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RI/FS WORK PLAN ADDENDUM K-65 SILO SUBSOILS AND PERCHED GROUNDWATER SAMPLING AND ANALYSIS PLAN JUNE 27, 1991

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ENCLOSURE

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REMEDIAL INVESTIGATION AND FEASIBILITY STUDY
FERNALD SITE OFFICE
FERNALD, OHIO

RI/FS WORK PLAN ADDENDUM

K-65 Silo Subsoils and Perched Groundwater Sampling and Analysis Plan

June 27, 1991

DRAFT

1.0 INTRODUCTION

The November 1990 Work Plan for K-65 silo subsoils (Document Change Request No. 51 Rev. A) outlined plans for drilling and sampling five unconventional low-angle borings to investigate possible leakage of wastes to the subsurface. During implementation of the plan in April and May, 1991, perched groundwater was encountered in Borings 1615 and 1617. Figures 1 and 2 depict cross-sections of Borings 1615 and 1617. Drilling activities were halted after encountering perched groundwater, because the existing Work Plan did not include procedures covering the sampling of and continued drilling through perched groundwater.

Continued drilling through perched groundwater into underlying strata presents several problems. If borings are continued below the confining clay layer after the occurrence of perched groundwater, it is possible that deeper perched zones could be contaminated by interconnecting the zones by means of the boring. Additionally, continued soil sampling below the perched water zone is not possible unless a method is available to prevent migration of potential contaminants from the perched water to the underlying soils.

The objectives of this Work Plan are to 1) describe temporary casing of Boring 1616 that will enable continued sampling of soils below the perched water zone, 2) add groundwater sampling procedures that were not covered in the original Work Plan, 3) describe nonstandard groundwater sampling techniques that are required for the low-angle borings and low-yielding perched water zones, 4) describe a reduced frequency for borehole-angle monitoring in light of experience gained from low-angle borings completed to date, and 5) restate the work instructions of the previous Work Plan addendum.

Only Boring 1616 will be temporarily cased and bored below the perched water zone. Borings 1615, 1617, 1618, and 1619 will not be bored deeper after encountering perched water. The four borings will be extended into the perched water zone only to a depth sufficient to enable collection of groundwater samples.

A site-specific health and safety plan was implemented to insure worker safety and satisfy applicable regulations. Ground stability was determined by previous drilling operations in the area and has proven not to be a concern in the areas where this drilling and sampling will continue to occur.

1.1 Geologic Setting

The current geologic interpretation is that the perched water found in Borings 1615 and 1617 is within a continuous sand layer that extends under the silos. Figures 3, 4, and 5 are geologic cross-sections and a three-dimensional fence diagram that provide the basis for the present geologic interpretation. These figures were constructed using stratigraphic descriptions from K-65 area borings available through May, 1991. Based on the present interpretation, perched groundwater will be encountered in all five of the subsoil borings.

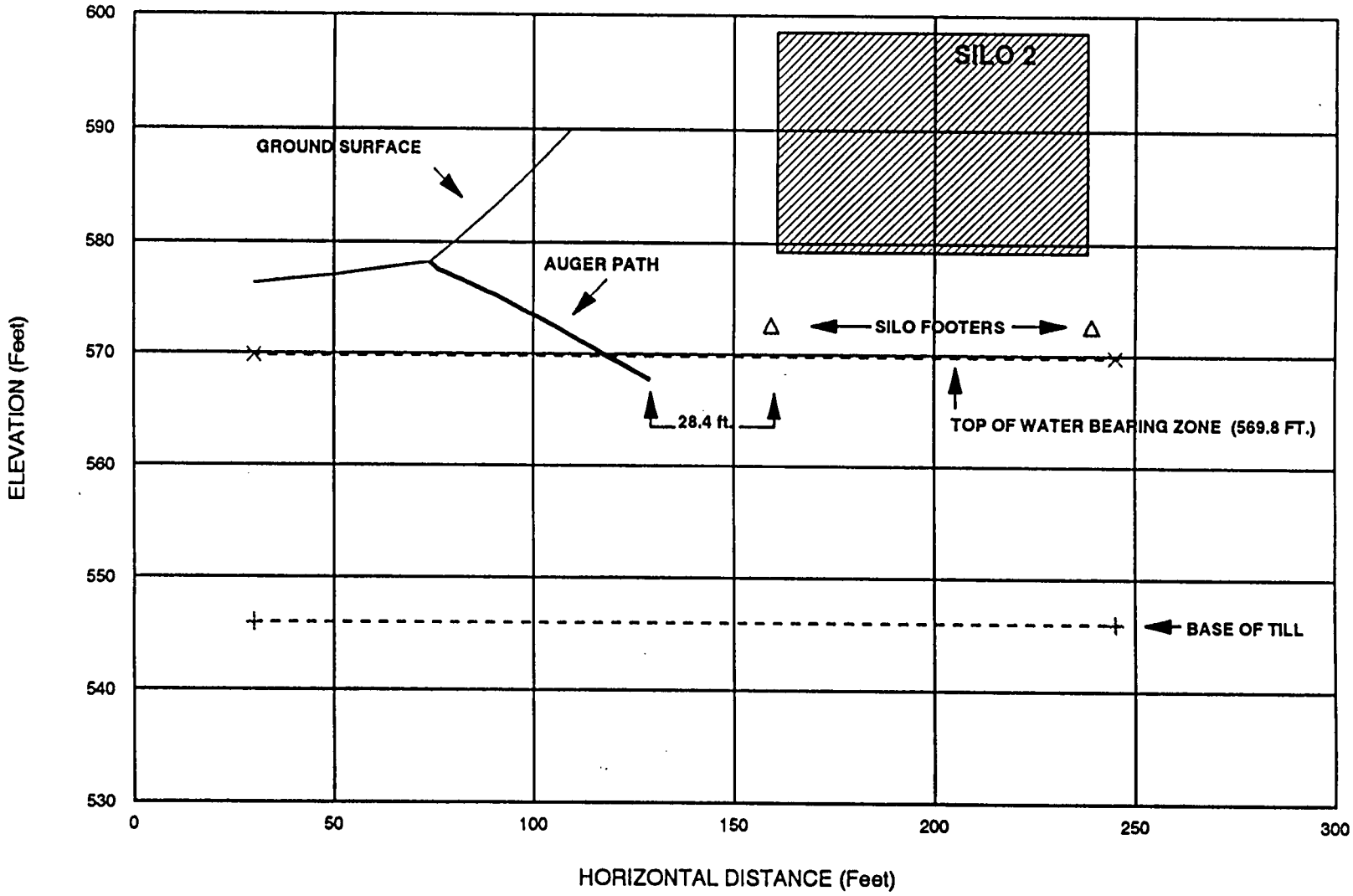
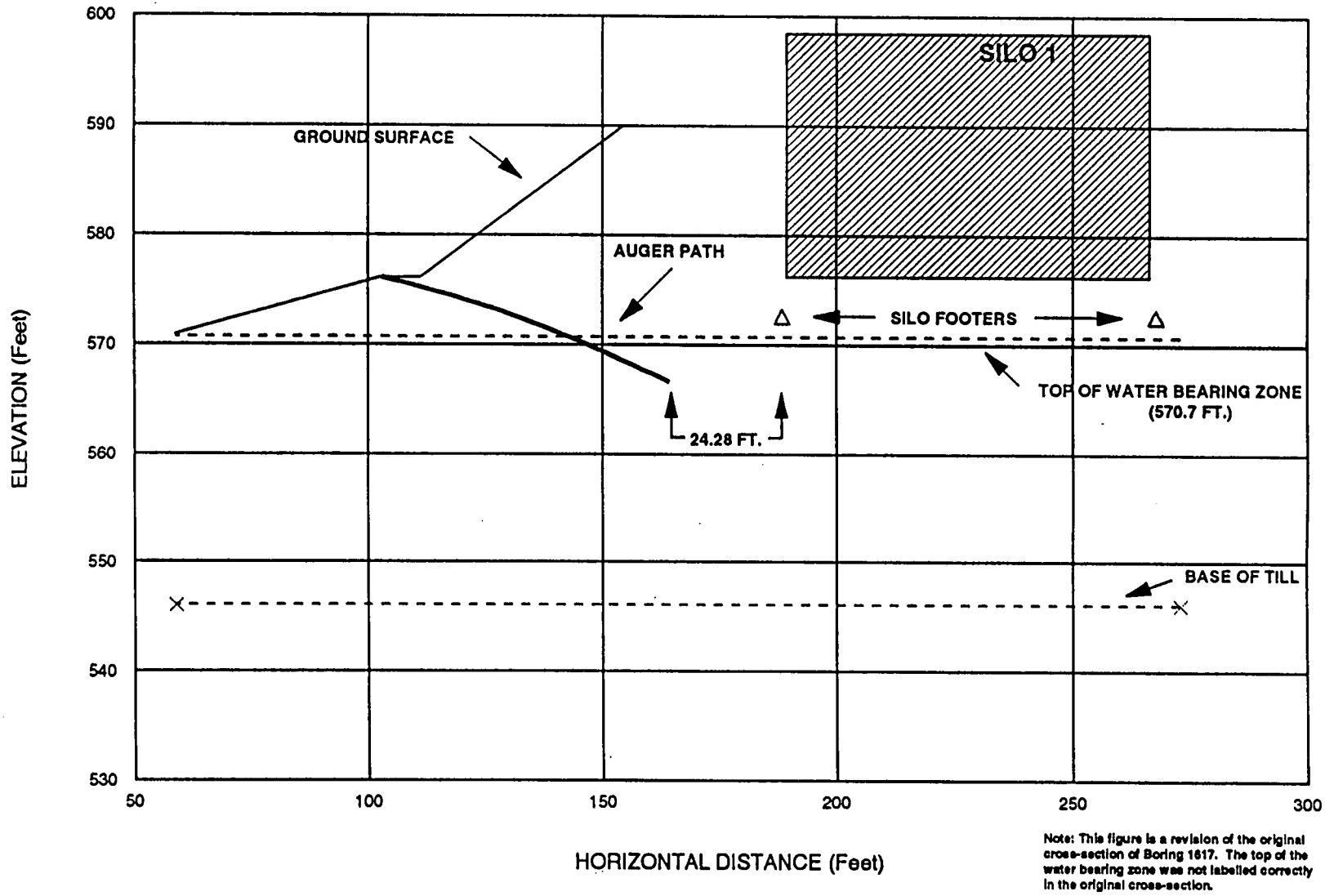


FIGURE 1
SLANT BORING 1615 (No. 1) AT K-65 SILO 2
Graph #: MK65B1KC. APRIL 25, 1991

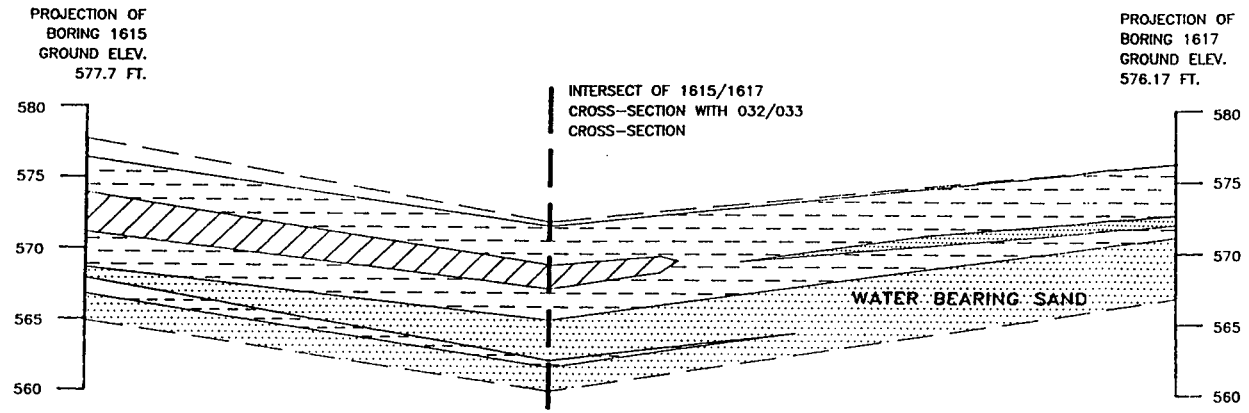


Note: This figure is a revision of the original cross-section of Boring 1617. The top of the water bearing zone was not labelled correctly in the original cross-section.

FIGURE 2

SLANT BORING 1617 (No. 3) AT K-65 SILO 1

Graph #: K65B3L. JUNE 07, 1991



VERTICAL SCALE

0 5 10 15 FEET

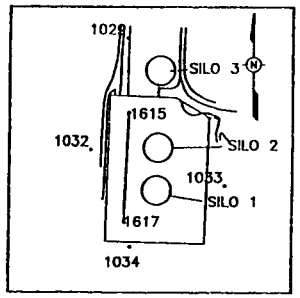
HORIZONTAL SCALE

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

602.8_3DSILO_FND_GEN_5/17/91_AM

FIGURE 3. GEOLOGICAL CROSS-SECTION OF PROJECTED BORINGS 1615/1617 IN THE K-65 SILO AREA

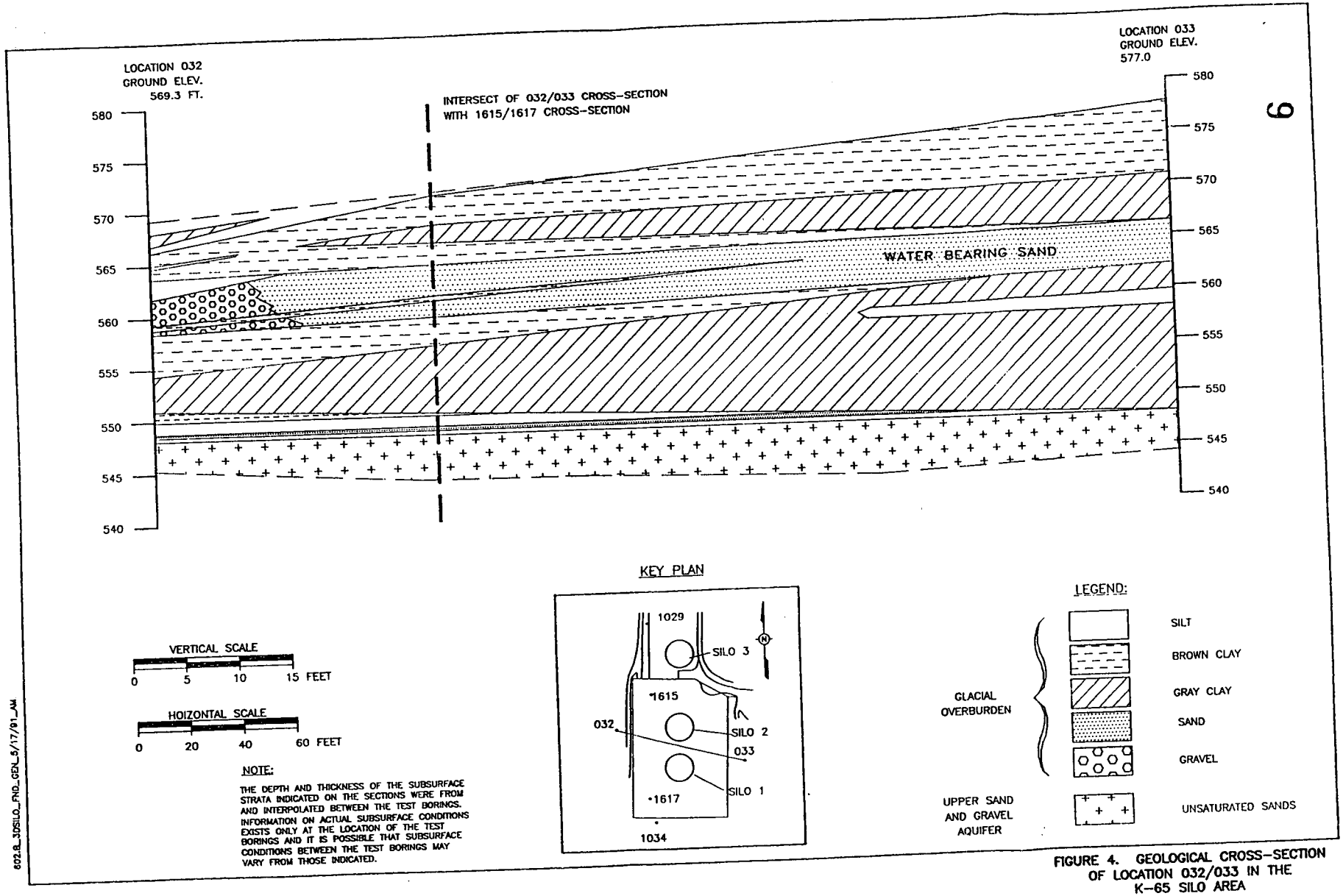


FIGURE 4. GEOLOGICAL CROSS-SECTION OF LOCATION 032/033 IN THE K-65 SILO AREA

602.8_3DSILO_FND_GEN_8/17/91_AM

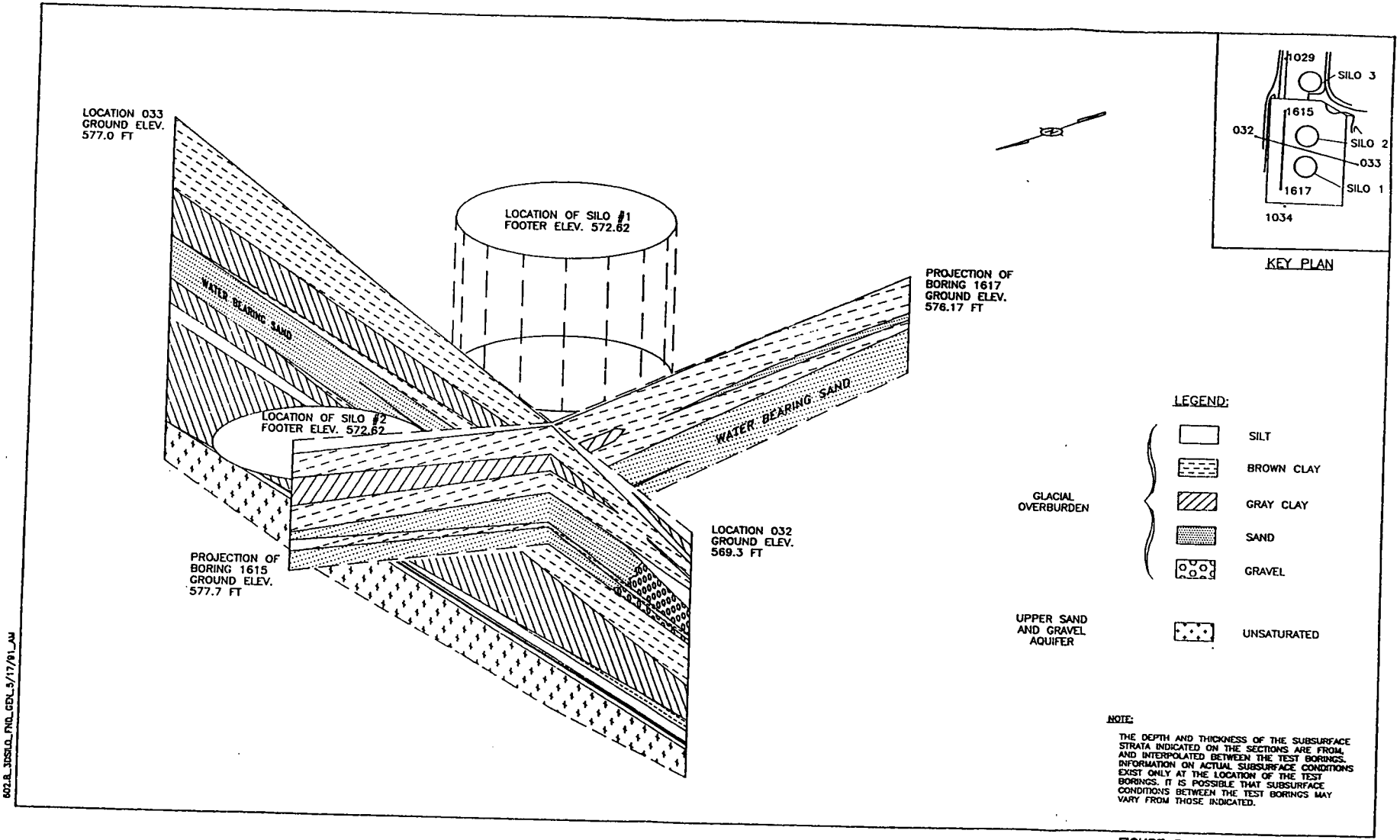


FIGURE 5. 3D FENCE DIAGRAM OF BORINGS 1615–1617 & 032–033 IN THE K-65 SILO AREA

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The soils below the K-65 silos, denoted subsoils, are being analyzed for geotechnical, chemical, and radiological parameters, based on the following historical information:

- The K-65 silo leakage history as documented in a memorandum from R.C. Heatherton, National Lead Company of Ohio (NLO), to Central Files, NLO, dated November 25, 1953, Subject: "K-65 Storage Tank No. 1."

- A preliminary radiological assessment indicates the possible presence of silo-derived radon daughter products, lead-210, polonium-210, and stable lead in the soils surrounding the K-65 silos.

- The existence of a buried underground decant tank, historically known as the upper sump, and associated piping system adjacent to and underneath the silos which was used to transport K-65 waste slurry and decanted silo liquids between the silos and the production plant.

The K-65 silo subsoils have been and will continue to be sampled and analyzed to determine and verify the extent of contamination in the soils surrounding the K-65 silos. Detailed drilling procedures presented in the following sections were developed to insure that the integrity of the silos are maintained during the drilling and sampling operations as well as minimizing the potential for breaching the silos. This plan pertains only to samples to be collected from low-angle auger borings. Samples to be collected from the berms around the silos are addressed in a separate plan.

Analyses of the water encountered in the borings will provide valuable insight as to the extent of migration of leakage from the silos into the underlying soils. The uppermost perched water zone is where any leakage from the silos will move laterally in the subsurface, as the horizontal permeability is much greater in the water-bearing zones than the vertical permeability of the underlying clay-rich zones. In other words, the presence of a perched water zone is direct evidence that lateral water movement is greater than vertical water movement. Thus, the perched water analysis is vital to this investigation. Groundwater samples were collected from Borings 1615, 1617, and 1616 on May 29, June 10, and June 21, respectively. The samples were sent to the on-site WMCO laboratory and the RI/FS contract laboratory for analyses of parameters listed in Section 2.5.2 of this plan. Results of the on-site analysis for these three borings are expected in early July, 1991.

Based on monthly water table measurements in 1000-series wells in the area, the indicated perched groundwater flow direction is to the west-northwest under the silos, assuming that the groundwater-bearing zone is continuous under the study area. Figure 6 shows contours of the water table in the glacial overburden based on data collected on June 4, 1991. The five borings involved in the slant boring program are located as follows, with respect to perched groundwater flow beneath the silos and the decant tank:

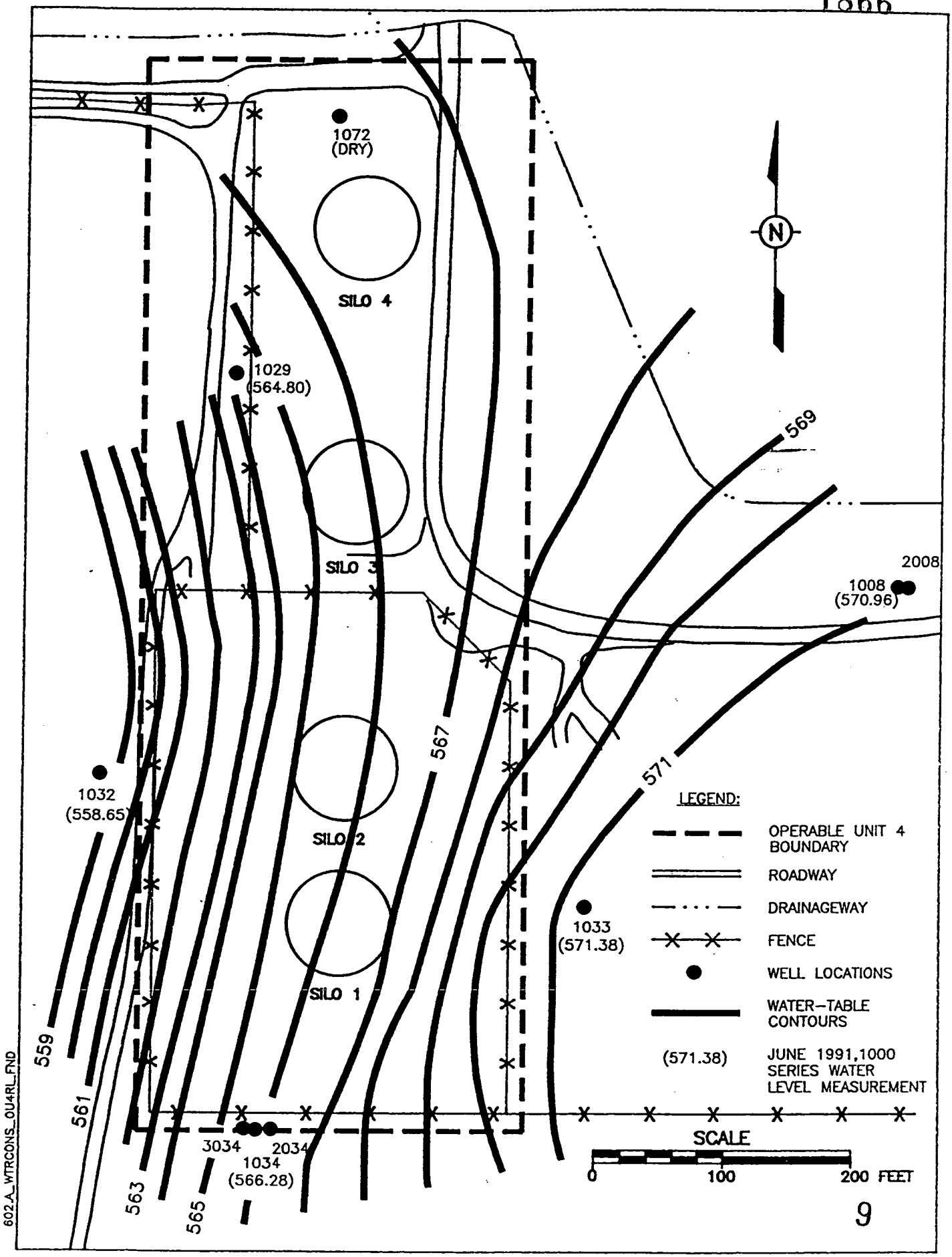


FIGURE 6. TYPICAL WATER TABLE CONTOURS 1000 SERIES WELLS, K-65 AREA, JUNE 1991

- Boring 1615 is in the approximate downgradient position for Silo 2
- Boring 1617 is lateral to the interpreted flow under Silo 1
- Boring 1616 is located downgradient from the decant tank and both silos
- Borings 1618 and 1619 will be downgradient from that portion of Silos 1 and 2 that the borings pass under prior to encountering perched water. If perched water is encountered prior to the borings passing below the silo footer, the water-sampling point will be upgradient to the silos.

2.0 DRILLING PROCEDURES -- FIVE LOW-ANGLE BORINGS

The hollow stem auger technique coupled with a horizontal boring machine is being used for the five low-angle borings. The horizontal boring machine was chosen over conventional drilling equipment due to the torque requirements of the project. The torque needed for low-angle auger drilling is much greater than that required for vertical drilling due to additional frictional resistance caused by gravity along the length of the augers rather than at a single point.

Due to the unconventional nature of low-angle borings and sensitivities concerning tracking of the boreholes, a practice boring was completed in an area away from the K-65 silos prior to drilling under the silos. This allowed crews to become more familiar with drilling and the borehole tracking and sampling phases of the project.

After the boring machine is set up and the exact initial boring point is established at each boring site, a licensed surveyor calculates the required drilling angles needed to clear critical structures by at least three feet and have a minimum of three feet of till below the final sampling point. The specified drilling angle is set by constructing a pad at the required angle. The boring machine is then anchored to the pad. Table 1 lists the critical elevations for each boring. Figure 7 depicts parameters used in calculating boring angles and tentative minimum and maximum calculated drilling angles. If for any reason the angle cannot be maintained within the specified window, the boring will be abandoned and plugged. Authorization to redrill any deviated borings will be obtained from DOE prior to any attempts at redrilling. An acceptable drilling angle is one that maintains the boring within the window defined in the first sentence of this paragraph. The drilling angle is checked at the surface by using an adjustable slope indicator, as illustrated in Figure 8; the angle of the boring is measured at depth with an Inclinometer TM[1].

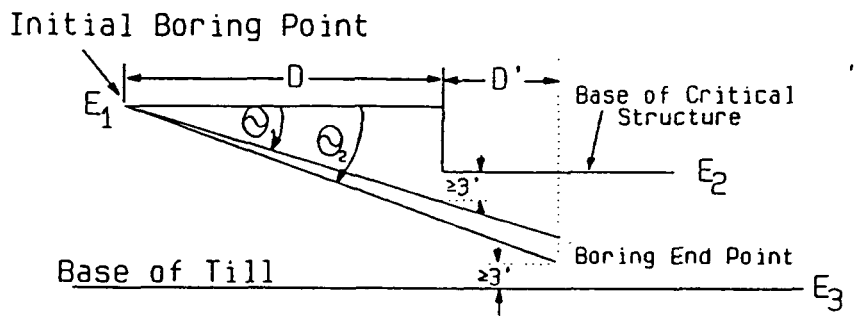
The frequency of the angle checks was initially proposed to be every five feet as the borehole is advanced. Tests and borings conducted previously showed that the five-foot frequency is more

[1]Manufactured by Slope Indicator Company, developed to be utilized to measure settlement or heave in foundations and embankments. The technology is transferable and can be used to measure the angle of a boring, accurate to within $\pm$ 0.1 inch per 100 feet of casing.

Table 1. Preliminary Boring Lengths, Critical Elevations, and Minimum Number of Samples Per Boring

Boring No.	Critical Structure/ Elevation	Approximate Base of Till at Final Sampling Pt. Elevation	Approximate Initial Boring Point Elevation	Approx. Boring Length (ft)	Min. # of Samples to be Submitted for the Specified Analyses
1	Silo Footer/ 572.62	546	578	145	7
2	Base of Decant Tank/560.75	547	573	145	4
3	Silo Footer/ 572.62	546	577	170	8
4	Silo Footer/ 572.62	546	576	115	4
5	Concrete Trench/571.1 Silo Footer/572.62	546	579	155	5

Ref: Drawing-3034-H-56-A; Trench Piping Sections
Drawing-51T20-3; Two 125,000 cf Slurry Storage Tanks-Type K-65
Map-75x 5500 G 00114 0; Fernald Facility (Topography)
Map-Base of Till Elevation, Prepared for the Fernald RI/FS



D = Distance to Critical Structure

L = Boring Length = D + D'

θ_1 = Minimum Drilling Angle

θ_2 = Maximum Drilling Angle

E_1 = Initial Boring Elevation

E_2 = Elevation of Base of Critical Structure

E_3 = Elevation of base of Till

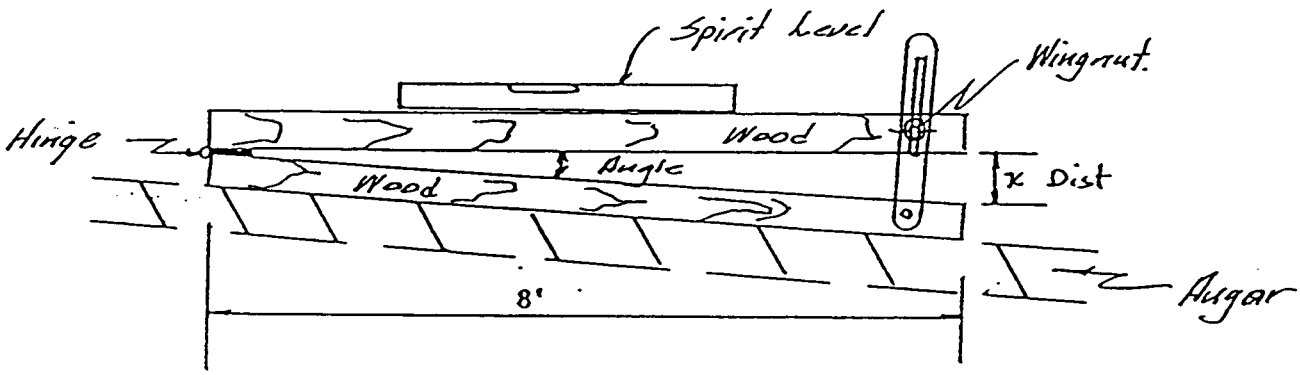
$$\theta_1 = \text{Arctan}\ \frac{E_1 - E_2 + 3}{D}$$

$$\theta_2 = \text{Arctan}\ \frac{E_1 - E_3 - 3}{L}$$

Boring Number	E_1 - Initial Boring Point Elevation (ft.)	E_2 - Critical Structure Elevation (ft.)	E_3 - Base of Till Elevation (ft.)	D - Distance to Critical Structure (ft.)	L - Boring Length Horizontal (ft.)	θ_1 - Minimum Drilling Angle (Degrees)	θ_2 - Maximum Drilling Angle (Degrees)
1	578	572.62	546	85	145	5.63	11.31
2	573	560.75	547	125	145	7.29	9.01
3	577	572.62	546	90	170	4.69	9.35
4	576	572.62	546	95	115	3.84	13.21
5	579	571.1	546	85	155	7.31	10.95

FIGURE 7 BORING ANGLE CALCULATION PARAMETERS

ADJUSTABLE SLOPE INDICATOR



ANGLE	X DISTANCE
13°	1.85'
12°	1.70'
11°	1.56'
10°	1.41'
9°	1.27'
8°	1.12'
7°	0.98'
6°	0.84'
5°	0.70'
4°	0.56'
3°	0.42'
2°	0.28'
1°	0.14'

Figure 8

often than is necessary. Further borings will be advanced based on the initial angle for one-half the distance from the ground surface to the critical structure before collecting down-hole inclination measurements. When a boring reaches the point that is half way to the critical structure, an inclinometer survey will be performed. An inclinometer survey collects angle data every two feet along the boring. Data from an inclinometer survey are used to construct a graph of the boring. The survey and graph provide the justification for continuing or abandoning the boring. Additional inclinometer surveys will be conducted at 20-foot intervals for the remainder of each boring. Note that the initial angle and distances to critical structures are calculated in the field by a licensed surveyor.

Borings 1615, 1617, 1618, and 1619 will not be advanced further than the perched water zone at this time. Boring 1616 will be temporarily cased and advanced through the perched water zone(s) in order to collect data from soils underlying the decant tank. Details of the use of temporary casing are presented in Section 2.2.

After drilling and sampling is complete, the boring will be plugged with cement-bentonite grout, utilizing the tremie line method. All cuttings will be drummed. All drums will be clearly labeled with location, depth interval, date, and drum contents. All drums will be staged pending RCRA and radiological characterization of the specified samples.

2.1 JUSTIFICATION FOR BORING ANGLE MONITORING FREQUENCY

The following provides justification for reducing the frequency of inclinometer surveys conducted on the slant borings:

- The test borings and Borings 1615 and 1617 have demonstrated that the boring angle can be maintained within tolerance so that inclinometer surveys every five feet are not necessary. Attachment 1 provides a summary of the borehole survey data collected from the test borings and Borings 1615 and 1617. These data show that the angle of the borings does indeed change with depth, but that the change is not a radical departure from the initial boring angle set at the surface.

- Each run of the inclinometer provides readings of the borehole angle every two feet. Therefore, the exact inclination of the boring is documented.

- Based upon test experience, an inclinometer survey at depth requires approximately two hours to perform. This means that in a 10-hour-workday a crew could drill only about 15 feet. At this rate a 150-foot-boring will require approximately 10 days to complete, not including demobilization and decontamination time.

- Conducting inclinometer surveys at five-foot intervals will unnecessarily expose the field crew to working in a radiation field for extended periods with little if any potential benefits.

2.2 USE OF TEMPORARY CASING

Boring 1616, which is intended to sample below the decant tank, will be cased during drilling in order to provide an opportunity to continue sampling soil for chemical and radiological analysis after encountering perched water. The complete set of the planned soil samples will be collected in order to determine if vertical migration of contaminants has occurred below the decant tank. The temporary casing will also provide an opportunity to distinguish and sample the individual perched water-bearing zone(s) as well as prevent hydraulic communication between the perched zones.

The temporary steel casing will be advanced along with, and slightly behind, the augers. The casing will be threaded, added in five-foot lengths, and have an inner diameter of 10 inches. In order to facilitate making up and breaking down the casing string, it is necessary to use a lubricant on the threads of the casing. The product to be used is a teflon-based lubricant with the trade name of Jet-Lube Well-Guard. A copy of the material safety data sheet and chemical analysis of the compound is included for review as Attachment 2.

2.3 SOIL SAMPLING PROCEDURES

Continuous, core type samples are being collected along the entire length of each of the five low-angle borings with a non-rotating bearing head sampler assembly. This sampler allows for the collection of up to five feet of relatively undisturbed sample per sampling run. Figure 9 is a general depiction of this type of sampling device. The sampler assembly is lined with two 30-inch tenite sleeves.

Figure 10 depicts the boring layout and scheduled sampling configuration. Additional samples may be submitted for analysis based on field screening. All samples are screened for radioactivity and volatiles. Radiological screening of samples is accomplished in the field with a pancake GM meter and an alpha detector. Alpha is screened for at the open ends of each 30-inch tube. Beta and gamma are screened for at the ends of the tubes as well as along the length of the tubes. Additionally, prior to archiving or shipping, the samples are screened for radioactivity with an ESP-1, Model 141, SPA-3, Sodium Iodine Scintillation Detector survey instrument as outlined in Section 6.0 of the RI/FS Quality Assurance Project Plan, Revision 3. Samples are being screened for volatiles with an HNu photoionization detector. Field measurements for volatiles are taken at both ends of each 30-inch tube. The use of an HNu photoionization detector is specified in the RI/FS Work Plan, Volume I, Section 4, page 3 of 9.

Samples displaying an elevated reading are analyzed for the corresponding parameters. For example, if a sample displays elevated radiation levels, it is submitted for full radiological analyses; if a sample displays an elevated HNu reading, it is analyzed for full HSL parameters. The scheduled samples are taken in five-foot lengths which are centered on each of the designated sample point locations shown in Figure 10. The final sample interval for analysis in each boring will be the last five feet of the boring. Results of field screening will be used to determine which section of the five-foot sample will be submitted for the specified analyses. If

BEARING HEAD SAMPLER

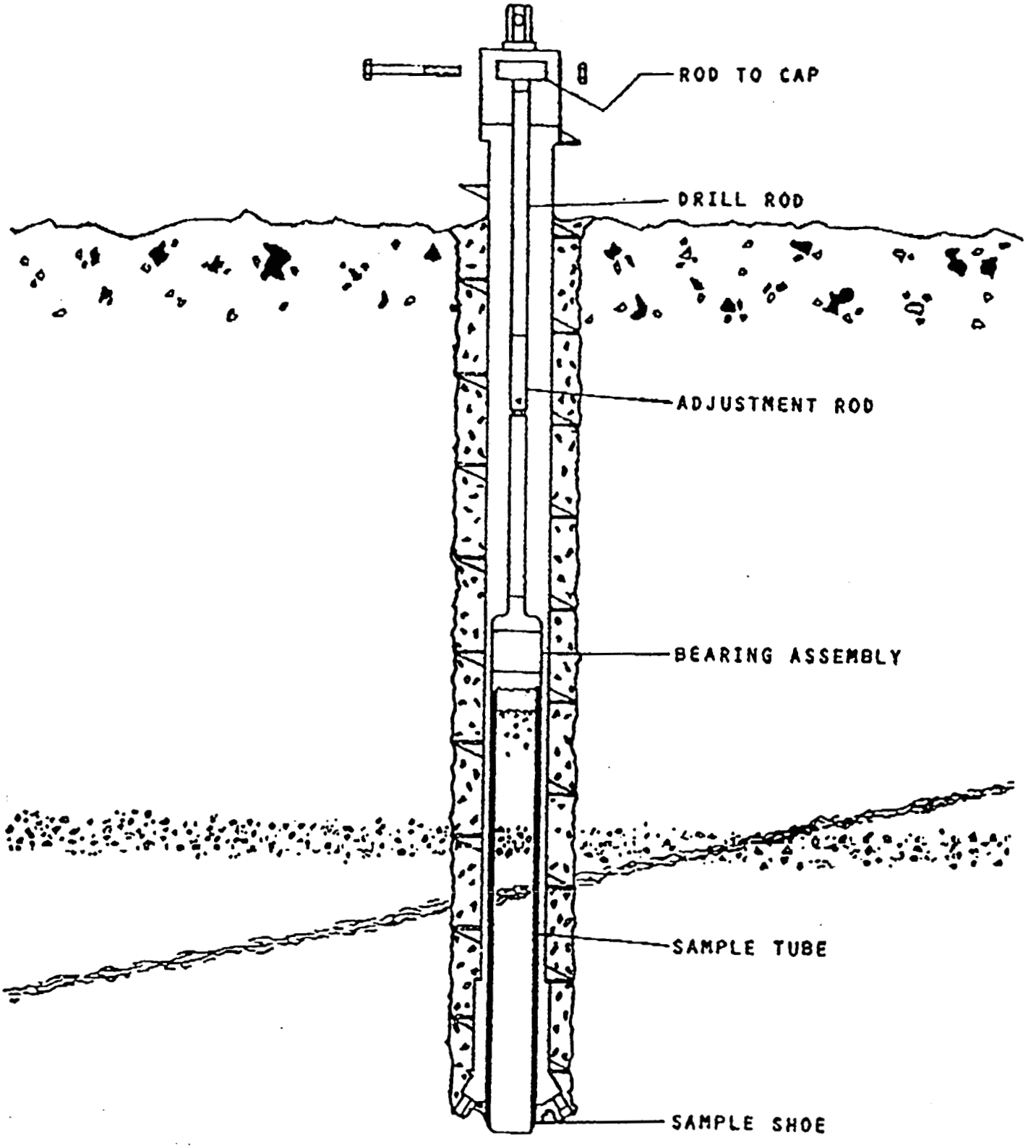
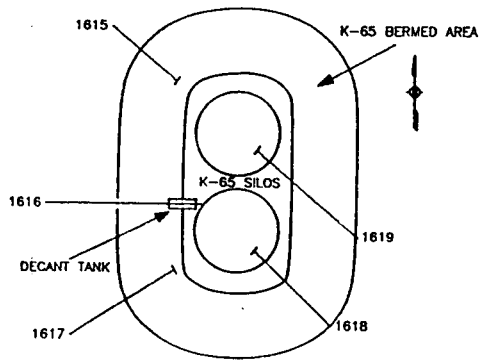
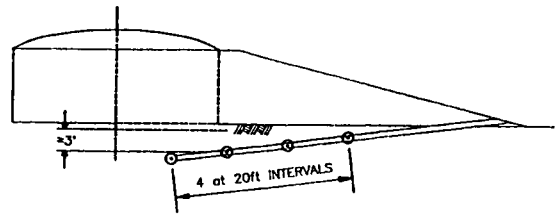


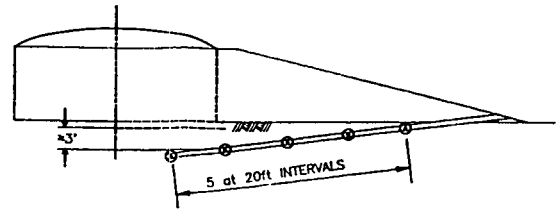
Figure 9



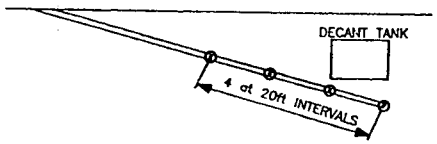
BORING LAYOUT



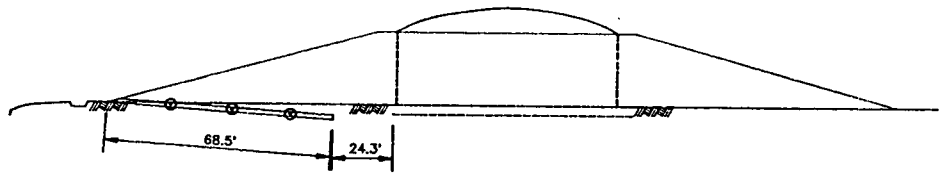
BORING 1618



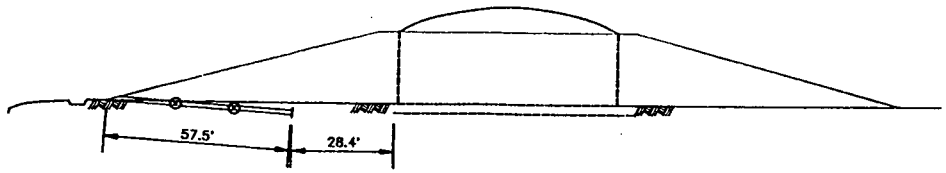
BORING 1619



BORING 1616



BORING 1617



BORING 1615

NOTES:

1. FOR DECANT TANK DETAILS SEE DWGS. 34x1450P00074 34x3500A00067
2. GENERAL LAYOUT K-65 STORAGE AREA: DWG. 3034-H-53-A, REV.3
3. FLOW DIAGRAM OF K-65 TRENCH PIPING: DWG. 34-4008, REV. 0
4. K-65 TANK EMBANKMENT STABILIZATION GENERAL LAYOUT: DWG. 34-5500G00084, REV. 1
5. SOIL SAMPLES HAVE BEEN SUBMITTED FOR ANALYSIS FROM BORINGS 1615 AND 1617 AT THE INDICATED LOCATIONS.
6. BORING 1616 WILL BE TEMPORARILY CASED IN ORDER TO COLLECT ALL THE SCHEDULED SAMPLES.

LEGEND:

⊙ LOW-ANGLE BORING CHEMICAL, RADIOLOGICAL, AND GEOTECHNICAL SAMPLE LOCATION

1615 THROUGH 1619 LOW-ANGLE BORING ALIGNMENT

602A_SLANTA_FND

FIGURE 10. REVISED BORING LAYOUT AND SCHEDULED SOIL SAMPLING CONFIGURATION – MAY 1991

field monitoring does not indicate a preference, then the first 2.5-foot length of the five-foot sample will be analyzed for chemical constituents, while the second 2.5-foot length will be analyzed for radiological constituents and geotechnical parameters. The balance of unused sample material will be sealed and archived. All boring logs, sample collection records, and analyses will be performed per the RI/FS Quality Assurance Project Plan requirements unless specifically altered by this addendum. Sample analyses are specified in Sections 2.5 and 2.6. They are summarized in Tables 2 and 3.

Soil sampling within Borings 1615 and 1617 has been suspended due to the occurrence of groundwater. Soil sampling may resume at Borings 1615 and 1617 based on the results of water sample analysis from the borings. Figures 10 and 11 show the revised soil sampling configuration and the originally proposed soil sampling configuration, respectively.

2.4 PERCHED GROUNDWATER SAMPLING PROCEDURES

Except for that noted here, sampling of groundwater from borings will be conducted as outlined in the RI/FS Work Plan Volume V, Section 6.0 (March, 1988). The Work Plan states that three well volumes will be purged prior to sampling in order to ensure that the sample is representative of the groundwater body. Experience has shown that the borings recharge slowly, and that water levels are currently falling due to seasonal drying. Consequently the pre-sample purge volume must be reduced to expedite groundwater sample collection from the slant borings. On June 6, 1991, technical staff from the United States Environmental Protection Agency (U.S. EPA) and Ohio Environmental Protection Agency (OEPA) were consulted and they concurred that sampling of the groundwater could occur after purging one volume of water if necessary. If recharge is sufficient, then three volumes of water will be purged prior to sampling.

During purging, field measurements of temperature, specific conductance, dissolved oxygen, pH, and turbidity will be collected. A stainless steel submersible pump will be used to purge and collect samples from the borings. Samples will be collected from a stainless steel sampling tee in the purge water line. Because the inclination of the boring is less than ten degrees from the horizontal, the submersible pump is the best tool for removing water from the boring; therefore, all samples will be collected using the submersible pump, including the HSL organics.

Water samples have been collected from Borings 1615, 1616, and 1617. If or when groundwater is encountered in Borings 1618 and 1619, it also will be collected as outlined above.

The groundwater sampling procedures described above have been previously described in RI/FS Variance Request Numbers 23 (May 14, 1991) and 24 (June 6, 1991).

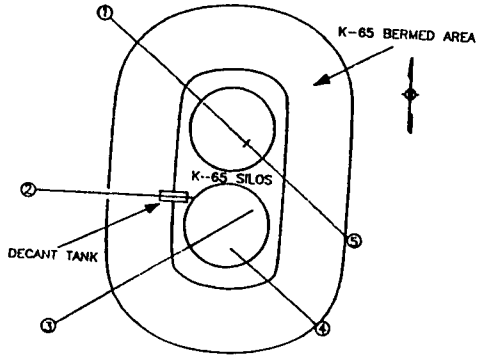
Table 2. K-65 Silo Subsoils
Geotechnical, Chemical, and Radiological Test Schedule

Test Type	Performed By	Minimum No. of Tests	Required Test Completion Date	Minimum Sample Size Per Test	Sample Location
Full radiological analysis per "RI/FS, FMPC, Work Plan," dated March 31, 1988	IT Corp.	18	8 weeks after receipt of sample	1.1 kg per[b] Series	Per Fig. 10
Pb^{210}, Po^{210}, Ac^{227}, Pa^{231}		18			
Full HSL analysis per "RI/FS, FMPC, Work Plan," dated March 31, 1988	IT Corp.	18	8 weeks after receipt of sample	1.3 kg per[b] Series	Per Fig. 10
TCLP Organics and Inorganics[c]		18			
ASTM D2216-80		18	8 weeks after receipt of samples		Per Fig. 10
ASTM D4318-84	GeoTechnical Subcontractor[a]	18		125 g	
ASTM D854-83		18			
ASTM D422-63		18		4 kg	
ASTM D2487-85		18			

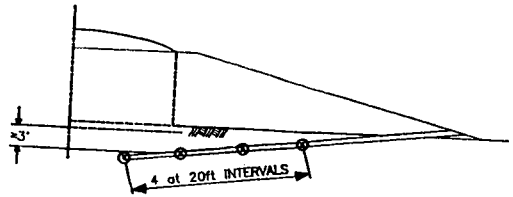
[a]Tests will be completed in laboratory setting and comply with the ASTM.
[b]Samples will be packaged and shipped in the appropriate containers as outlined in Revision 3 of the RI/FS Work Plan, Volume I: Sampling Plan and Volume V: Quality Assurance Project Plan.
[c]TCLP organics will be analyzed at the same frequency as the HSL analyses due to the short holding times for organics. TCLP inorganics will be analyzed when the HSL inorganics are found to be above regulatory limits.

Table 3. Geotechnical Properties

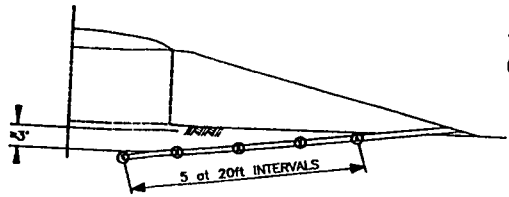
Method Title	Reference
Water Content Determination	ASTM D2216-80, "Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures," 1987 Annual Book of ASTM Standards Vol. 04.08 Soil and Rock; Building Stones; Geotextiles
Atterberg Limits	ASTM D4318-84, "Standard Test Methods for Liquid Limit, Plastic Limit, and Plastic Index of Soils," 1987 Annual Book of ASTM Standards Vol. 04.08 Soil and Rock; Building Stones; Geotextiles
Specific Gravity Determination	ASTM D854-83, "Standard Test Method for Specific Gravity of Soils," 1987 Annual Book of ASTM Standards Vol. 04.08 Soil and Rock; Building Stones; Geotextiles
Grain Size	ASTM D422-63, "Particle Size Analysis of Soils," 1987 Annual Book of ASTM Standards Vol. 04.08 Soil and Rock; Building Stones; Geotextiles
Soils Classification	ASTM D2487-85, "Standard Test Method for Classification of Soils for Engineering Purposes," 1987 Annual Book of ASTM Standards Vol. 04.08 Soil and Rock; Building Stones; Geotextiles



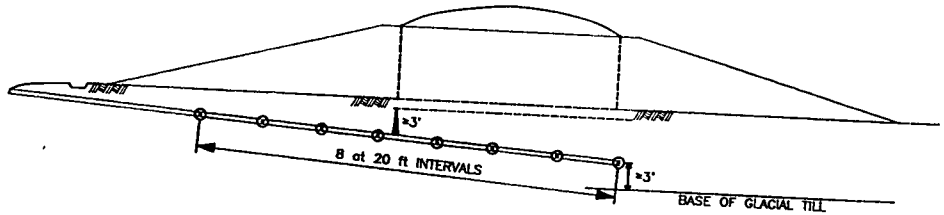
BORING LAYOUT



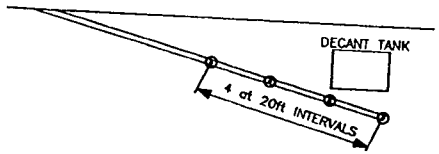
BORING 4



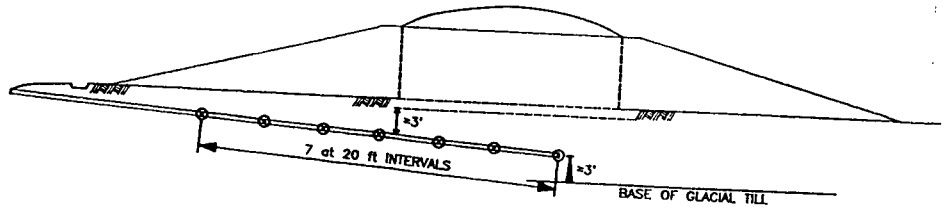
BORING 5



BORING 3



BORING 2



BORING 1

NOTES:

1. FOR DECANT TANK DETAILS SEE DWGS. 34x1450P00074 34x3500A00067
2. FILL ALL BORINGS WITH BENTONITE GROUT PRIOR TO ABANDONING.
3. GENERAL LAYOUT K-65 STORAGE AREA: DWG. 3034-H-53-A, REV.3
4. FLOW DIAGRAM OF K-65 TRENCH PIPING: DWG. 34-4008, REV. 0
5. K-65 TANK EMBANKMENT STABILIZATION GENERAL LAYOUT: DWG. 34-5500G00084, REV. 1

LEGEND:

⊙ DIAGONAL BORING SAMPLE LOCATION

① THROUGH ⑤ DIAGONAL BORING ALIGNMENT

602A_SLANT_FND

FIGURE 11 PROPOSED BORING LAYOUT AND SCHEDULED SOIL SAMPLING CONFIGURATION – NOV. 1990

2.5 RADIOLOGICAL AND CHEMICAL ANALYSES

2.5.1 SOIL ANALYSES

Soil samples at the specified intervals will be analyzed for radiological and chemical constituents. The required radiological and chemical analyses are listed below:

- Full radiological analysis as defined in the RI/FS Quality Assurance Project Plan, dated March 31, 1988, Section 4.0.
- Lead-210 (Pb-210), Polonium-210 (Po-210), Actinium-227 (Ac-227), and Protactinium-231 (Pa-231).
- Full HSL analysis as defined in the RI/FS Quality Assurance Project Plan, dated March 31, 1988.
- TCLP Organics and inorganics[2]

2.5.2 GROUNDWATER ANALYSES

The groundwater from the borings will be analyzed for radiological and HSL parameters consistent with the analytical requirements specified above. Additionally, the groundwater samples will be analyzed for RI/FS general water chemistry parameters and metals as outlined in Table 4-1 of the RI/FS Quality Assurance Project Plan, dated March 1988. All of the above analyses will be completed at one of the laboratories listed in the March 1988 RI/FS Work Plan. Splits of the groundwater samples will be analyzed for the following parameters at the on-site WMCO laboratory: barium, total lead, gross alpha, gross beta, thorium-230, total thorium, radium-226, isotopic uranium, and total uranium.

2.6 GEOTECHNICAL ANALYSES

The physical properties of the embankment and subsoils will be used to determine the expected soils behavior during remedial alternative soil conditioning, as well as general geological and descriptive geotechnical parameters. The ASTM standards and analytical procedures are identified in Table 3.

All sample analytical testing will be conducted as specified under the appropriate ASTM standards and laboratory procedures using qualified geotechnical technician(s) and properly calibrated apparatus which meet the intent of ASTM D3740-80. Documentation for the testing will conform to the standards set forth in the RI/FS Quality Assurance Project Plan.

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[2]If the HSL analyses show that inorganics are above regulatory concern, TCLP inorganics will be analyzed.

2.7 TECHNICAL APPROACH

On May 22, 1991, representatives from the Department Of Energy (DOE) and Westinghouse Materials Company Of Ohio (WMCO) met with EPA and OEPA concerning the K-65 subsoils sampling. The meeting was held to inform the EPAs of the status of the K-65 subsoils sampling and to obtain their concurrence on the direction in which to proceed with the project, as a result of encountering water in Borings 1615 and 1617. The investigation is to proceed as follows:

- Water in Borings 1615 (No. 1) and 1617 (No. 3) has been sampled. Results will be available in early July, 1991.

- Boring 1616 (No. 2) has been extended to the perched water zone and groundwater samples were collected. Borings 1618 (No. 4) and 1619 (No. 5) will be completed per the K-65 Silo Subsoils Sampling and Analysis Plan, dated November 13, 1990.

- Procure and advance a temporary casing along with the augers in Boring 1616 (No. 2) so that soil samples may be collected and analyzed below any perched water that may be encountered.

- If perched water is encountered in Borings 1618 or 1619, the borings will be halted and the water sampled.

- All perched water samples will be collected and analyzed as outlined in Section 2.4 of this Sampling and Analysis Plan

- When the results of all the perched water samples analyzed at the on-site WMCO laboratory are available, they will be presented to the EPAs for their concurrence on whether the objectives of the plan have been met or additional sampling is required.

2.8 EMERGENCY PROCEDURES

If an emergency situation arises during the course of this work, it will be handled as outlined in the WMCO K-65 Silo Numbers 1 and 2 Area Emergency Procedures (SOP 65-C-107 dated 3/1/90). If highly radioactive material is encountered, as defined in the safety plan, the boring will be immediately plugged as this will be an indication that the silo is leaking excessively.

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JET-LUBE INC.

MATERIAL SAFETY DATA SHEET

4849 HOMESTEAD ROAD / P.O. BOX 21258 / HOUSTON, TEXAS 77226 / 713/674-7617 / TELEX 775393

SECTION I: IDENTIFICATION AND EMERGENCY INFORMATION

Product: JET-LUBE WELL-GUARD™
Chemical Name: Mixture

Emergency Phone: 713-674-7617
Formula: Proprietary

SECTION II: HAZARDOUS INGREDIENTS

Hazardous Components	CAS No.	Wt%	OSHA PEL	ACGIH TLV	Other Limits of Exposure
None					

SECTION III: PHYSICAL & CHEMICAL DATA

Specific Gravity (H_2O=1): 1.28
Boiling Point: UN
Melting Point: NA
Vapor Pressure (mm Hg): <0.01
Vapor Density (Air=1): 75
Evaporation Rate (n-Butyl Acetate=1): NIL
Volume % Volatile: None
Solubility in Water: None
Reactivity With Water: Non
Appearance and Odor: Ivory colored, grainy paste, sweet odor.

SECTION IV: FIRE & EXPLOSION HAZARD DATA

Flash Point (COC): >500°F 260°C
Flammable Limits: LEL= UN UEL= UN
Auto-Ignition Temperature: >300°C
Extinguishing Media: Use foam, dry chemical, water spray (fog), carbon dioxide, or vaporizing liquid-type extinguishing agents.
Special Fire Fighting Procedures: Use supplied-air breathing equipment for enclosed or confined spaces.
Unusual Fire and Explosion Hazards: None

SECTION V: REACTIVITY DATA

Stability: Stable (x) Unstable ( )
Conditions to Avoid: Strong oxidizing materials
Incompatible Materials: Strong oxidizing materials
Hazardous Decomposition Products: None
Hazardous Polymerization: (x) Will Not Occur ( ) May Occur
Conditions to Avoid: Gaseous oxygen systems

< = LESS THAN > = GREATER THAN M = MAXIMUM NA = NOT APPLICABLE
! = NOT REQUIRED UN = UNKNOWN CL = CEILING PK = PEAK

1866

SECTION VI: HEALTH HAZARD DATA

Symptoms of Exposure: None known.
Effects of Overexposure: None expected if reasonable care and caution exercised.
Medical Conditions Potentially Aggravated by Exposure: UN
Material Listed as Carcinogen or Potential Carcinogen
National Toxicology Program: No IARC Monographs: No OSHA: No
Emergency and First Aid Procedures (by route of entry)
Inhalation: Clear air passage, call physician.
Ingestion: Product non-toxic. Will result in mild discomfort and diarrhea. Consult a physician.
Eyes: Wash with copious quantities of water.
Skin: Remove by wiping, or waterless hand cleaner, followed by washing.

SECTION VII: SPILL OR LEAK PROCEDURES

Steps to be Taken in Case Material is Released or Spilled: Scoop up excess, wipe up with rags, pick-up residue with diatomaceous earth to avoid walking hazard.
Waste Disposal Method: Product contains biodegradable fluids and non-toxic, non-metallic, inorganic powdered solids. Consult federal, state, and local regulations.

SECTION VIII: SPECIAL PROTECTION INFORMATION

Respiratory Protection (Type): NR
Ventilation: Local Exhaust: NR Special: NR Mechanical: NR
Other: NR
Protective Gloves: NR Eye Protection: NR Other: NR
Other Protective Equipment: Persons with hypersensitive skin should use gloves.
Special Hygienic Practice: Wash hands before eating.

SECTION IX: SPECIAL PRECAUTIONS

Precautions to be Taken in Handling and Storing: None
Other Precautions: None

< = LESS THAN > = GREATER THAN M = MAXIMUM NA = NOT APPLICABLE
NR = NOT REQUIRED UN = UNKNOWN CL = CEILING PK = PEAK

Signature: Donald A. Oldiges Date Issued: December 21, 1988
Prepared By: Donald A. Oldiges
Technical Director

Disclaimer

The information contained herein is accurate and reliable as of the date issued to the best of Jet-Lube's knowledge. Jet-Lube doesn't warrant or guarantee its accuracy or reliability and shall not be liable for any loss or damage arising out of the use thereof. It is the user's responsibility to satisfy itself that the information offered for its consideration is suitable for its particular use.

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ACS LABS
ANALYTICAL CONSULTING SERVICES
16203 Park Row, Suite 100 • Houston, Texas 77084
(713) 579-8822 Fax (713) 579-9663

January 10, 1989

Mr. Dan Oldiges
JET-LUBE, INC.
P. O. box 21258
Houston, Texas 77226-1258

Subject: Analysis of one Monitor Well Drilling Compound sample.

RE: Lab No. 812-147

EP TOXIC METALS Results reported in milligrams per liter, Leachate basis.

Parameter	Monitor Well Drill Compound
Arsenic	<0.01
Barium	<0.01
Beryllium	<0.01
Cadmium	<0.01
Chromium	<0.01
Copper	<0.01
Nickel	<0.01
Lead	<0.01
Mercury	<0.005
Antimony	<0.01
Selenium	<0.01
Silver	<0.01
Zinc	0.01
Thallium	<0.01

VOLATILE ORGANICS Results reported in milligrams per kilogram.

Parameter	Monitor Well Drill Compound
Methylene Chloride	<0.5
Trichlorofluoromethane	<0.5
1,1-Dichloroethene	<0.5
1,1-Dichloroethane	<0.5
Chloroform	<0.5
Carbon Tetrachloride	<0.5
1,2-Dichloropropane	<0.5
Trichloroethene	<0.5

-continued-

Mr. Dan Oldiges
JET-LUBE
Lab No. 812-147
Jan. 10, 1989
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VOLATILE ORGANICS Continued

Parameter	Monitor Well Drill Compound
Dibromochloromethane	<0.5
1,1,2-Trichloroethane	<0.5
2-Chloroethylvinyl Ether	<0.5
Trans-1,2-Dichloroethene	<0.5
1,2-Dichloroethane	<0.5
1,1,1-Trichloroethane	<0.5
Bromodichloromethane	<0.5
Cis-1,3-Dichloroporpene	<0.5
Benzene	<0.5
Trans-1,3-Dichloropropene	<0.5
Bromoform	<0.5
1,1,2,2-Tetrachloroethane	<0.5
Acrolein	<0.5
Acrylonitrile	<0.5
Chloromethane	<0.5
Bromomethane	<0.5
Vinyl Chloride	<0.5
Chloroethane	<0.5
Tetrachloroethene	<0.5
Chlorobenzene	<0.5
Toluene	<0.5
Ethyl Benzene	<0.5

PESTICIDE EXTRACTABLES Results reported in milligrams per kilogram.

Parameter	Monitor Well Drill Compound
A-BHC	<1
B-BHC	<1
D-BHC	<1
G-BHC	<1
Aldrin	<1
Chlordane	<1
4,4'-DDD	<1

-continued-

Mr. Dan Oldiges
JET-LUBE
Lab No. 812-147
Jan. 10, 1989
Page -3-

PESTICIDE EXTRACTABLES Continued

Parameter	Monitor Well Drill Compound
4,4'-DDE	<1
4,4'-DDT	<1
Dieldrin	<1
Endosulfan I	<1
Endosulfan II	<1
Endosulfan Sulfate	<1
Endrin	<1
Endrin Aldehyde	<1
Heptachlor	<1
Heptachlor Epoxide	<1
Toxaphene	<1
PCB-1016	<1
PCB-1221	<1
PCB-1232	<1
PCB-1242	<1
PCB-1248	<1
PCB-1254	<1
PCB-1260	<1

SEMIVOLATILE COMPOUNDS Results reported in micrograms per kilogram.

Parameter	Monitor Well Drill Compound
Phenol	<34000
bis(2-Chloroethyl)Ether	<34000
2-Chlorophenol	<34000
1,3-Dichlorobenzene	<34000
1,4-Dichlorobenzene	<34000
Benzyl Alcohol	<34000
1,2-Dichlorobenzene	<34000
2-Methylphenol	<34000
bis(2-Chloroisopropyl)Ether	<34000
4-Methylphenol	<34000
N-Nitroso-Di-n-Propylamine	<34000

-continued-

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Mr. Dan Oldiges
JET-LUBE
Lab No. 812-147
Jan. 10, 1989
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SEMIVOLATILE COMPOUNDS Continued

Parameter	Monitor Well Drill Compound
Hexachloroethane	<34000
Nitrobenzene	<34000
Isophorone	<34000
2-Nitrophenol	<34000
2,4-Dimethylphenol	<34000
Benzoic Acid	<34000
bis(2-Chloroethoxy)Methane	<34000
2,4-Dichlorophenol	<34000
1,2,4-Trichlorobenzene	<34000
Naphthalene	<34000
4-Chloroaniline	<34000
Hexachlorobutadiene	<34000
4-Chloro-3-Methylphenol	<34000
2-Methylnaphthalene	<34000
Hexachlorocyclopentadiene	<34000
2,4,6-Trichlorophenol	<34000
2,4,5-Trichlorophenol	<160000
2-Chloronaphthalene	<34000
2-Nitroaniline	<160000
Dimethyl Phthalate	<34000
Acenaphthylene	<34000
3-Nitroaniline	<160000
Acenapphthene	<34000
2,4-Dinitrophenol	<160000
4-Nitrophenol	<160000
Dibenzofuran	<34000
2,4-Dinitrotoluene	<34000
2,6-Dinitrotoluene	<34000
Diethylphthalate	<34000
4-Chlorophenyl-phenylether	<34000
Fluorene	<34000
4-Nitroaniline	<160000
4,6-Dinitro-2-Methylphenol	<160000
N-Nitrosodiephenylamine (1)	<34000
4-Bromophenyl-phenylether	<34000

-continued-

Mr. Dan Oldiges
JET-LUBE
Lab No. 812-147
Jan. 10, 1989
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SEMIVOLATILE COMPOUNDS Continued

Parameter	Monitor Well Drill Compound
Hexachlorobenzene	<34000
Pentachlorophenol	<160000
Phenanthrene	<34000
Anthracene	<34000
Di-n-Butylphthalate	<34000
Fluoranthene	<34000
Pyrene	<34000
Butylbenzylphthalate	<34000
3,3'-Dichlorobenzidine	<67000
Benzo-(a)Anthracene	<34000
bis(2-Ethylhexyl)Phthalate	<34000
Chrysene	<34000
Di-n-Octyl Phthalate	<34000
Benzo(b)Fluoranthene	<34000
Benzo(k)Fluoranthene	<34000
Benzo(a)Pyrene	<34000
Indeno(1,2,3-cd)Pyrene	<34000
Dibenz(a,h)anthracene	<34000
Benzo(g,h,i)Perylene	<34000

UNLESS OTHERWISE REQUESTED ALL SAMPLES WILL BE DISPOSED OF AFTER 30 DAYS

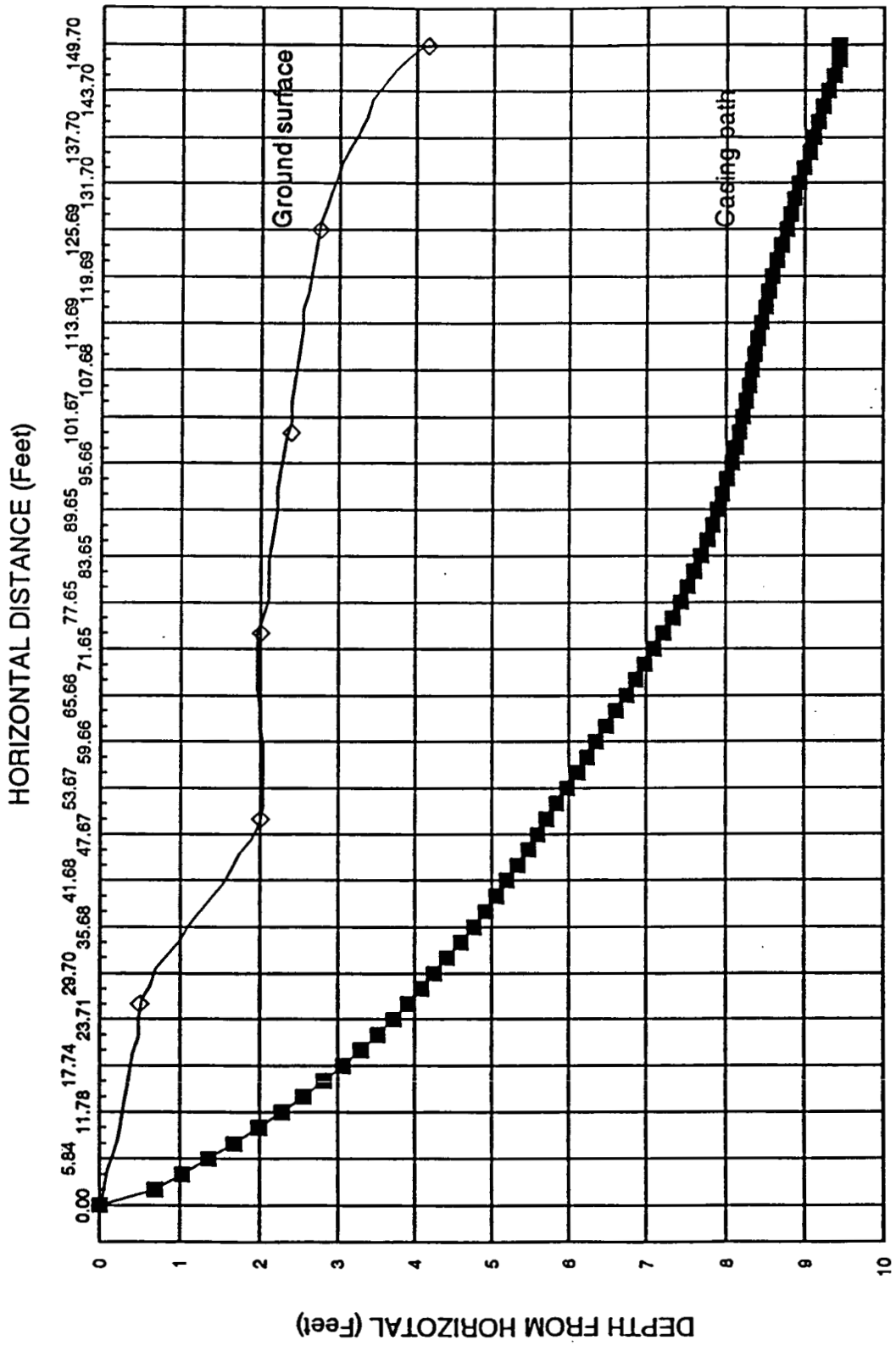
QUALITY ASSURANCE: Samples are analyzed in accordance with EPA, Standard Methods or ASTM procedures with at least 10% analyzed in duplicate. Serial dilutions and/or process spikes are routinely employed to assure accuracy and precision of the reported data.

ANALYTICAL CONSULTING SERVICES, INC.

Ernest P. Williams
Lab Director

EPW/bdm.

1866



SLANT BORING No.1 SOUTH OF BLDG UNO

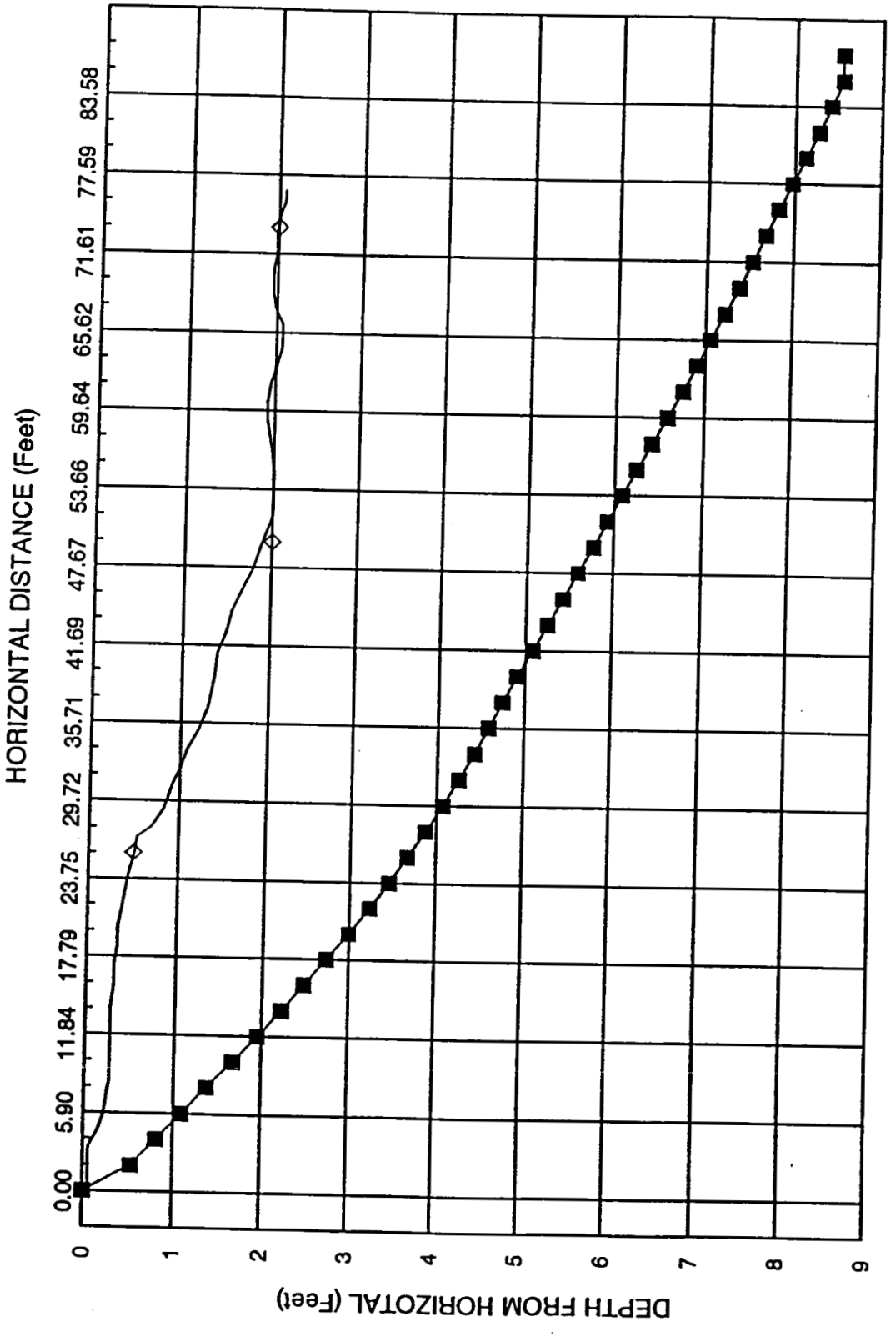
Graph #: SB1. March 07, 1991

DATA SHEET
SLANT BORING No. 1 SOUTH OF BLDG UNO
Data #: SB1. MARCH 07, 1991
GRAPH # SB1

Depth of casing	A+	A−	Check sum	Initial diff.	Angle at Xn point	AVG Angle Xo to Xn	Change	Depth from hztl. Inches	Feet
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	3397.00	−3316.00	81.00	6713.00	9.66	9.66	6982.00	4.19	0.35
4.00	3511.00	−3471.00	40.00	6982.00	10.05	9.86	13751.00	8.25	0.69
6.00	3401.00	−3368.00	33.00	6769.00	9.74	9.82	20318.00	12.19	1.02
8.00	3311.00	−3256.00	55.00	6567.00	9.45	9.73	26632.00	15.98	1.33
10.00	3178.00	−3136.00	42.00	6314.00	9.08	9.60	32874.00	19.72	1.64
12.00	3144.00	−3098.00	46.00	6242.00	8.98	9.49	38747.00	23.25	1.94
14.00	2956.00	−2917.00	39.00	5873.00	8.44	9.34	44245.00	26.55	2.21
16.00	2765.00	−2733.00	32.00	5498.00	7.90	9.16	49449.00	29.67	2.47
18.00	2632.00	−2572.00	60.00	5204.00	7.48	8.98	54336.00	32.60	2.72
20.00	2441.00	−2446.00	−5.00	4887.00	7.02	8.78	58960.00	35.38	2.95
22.00	2287.00	−2337.00	−50.00	4624.00	6.64	8.59	63317.00	37.99	3.17
24.00	2165.00	−2192.00	−27.00	4357.00	6.25	8.39	67311.00	40.39	3.37
26.00	2004.00	−1990.00	14.00	3994.00	5.73	8.19	71189.00	42.71	3.56
28.00	2007.00	−1871.00	136.00	3878.00	5.56	8.00	74668.00	44.80	3.73
30.00	1807.00	−1672.00	135.00	3479.00	4.99	7.80	78029.00	46.82	3.90
32.00	1765.00	−1596.00	169.00	3361.00	4.82	7.61	81476.00	48.89	4.07
34.00	1742.00	−1705.00	37.00	3447.00	4.94	7.46	84923.00	50.95	4.25
36.00	1736.00	−1711.00	25.00	3447.00	4.94	7.32	88365.00	53.02	4.42
38.00	1739.00	−1703.00	36.00	3442.00	4.94	7.19	91340.00	54.80	4.57
40.00	1504.00	−1471.00	33.00	2975.00	4.27	7.04	94070.00	56.44	4.70
42.00	1387.00	−1343.00	44.00	2730.00	3.91	6.90	96806.00	58.08	4.84
44.00	1387.00	−1349.00	38.00	2736.00	3.92	6.76	99598.00	59.76	4.98
46.00	1415.00	−1377.00	38.00	2792.00	4.00	6.64	102374.00	61.42	5.12
48.00	1408.00	−1368.00	40.00	2776.00	3.98	6.53	104791.00	62.87	5.24
50.00	1225.00	−1192.00	33.00	2417.00	3.46	6.41	107100.00	64.26	5.36
52.00	1172.00	−1137.00	35.00	2309.00	3.31	6.29	109578.00	65.75	5.48
54.00	1261.00	−1217.00	44.00	2478.00	3.55	6.19	112233.00	67.34	5.61
56.00	1350.00	−1305.00	45.00	2655.00	3.81	6.10	114984.00	68.99	5.75
58.00	1395.00	−1356.00	39.00	2751.00	3.94	6.03	117389.00	70.43	5.87
60.00	1218.00	−1187.00	31.00	2405.00	3.45	5.94	119743.00	71.85	5.99
62.00	1203.00	−1151.00	52.00	2354.00	3.37	5.86	122209.00	73.33	6.11
64.00	1256.00	−1210.00	46.00	2466.00	3.53	5.79	124811.00	74.89	6.24
66.00	1323.00	−1279.00	44.00	2602.00	3.73	5.72	127502.00	76.50	6.38
68.00	1364.00	−1327.00	37.00	2691.00	3.86	5.67	129915.00	77.95	6.50
70.00	1227.00	−1186.00	41.00	2413.00	3.46	5.61	132198.00	79.32	6.61
72.00	1163.00	−1120.00	43.00	2283.00	3.27	5.54	134518.00	80.71	6.73
74.00	1182.00	−1138.00	44.00	2320.00	3.33	5.48	136928.00	82.16	6.85
76.00	1226.00	−1184.00	42.00	2410.00	3.45	5.43	139341.00	83.60	6.97
78.00	1221.00	−1192.00	29.00	2413.00	3.46	5.38	141300.00	84.78	7.07
80.00	996.00	−963.00	33.00	1959.00	2.81	5.31	142943.00	85.77	7.15
82.00	840.00	−803.00	37.00	1643.00	2.35	5.24	144609.00	86.77	7.23
84.00	856.00	−810.00	46.00	1666.00	2.39	5.17	146304.00	87.78	7.32
86.00	868.00	−827.00	41.00	1695.00	2.43	5.11	147966.00	88.78	7.40
88.00	852.00	−810.00	42.00	1662.00	2.38	5.05	149242.00	89.55	7.46
90.00	653.00	−623.00	30.00	1276.00	1.83	4.98	150363.00	90.22	7.52

DATA SHEET
SLANT BORING No. 1 SOUTH OF BLDG UNO
Data #: SB1. MARCH 07, 1991
GRAPH # SB1

Depth of casing	A+	A-	Check sum	Initial diff.	Angle at Xn point	AVG Angle Xo to Xn	Change	Depth from hztl. Inches	Feet
92.00	579.00	-542.00	37.00	1121.00	1.61	4.90	151539.00	90.92	7.58
94.00	612.00	-564.00	48.00	1176.00	1.68	4.83	152815.00	91.69	7.64
96.00	660.00	-616.00	44.00	1276.00	1.83	4.77	154081.00	92.45	7.70
98.00	653.00	-613.00	40.00	1266.00	1.81	4.71	155032.00	93.02	7.75
100.00	491.00	-460.00	31.00	951.00	1.36	4.64	155847.00	93.51	7.79
102.00	428.00	-387.00	41.00	815.00	1.17	4.58	156673.00	94.00	7.83
104.00	433.00	-393.00	40.00	826.00	1.18	4.51	157619.00	94.57	7.88
106.00	493.00	-453.00	40.00	946.00	1.36	4.45	158566.00	95.14	7.93
108.00	492.00	-455.00	37.00	947.00	1.36	4.39	159269.00	95.56	7.96
110.00	370.00	-333.00	37.00	703.00	1.01	4.33	159907.00	95.94	8.00
112.00	339.00	-299.00	40.00	638.00	0.91	4.27	160758.00	96.45	8.04
114.00	398.00	-453.00	-55.00	851.00	1.22	4.22	161678.00	97.01	8.08
116.00	485.00	-435.00	50.00	920.00	1.32	4.17	162746.00	97.65	8.14
118.00	554.00	-514.00	40.00	1068.00	1.53	4.12	163559.00	98.14	8.18
120.00	425.00	-388.00	37.00	813.00	1.16	4.07	164403.00	98.64	8.22
122.00	443.00	-401.00	42.00	844.00	1.21	4.03	165399.00	99.24	8.27
124.00	521.00	-475.00	46.00	996.00	1.43	3.98	166604.00	99.96	8.33
126.00	627.00	-578.00	49.00	1205.00	1.73	3.95	167954.00	100.77	8.40
128.00	694.00	-656.00	38.00	1350.00	1.93	3.92	168952.00	101.37	8.45
130.00	515.00	-483.00	32.00	998.00	1.43	3.88	169880.00	101.93	8.49
132.00	482.00	-446.00	36.00	928.00	1.33	3.84	171025.00	102.62	8.55
134.00	595.00	-550.00	45.00	1145.00	1.64	3.81	172343.00	103.41	8.62
136.00	683.00	-635.00	48.00	1318.00	1.89	3.78	173796.00	104.28	8.69
138.00	747.00	-706.00	41.00	1453.00	2.08	3.75	174993.00	105.00	8.75
140.00	616.00	-581.00	35.00	1197.00	1.71	3.73	176078.00	105.65	8.80
142.00	560.00	-525.00	35.00	1085.00	1.55	3.69	177290.00	106.37	8.86
144.00	627.00	-585.00	42.00	1212.00	1.74	3.67	178638.00	107.18	8.93
146.00	699.00	-649.00	50.00	1348.00	1.93	3.64	180034.00	108.02	9.00
148.00	718.00	-678.00	40.00	1396.00	2.00	3.62	181178.00	108.71	9.06
150.00	590.00	-554.00	36.00	1144.00	1.64	3.60	181178.00	108.71	9.06

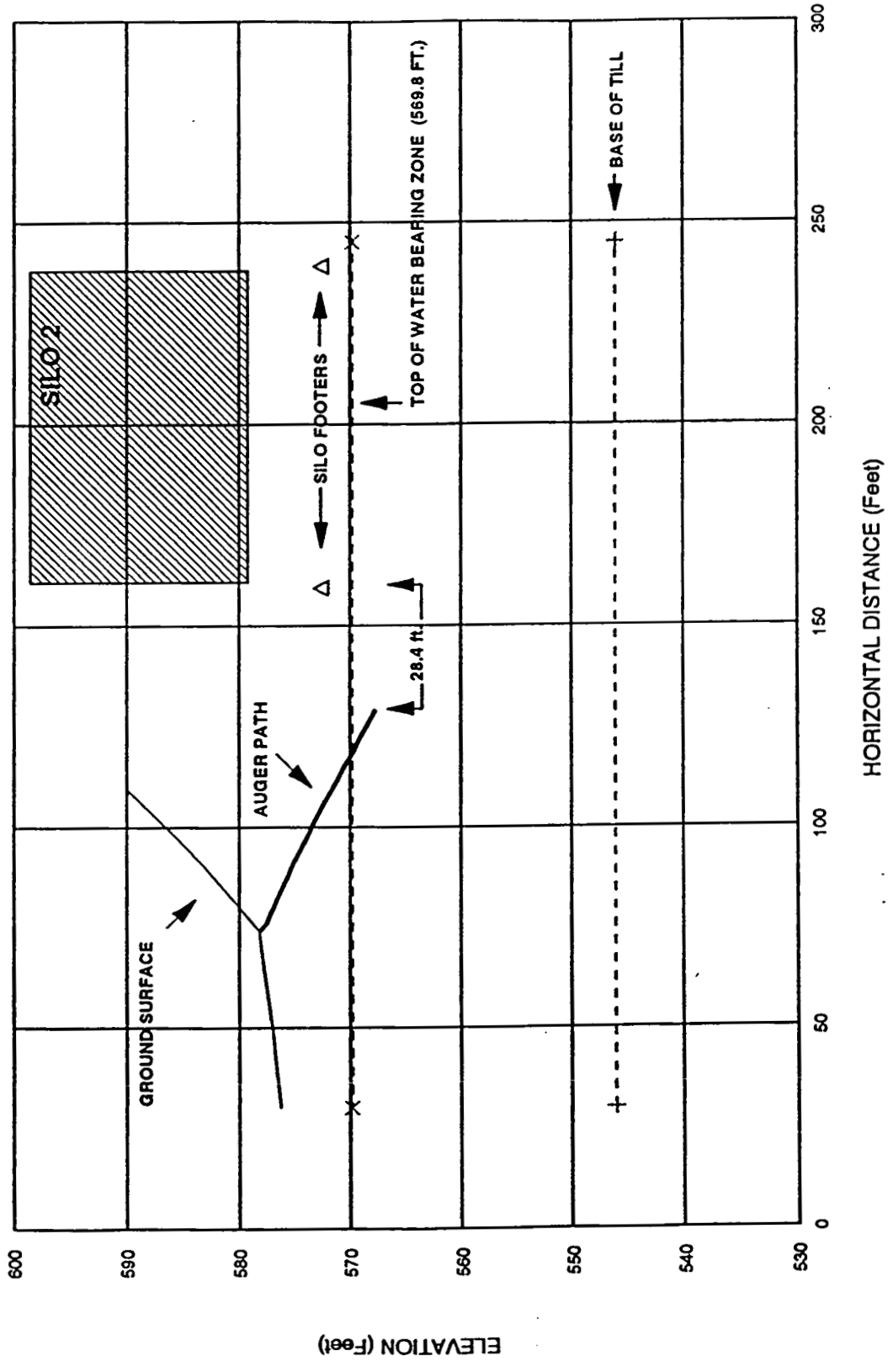


SLANT BORING No.2 SOUTH OF BLDG UNO

Graph #: SB2. March 18, 1991

DATA SHEET
SLANT BORING No. 2 SOUTH OF BLDG UNO
DATA #: SB2. MARCH 18, 1991
GRAPH #:SB2

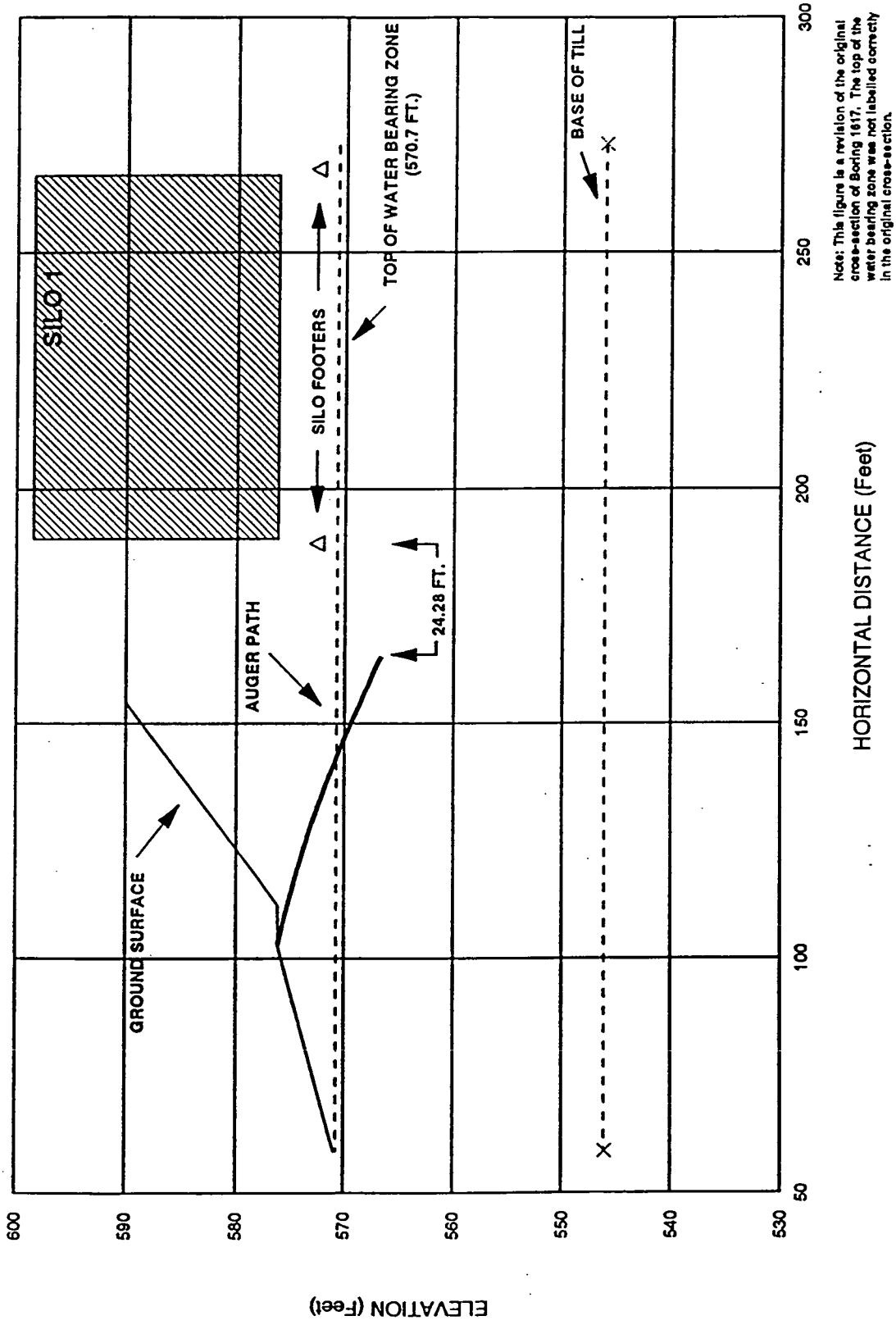
Depth casing	A+	A−	Check sum	Inital diff.	Angle at Xn point	AVG Angle Xo to Xn	Change	Depth from hzl. Inches	Feet
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	2618.00	−2592.00	26.00	5210.00	7.48	7.48	10510.00	6.31	0.53
4.00	2664.00	−2636.00	28.00	5300.00	7.61	7.55	16093.00	9.66	0.80
6.00	2806.00	−2777.00	29.00	5583.00	8.02	7.71	21726.00	13.04	1.09
8.00	2830.00	−2803.00	27.00	5633.00	8.10	7.80	27492.00	16.50	1.37
10.00	2895.00	−2871.00	24.00	5766.00	8.29	7.90	33305.00	19.98	1.67
12.00	2917.00	−2896.00	21.00	5813.00	8.36	7.98	38920.00	23.35	1.95
14.00	2818.00	−2797.00	21.00	5615.00	8.07	7.99	44289.00	26.57	2.21
16.00	2696.00	−2673.00	23.00	5369.00	7.71	7.96	49412.00	29.65	2.47
18.00	2573.00	−2550.00	23.00	5123.00	7.36	7.89	54606.00	32.76	2.73
20.00	2613.00	−2581.00	32.00	5194.00	7.46	7.85	59778.00	35.87	2.99
22.00	2598.00	−2574.00	24.00	5172.00	7.43	7.81	64644.00	38.79	3.23
24.00	2450.00	−2416.00	34.00	4866.00	6.99	7.74	69045.00	41.43	3.45
26.00	2213.00	−2188.00	25.00	4401.00	6.32	7.63	73157.00	43.89	3.66
28.00	2078.00	−2034.00	44.00	4112.00	5.90	7.51	77292.00	46.38	3.86
30.00	2075.00	−2060.00	15.00	4135.00	5.93	7.40	81306.00	48.78	4.07
32.00	2019.00	−1995.00	24.00	4014.00	5.76	7.30	85053.00	51.03	4.25
34.00	1880.00	−1867.00	13.00	3747.00	5.38	7.19	88502.00	53.10	4.43
36.00	1731.00	−1718.00	13.00	3449.00	4.95	7.06	91671.00	55.00	4.58
38.00	1588.00	−1581.00	7.00	3169.00	4.54	6.93	94722.00	56.83	4.74
40.00	1570.00	−1481.00	89.00	3051.00	4.37	6.80	98031.00	58.82	4.90
42.00	1763.00	−1546.00	217.00	3309.00	4.75	6.70	101547.00	60.93	5.08
44.00	1790.00	−1726.00	64.00	3516.00	5.04	6.63	104982.00	62.99	5.25
46.00	1719.00	−1716.00	3.00	3435.00	4.93	6.55	108398.00	65.04	5.42
48.00	1700.00	−1716.00	−16.00	3416.00	4.90	6.49	111776.00	67.07	5.59
50.00	1702.00	−1676.00	26.00	3378.00	4.84	6.42	115172.00	69.10	5.76
52.00	1710.00	−1686.00	24.00	3396.00	4.87	6.36	118415.00	71.05	5.92
54.00	1634.00	−1609.00	25.00	3243.00	4.65	6.30	121620.00	72.97	6.08
56.00	1616.00	−1589.00	27.00	3205.00	4.60	6.24	124841.00	74.90	6.24
58.00	1708.00	−1513.00	195.00	3221.00	4.62	6.18	128210.00	76.93	6.41
60.00	1709.00	−1660.00	49.00	3369.00	4.83	6.14	131652.00	78.99	6.58
62.00	1736.00	−1706.00	30.00	3442.00	4.94	6.10	134950.00	80.97	6.75
64.00	1660.00	−1638.00	22.00	3298.00	4.73	6.05	138072.00	82.84	6.90
66.00	1579.00	−1543.00	36.00	3122.00	4.48	6.01	141029.00	84.62	7.05
68.00	1538.00	−1419.00	119.00	2957.00	4.24	5.95	144285.00	86.57	7.21
70.00	1646.00	−1610.00	36.00	3256.00	4.67	5.92	147513.00	88.51	7.38
72.00	1630.00	−1598.00	32.00	3228.00	4.63	5.88	150584.00	90.35	7.53
74.00	1554.00	−1517.00	37.00	3071.00	4.40	5.84	153626.00	92.18	7.68
76.00	1538.00	−1504.00	34.00	3042.00	4.36	5.80	156488.00	93.89	7.82
78.00	1443.00	−1419.00	24.00	2862.00	4.10	5.76	159496.00	95.70	7.97
80.00	1522.00	−1486.00	36.00	3008.00	4.31	5.72	162534.00	97.52	8.13
82.00	1530.00	−1508.00	22.00	3038.00	4.36	5.69	165424.00	99.25	8.27
84.00	1461.00	−1429.00	32.00	2890.00	4.14	5.65	168250.00	100.95	8.41
86.00	1432.00	−1394.00	38.00	2826.00	4.05	5.62	170895.00	102.54	8.54
88.00	1352.00	−1293.00	59.00	2645.00	3.79	5.57	170895.00	102.54	8.54



SLANT BORING 1615 (No. 1) AT K-65 SILO 2
Graph #: MK65B1KC. APRIL 25, 1991

OU4 SLANT BORINGS AT K-65 SILOS - BORING 1615 (No 1)
DATA #:MK65B1J. APRIL 22, 1991
GRAPH #: MK65B1KC
DATA FOR RUN No. 11

Depth casing	A+	A-	Check sum	Inital diff.	Angle at X point	Avg angle X+Xn	Change	Depth from Hztl. (feet) From O point	In elevation	Hztl. dist.(feet) From O point
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	578.20	0.00
2.00	3228.00	-3217.00	11.00	6445.00	9.27	9.27	12715.00	0.64	577.56	1.90
4.00	3142.00	-3128.00	14.00	6270.00	9.02	9.15	18947.00	0.95	577.25	3.89
6.00	3122.00	-3110.00	12.00	6232.00	8.96	9.08	25036.00	1.25	576.95	5.87
8.00	3052.00	-3037.00	15.00	6089.00	8.76	9.00	31340.00	1.57	576.63	7.85
10.00	3168.00	-3136.00	32.00	6304.00	9.07	9.02	37826.00	1.89	576.31	9.82
12.00	3245.00	-3241.00	4.00	6486.00	9.33	9.07	44223.00	2.21	575.99	11.79
14.00	3206.00	-3191.00	15.00	6397.00	9.20	9.09	50793.00	2.54	575.66	13.77
16.00	3293.00	-3277.00	16.00	6570.00	9.45	9.13	57329.00	2.87	575.33	15.74
18.00	3277.00	-3259.00	18.00	6536.00	9.40	9.16	64338.00	3.22	574.98	17.71
20.00	3515.00	-3494.00	21.00	7009.00	10.09	9.26	71744.00	3.59	574.61	19.68
22.00	3709.00	-3697.00	12.00	7406.00	10.67	9.38	79012.00	3.95	574.25	21.64
24.00	3644.00	-3624.00	20.00	7268.00	10.47	9.47	86266.00	4.31	573.89	23.61
26.00	3637.00	-3617.00	20.00	7254.00	10.45	9.55	93344.00	4.67	573.53	25.58
28.00	3553.00	-3525.00	28.00	7078.00	10.19	9.60	100497.00	5.02	573.18	27.55
30.00	3582.00	-3571.00	11.00	7153.00	10.30	9.64	107968.00	5.40	572.80	29.51
32.00	3748.00	-3723.00	25.00	7471.00	10.76	9.71	115711.00	5.79	572.41	31.47
34.00	3882.00	-3861.00	21.00	7743.00	11.16	9.80	123635.00	6.18	572.02	33.43
36.00	3971.00	-3953.00	18.00	7924.00	11.43	9.89	131766.00	6.59	571.61	35.39
38.00	4081.00	-4050.00	31.00	8131.00	11.73	9.99	139738.00	6.99	571.21	37.35
40.00	3994.00	-3978.00	16.00	7972.00	11.50	10.06	147478.00	7.37	570.83	39.31
42.00	3873.00	-3867.00	6.00	7740.00	11.16	10.11	155197.00	7.76	570.44	41.28
44.00	3864.00	-3855.00	9.00	7719.00	11.13	10.16	162940.00	8.15	570.05	43.24
46.00	3878.00	-3865.00	13.00	7743.00	11.16	10.20	170678.00	8.53	569.67	45.20
48.00	3874.00	-3864.00	10.00	7738.00	11.15	10.24	178301.00	8.92	569.28	47.16
50.00	3822.00	-3801.00	21.00	7623.00	10.99	10.27	186016.00	9.30	568.90	49.13
52.00	3863.00	-3852.00	11.00	7715.00	11.12	10.30	193893.00	9.69	568.51	51.09
54.00	3948.00	-3929.00	19.00	7877.00	11.36	10.34	201862.00	10.09	568.11	53.05
56.00	3992.00	-3977.00	15.00	7969.00	11.49	10.38	209907.00	10.50	567.70	55.01
58.00	4042.00	-4003.00	39.00	8045.00	11.60	10.43	209907.00	10.50	567.70	57.04



Note: This figure is a revision of the original cross-section of Boring 1617. The top of the water bearing zone was not labelled correctly in the original cross-section.

SLANT BORING 1617 (No. 3) AT K-65 SILO 1

Graph #: K65B3L, JUNE 07, 1991

OU4 SLANT BORINGS AT K65 SILOS -- BORING 1617 (No 3)
DATA #:K65B3L. MAY 06, 1991
GRAPH #: K65B3I
DATA FOR RUN No. 11

Depth casing	A+	A-	Check sum	Inital diff.	Angle at X point	Avg angle X+Xn	Change	Depth from Hztl. (feet) From O point	In elevation
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	576.17
2.00	2204.00	-2188.00	16.00	4392.00	6.30	6.30	4287.00	0.21	575.96
4.00	2149.00	-2138.00	11.00	4287.00	6.15	6.23	8479.00	0.42	575.75
6.00	2110.00	-2082.00	28.00	4192.00	6.02	6.16	13073.00	0.65	575.52
8.00	2305.00	-2289.00	16.00	4594.00	6.59	6.27	17474.00	0.87	575.30
10.00	2209.00	-2192.00	17.00	4401.00	6.32	6.28	21933.00	1.10	575.07
12.00	2240.00	-2219.00	21.00	4459.00	6.40	6.30	26447.00	1.32	574.85
14.00	2270.00	-2244.00	26.00	4514.00	6.48	6.32	30864.00	1.54	574.63
16.00	2220.00	-2197.00	23.00	4417.00	6.34	6.33	35989.00	1.80	574.37
18.00	2570.00	-2555.00	15.00	5125.00	7.36	6.44	41041.00	2.05	574.12
20.00	2533.00	-2519.00	14.00	5052.00	7.26	6.52	46298.00	2.31	573.86
22.00	2633.00	-2624.00	9.00	5257.00	7.55	6.62	51630.00	2.58	573.59
24.00	2678.00	-2654.00	24.00	5332.00	7.66	6.70	56863.00	2.84	573.33
26.00	2626.00	-2607.00	19.00	5233.00	7.52	6.77	62970.00	3.15	573.02
28.00	3059.00	-3048.00	11.00	6107.00	8.78	6.91	68967.00	3.45	572.72
30.00	3005.00	-2992.00	13.00	5997.00	8.62	7.02	75143.00	3.76	572.41
32.00	3100.00	-3076.00	24.00	6176.00	8.88	7.14	81377.00	4.07	572.10
34.00	3126.00	-3108.00	18.00	6234.00	8.97	7.25	87549.00	4.38	571.79
36.00	3096.00	-3076.00	20.00	6172.00	8.88	7.34	94358.00	4.72	571.45
38.00	3410.00	-3399.00	11.00	6809.00	9.80	7.47	101032.00	5.05	571.12
40.00	3346.00	-3328.00	18.00	6674.00	9.60	7.57	107766.00	5.39	570.78
42.00	3381.00	-3353.00	28.00	6734.00	9.69	7.68	114553.00	5.73	570.44
44.00	3406.00	-3381.00	25.00	6787.00	9.77	7.77	121294.00	6.06	570.11
46.00	3383.00	-3358.00	25.00	6741.00	9.70	7.85	128733.00	6.44	569.73
48.00	3727.00	-3712.00	15.00	7439.00	10.72	7.97	136088.00	6.80	569.37
50.00	3685.00	-3670.00	15.00	7355.00	10.60	8.08	143534.00	7.18	568.99
52.00	3731.00	-3715.00	16.00	7446.00	10.73	8.18	151029.00	7.55	568.62
54.00	3757.00	-3738.00	19.00	7495.00	10.80	8.28	158454.00	7.92	568.25
56.00	3726.00	-3699.00	27.00	7425.00	10.70	8.36	165988.00	8.30	567.87
58.00	3791.00	-3743.00	48.00	7534.00	10.86	8.45	173658.00	8.68	567.49
60.00	3865.00	-3805.00	60.00	7670.00	11.05	8.54	181459.00	9.07	567.10
62.00	3905.00	-3896.00	9.00	7801.00	11.25	8.62	189508.00	9.48	566.69