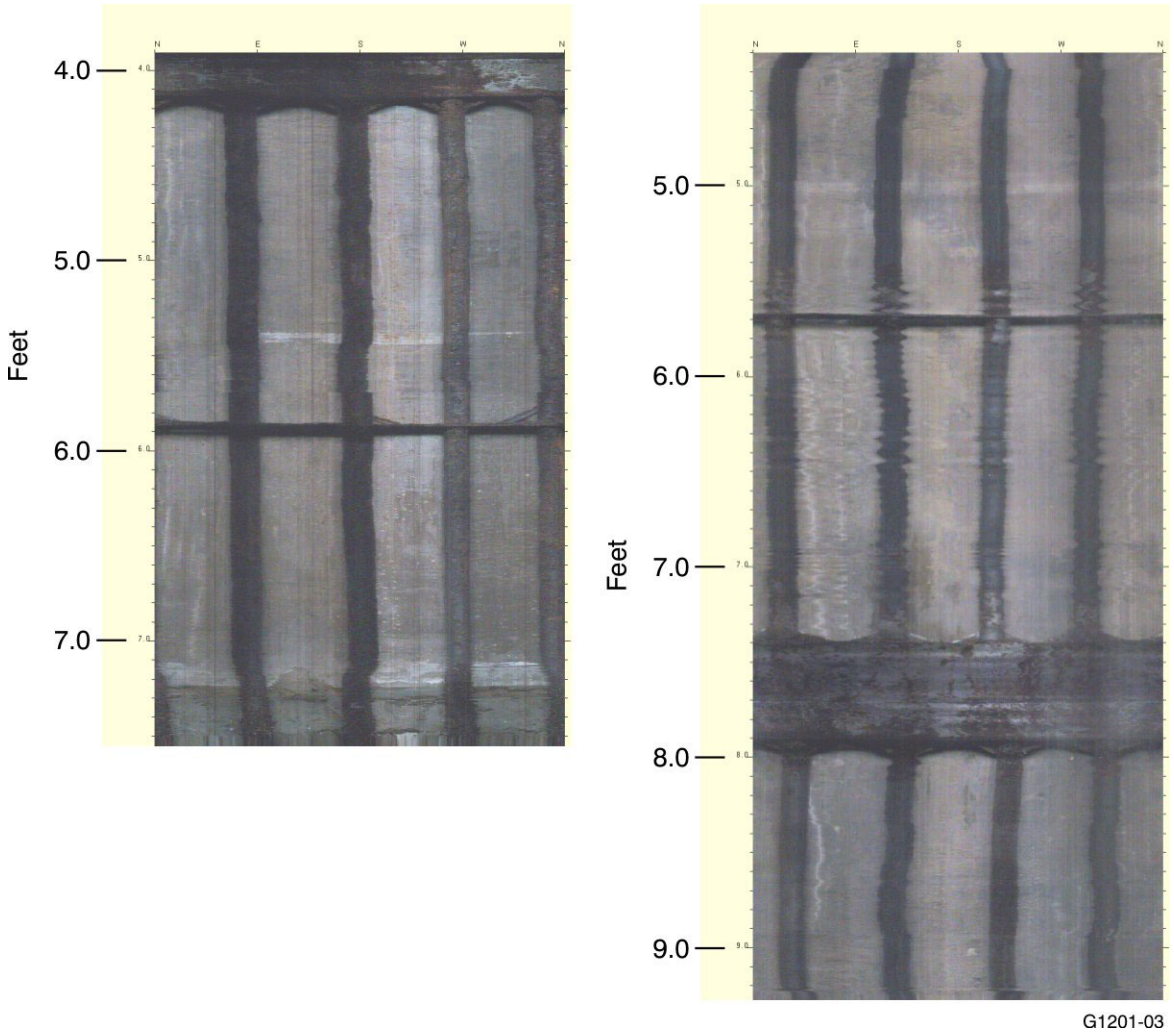


Figure E-3. Visual probe Clusters DU-10 and DU-14.