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WORK PLAN ADDENDUM TO THE RI/FS WORK PLAN REVISION 3, MARCH 1988 FOR ADDITIONAL CHARACTERIZATION OF VADOSE AND PERCHED WATER IN THE K-65 AREA REVISION 1

DOE-FN/EPA

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REPORT

WORK PLAN ADDENDUM
to the
RI/FS Work Plan
Revision 3, March 1988

for

ADDITIONAL CHARACTERIZATION OF VADOSE AND PERCHED WATER IN THE K-65 AREA

WBS #40.03.04

Revision 1

Prepared by

Fernald Environmental Restoration Management Company
(FERMCO)
for the

Department of Energy
Fernald Environmental Management Project

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WORK PLAN ADDENDUM
ADDITIONAL CHARACTERIZATION OF VADOSE AND PERCHED WATER IN THE K-65 AREA
WBS #40.03.04

1.0 INTRODUCTION

This work plan addendum presents a sampling and analysis plan for further investigations to characterize the presence, extent, and quality of vadose and groundwater in the glacial overburden immediately to the west of K-65 Silos 1 and 2. Results of the proposed work will be incorporated in the CERCLA/RCRA Unit (CRU) 4 and CRU5 Remedial Investigation Reports. Assessment of the contamination in the unsaturated (vadose) zone of the glacial tills and an assessment of the probability of leakage into the subsurface from potential source areas, including the K-65 Decant Sump Tank, are also major objectives of this investigation. Results of previous investigations have been incorporated in the Remedial Investigation Report for OU4 (CRU4), dated October, 1992 (Draft); those results, tables, and figures pertinent to the soils and perched groundwater near Silos 1 and 2, and to the proposed work are presented in Section 2.0 below.

The K-65 waste storage silos are large concrete storage structures which were built in 1951-52 at the FEMP. The silos are located south and west of the Waste Storage Area on the west side of the FEMP property. The cylindrical silos are approximately 80 feet in diameter, with walls approximately 26 feet high and domed roofs. They were constructed to provide storage for the residues resulting from processing pitchblende ore and concentrates to extract uranium content. The term "K-65" refers specifically to radium-bearing wastes generated during the uranium extraction process. Historical data indicate that the waste slurries in Silos 1 and 2 have settled to form a mud-like material that is a mixture of clay, silt, and sand-sized particles. Uranium concentration has been measured at approximately 1400 ppm in Silo 1 and 1800 ppm in Silo 2. Approximately 1.6 to 3.7 kg of radium has been estimated to be stored in the K-65 silos.

The K-65 silos were constructed with an underdrain system to collect any potential leakage through the floors. This underdrain system consists of an 8-inch thick layer of gravel with a series of drainage pipes beneath the floor which discharge into the decant sump tank. Access to this tank is provided by a 30-inch diameter vertical corrugated pipe.

By 1963, repairs to the deteriorated exterior surfaces and roofs of the silos had begun. After repairs to the walls were completed, an earthen embankment was built to the roof line of Silos 1 and 2 to provide relief from tensile stress within the walls. The embankment also provides weather protection, a reduction in radon emissions, and increased shielding from penetrating radiation. To further reduce the risk of routine or catastrophic emissions of radon from Silos 1 and 2, the K-65 Silos Removal Action (No. 4) involved the installation of a bentonite clay layer over the radium-bearing radioactive wastes. Also, the Decant Sump Removal Action (No. 5) was performed to remove and dispose of contaminated water from the tank.

2.0 PREVIOUS INVESTIGATIONS

2.1 Subsurface Soils

The objectives of the silo subsurface soil sampling program were to determine the vertical and horizontal extent and verify the source of radiological and chemical contamination surrounding the silos. Low-angle slant and vertical borings were placed at selected down and up-gradient locations, and laboratory analyses were performed on samples. Summary results are presented in Appendix A of this addendum excerpted from Table 4-22 of the draft OU4 (CRU4) RI Report. Radiological analyses revealed that the principal constituents above background levels include: Pb-210, Po-210, Ra-226, Th-230, total Th, U-234, U-238, and total U.

2.1.1 The five slant borings and sample locations are shown in Appendix A, Figure 2-5. All borings except 1616 were advanced only to the first perched water zone. Boring 1616 was temporarily cased and advanced through the perched water zone to soils underlying the decant tank. Cross-sectional profiles are shown in Figures 4-12 through 4-16; analytical results of the major contaminants, total U, Ra-226, and Pb-210 are also shown at their respective sample locations.

2.1.2 Additional glacial overburden subsurface samples were collected at various depths during the installation of monitoring wells drilled around the silos (Figure 2-7, Appendix A). The analytical results presented in the accompanying Table 4-33 show that the radiological concentrations range from <0.05 to 15 pCi/g. The highest concentration, U-238 at 15.0 pCi/g, was found in Monitoring Well 1072 at a depth of 0-1.5 feet. Results indicate that contamination is confined principally to the area immediately under the silos or near the surface around the silos. There is a general decrease in concentrations of Ra-226, Pb-210, and total U with depth.

2.2 Perched Groundwater

2.2.1 To supplement existing data and more accurately determine the nature and extent of contamination beneath the silos, six water samples were collected from the slant borings. Results of radiological analyses performed at the contract RI/FS laboratory are presented in Appendix B, Table 4-27A. Among the detected radionuclides, Ra-226 was detected only once in Boring 1618; uranium was the most frequently detected constituent in most of the borings, with a maximum total concentration of 6.3 µg/L. Ra-226, Pb-210, and Po-210 were not detected in the perched water downgradient of the silos. Concentrations of Total U were detected at 439 µg/l and 276 µg/l in Boring 1616 and in Monitoring Well 1032 respectively. The 439 µg/l from Boring 1616 was rejected due to lack of proper QA/QC, but it should be noted that the onsite split of this same sample revealed a concentration of 390 µg/l Total U.

Sample splits of the slant boring water samples were sent to the FEMP laboratory for duplicate radiological analyses (Appendix B, Table 4-27B). Many of the analytes were found in concentrations consistent with the RI/FS laboratory results. However, the total U and individual isotope results from Boring 1617 differ dramatically from the other borings and from the results obtained by the RI/FS laboratory. Due to more stringent QA/QC protocols at the RI/FS laboratory, the FEMP laboratory analysis was disregarded at that time. Additional analyses are now proposed to clarify the discrepancy.

2.2.2 Perched water samples have been collected from five 1000-series monitoring wells around the silos. Figure 4-22 in Appendix B shows the distribution of total U in these five wells. Well 1032, west of Silo 2, contains the highest concentration of total U 276 µg/L and its highest individual isotope, U-238 (96.8 pCi/L, (Appendix B, Table 4-38); this concentration may be attributable either to silo/decant system leakage, historic spills, or to contaminated backfill encountered in the boring.

2.2.3 Possible leakage from the silos, moving through the vadose zone into the groundwater, may account for detected above-background uranium values in the shallow soils. However, in only one instance have above-background levels of Ra-226 been detected in the perched water. This level was at Location 4 in Boring 1618, where the concentration of Ra-226 was 2.89 pCi/L directly below the center of Silo 1. This evidence suggests that migration from beneath the silos toward Paddys Run may not have occurred. The silos are a unique source of large quantities of Ra-226; therefore, Ra-226 should be useful as an indicator of releases. But, there are significant differences in the solubility of radium and uranium compounds found in the silos and the presence or absence of Ra-226 alone is inconclusive evidence of leakage. Also, uranium contamination could be originating from any of the waste storage facilities at the site. Additional sampling and analyses proposed below will further characterize Ra-226 as an indicator.

3.0 PROPOSED INVESTIGATIONS

3.1 Background and Summary

Previous monitor well installations and slant borings under the silos have indicated the presence of a prominent perched water-bearing zone encountered at an elevation of approximately 563 feet above mean sea level (MSL) or approximately 7 feet below ground surface (Figures 2B and 2C). Indications of a lower perched zone at approximately 552 feet MSL were found only in slant Boring 1616 (Figure 2A).

However, the lower perched zone appeared as a brown clay in Boring 1032, at 551 feet MSL (Figure 2C); contamination found in Boring 1616 could represent cross-contamination from the upper perched zone. Proposed work is intended to further evaluate this suspected lower zone.

This project will also evaluate discrepancies in total U and individual isotopic analyses on Boring 1617 obtained from the contract RI/FS and FEMP laboratories. Due to more stringent QA/QC procedures at the RI/FS laboratory, the FEMP analyses were originally considered inaccurate.

Data Quality Objectives for the proposed work are presented in Table 1. The following investigation will be conducted in order to further characterize the vadose and perched water zones:

a) drill, install, collect, and analyze samples from two 1000-series piezometers in the uppermost perched water interval, in the K-65 silos area (No. 1891 and 1893, Figure 1).

b) collect Hydropunch II(TM) water samples in the upper perched water zone at a single location west of the K-65 Decant Sump Tank (1892, Figure 1). After cementing casing through the upper perched zone, drilling will continue to a possible lower perched water zone indicated during slant boring and sampling operations, or to an equivalent elevation if the zone is absent: Depending on the availability of perched water, a piezometer or lysimeter will be installed to obtain a water sample.

c) install and sample three lysimeters in the east bank of Paddys Run (Figure 1) to determine if contaminated vadose or perched water is entering the stream and, by inference, the Great Miami Aquifer. The borings for the lysimeter installations will be completed by hand augering. A technical specification summary which demonstrates the installation methodology for the lysimeters is presented in Appendix C.

d) collect one round of groundwater samples from Monitoring Wells 1032 and 2032.

All drilling, sampling, and piezometer installations will be conducted according to procedures defined in Appendices D, J, and K, Draft Sitewide CERCLA Quality Assurance Project Plan (SCQ), dated September 22, 1992, and in Section 5 of the FEMP RI/FS Quality Assurance Project Plan (QAPP). When more specific or more stringent, the SCQ procedures will take precedence. Procedures for lysimeter installation and sampling are presented in the attached Appendix C. Data Quality Objectives are shown in Table 1.

Continuous soil samples will be collected through the till in each boring and hand-augered location. All recovered samples will be radiologically screened, stored in 500 ml glass jars, and archived for possible future analyses. The results of the radiological screening will be evaluated by FEMP CRU4 and CRU5 staff to determine if additional soil analysis is required. All water samples collected from the various locations will be analyzed primarily for Ra-226 and U-238 contamination and fluorescein dye tracer placed in the K-65 Decant Sump in mid-1991 and October 1992 (TAL 50.03.13-A). General Groundwater Chemistry, Limited Radiological, and Limited HSL analyses (TAL 50.03.13-B) will be performed if sufficient water volume can be collected. All analyses will be performed at an approved RI/FS laboratory.

3.2 Drilling, Hydropunch Sampling, and Installation Procedures

3.2.1 Piezometers 1891 and 1893

Two 1000-series piezometers, 1891 and 1893, will be installed. These piezometers, shown in Figure 1, are located approximately 100 feet southwest and northwest of K-65 Silos 1 and 2 respectively. Total depth is anticipated to be approximately 12 feet below ground surface (+558 feet MSL, Figures 2A, 2B, and 2C), at the base of the upper perched water interval within the glacial till.

Soil boring will be performed with a truck-mounted drilling rig using hollow-stem augers; continuous samples will be collected by advancing a split-spoon sampler (minimum 2-inch ID) ahead of the auger bit. Soil samples will be screened and archived as described in Section 6.0 below for possible future analysis as determined by site CRU4 and CRU5 personnel. Borings will be converted to piezometers by installing 2-inch schedule 40 PVC screen (.02 Slot) and riser and developed for water quality sampling.

3.2.2 Hydropunch Sampling, Boring 1892

At Location 1892, a drilling rig with at least a 10-inch outer diameter hollow-stem auger will be used in conjunction with a Hydropunch II(TM) sampler to collect water samples within the upper perched water bearing zone beginning at approximately +563 feet MSL (Figures 2A and 3); samples will be analyzed for parameters as previously stated. If adequate volume is available, additional analyses for secondary parameters will be performed. In order to maximize water recovery, the Hydropunch sampler will be operated in the hydrocarbon recovery mode. Continuous split-spoon samples will be taken ahead of the rotary auger, providing a pilot hole in the perched zone for the Hydropunch sampler. Samples of the glacial till will be archived as described in Section 6.0 below for possible future analysis.

After Hydropunch sampling has been completed, boring will continue to the underlying confining layer, and 8-inch ID steel casing will be cemented in place to the surface. After the cement has been allowed to cure for a minimum of 24 hours, 8-inch augers will then be used to drill through the depth of the suspected lower perched water interval (approximately +552 feet MSL), and either a 2-inch PVC piezometer or a 2-inch lysimeter will be installed; continuous soil samples will be collected and archived through the till. Final selection will be the responsibility of the FERMCO Manager, Field Program Development Section, depending on the volume of water found in the boring after it is left open overnight.

3.2.3 Lysimeter Installation

If water yield in the lower zone of Boring 1892 is determined to be inadequate for a conventional piezometer, a lysimeter will be installed at a depth corresponding to that of the suspected second perched water bearing zone. The lysimeter proposed for use during the monitoring and sampling period is a 2-inch diameter pressure vacuum soil water sampler as presented in Appendix C; the manufacturer may vary. This lysimeter consists of a micro-porous ceramic cup at the base which allows water entry through capillary forces, an 18-inch PVC cylindrical body with full-depth riser, and a PVC head. The head assembly attaches to the riser and connects sample and pressure ports to the lysimeter via 1/4-inch nylon tubing. The lengths of nylon tubing extend from the lysimeter body through the riser to the head at the surface and are used for vacuum extraction and pressure sampling. The sample tube extends from the head through the lysimeter to a point just in contact with the inside base of the lysimeter. The vacuum extraction tube extends into the lysimeter to a point approximately 3 inches below the inside of the cap.

Each length of nylon tubing will be clearly identified and attached to the proper fitting at the lysimeter head. Installation will be performed in general accordance to manufacturer's recommendations shown in the Appendix C. Specifically:

a) The lysimeter and associated tubing will be thoroughly decontaminated in accordance with standard procedures utilized for well screens prior to installation. After lysimeter and nylon tube decontamination, the ends of the tubing will be clamped off at the surface to avoid the inadvertent introduction of foreign material into the tubing. The lysimeter components will then be assembled and installed with full depth 2 inch PVC riser screwed onto the lysimeter body to house the nylon tubing. The tubing will be measured and cut to allow approximately a 2 feet stick-up at the surface.

A 3 to 6 inch thick slurry of silica flour and distilled water will first be tremied into the open borehole. The lysimeter and riser will be gently lowered into the boring and secured at the surface to prevent floating.

b) Additional slurry will then be placed to 2-4 inches above the top of the ceramic tip of the lysimeter. At that point, 80/100 mesh sand will be poured to approximately 3-6 inches above the top of the lysimeter, followed by a column of Volclay grout to within three feet of surface; this grout seal will be placed with a tremie line and will prohibit shallow water from draining down into the lysimeter zone. The lysimeter head will then be connected to the tubing.

c) Finally, protective casing will be cemented in the boring to complete the installation according to RI/FS QAPP procedures used for 1000-series piezometers.

3.2.4 Paddys Run Lysimeters

Three lysimeters will be installed along the east bank of Paddys Run (Figure 1) to determine if contaminated groundwater is migrating into the surface water and subsequently, the Great Miami Aquifer. Topography along the creek precludes the use of a drilling rig. Therefore, a 4 inch hand auger will be used to drill a boring to a depth of 6 feet; soil samples will be collected, screened, and archived as described above. Visible moisture has been observed seeping from an interval 5-6 feet below the top of the east bank of Paddys Run adjacent to the silos (approximately +550 feet MSL). Two inch lysimeters will be installed with silica flour, 80/100 mesh sand and Volclay as described above. Since the locations are relatively inaccessible and untraveled, final backfill will consist of Volclay grout to surface. PVC tubing and locking lysimeter head will be installed to allow approximately a stick-up of 2 feet at the surface; steel protective casing and final cement cap will not be installed.

4.0 PIEZOMETER DEVELOPMENT AND WATER SAMPLING

After final determination of the screen length and completion of Piezometers 1891 and 1893, FERMCO will develop them according to procedures outlined in the RI/FS QAPP for 1000-series piezometers to ensure that they are as clear of fine sediment as possible and to obtain one round of groundwater samples. Perched water samples will be analyzed at a contract RI/FS laboratory for both the primary and secondary parameters presented above if sufficient groundwater can be recovered within 48 hours after development. (Figures 4 and 5).

Trip blanks for Volatile Organic Compounds (VOCs) will be included with the post-development water samples collected (TAL 50.03.13-C). In addition, rinsate and duplicate samples (one for every 20 samples or fraction thereof) will be collected and analyzed for all secondary parameters as specified in TAL 50.03.13-B. When sampling has been completed, the wells will be incorporated into the site long-term groundwater monitoring program.

5.0 LYSIMETER SAMPLING

After satisfactory installation of each lysimeter, a vacuum hand pump will be attached to the pressure port of the lysimeter head and used to evacuate the lysimeter body to a pressure of approximately 18 inches of mercury. The lysimeter will then be allowed to equilibrate for a period of 24-48 hours. After that time, a positive displacement pump will be attached to the pressure port and will be used to pressurize the lysimeter, forcing collected water out through the sample line to a container at the surface. The process will be continued until enough water is collected to satisfy primary (TAL 50.03.13-A) analyses, and secondary analytical requirements (TAL 50.03.13-B) if an adequate water supply collects within 48 hours (Figures 6, 7, and 8). One round of sampling will be conducted. All samples will be handled, documented, shipped and validated according to procedures defined in the SCQ.

6.0 SOIL SAMPLE ARCHIVING

Soil samples will be radiologically screened and archived according to the methods currently defined in the Advanced Sciences, Inc. Standard Operating Procedure No. FPP-404, titled "Archive Sample Management." In general, all split-spoon and hand-augered samples will be containerized from a point immediately below surface vegetation to total planned depth. Samples will be placed in 500 ml glass jars, sealed with teflon lined lids, and stored in secure on-site containers for future use as determined by site CRU4 and CRU5 personnel.

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TABLE 1
DATA QUALITY OBJECTIVES FOR K-65 ADDITIONAL PERCHED WATER

Activities	Install 2 piezometers in upper perched zone; install 1 piezometer/lysimeter in suspected lower perched zone	Install three hand-augered lysimeters along Paddys Run
	One round of sampling in new locations and in MW 1032, 2032	Analyze for Ra-226, U-238, fluorescein dye, Limited Rad/HSL, and GWQ
Prioritized data uses	Data will be used to: 1) characterize nature and extent of contamination in the K-65 perched water and a suspected lower perched zone; 2) define the western extent of contamination, possible influx to Paddys Run, and possible leakage from K-65 silos/decant system; 3) evaluate discrepancies in analytical results from RI/FS and FEMP labs.	
Appropriate analytical level	Level E for radiological; Level D for HSL, VOC inorganics; Level C for GWQ	
Constituents of concern	Ra-226, U-238, fluorescein dye primary (TAL 50.03.13A), limited HSL, GWQ, Limited Rad secondary (TAL 50.03.13B)	
Level of concern	Documented in Preliminary Remediation Goals, Site-Wide Characterization Report (Draft), August 1992	
Required detection limits	Documented in Section D, Sitewide CERCLA Quality Assurance Project Plan (Draft), September 1992	
Critical samples	Perched water samples from upper zone Hydropunch and piezometers and from suspected lower zone lysimeter or piezometer	

TABLE 2
SAMPLING REQUIREMENTS

Parameter	Min. Vol.	Desired Vol.	Priority	Preservatives**	Filtered***
Ra-226/U-238	1 liter	1 liter	1	HNO3	yes
Fluorescein	40 ml	100 ml	1	none	no
Inorganics	2 X 1 liter	4 X 1 liter	2	4∘ C, HNO3	yes
VOC*	2 X 40 ml	3 X 40 ml	3	4∘ C, HCL	no
GWQ	3 X 1 liter	6 X 1 liter	4	4∘ C, H2SO4	no
Alkalinity	500 ml	1 liter	5	4∘ C, H2SO4	no
Full Rad	2 liter	4 liter	6	HNO3	yes
Misc. Rad	500 ml	1 liter	7	HNO3	yes

- Store all VOC samples at 4°C until analyses. If HNu readings of >5 units for >10 seconds are obtained or there is reason to suspect the presence of VOC's, then sample will be analyzed at RI/FS lab. Otherwise sample will be used for lower priority analyses.

** All acids used for preservative will have pH<2

*** Hydropunch sample may contain significant suspended silt; sample will be pre-filtered before final filtering at 0.45 microns.

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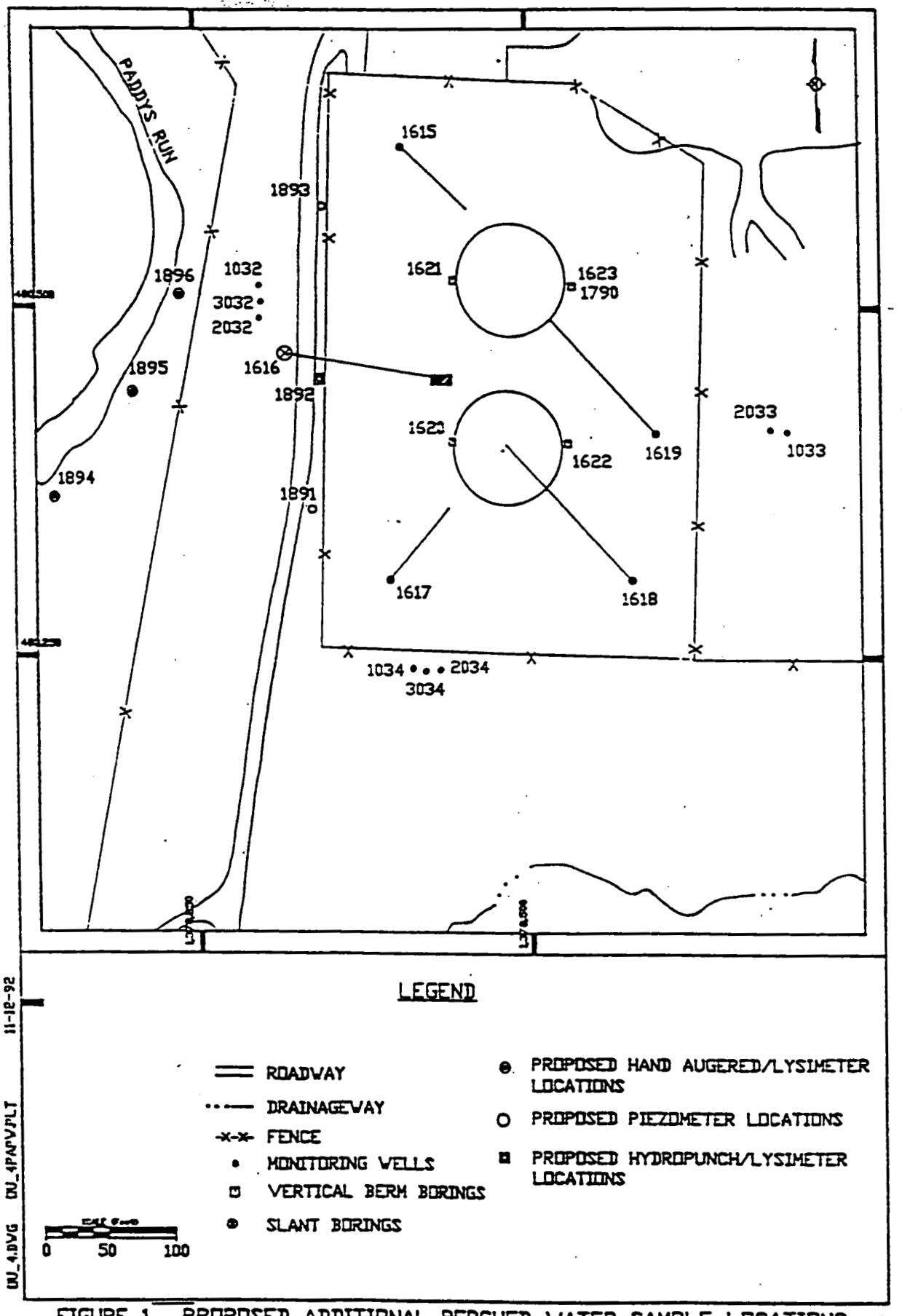
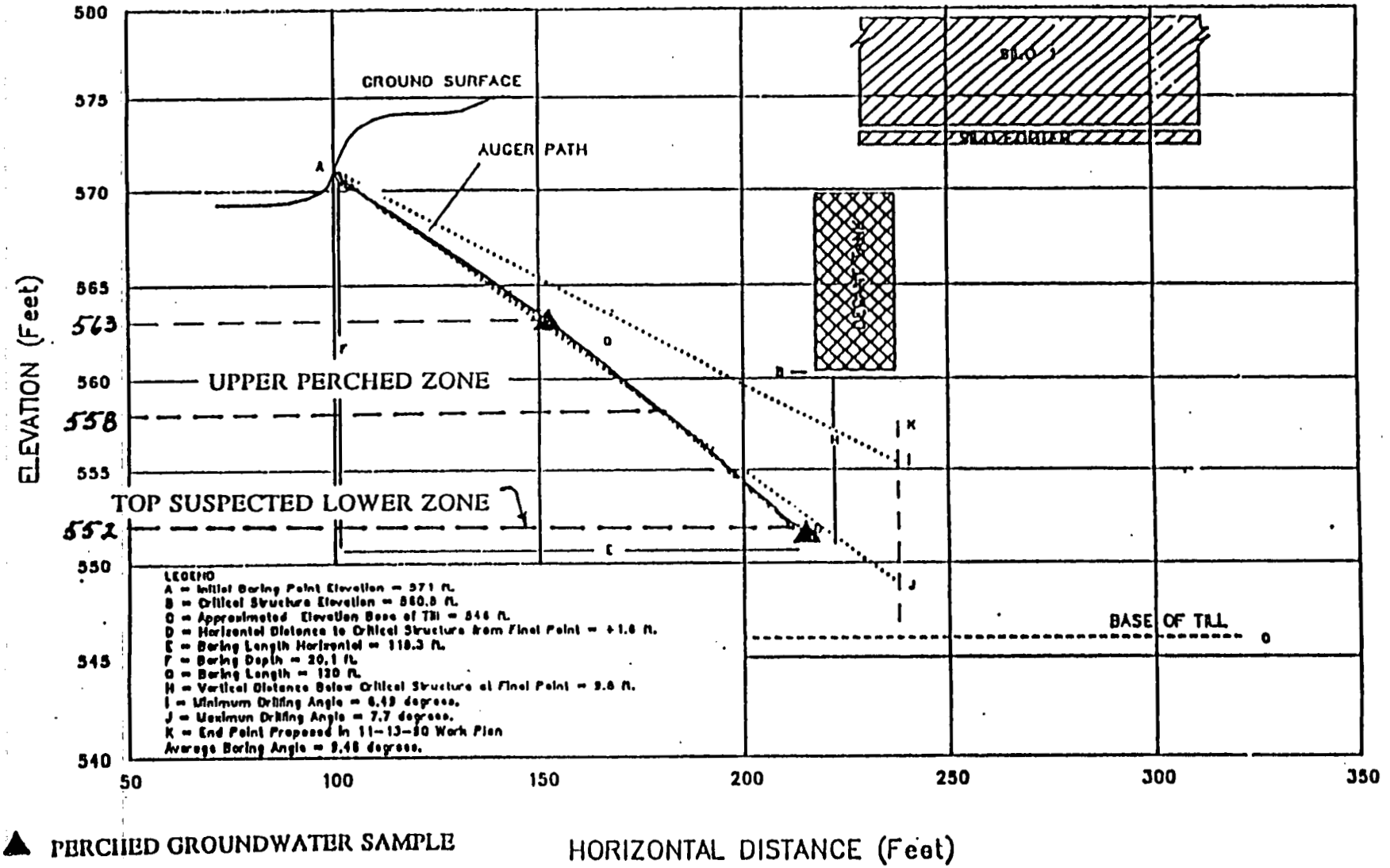


FIGURE 1. PROPOSED ADDITIONAL PERCHED WATER SAMPLE LOCATIONS

SLANT BORING 1616 (No.2) AT K-65 SILOS

Graph #: K65B2C. JULY 02, 1991

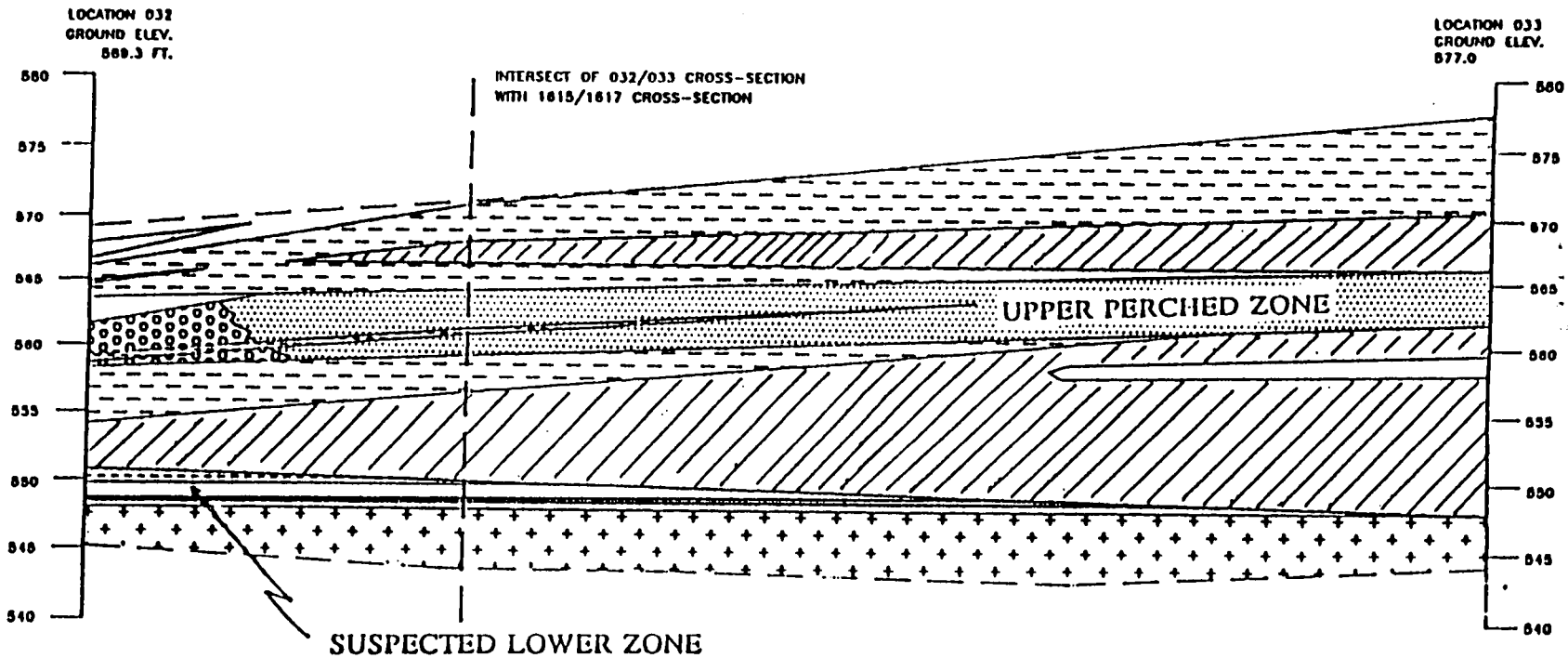


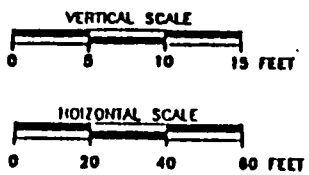
▲ PERCHED GROUNDWATER SAMPLE

HORIZONTAL DISTANCE (Feet)

MONA_K65B2CO.DRW_A3FHD_08-08-91_REV000

Fig. 2A

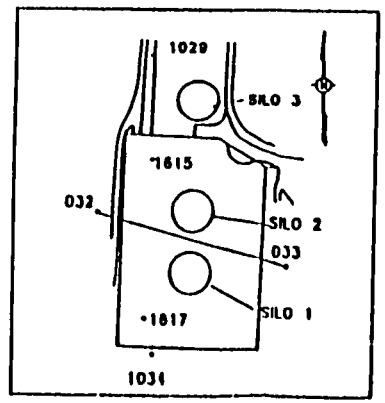




NOTE:

THE DEPTH AND THICKNESS OF THE SUBSURFACE STRATA INDICATED ON THE SECTIONS WERE FROM AND INTERPOLATED BETWEEN THE TEST BORINGS. INFORMATION ON ACTUAL SUBSURFACE CONDITIONS EXISTS ONLY AT THE LOCATION OF THE TEST BORINGS AND IT IS POSSIBLE THAT SUBSURFACE CONDITIONS BETWEEN THE TEST BORINGS MAY VARY FROM THOSE INDICATED.

KEY PLAN



LEGEND:

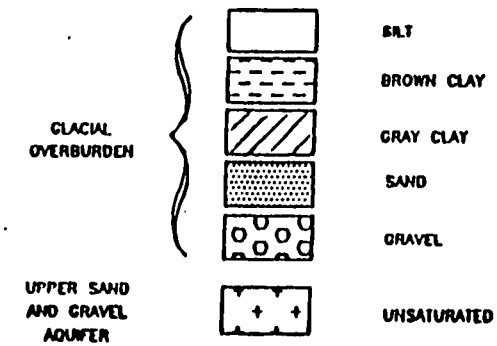
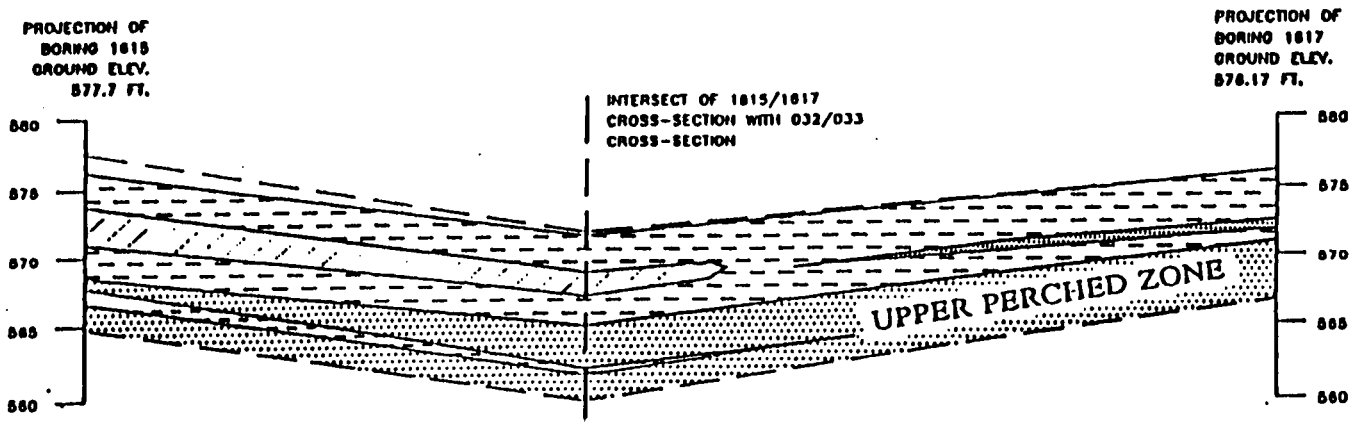


Fig. 2B GEOLOGICAL CROSS-SECTIONS OF LOCATION 032/033 IN THE K-65 SILO AREA



VERTICAL SCALE

0 5 10 15 FEET

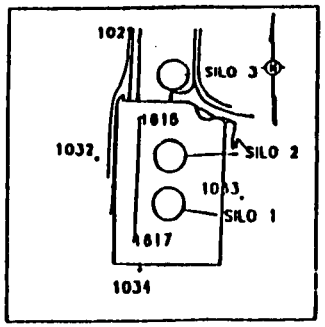
HORIZONTAL SCALE

0 20 40 60 FEET

NOTES:

THE DEPTH AND THICKNESS OF THE SUBSURFACE STRATA INDICATED ON THE SECTIONS ARE FROM, AND INTERPOLATED BETWEEN THE TEST BORINGS. INFORMATION ON ACTUAL SUBSURFACE CONDITIONS EXIST ONLY AT THE LOCATION OF THE TEST BORINGS. IT IS POSSIBLE THAT SUBSURFACE CONDITIONS BETWEEN THE TEST BORINGS MAY VARY FROM THOSE INDICATED

KEY PLAN



LEGEND:

GLACIAL OVERBURDEN

- SILT
- BROWN CLAY
- GRAY CLAY
- SAND

Fig. 2C GEOLOGICAL CROSS-SECTION OF BORINGS 1615/1617 IN THE K-65 SILO AREA

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FIGURE 3

ADDITIONAL PERCHED WATER CHARACTERIZATION IN THE K-65 AREA
HYDROPUNCH II SAMPLING / PIEZOMETER / LYSIMETER

LOCATION No. 1892

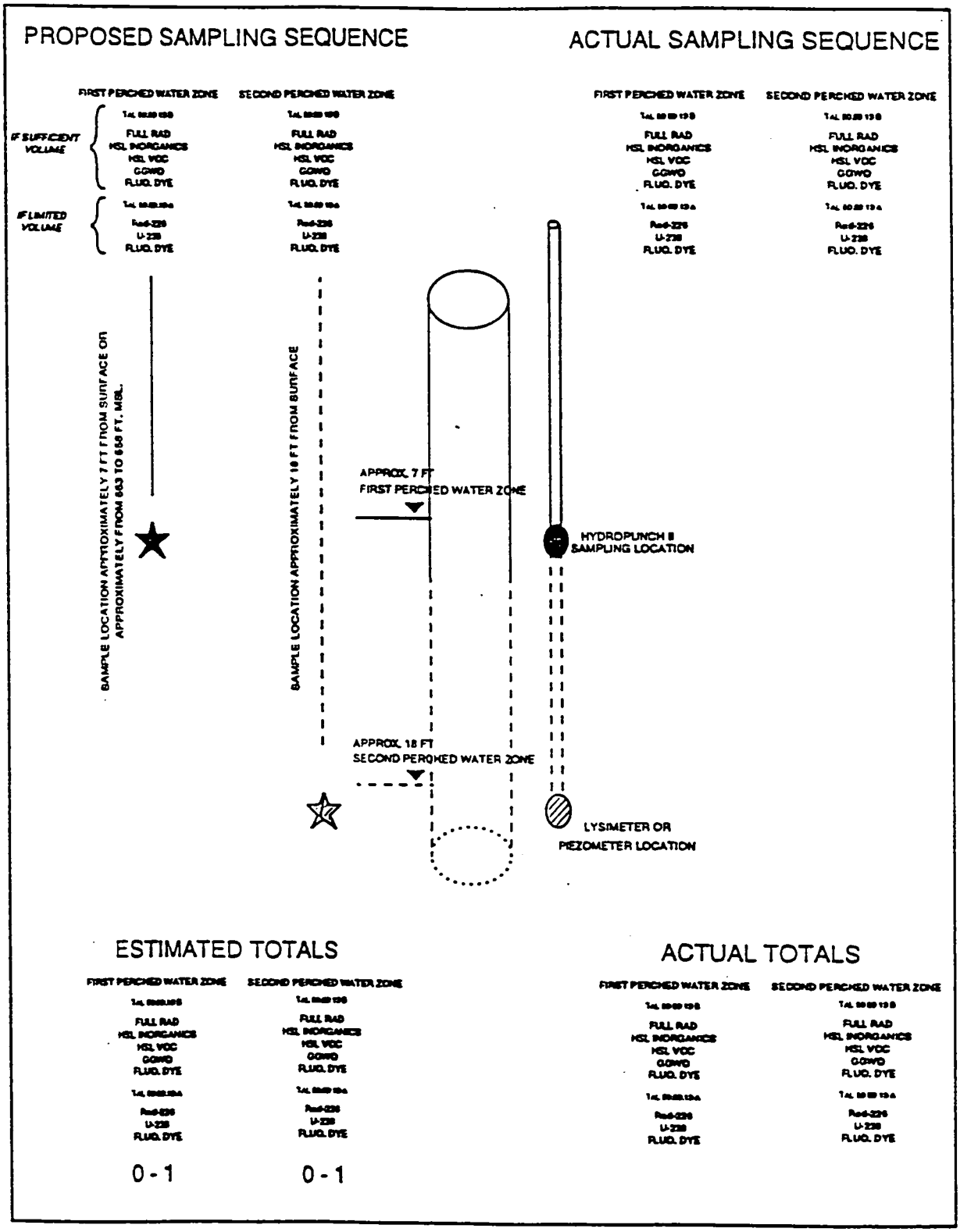

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FIGURE 4

ADDITIONAL PERCHED WATER CHARACTERIZATION IN THE K-65 AREA

PIEZOMETERS

LOCATION No. 1891

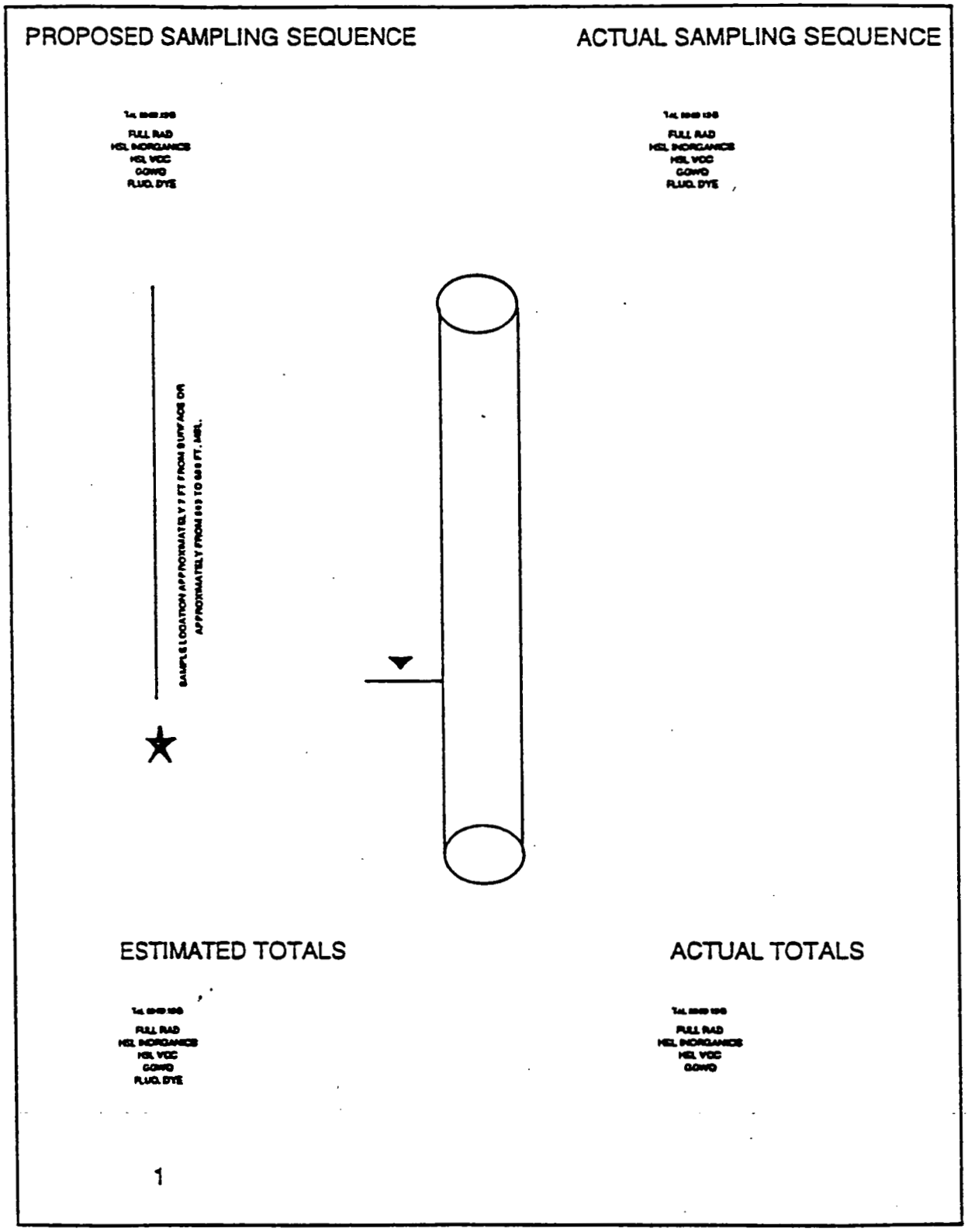

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FIGURE 5

ADDITIONAL PERCHED WATER CHARACTERIZATION IN THE K-65 AREA

PIEZOMETERS

LOCATION No. 1893

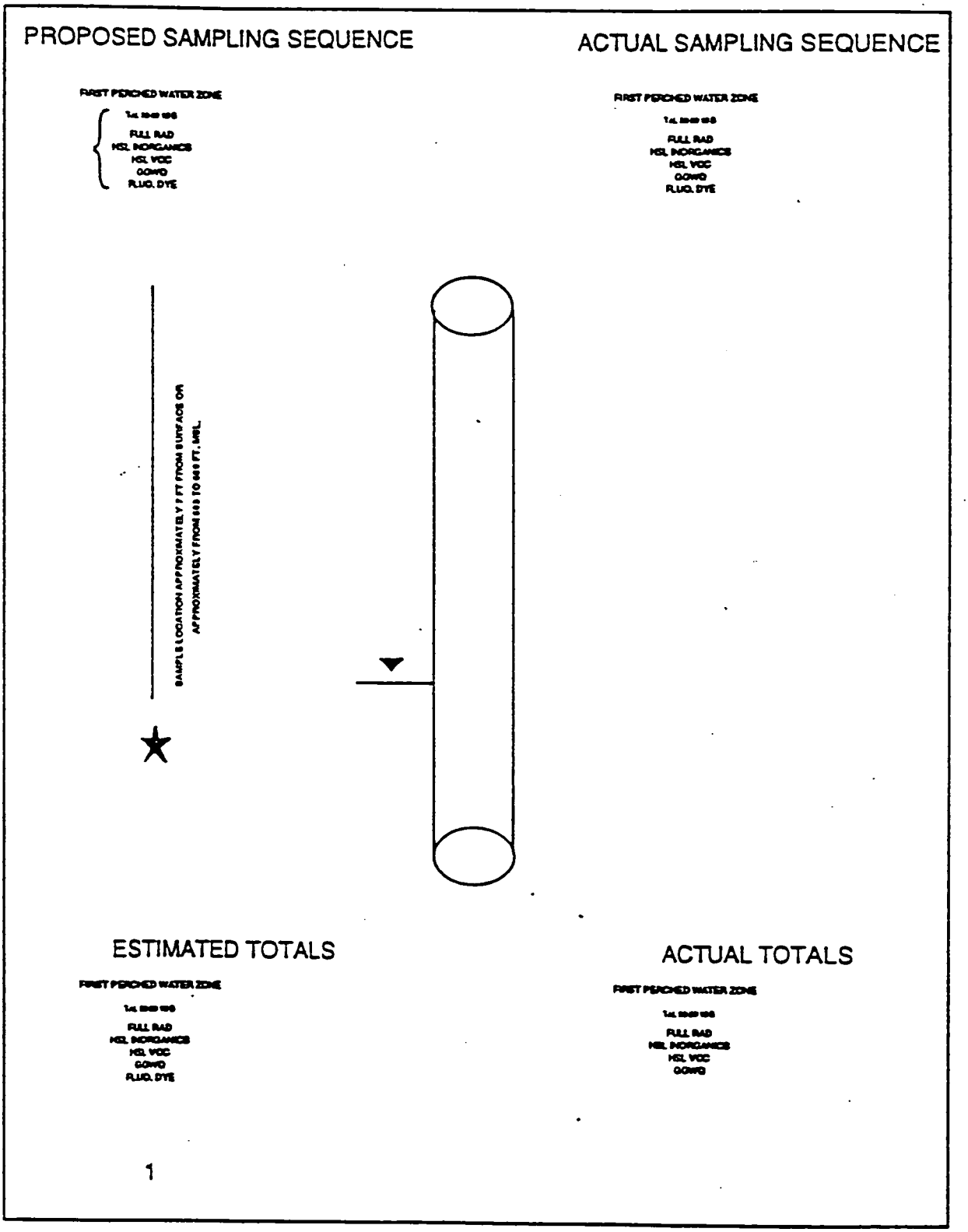

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FIGURE 6

ADDITIONAL PERCHED WATER CHARACTERIZATION IN THE K-65 AREA

LYSIMETERS

LOCATION No. 1894

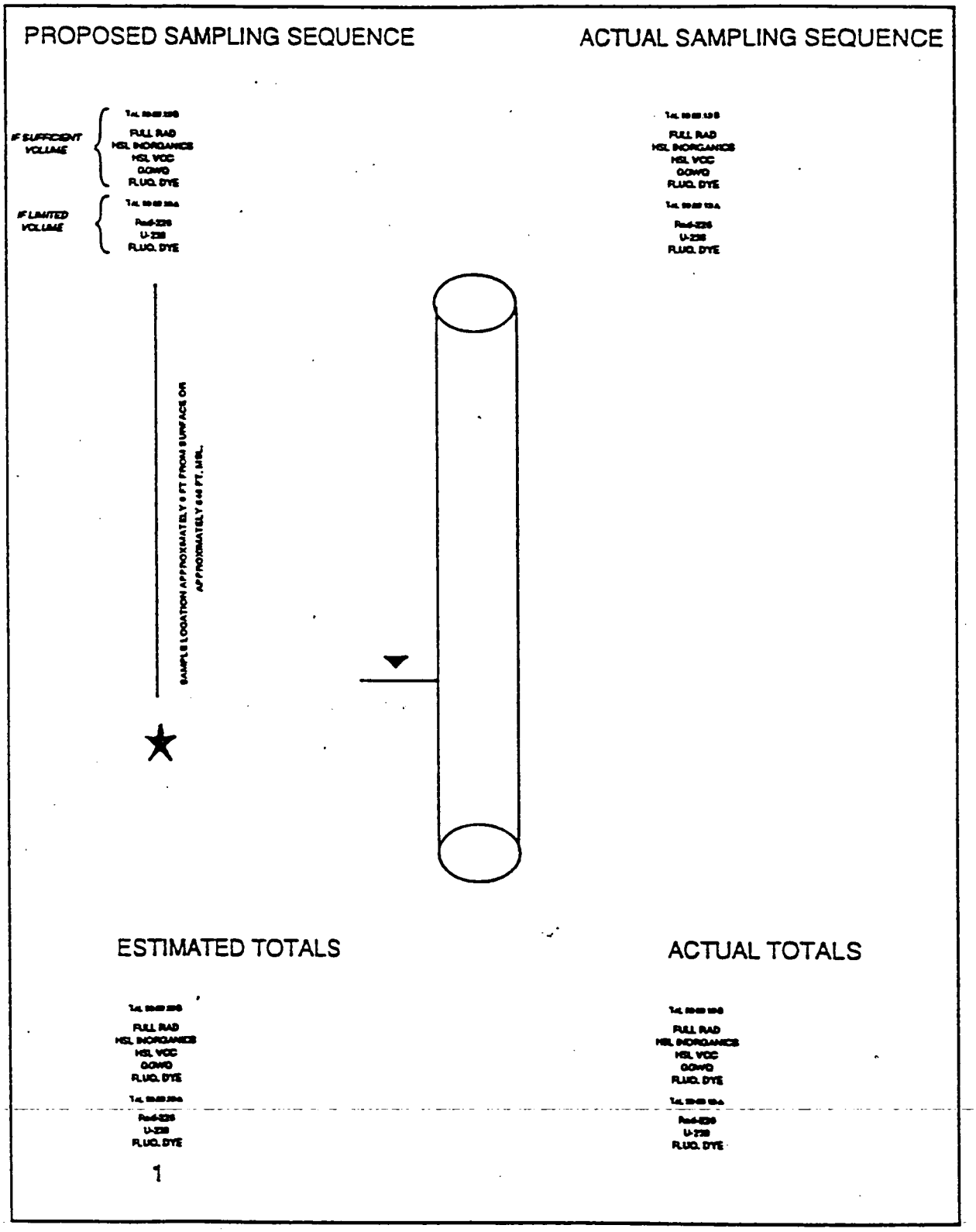

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FIGURE 7

ADDITIONAL PERCHED WATER CHARACTERIZATION IN THE K-65 AREA

LYSIMETERS

LOCATION No. 1895

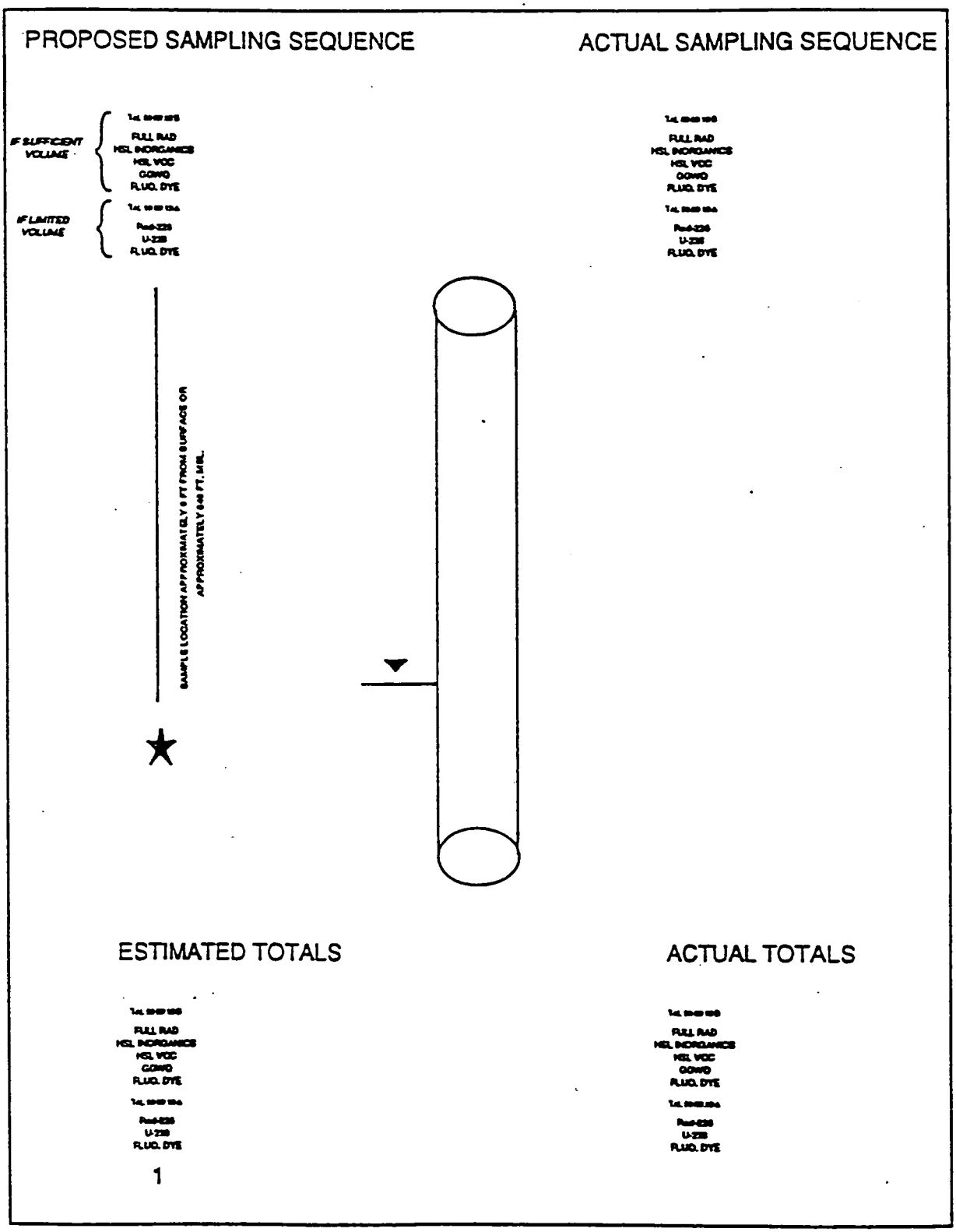

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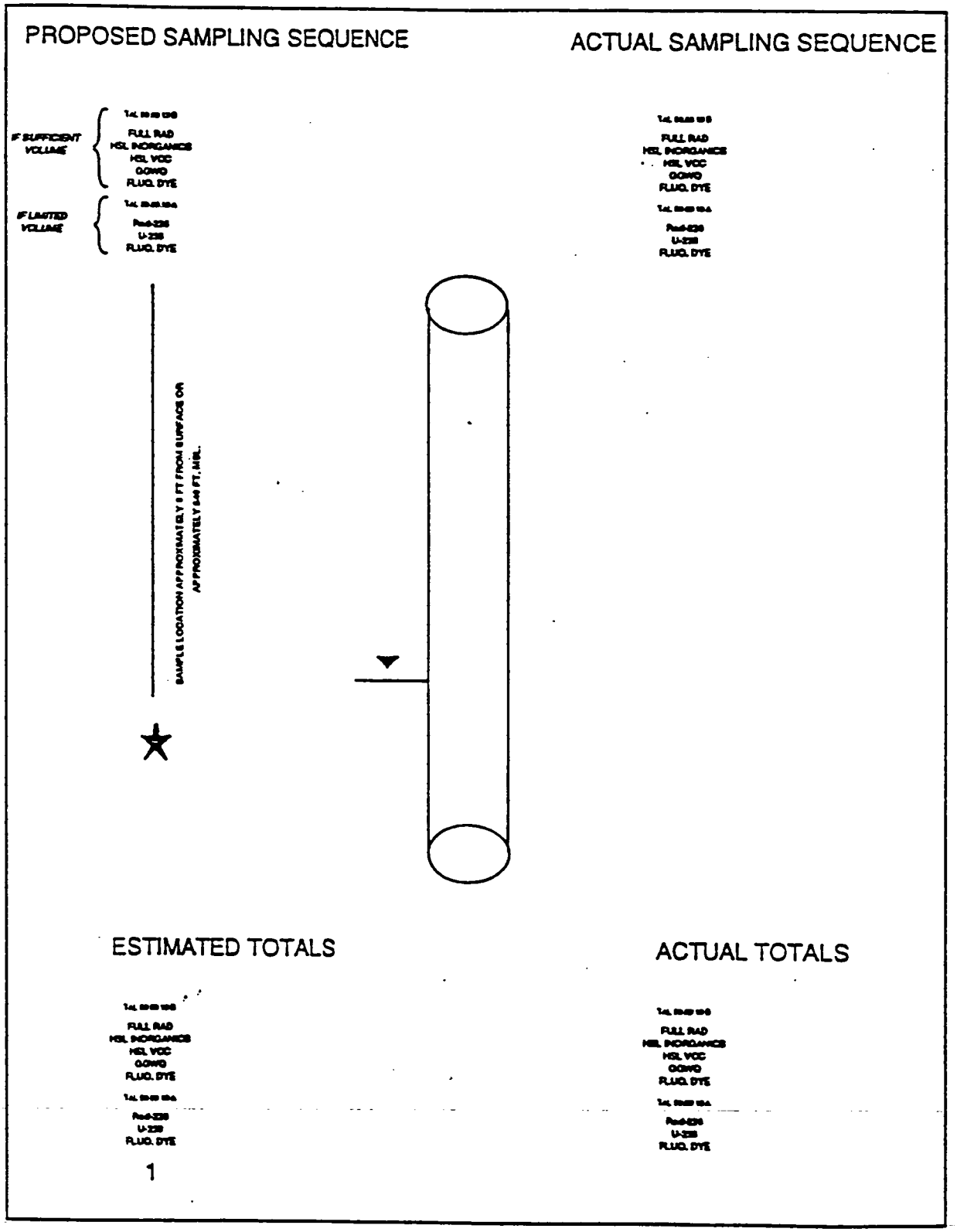
FIGURE 8

ADDITIONAL PERCHED WATER CHARACTERIZATION IN THE K-65 AREA

LYSIMETERS

LOCATION No. 1896



ADDITIONAL PERCHED WATER CHARACTERIZATION IN THE K-65 AREA

PRIMARY GROUNDWATER SAMPLES

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TAL 50.03.13 A

FEMP RI/FS – RADIOLOGICAL – ANALYTICAL PARAMETERS

RADIOLOGICAL

1	Radium 226
2	Uranium 238

MISC. PARAMETERS

1	Fluorescein Dye

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ADDITIONAL PERCHED WATER CHARACTERIZATION IN THE K-65 AREA

SECONDARY GROUNDWATER SAMPLES / FIELD BLANKS / RINSATES

TAL 50.03.13 B

FEMP RI/FS - LIMITED HSL - ANALYTICAL PARAMETERS

INORGANICS

1	Aluminum
2	Antimony
3	Arsenic
4	Barium
5	Beryllium
6	Cadmium
7	Calcium
8	Chromium (Total)
9	Cobalt
10	Copper
11	Cyanide
12	Iron
13	Lead
14	Magnesium
15	Manganese
16	Mercury
17	Molybdenum
18	Nickel
19	Potassium
20	Selenium
21	Silicon
22	Silver
23	Sodium
24	Thallium
25	Vanadium
26	Zinc

VOLATILE ORGANICS

1	1,1-Dichloroethane
2	1,1-Dichloroethene
3	1,1,1-Trichloroethane
4	1,1,2-Trichloroethane
5	1,1,2,2-Tetrachloroethane
6	1,2-Dichloroethane
7	1,2-Dichloroethene (total)
8	1,2-Dichloroethylene
9	1,2-Dichloropropane
10	2-Butanone
11	2-Hexanone
12	4-Methyl-2-pentanone
13	Acetone
14	Benzene
15	Bromodichloromethane
16	Bromoform
17	Bromomethane
18	Carbon disulfide
19	Carbon tetrachloride
20	Chlorobenzene
21	Chloroethane
22	Chloroform
23	Chloromethane
24	cis-1,3-Dichloropropene
25	Dibromochloromethane
26	Ethylbenzene
27	Methylene chloride
28	Styrene
29	Tetrachloroethene
30	Toluene
31	Total xylenes
32	trans-1,3-Dichloropropene
33	Trichloroethene
34	Vinyl acetate
35	Vinyl chloride

FEMP RI/FS - GENERAL GROUNDWATER QUALITY - ANALYTICAL PARAMETERS

GENERAL CHEMISTRY

1	Ammonia
2	Chloride
3	Fluoride
4	Nitrate
5	Phenols
6	Phosphorus (total)
7	Sulfate
8	Sulfide
9	Total Organic Carbon (TOC)
10	Total Organic Halogens (TOX)
11	Total Organic Nitrogen (TON)

MISC. GENERAL CHEMISTRY

1	Alkalinity

FEMP RI/FS - RADIOLOGICAL - ANALYTICAL PARAMETERS

RADIOLOGICAL

1	Cesium 137
2	Neptunium 237
3	Plutonium 238
4	Plutonium 239/240
5	Radium 226
6	Radium 228
7	Ruthenium 106
8	Strontium 90
9	Technetium 99
10	Thorium 228
11	Thorium 230
12	Thorium 232
13	Total Uranium
14	Uranium 234
15	Uranium 235/236
16	Uranium 238

MISC. RADIOLOGICAL

1	Gross alpha
2	Gross beta
3	Total Thorium

MISC. PARAMETERS

1	Fluorescein Dye

ADDITIONAL PERCHED WATER CHARACTERIZATION IN THE K-65 AREA

TRIP BLANKS

TAL 50.03.13 C

4112

FEMP RI/FS - LIMITED HSL - ANALYTICAL PARAMETERS

VOLATILE ORGANICS

1	1,1-Dichloroethane
2	1,1-Dichloroethene
3	1,1,1-Trichloroethane
4	1,1,2-Trichloroethane
5	1,1,2,2-Tetrachloroethane
6	1,2-Dichloroethane
7	1,2-Dichloroethene (total)
8	1,2-Dichloroethylene
9	1,2-Dichloropropane
10	2-Butanone
11	2-Hexanone
12	4-Methyl-2-pentanone
13	Acetone
14	Benzene
15	Bromodichloromethane
16	Bromoform
17	Bromomethane
18	Carbon disulfide
19	Carbon tetrachloride
20	Chlorobenzene
21	Chloroethane
22	Chloroform
23	Chloromethane
24	cis-1,3-Dichloropropene
25	Dibromochloromethane
26	Ethylbenzene
27	Methylene chloride
28	Styrene
29	Tetrachloroethene
30	Toluene
31	Total xylenes
32	trans-1,3-Dichloropropene
33	Trichloroethene
34	Vinyl acetate
35	Vinyl chloride

APPENDIX A

313327-A-128 OU4 KNOX 10/14/92

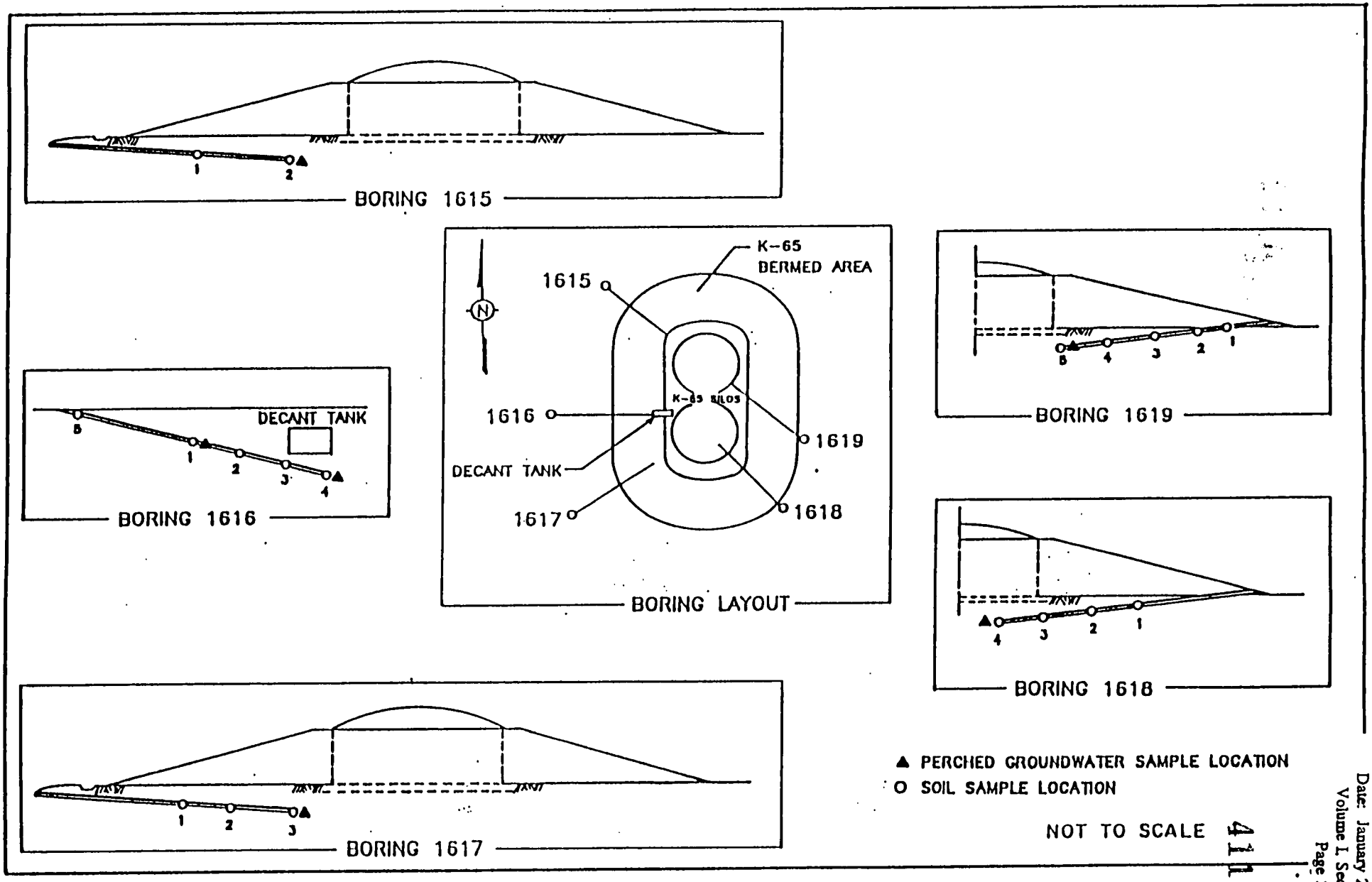
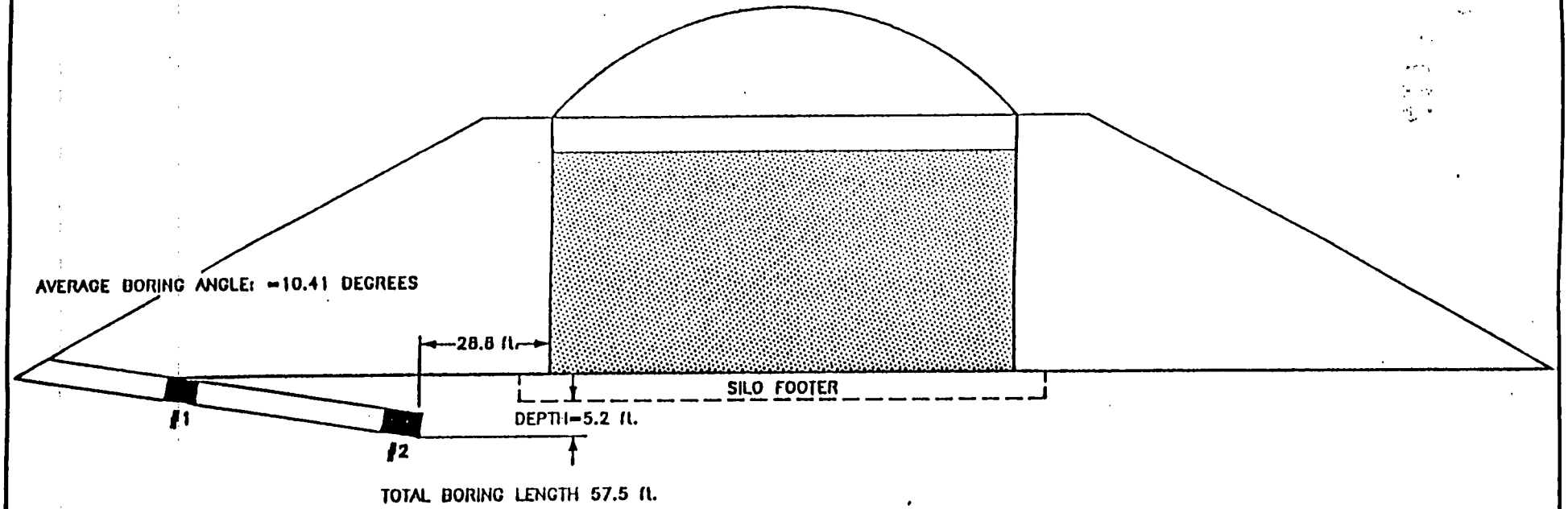


FIGURE 2-5. BORING LAYOUT AND SAMPLING CONFIGURATION

313327-A-42 004 KNOX
31332742 10/14/92 2:33pm GWP



SAMPLE LOCATION #1

LENGTH	SAMPLE #	ANALYTE	RESULTS
15 ft.	66956	Total U	63.70 ug/g
"	"	Ra 226	206.00 pCi/g
"	"	Pb 210	101 pCi/g
17 ft.	66974	Total U	<15 ug/g
"	"	Ra 226	176.00 pCi/g
"	"	Pb 210	97.90 pCi/g
19 ft.	66983	Total U	4.77 ug/g (R)
"	"	Ra 226	1.31 pCi/g
"	66984	Pb 210	0.55 pCi/g (R)
21 ft.	66960	Pb 210	1.75 pCi/g
21 ft.	66959	Total U	<4.2 ug/g
"	"	Ra 226	1.74 pCi/g

SAMPLE LOCATION #2

LENGTH	SAMPLE #	ANALYTE	RESULTS
41 ft.	66968	Total U	3.27 ug/g
"	66968	Ra 226	0.98 pCi/g
"	66969	Pb 210	<0.6 pCi/g
* 57.5 ft.	64007	Total U	1.51 ug/L
* "	"	Ra 226	<1.0 pCi/l
* "	"	Pb 210	<3.0 pCi/l

* = Perched Groundwater
R = Rejected Data

DRAWING NOT TO SCALE

FIGURE 4-12. SLANT BORING NO. 1615 (SILO 2)
RADIOLOGICAL DATA

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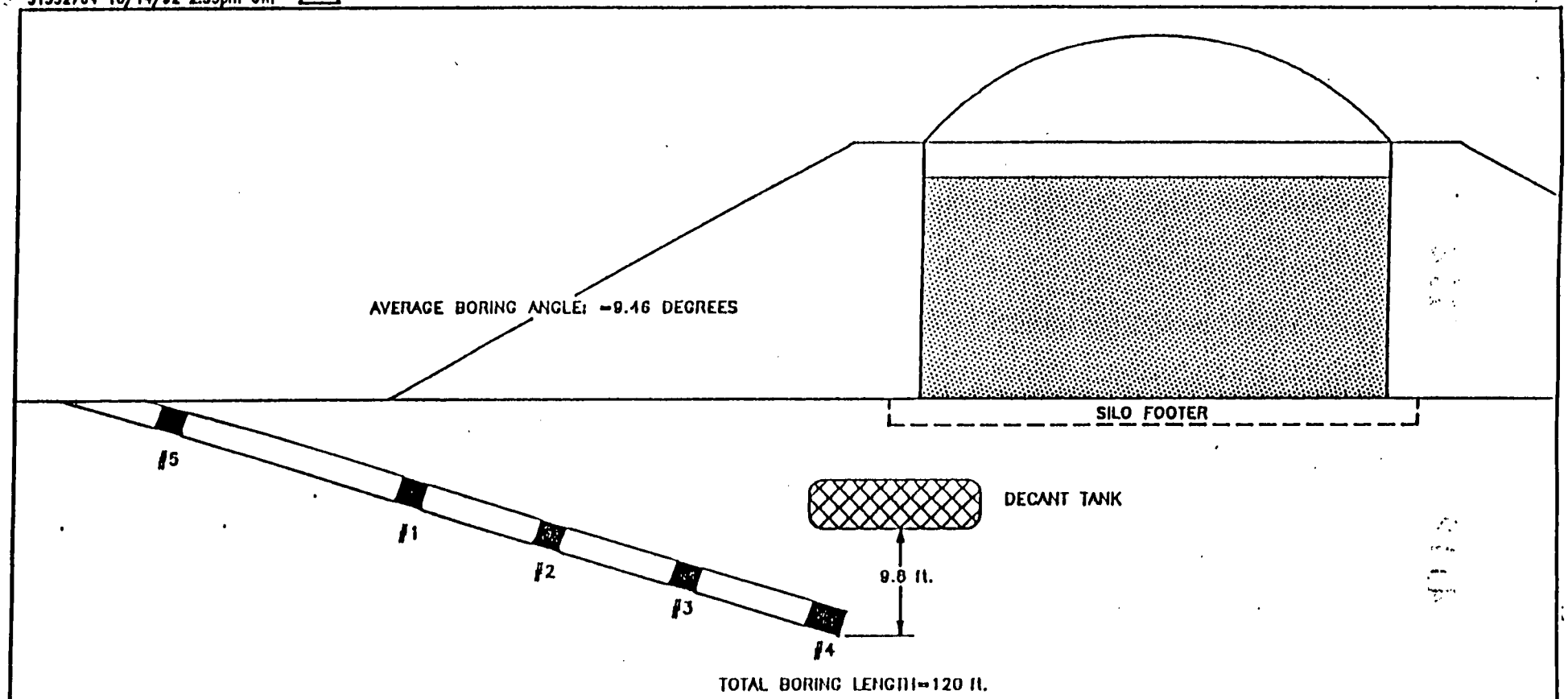
313327-A-A4 OU4 KNOX
31332764 10/14/92 2:35pm GWP



SAMPLE LOCATION #1

LENGTH	SAMPLE #	ANALYTE	RESULTS
*48 ft.	64021	Total U	439.00 ug/l (R)
* "	"	Ra 226	<1.0 pCi/l
* "	"	Pb 210	<3.0 pCi/l

SAMPLE LOCATION #2

LENGTH	SAMPLE #	ANALYTE	RESULTS
89 ft.	64032	Total U	<4.5 ug/g
"	64032	Ra 226	0.79 pCi/g
"	64033	Pb 210	0.56 pCi/g

SAMPLE LOCATION #3

LENGTH	SAMPLE #	ANALYTE	RESULTS
106 ft.	64041	Total U	<3.2 ug/g
"	"	Ra 226	0.66 pCi/g
"		Pb 210	0.46 pCi/g

SAMPLE LOCATION #4

LENGTH	SAMPLE #	ANALYTE	RESULTS
*120 ft.	64052	Total U	6.17 ug/l
* "	"	Ra 226	<1.0 pCi/l
* "	"	Pb 210	<1.0 pCi/l

* = Perched Groundwater
R = Rejected Data

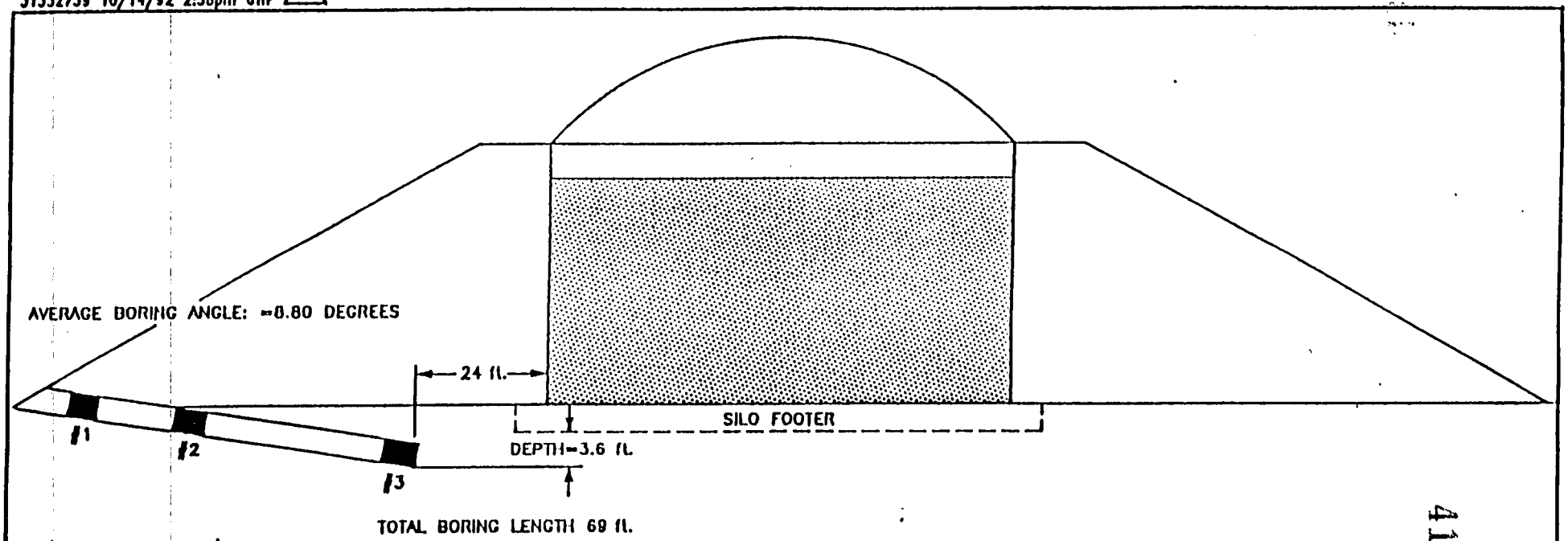
DRAWING NOT TO SCALE

SAMPLE LOCATION #5

LENGTH	SAMPLE #	ANALYTE	RESULTS
4 ft.	64157	Total U	26.60 ug/g
"	"	Ra 226	137.00 pCi/g
"	"	Pb 210	34.00 pCi/g

FIGURE 4-13. SLANT BORING NO. 1616 (DECANT TANK)
RADIOLOGICAL DATA

4112



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SAMPLE LOCATION #1

LENGTH	SAMPLE #	ANALYTE	RESULTS
18 ft.	66984	Pb 210	0.55 pCi/g (R)

SAMPLE LOCATION #2

LENGTH	SAMPLE #	ANALYTE	RESULTS
38 ft.	66992	Total U	54.20 ug/g
"	66992	Ra 226	0.97 pCi/g
"	66993	Pb 210	1.03 pCi/g

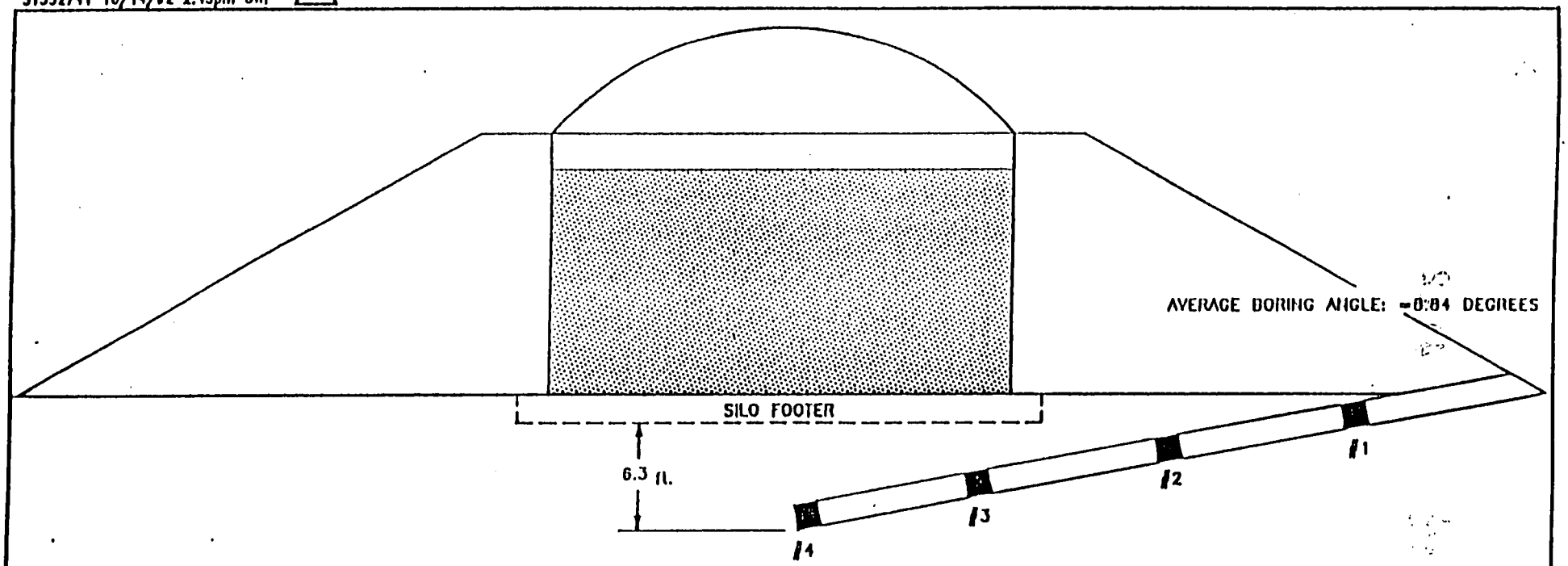
SAMPLE LOCATION #3

LENGTH	SAMPLE #	ANALYTE	RESULTS
60 ft.	64001	Total U	15.8 ug/g
"	64001	Ra 226	0.61 pCi/g
"	64002	Pb 210	<0.3 pCi/g
* 69 ft.	64009	Total U	6.33 ug/l*
* "	"	Ra 226	<1.0 pCi/g (R)
* "	"	Pb 210	ND

* = Perched Groundwater
R = Rejected Data

DRAWING NOT TO SCALE

FIGURE 4-14: SLANT BORING NO. 1617 (SILO 1)
RADIOLOGICAL DATA



TOTAL BORING LENGTH 130 ft.

SAMPLE LOCATION #1

LENGTH	SAMPLE #	ANALYTE	RESULTS
51 ft.	64105	Total U	4.76 ug/g
"	64105	Ra 226	1.29 pCi/g
"	64106	Pb 210	1.06 pCi/g

SAMPLE LOCATION #2

LENGTH	SAMPLE #	ANALYTE	RESULTS
71 ft.	64115	Total U	10.30 ug/g
"	64115	Ra 226	0.75 pCi/g
"	64116	Pb 210	0.73 pCi/g

SAMPLE LOCATION #3

LENGTH	SAMPLE #	ANALYTE	RESULTS
106 ft.	64136	Total U	110.00 ug/g
"	64136	Ra 226	0.90 pCi/g
"	64137	Pb 210	0.63 pCi/g

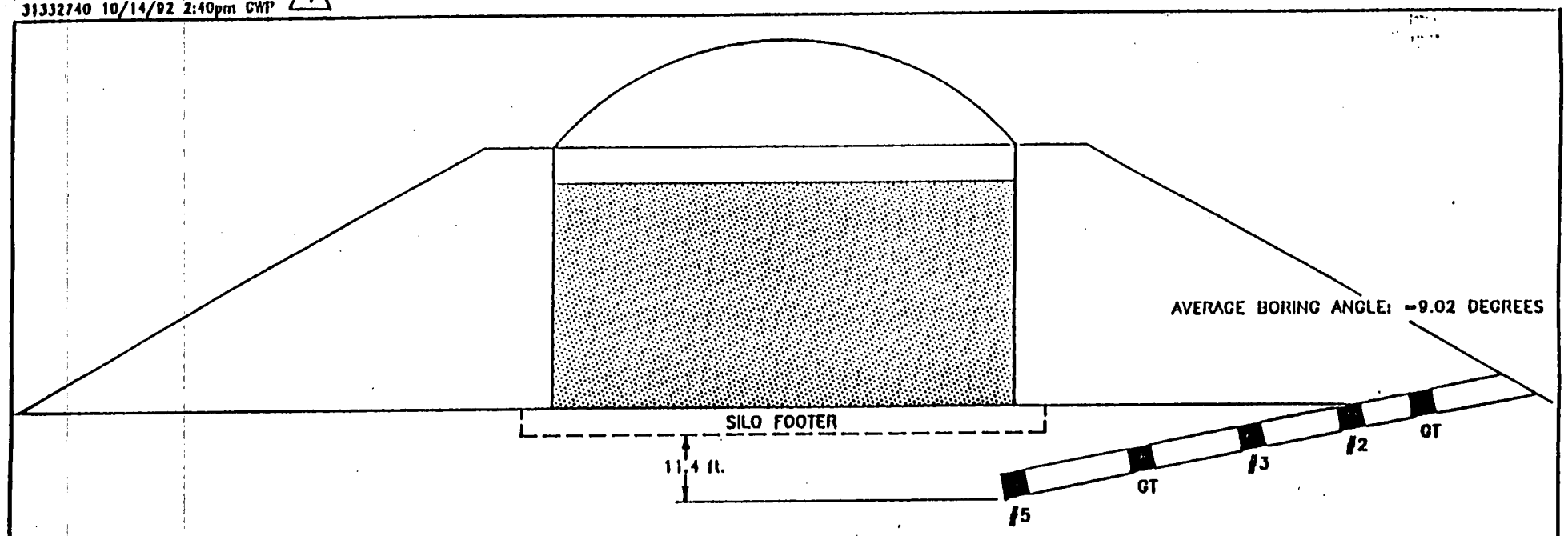
SAMPLE LOCATION #4

LENGTH	SAMPLE #	ANALYTE	RESULTS
128 ft.	64148	Total U	10.70 ug/g
"	64148	Ra 226	0.96 pCi/g
"	64149	Pb 210	0.52 pCi/g
*130 ft.	64152	Ra 226	2.09 pCi/L*
* "	"	Pb 210	1.96 pCi/L

* = Perched Groundwater

DRAWING NOT TO SCALE

FIGURE 4-15. SLANT BORING NO. 1618 (SILO 1)
RADIOLOGICAL DATA



SAMPLE LOCATION #2

LENGTH	SAMPLE #	ANALYTE	RESULTS
61 ft.	64071	Total U	<4.5 ug/g
•	64071	Ra 226	0.88 pCi/g
•	64071	Pb 210	0.71 pCi/g

SAMPLE LOCATION #3

LENGTH	SAMPLE #	ANALYTE	RESULTS
91 ft.	64125	Pb 210	<6.9 pCi/g (R)
•	64125	Total U	74.9 ug/g
•	64125	Ra 226	0.97 pCi/g

SAMPLE LOCATION #5

LENGTH	SAMPLE #	ANALYTE	RESULTS
110 ft.	64090	Ra 226	<1.0 pCi/L• (R)
•	•	Pb 210	2.81 pCi/L• (R)

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• = Perched Groundwater
GT = Geotechnical Sample Only
R = Rejected Data

DRAWING NOT TO SCALE

FIGURE 4-16: SLANT BORING NO. 1619 (SILO 2)
RADIOLOGICAL DATA

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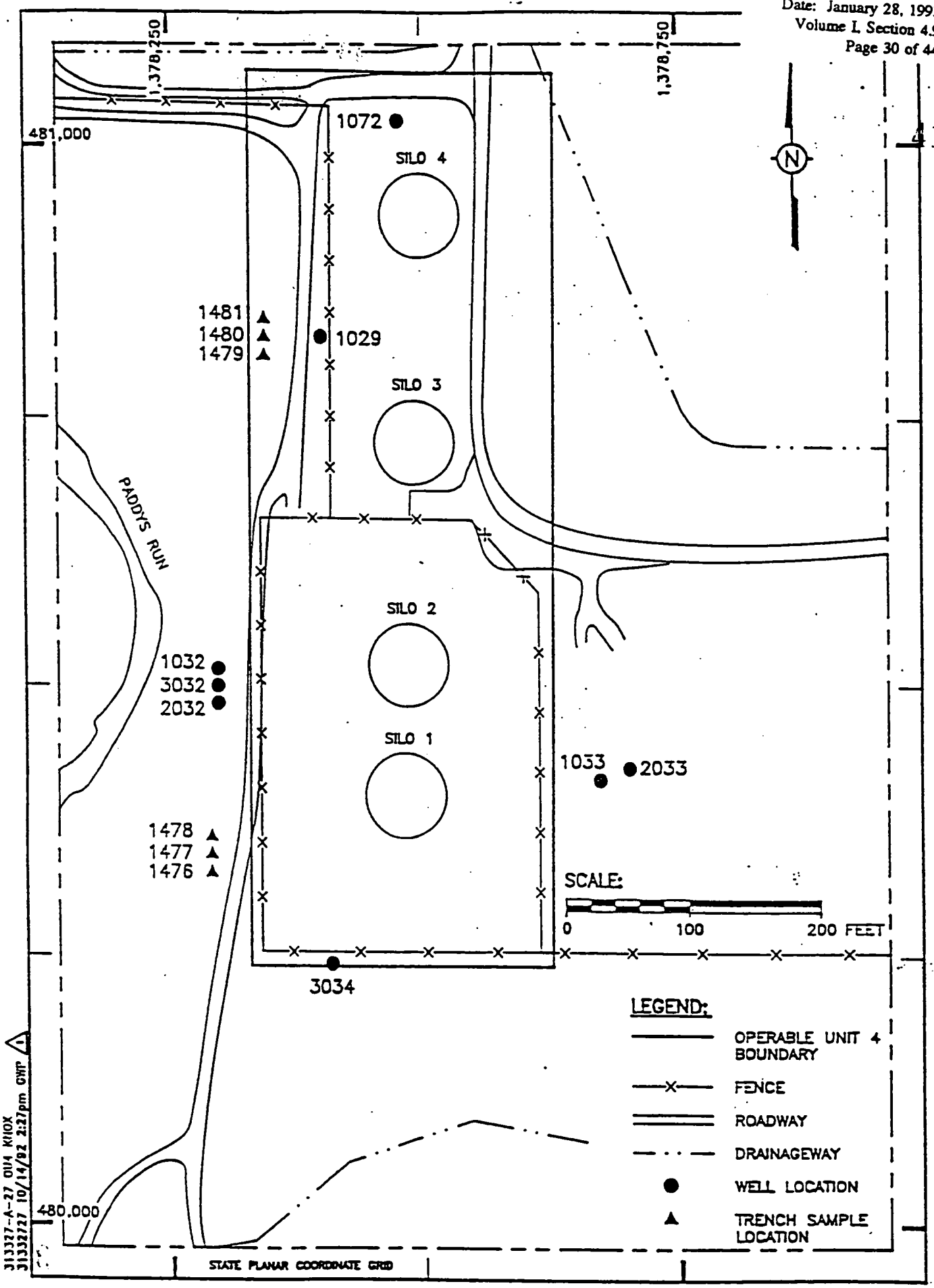

FIGURE 2-7. SUBSURFACE SOIL SAMPLING LOCATIONS

4112

TABLE 4-22

RADIOLOGICAL CONSTITUENTS FOR K-65 SILO SUBSURFACE SOILS

Compounds (pCi/g)	Frequency of Detection	Mean	Range	UTL *
Ac-227	4/17	5.03750	0.56-9.66	NA
Pb-210	10/14	24.11400	0.52-101	2.23
Po-210	10/13	9.55180	0.938-62.6	2.23
Ra-224	11/15	1.08182	0.67-1.71	1.475
Ra-226	16/21	33.36869	0.613-206	2.613
Ra-228	12/21	0.86483	0.485-1.24	1.475
Sr-90	1/6	0.81600	0.816-0.816	NA
Th-228	16/19	1.48988	0.768-2.06	1.475
Th-230	14/20	5.78871	0.8-53.7	2.109
Th-232	12/21	0.99950	0.62-1.5	1.668
Th-TOTAL	15/21	8.24267	3.34-13.6	NA
U-234	18/19	14.88806	0.8-139	2.109
U-235/236	5/20	3.64660	0.853-9.92	0.097
U-238	18/19	16.23800	0.76-146	2.368
U-TOTAL	12/17	59.35667	1.51-110	NA

* Upper Tolerance Limit

TABLE 4-33

SUBSURFACE SOIL RADIOLOGICAL RESULTS WITHIN OPERABLE UNIT 4 AREA

			Analytical Results (pCi/g)							
Well No.	Sample ID	Depth (ft.)	Ra-226	Ra-228	Tc-99	Th-230	Th-232	U-234	U-235/236	U-238
Background			1.51	1.28	-	2.18	1.36	1.28	0.15	1.22
1018	07311	3.0 - 4.5	1.1	<0.8	<0.9	1.8	0.8	1.0	<0.6	1.1
1029	07407	13.5 - 15.0	0.6	0.5	<0.9	1.0	<0.6	<0.6	<0.6	0.6
— 1032	07504	15.0 - 16.5	1.0	0.6	<0.9	1.6	0.7	2.1	<0.6	1.3
— 1033	08854	1.5 - 3.0	1.3	1.1	<1.3	1.6	1.3	1.2	<0.6	1.4
— 1072	08188	0.0 - 1.5	1.5	1.0	3.6	4.8	0.9	3.4	<0.6	15.0
— 2032	32456	7.5 - 9.0	0.69	<0.5	<0.9	0.8	<0.6			
— 2032	32465	25 - 26.0	0.59	<0.5	<0.9	1.4	<0.6	<0.6	<0.6	0.6
— 2033	32766	40 - 40.0	0.53	<0.05	<0.9	1.17R	<0.6	<0.6	<0.6R	<0.6
2033	33083	95 - 96	0.87R	0.41R	<0.9	1.75R	<0.6	0.94R	<0.6R	0.99
— 3034	08272	10.5 - 12.0	<0.3	<0.5	<0.9	0.9	0.6	0.6	<0.6	0.6
— 3034	08279	21.0 - 22.5	0.7	0.6	2.1	3.8	0.7	0.8	<0.6	0.9
3034	08295	95.0 - 96.5	0.6	<0.5	<0.9	0.7	<0.6	<0.6	<0.6	<0.6

Note: R - Rejected

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APPENDIX B

TABLE 4-27A

RADIOLOGICAL RESULTS FOR PERCHED GROUNDWATER FROM THE SLANT BORINGS
(RESULTS IN pCi/L)

Boring Number Sample Number Sample Interval[a]	1615 64007 57.0 ft	1616 64021 48.0 ft	1616 64052 120.0 ft	1617 64009 68.5 ft	1618 64152 130.0 ft	1619 64090 110.0 ft	UTL (EPA 1989)
Compound							
Pb-210	<3.0	<3.0 J	<1.0 J	NA	1.96 J	2.81 R	1.330
Po-210	NA	<1.6 J	<1.7 J	NA	4.69 R	<1.2 J	NA
Ra-226	<1.0	<1.0 J	<1.0 J	<1.0 R	2.89 J	<1.0 R	1.507
Th-228	1.96	<1.0 R	1.54 J	<1.0 R	<1.0 J	<1.0 J	1.560
U-234	1.17 J	139.0 R	3.04 J	<1.0 R	NA	NA	1.275
U-235/236	<1.0	9.92 R	<1.0 J	<1.0 R	NA	NA	0.151
U-238	<1.0 J	146.0 R	1.96 J	1.22 J	NA	NA	1.223
U-TOTAL[b]	1.51	439.0 R	6.17 J	6.33	NA	NA	17.100

[a] - Sample interval indicates length along the slant boring, measured from entrance at grade, at which the sample was obtained.
[b] - Results reported in µg/L
NA - Not analyzed
J - Estimated value
R - Rejected data due to lack of proper QA/QC

4112

TABLE 4-27B

PERCHED GROUNDWATER RESULTS FROM THE WEMCO ON-SITE LABORATORY (OCTOBER 28, 1991)

Boring Number	1615	1615	1616	1616	1617	1618	1619	
Location Within Boring	57 ft.	57 ft.	48 ft.	120 ft.	68 ft.	130 ft.	110 ft.	
Parameters	Results							Units
Total Thorium	<400	<400	<400	<400	<400	<400	<400	µg/l
Thorium-230	3.0	<3.0	1.0	4.5	5.0	<10.0	2.6	pCi/l
Uranium-234	0.69	0.66	96.9	1.01	3400	280	100	pCi/l
Uranium-235	0.03	0.038	4.8	0.04	140.0	13	5.1	pCi/l
Uranium-236	.017	0.018	0.25	0.01	<5.9	<0.54	<1.0	pCi/l
Uranium-238	0.66	0.73	129.6	0.797	3100	<280	110	pCi/l
Total Uranium by Laser	2.00	2.20	390	2.4	9240	840	330	ppb
Radium-226	1.00	0.9	<3.40	<4.5	<3.3	6.50	<3.40	pCi/l
Lead	<6	<6	19.2	4.0	<6	<3	5.0	ug/l
Barium	310	307	226.1	291.0	57	<200	<200	ug/l

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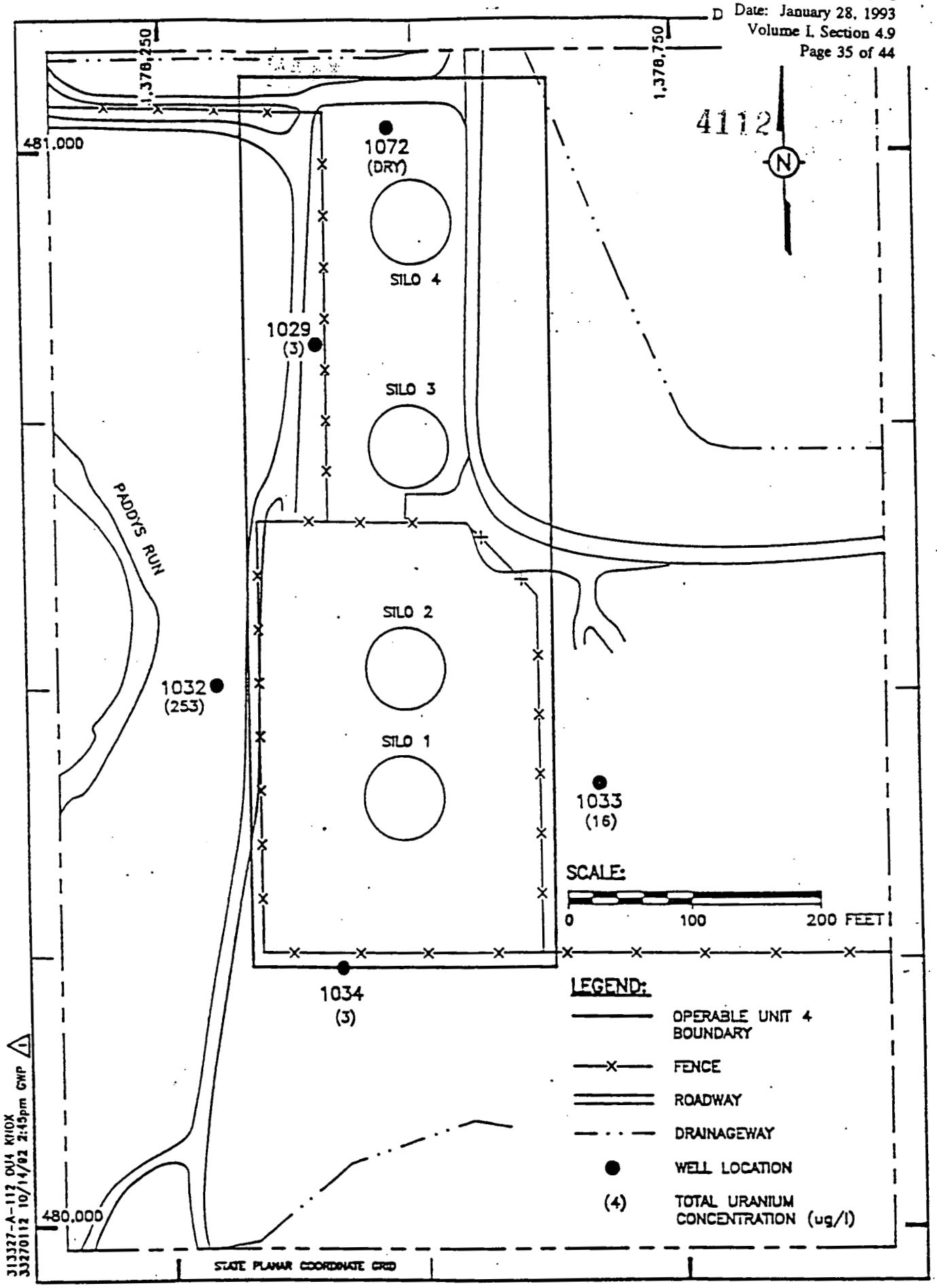

FIGURE 4-22. AVERAGE TOTAL URANIUM CONCENTRATION IN 1000 SERIES WELLS, (1988-1989)

4112

TABLE 4-38

DETECTED RADIONUCLIDES IN GROUNDWATER
(RESULTS IN pCi/L)

Well Number	Sample Number	Date	Th-228	Th-230	Total Thorium[a]	U-234	U-238	Total Uranium[a]
1029	3076	4/88	<1	<1	NA	1.7	1.4	3 R
	3354	7/88	<1	<1	<2	1.4	<1	3 R
	3634	10/88	<1	<1	<3	1.2	<1	2
	3852	1/89	<1	<1	<4	1.7	<1	3
1032	3133	4/88	<1	1.6	NA	84.9	96.8	256 R
	3355	7/88	<1	<1	<5	61.3	70.5	196 R
	3635	10/88	<1	<1	<5	82.4	92.4	230
	3851	1/89	<1	<1	<4	76.1	88.8	276
1033	3220	5/88	<1	1.4	NA	3.7	3.5	11 R
	3567	8/88	<1	<1	3	3.3	3.0	9.0
	3773	11/88	<1	<1	<2	4.9	5.0	15
	3961	3/89	<1	<1	<2	7.1	8.2	23
1034	3122	4/88	<1	<1	NA	1.3	1.1	4
	3850	1/89	<1	<1	<3	1.2	1.1	3
	3356	7/88	<1	2.4	<4	2.6	1.8	10
	3636	10/88	<1	<1	<2	2.9	3.4	7.0
2032	4299	6/90	4.29	14.7	<7.2	13.6	14.4	39.9
2033	4208	6/90	<1 R	<1 J	5.85	14 R	14.5 J	39.8
	4334	8/90	1.69 R	<1 R	<3.1 J	11.9 R	12.3 R	40.3 R

FER/OU4RI/SA.WP7414.37/10-15-92

APPENDIX C

TIMCO™ Lysimeters for Vadose Zone Monitoring

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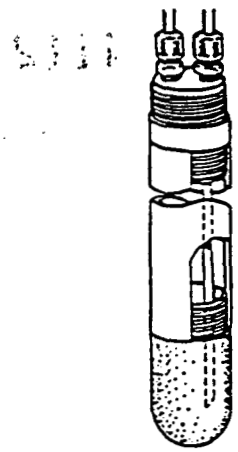
TIMCO™ Cup Type Lysimeter with Porous Ceramic Filter



Also Available in Tube Type Body in Teflon® or PVC

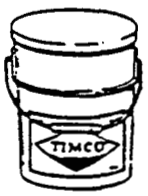
TIMCO™ Porous Ceramic Lysimeters

TIMCO'S™ Porous Ceramic Lysimeters are constructed similar to the TIMCO™ Porous Teflon® Lysimeters. Advanced machining techniques allow the ceramic filter to be threaded. This permits, for the first time, a totally adhesive and sealant free construction. Sealants, potential sources of contamination, are eliminated. The TIMCO™ Ceramic Filter Elements have a pore size of 0.446 micrometers by the mercury penetration porosimetry method (ASTM C-699).

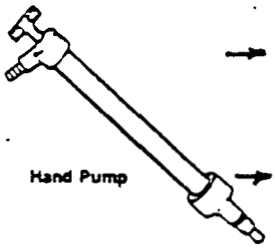
The TIMCO™ Porous Ceramic Filter element may be easily removed from the body for decontamination or replacement if accidental breakage occurs. TIMCO™ uses Viton® O-rings in the flush threaded ceramic joints, to ensure a leak-free seal. The top plug is threaded to allow attachment of casing. If the lysimeter unit is located more than 20' (6M) below the ground surface, a TIMCO™ Deep Sampling Lysimeter will be required. Sample recovery in excess of 10 psi may damage the filter and/or silica pack and force the collected pore water sample out of the lysimeter, back into the soil. TIMCO™ recommends the use of its Select Silica Flour as a pack around the installed lysimeter.

Porous Ceramic Lysimeters: Sizes Available with PVC Body	
Tube type	1.90" (48.3mm) x 17.5" (44.5cm)
Cup type	1.90" (48.3mm) x 17.5" (44.5cm)

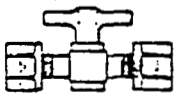
Lysimeter Accessories



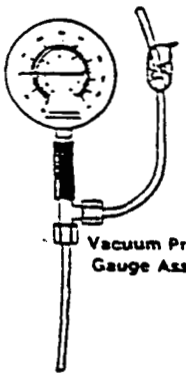
Silica Flour



Hand Pump

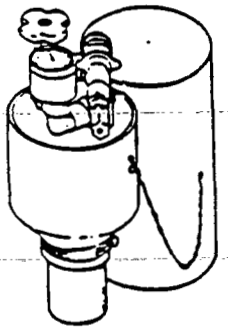


Teflon® Stopcock



Vacuum Pressure Gauge Assembly

Delrin® Stopcock



Lysimeter Head Assembly

TIMCO™ Lysimeter Accessory Items

Tubing

TIMCO™ provides tubing to connect the lysimeter to the surface. Usually 1/4" OD Teflon® or polyethylene is suitable.

TIMCO™ Select Silica Flour

Silica, 200 mesh (99.8% pure) is available in 50lb (23kg) plastic pails. Allow a minimum of 1 pail per installed lysimeter. Mix each pail with 2 gallons of distilled water to make about 6 gallons of silica slurry.

Vacuum Pressure Hand Pump

The pump is used to apply vacuum to the lysimeter during the pore water extraction phase. Pressure or vacuum is applied to deliver the sample to the surface.

Vacuum Pressure Gauge Assembly

When installed on the lysimeter vacuum/pressure tube, allows for constant monitoring during the pore water extraction phase. During the sample recovery phase, it will alert the user to potential over-pressurization.

Teflon® Stopcock and Delrin® Shut-Off Valves

Designed to allow easy sealing of the sample delivery and vacuum/pressure lines when not using a lysimeter well head assembly. The Teflon® stopcock is used with Teflon® tubing, the Delrin® shut off valve is used with polyethylene tubing.

Lysimeter Head Assembly

Designed for placement on the casing at the ground surface, it provides a neat and secure termination of the tubes from the lysimeter. A permanent vacuum/pressure gauge and taps for the vacuum/pressure and sample line are mounted beneath the weatherproof cap. Stopcocks and gauge assembly are not needed with Head Assembly.

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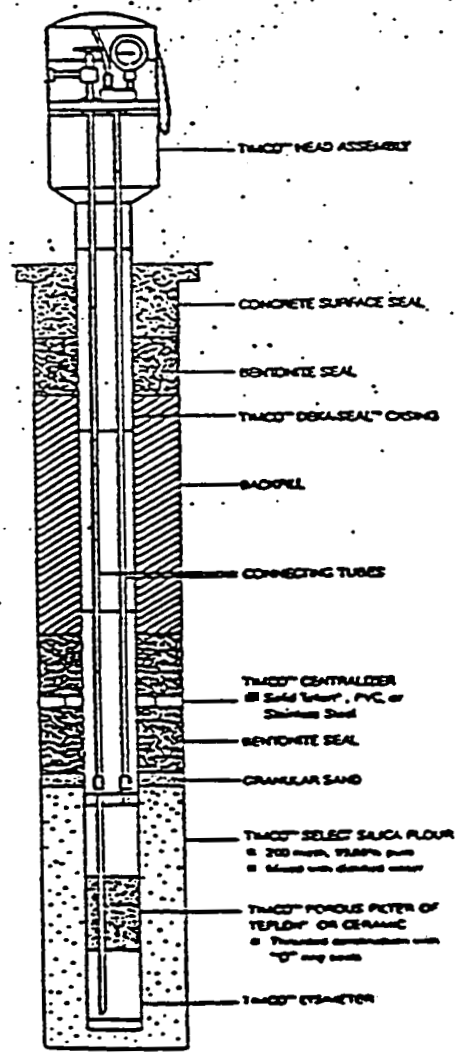
Operating Principles

The Timco(TM) Lysimeter System is designed for long term use in one location. are must be taken with the installation to ensure correct operation for a long eriod. The assembled system should always be checked for leaks prior to being ut in the ground.

A Tube or Cup Type Lysimeter has an outside diameter of 1.9" or 2.375". These hould be placed in boreholes of at least 6" in diameter to allow for an adequate ilica slurry pack to surround the lysimeter.

The lysimeter has the vacuum/pressure outlet marked on the lysimeter top plug. his connection leads to the vacuum gauge on the head assembly. It allows a vacuum o be applied to the system, thereby creating a vacuum gradient between the inside f the lysimeter, the silica slurry pack, and the soil under investigation. The econd unmarked connection is the sample evacuation tube. This is connected to he head assembly sample line.

The specification of the silica flour used to surround the installed lysimeter s critical and should only be purchased from Timco. If a 6" borehole is used, single 50 lb. pail will be sufficient for each lysimeter installation. The flour s made into a slurry with distilled water before placement. The silica slurry s used to establish a continuum between the lysimeter and the surrounding soil. ince the Timco(TM) silica is not water soluble, it immediately begins to separate tself from the distilled water. When placed in the ground the water migrates nto the soil and establishes the continuity required for surface tension to be ransmitted in an outward direction upon application of a vacuum. This allows ny moisture attached to the soil particles to be drawn into the lysimeter through he silica pack.



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Assembling the Lysimeter

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If properly installed, the typical lysimeter system will be expected to produce representative samples for several decades. It is therefore important to check out the system thoroughly before taking it to the installation site. Prior to installation the system should be pressure and/or vacuum tested to ensure it is leak free.

The lysimeter system components supplied by Timco are cleaned and packed in plastic bags. They have not been subjected to the rigorous decontamination procedures required for equipment used to obtain samples for subsequent micro-analysis of trace pollutants. If complete decontamination is required, see the section titled "Decontamination Procedures" and/or follow those specified for the specific job. Note that if the lysimeter body is decontaminated it will be necessary to pass at least 2 liters of distilled water through the porous section to ensure complete removal of the liquids used for the decontamination. After this procedure is completed the components should be bagged. Subsequent handling should be done in a clean area using sterile gloves.

The system components supplied are manufactured by Timco to satisfy the requirements of the order. Mixing these with components from other sources may lead to incompatibility problems resulting in leakage or failure of the lysimeter system.

1). Assembly of Tubing to Fittings.

Tubing, because of its slippery nature and rigidity, has to be specially grooved before a fitting is attached. Failure to do so will allow the tubing to slip out of the fitting and cause leakage. Timco normally grooves each end of the tubing supplied with the order. If the installation requires the tubing to be shortened the new end will need to be grooved using a special grooving tool available from Timco. The tool not only cuts the groove but also places the groove at the correct distance from the end of the tube.

2). Assembling the System.

As mentioned earlier, it is suggested that the complete system be assembled away from the installation site. This will allow for the assembly and testing under clean conditions. The assembled lysimeter may then be easily placed at the job site.

The assembly should begin with the attachment of the vacuum/pressure and sample evacuation lines to the lysimeter top plug. If necessary cut each to length, making certain cuts are clean and vertical to the horizontal length of the tubing. Follow the previous instructions for the grooving. Note that the Vacuum /Pressure outlet at the top of the lysimeter plug is marked with a "V". Make certain that the other end of the tube connected to this fitting is suitably marked or tagged. This will provide assurance that the tubing is correctly connected to the Timco Head Assembly.

If the installation is to involve threaded riser casing of appropriate length, assemble it at this time. Pass the two tubes from the lysimeter through the casing string. To complete the assembly attach the sample evacuation and vacuum/pressure lines to the bottom of the head assembly. The Timco Vacuum/Pressure Hand Pump is connected in the vacuum mode. The black female hose connector should be used to attach the end of the tubing to the hand pump (black end). The assembled system may now be tested for leaks.

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Testing the System

Effective use of the lysimeter system requires that there be no air leaks. Two methods are described to check the assembled system for leaks.*

Pressure Testing

Completely immerse the lysimeter and the head assembly components, except for the gauge, in water. Connect the pressure outlet of the Timco Hand Pump to the vacuum/pressure line fitting on the head assembly. Apply 15 psi. of air pressure. Observe all connections for evidence of bubble leakage. The porous filter section should give off bubbles over its entire surface area. If leaks are observed in the tubing fittings, disassemble and check for correct assembly and retighten. Leaks at the fitting connections to the lysimeter body or the head assembly may be wrapped with Teflon(R) tape prior to reassembly. Leaks involving the body components of the lysimeter should be checked for cleanliness, particularly the surface that touches the O-Rings.

Vacuum Testing

The porous filter media of the lysimeter body is sealed off with a latex or flexible plastic membrane. Secure a seal by placing rubber bands over the membrane and securing it to the body of the lysimeter above the porous filter. Shut off the sample valve. Connect the vacuum inlet of the pump to the vacuum/pressure port on the head assembly, and apply a vacuum in excess of 20 inches of mercury. Shut off the vacuum valve. Note the vacuum reading on the gauge. Leave the system for several hours and then recheck the vacuum reading. A small drop of up to 3 inches of mercury may be expected. If a large drop is noted, check and retighten all connections as described above.

Prewetting the Porous Filter Media

Finally, before taking the assembled lysimeter system to the installation site, Timco(TM) recommends that the lysimeter body be placed in distilled water and a vacuum of about 15 inches of mercury be applied for 1 hour. This procedure prewets all surfaces of the porous filter media, eliminating any entrapped air in the filter media. The lysimeter should be installed with the body filled with distilled water if no riser casing is used. An empty, unsupported lysimeter will float on the wet silica slurry when placed in the borehole.

* NOTE —— All Timco Lysimeters are tested at Timco prior to shipping. Fittings may loosen during transit.

Installation and Evacuation of the Shallow Lysimeter

The installation of a Timco Lysimeter System should be in accordance with the following procedure. It is suitable for depths of up to 20 feet. For greater depths a Timco(TM) Deep-Sampling Lysimeter should be used.

1). Borehole Preparation

The borehole must provide adequate space to allow the lysimeter body to be surrounded by the silica slurry pack. For a 2" diameter lysimeter use a 6" or larger borehole. The borehole must allow for at least a 1.5" thickness of silica slurry all around the porous filter of the lysimeter. If difficulties are anticipated in maintaining an open borehole, use casing to hold back the material. Immediately after installation of the silica pack and lysimeter pull back the casing and install a bentonite plug.

2). Mixing the Silica Flour Slurry

The Timco(TM) 200 mesh, 99.88% pure crystalline silica flour is mixed with distilled water using a ratio of 150 mls. water to 450 grams of silica flour. The Timco Silica Flour is supplied in a 50 lb. sealed pail. This will require about 2 gallons of distilled water to make the slurry and will be sufficient for a single lysimeter installation in a 6" borehole. Add the flour slowly to the distilled water with constant stirring. The mix must be completely blended and lumpfree. Constant stirring is essential as the silica is not water soluble and will settle if not agitated.

3). Placing the Silica Slurry Pack

Pour part of the silica slurry into the borehole to provide a bed for the lysimeter. A minimum of 4" depth for the cup-type lysimeter and 2" for the tube-type lysimeter. Depending upon the borehole diameter, between a quarter and a third of the total mix is usually sufficient

The Timco(TM) Lysimeter System should now be lowered into the borehole. Take particular care to make certain that the lysimeter body is centrally located within the borehole diameter. A minimum of 1.5" of silica slurry around the annular area of the unit is essential. Timco suggests Deka-Seal(R) casing be used for support and accurate placement. Centralizers will also assure correct placement.

The balance of the silica slurry should now be poured into the borehole to completely cover and surround the lysimeter body. Note that you must have the lysimeter in intimate contact with the silica slurry and the slurry must fill all voids in the bottom of the borehole. The Lysimeter should be supported at the surface with stakes for at least 2 hours until the silica sets.

A bentonite seal should be installed next, followed by tamped backfill. A second bentonite seal is suggested near the surface. Protection at the surface can be achieved with the Timco(TM) Lysimeter Head Assembly and a Timco(TM) Security Cover set in concrete.

4). Activating the Lysimeter

If the lysimeter was filled with distilled water before installation, this should now be removed and discarded. Timco recommends the use of a two port rubber stopper in a collection flask. The flask should be of adequate size to hold the sample from a full lysimeter. This method is unlikely to disturb the silica pack and break the seal between the pack and the porous section of the lysimeter which would result in a lysimeter system failure.

1. Open the vacuum-pressure valve and the sample valve on the head assembly.
2. Attach the tube from the sample port on the head assembly to the hole in

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rubber stopper. (Tube to protrude about 1" into the flask).

3. Attach the second tube from the flask to the vacuum-pressure inlet on the Timco Hand Pump. (Tube to be flush with the bottom of the rubber stopper).
4. Apply a gentle vacuum to the system, the distilled water will flow into the collection flask.

After removing the distilled water from the lysimeter, you are ready to activate the lysimeter to obtain a sample. If you start the activating procedure immediately after installation, it will be necessary to remove and discard the distilled water used to make up the silica pack. (Remove a water volume equivalent to approximately one third of that used to make up the slurry).* If the installation is left for a few days, the water in the silica pack will migrate into the surrounding soil and establish the continuity needed between the porous filter media and the soil. Samples collected in this situation should be considered representative. Use the following steps to activate the system.

1. Close the sample evacuation valve.
2. Connect the vacuum inlet of the Hand Pump to the vacuum-pressure port on the Head Assembly.
3. Apply a vacuum of 18-21 inches of mercury and close the vacuum-pressure valve.
4. When the gauge reads 10 inches of mercury or less, evacuation of water should be attempted. (Up to 24 hours may be needed).

* EXAMPLE: Using 2 gallons (7570 mls.) to mix the silica slurry would mean that the first .6 gallons (2271 mls.) of distilled water should be discarded.

5). Evacuating the Lysimeter with Pressure

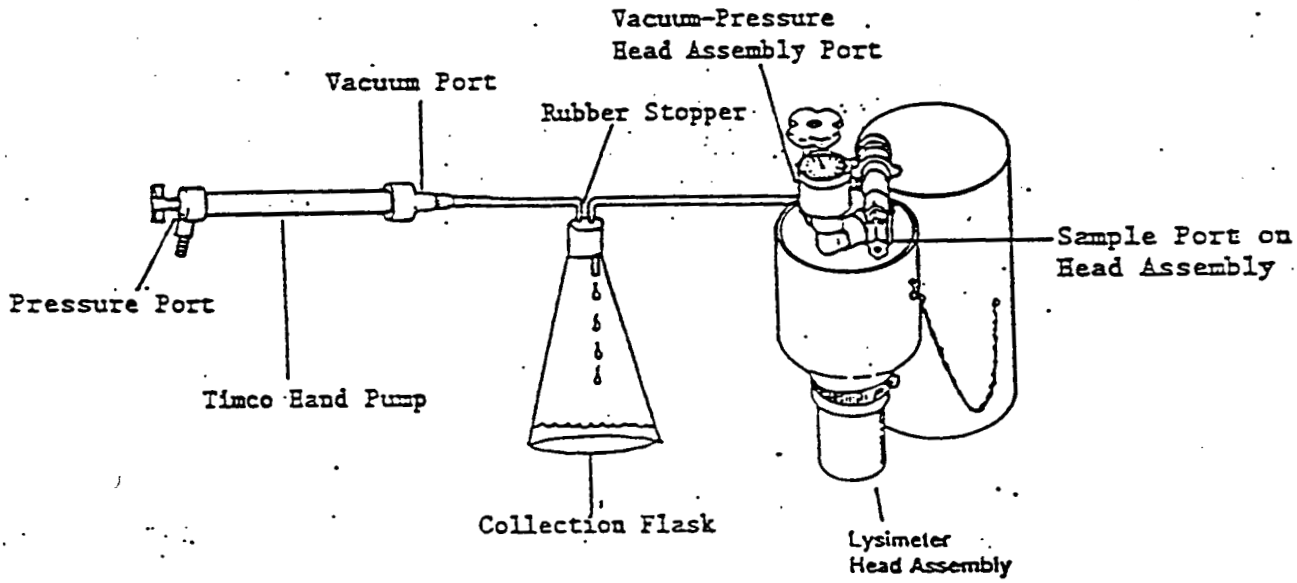
The lysimeter body is pressurized and the sample is driven to the ground surface. A pressure of .44 psi is required for each foot of depth. For a 20' installation 9 psi will be needed to lift the sample. The time taken to accumulate a sample will depend upon the soil conditions. Sampling intervals separated by 48 hours or more are not uncommon. Use the following steps to evacuate the lysimeter.

1. Open the sample evacuation valve and the vacuum-pressure valve.
2. Connect the pressure outlet of the Timco(TM) Hand Pump to the vacuum-pressure port on the lysimeter head assembly.
3. Pressure should be increased gently until 9 psi is achieved. (If 9 psi were applied instantly, it is possible the silica pack would be damaged resulting in a lysimeter system failure).
4. Sample is forced up through the evacuation line and into a sample collection flask.

6). Evacuating the Lysimeter with Vacuum

This method is unlikely to disturb the silica pack and also reduces the possibility of sample aeration. Timco does not recommend this method for installations greater than 20 feet in depth. A two port rubber stopper in a collection flask is required. Use the following steps to evacuate the lysimeter.

1. Open the vacuum-pressure valve and the sample valve on the Head Assembly.
2. Attach the tube from the sample port on the Head Assembly to the hole in the rubber stopper. (Tube to protrude about 1" into the flask).
3. Attach the second tube from the flask to the vacuum-pressure port on the Timco(TM) Hand Pump. (Tube to be flush with the bottom of the rubber stopper).
4. Apply a gentle vacuum to the system, the sample will flow into the collection flask. (Flask to be of adequate size to hold the sample from a full lysimeter).



Cleaning and Decontamination

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The following advice is provided by Timco. Timco can assume no liability and provides no guarantee that the procedures will ensure that a Timco product has been 100% cleaned. Timco does however believe that the procedures will give the proper purity characteristic required under state of the art conditions.

Teflon(R) & Ceramic Components

Step 1 - Disassemble all components.

Step 2 - Prepare a normal solution of Hydrochloric Acid. (120 g. concentrated HCL diluted in 1 liter distilled water).

Step 3 - Rinse all components in distilled water.

Step 4 - Submerge all components in this solution for 30 minutes minimum. Use a tool to remove from the solution. Soak in distilled water.

Step 5 - Resubmerge the components in clean water at least 2 more times to remove all traces of Hydrochloric Acid.

Step 6 - Timco believes an additional step of an Isopropyl Alcohol (IPA) bath and then another bath of Hydrogen Peroxide should render the equipment clean.

Step 7 - In all cases a final rinse in distilled, deionized water should ensure that the device is then suitable for representative sampling.

PVC Components

Step 1 - All products must be thoroughly cleaned of loose PVC particles, machining burrs and any other loose materials both inside and out. (Timco normally does this with all products shipped, but occasionally mistakes do happen).

Step 2 - Prepare a suitable Isopropyl Alcohol (IPA) bath which will allow total immersion of the product to be decontaminated.

Step 3 - Allow products to remain fully immersed for a period of no less than 10 minutes.

Step 4 - Remove products with clean surgical gloves to reduce chances of new contamination. Allow excess IPA to drain off.