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Division of Solid & Hazardous Waste
Utah Department of Environmental Quality

RCRA Comprehensive Groundwater Monitoring Evaluation (CME) Report

For

LANDFILL #5
Utah Test and Training Range
Department of the Air Force
UT0570090001

2000

Prepared By

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1.0 Introduction

A Comprehensive Groundwater Monitoring Evaluation (CME) Inspection was conducted at Landfill #5, a closed hazardous waste landfill located at the Utah Test and Training Range (UTTR), Utah during 1998 and 1999.

The Utah Test and Training Range is located on the west side of the Great Salt Lake, approximately 70 miles west of Salt Lake City, Utah. Landfill #5, the focus of this CME, is located 5.5 miles north of the Oasis Complex (the headquarters of the UTTR). The landfill is on the west side of the county road that connects Lakeside, Utah to interstate highway I-80. Figure 1 shows the regional setting of the UTTR and Landfill #5.

The purpose of this CME is to determine whether the groundwater monitoring system at Landfill # 5 is:

1) adequately designed,
2) correctly installed,
3) being properly operated, and
4) being satisfactorily maintained.

Each of these components of the groundwater monitoring system will be evaluated to determine if the existing system can detect releases of hazardous waste or hazardous constituents from the closed landfill.

To accomplish the goal of release detection, the system must be capable of yielding water samples that accurately represent the water quality in the uppermost aquifer. In addition to detecting releases, the system must be capable of defining the rate and extent of contaminant migration from the unit, if there has been a release.

This report is based on three main data sources: 1) The first is an evaluation of the existing reports on the groundwater in the area around Landfill #5. These reports fall into two categories. There are articles in scientific publications describing the regional groundwater in northwestern Utah. In addition, there are reports generated by the Air Force and their consultants, which provide a more detailed description of the groundwater in the immediate vicinity of the landfill. 2) The second is a field inspection of the existing wells and an evaluation of the operation of the system. This includes the actual collection of groundwater samples and the analytical results generated by the

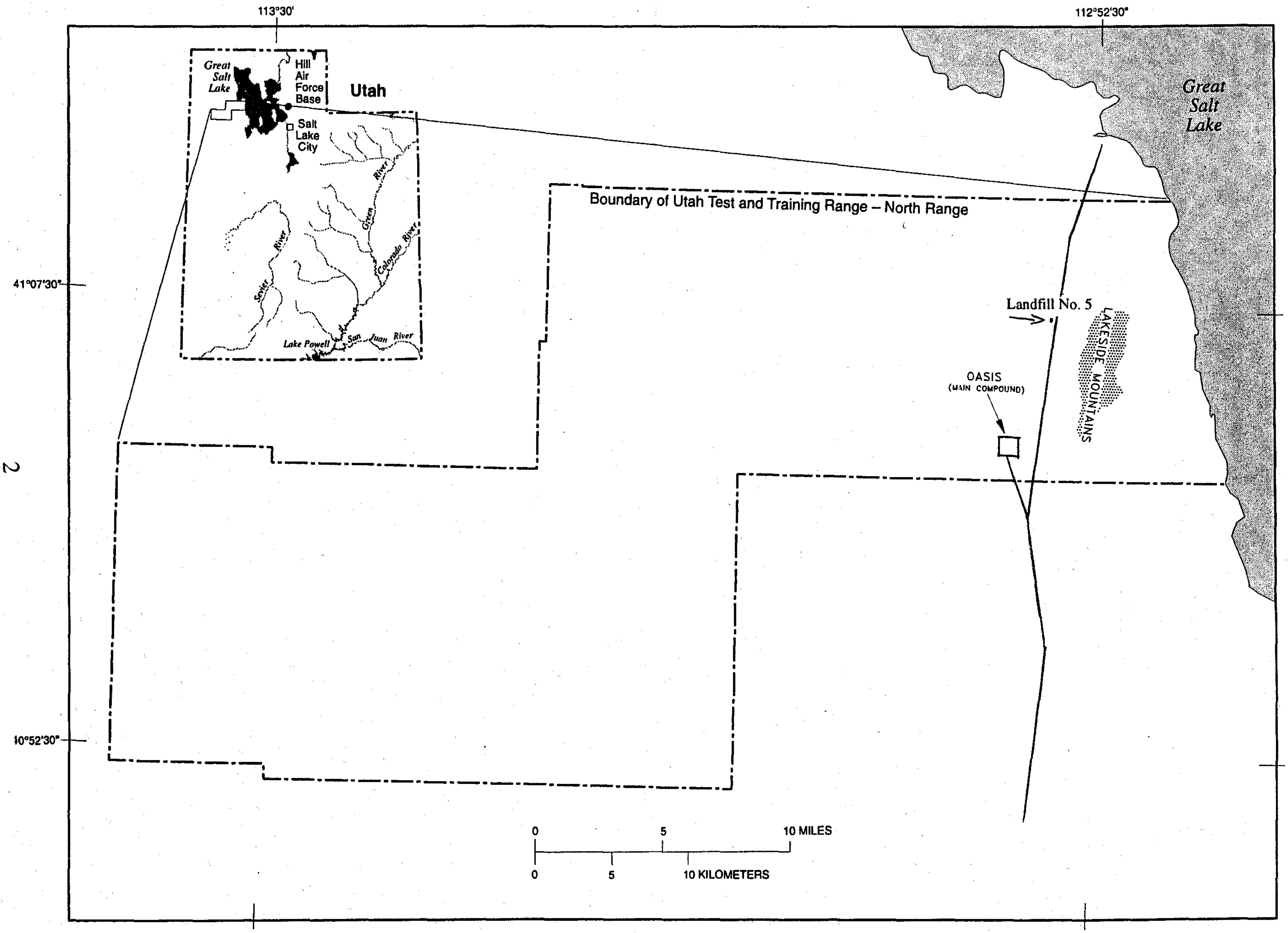


FIGURE 1 Regional UTTR Map

laboratory for those samples. 3) The third is a review of the semi-annual groundwater reports that have been submitted to the Division of Solid and Hazardous Waste (Division) by the Air Force since the groundwater monitoring system was installed in 1989. This portion of the data review will focus on the quality of the analytical results and the statistical methods used to assist in interpreting the semi-annual analytical results.

The aquifer being monitored by the six groundwater monitoring wells (installed in accordance with the Post-Closure Permit issued in 1988) is approximately 400 feet below ground surface. Consequently, any release of hazardous waste or hazardous constituents would need to travel through 400 feet of unsaturated soil before coming in contact with the groundwater. There is presently no vadose zone monitoring system in place to determine if any hazardous constituents have been released to the vadose zone from the unlined landfill cells.

2.0 Facility Description

Utah Test and Training Range (UTTR) is a remote military reservation managed by Hill Air Force Base (Hill AFB). It is located approximately 70 miles west of Salt Lake City and covers 348,767 acres. The UTTR is geographically located directly west of the Great Salt Lake, in Northwestern Utah. The facility straddles the border between Box Elder and Tooele Counties (Figure 1). Operations at the range started in the 1940's when the facility was a site for research and development of guided missiles, pilotless aircraft, and remotely controlled bombs. Present day operations at the facility include:

1) Practice bombing and gunnery range for military aircraft.
2) Propagation testing of military ordinance.
3) Missile motor test firing.
4) Missile motor cutting facility.
5) Missile motor storage.
6) Small arms and machine-gun firing ranges.
7) Open-burn/open-detonation treatment of hazardous waste explosives and military propellants (missile motor propellant).
8) Maintenance of vehicles and preparation of junk vehicles that are used as targets on the bombing ranges.

The UTTR has its own fire department at the Oasis Complex. The fire department has a 1,000-gal "structural/crash" truck with a 1,250 gallon-per-minute pump, a 600-gal "pumper" truck with a 1,000 gallon-per-minute pump, two 600-gal "brush-fire" trucks with 100 gallon-per-minute pumps, a 250-gal "mini-pumper" truck with a 500 gallon-per-minute pump and, a 400-gal "water buffalo" trailer. Each truck is equipped with a UHF radio and a cellular telephone for emergency response coordination.

There is a medical clinic located at the Oasis Complex staffed by two medical technicians. The clinic has an ambulance on site to transport patients to a local hospital if needed. The ambulance is equipped with a UHF radio and a cellular telephone for emergency response coordination. In addition, Air-Med and LifeFlight helicopters from University of Utah Medical Center and LDS Hospital, respectively, can be summoned if more rapid transport is required or, if multiple patients need to be transported simultaneously.

Security at the UTTR is under the control of the on-site Oasis Security Police Department. The Range police are on duty 24 hours a day. They are responsible for maintaining security and control all personnel access and traffic to the Oasis Complex. In conjunction with Hill Range Control, they regulate all personnel access to all parts of the UTTR, including Landfill #5.

The RCRA regulated units at the UTTR and applicable permits or rules include:

1) Hazardous Waste Landfill (Landfill # 5)
Post-Closure Permit and Closure Plan July 15, 1988

2) Thermal Treatment Unit (TTU)
[Open Burn/Open Detonation (OB/OD) Facility]
Regulated Under Interim Status (R315-7)

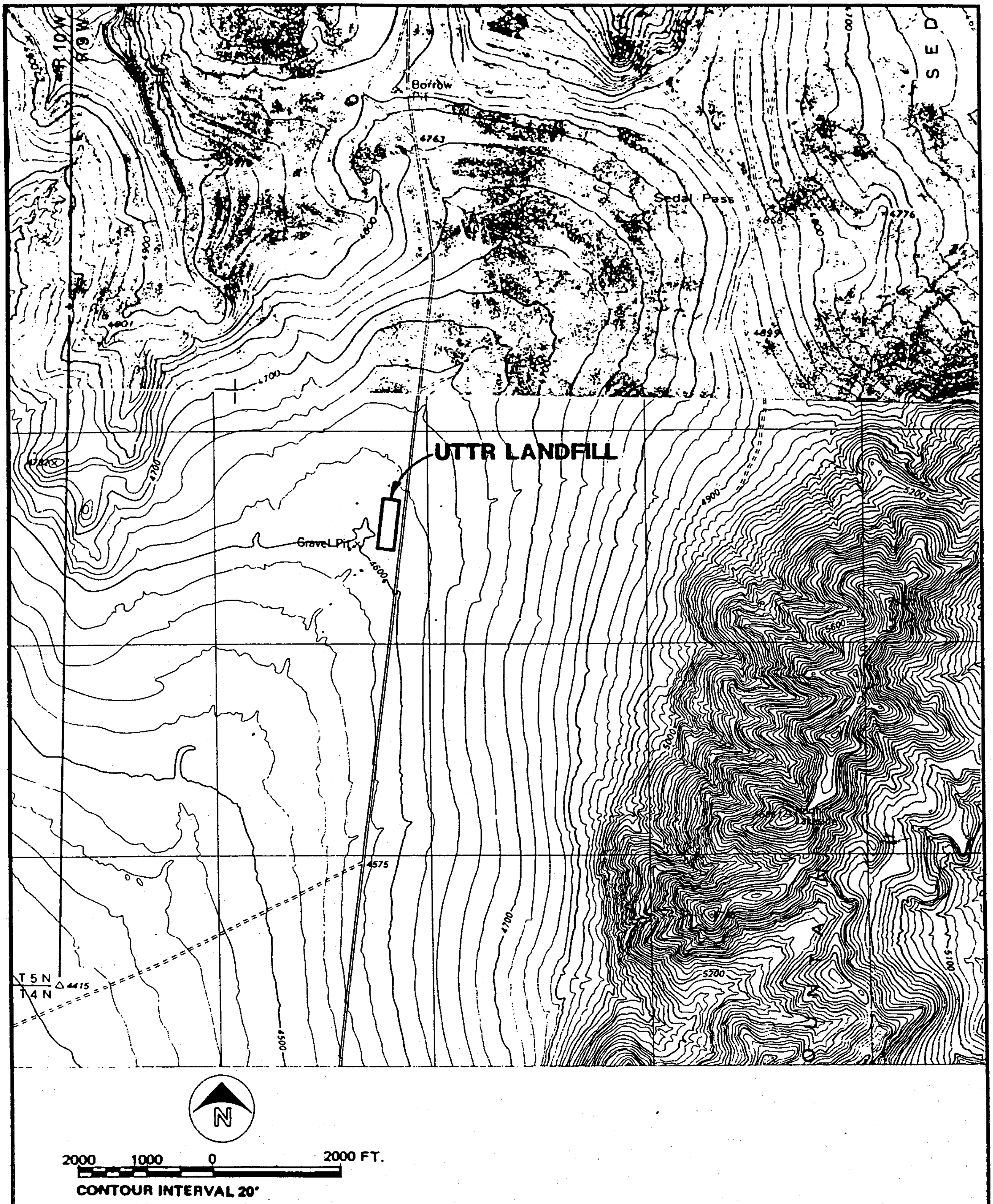
3) Motor Treatment Area (MTA)
[Open Detonation Facility for missile motors]
PROPOSED - Regulated Under Interim Status (R315-7)

The hazardous waste landfill, is located in Box Elder County, Utah (T5N, R9W, Section 30; see Figure 2) toward the extreme northern end of Sink Valley, on the western slope of the Lakeside Mountains. It is on the western side of the county road between Interstate 80 and Lakeside, Utah, approximately 5.5 miles north of the Oasis Complex (headquarters for the UTTR).

2.1 Operations Processes, Products

Due to the vast physical size of the UTTR, 348,767 acres, this report will only address the operations processes, products and most specifically the groundwater in the immediate vicinity of Landfill #5. The hazardous waste that was disposed of in Landfill #5 primarily came from Hill AFB; the waste was not derived from operations processes or products at the UTTR.

The only operations at Landfill #5 were the construction of the landfill cells, placement of waste in the cells, and backfilling over the top of the waste after placement. Landfill # 5 was operated under interim status guidelines in compliance with Chapter 7 of the UHWMR. It consists of six cells (see Figure 3) in which a variety of hazardous wastes were deposited between 1976 and 1983. The landfill cells, which are 90 feet wide by 150 feet long by 15 feet deep (see Figure 4), were dug in soil that is a light-gray alkaline silty-clay loam. The location of the landfill was chosen because of the low soil permeability, low annual precipitation, high evapotranspiration and remoteness of the site. Active use of the landfill was discontinued in 1983 and under conditions specified



CONTOUR INTERVAL 20'
BASE FROM U.S.G.S. 7.5 MINUTE SERIES: SALLY MOUNTAIN, UTAH 1983, AND STRONGS KNOB, UTAH, 1969.

FIGURE 2 Local Site Location Map

CH2M HILL

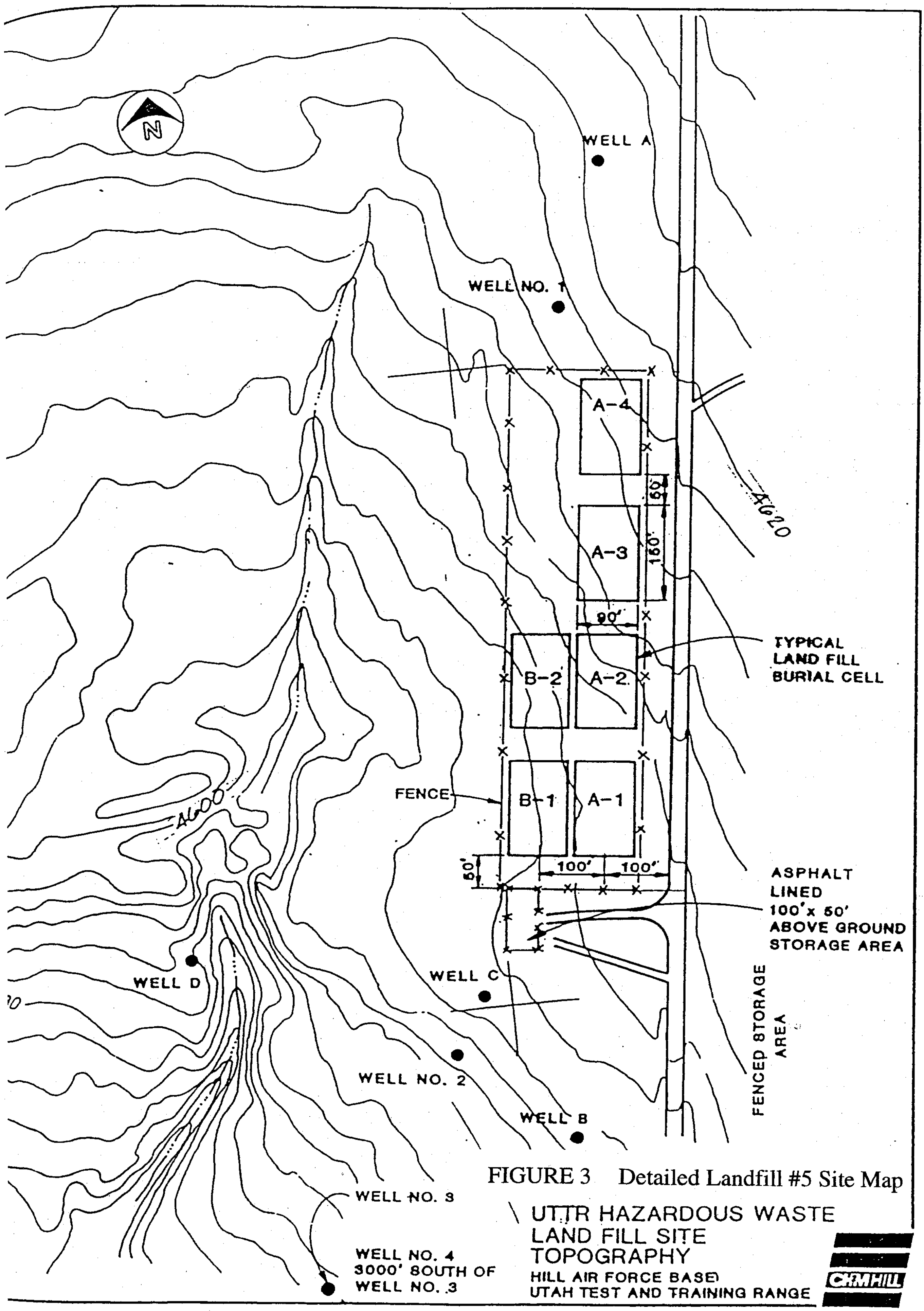
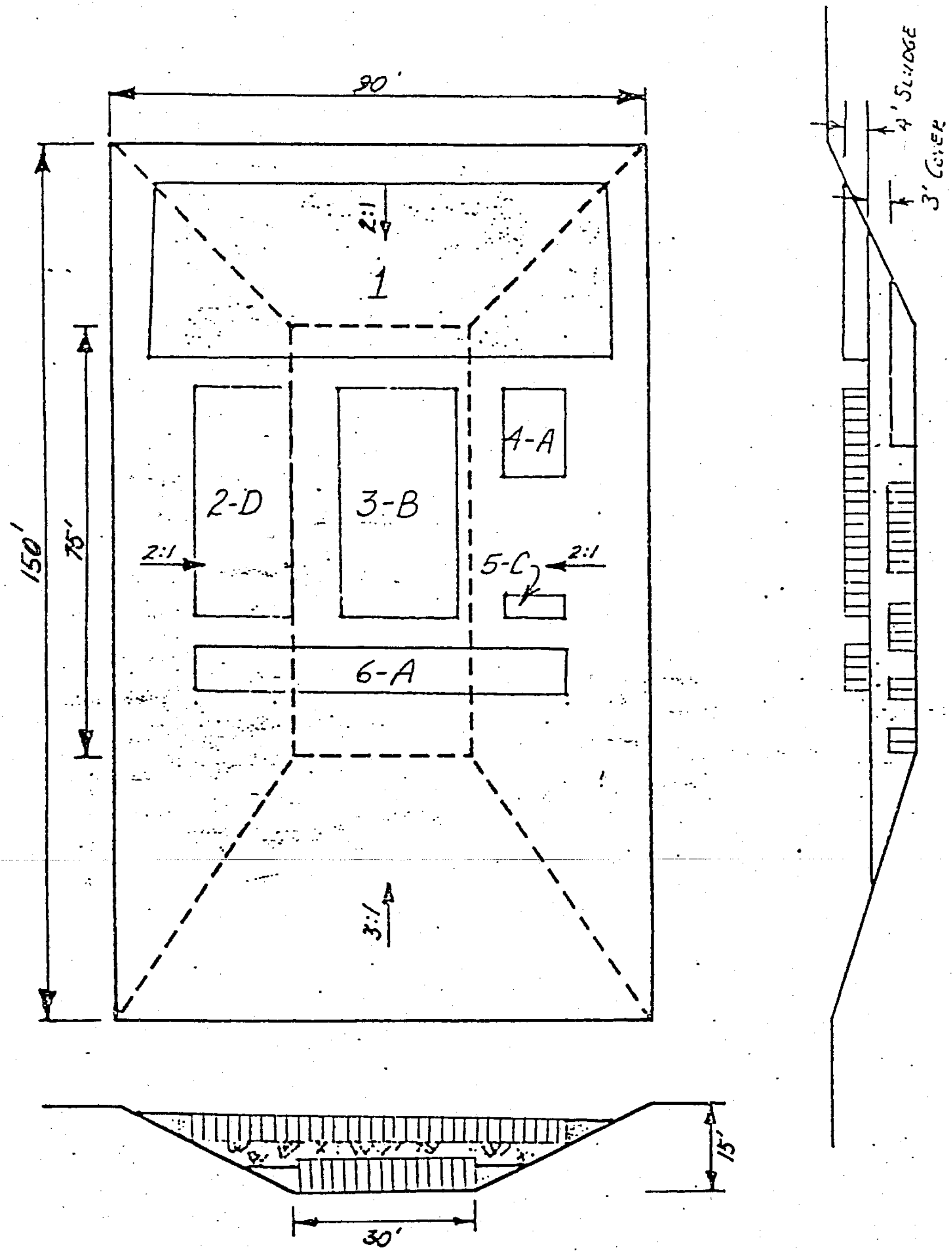


FIGURE 3 Detailed Landfill #5 Site Map

CELL A-2

UPPER LEVEL



SECTION:	1
MATERIAL:	Industrial Waste Treatment Plant sludge
AMOUNT:	1019 tons (wet weight), 4 feet thick on end of cell
BURIAL DATE:	November 1977
MODE OF TRANS.:	Hauled by truck under Contract F42650-78-M0031

FIGURE 4 Typical Cell Plan-view and Cross-section

in the Post-Closure Permit and Closure Plan issued in July 1988, the landfill was permanently closed with a low permeability cap in 1989. During closure, six groundwater monitoring wells were installed according to the specifications listed in the Post-Closure Permit.

2.2 Waste Management Practices

Landfill cells were excavated and used as needed. Containerized wastes (mostly in 5 and 55-gallon drums) were loaded into the cells in an upright position and then covered with a layer of backfill. Each cell consisted of two layers, each was the height of a 55-gallon drum. Total depth to the bottom of each cell is approximately 15 feet. A typical plan view and cross sections of the cells can be found in Figure 4. Sludge from the Hill AFB Industrial Wastewater Treatment Plant (IWTP) was deposited directly into the cells upon arrival (no container).

Backfill consisting of native soil was placed around the waste in each layer and in between the two layers. Then a layer of backfill, at least 3 feet thick, was placed over the top of the second layer to isolate it from surface contact. A permanent low permeability cap was placed over the landfill in 1989 in accordance with the Post-Closure Permit issued in 1988.

The permanent cap consists of a Claymax synthetic liner covered with three individually compacted eight inch lifts of native soil. The three lifts of native soil were placed to protect the Claymax liner and provide a base for vegetation. Although the cover has been seeded with a native grass seed mix, permanent vegetation has not successfully been established. The compacted high clay content soil used in the protective cover forms a very hard dry base for plants to grow. This combined with the local desert environment makes it unlikely that permanent vegetation will ever be established on the cover. For this reason erosion of the cover is a permanent concern; the cover is inspected monthly to insure that erosion does not degrade the cover.

2.2.1 Nature and Volume of Waste

The wide variety of wastes deposited in Landfill No. 5 were generated at Hill Air Force Base. A summary of the most common items found in the landfill is given in Table 1. This table was generated from the operating record that was kept during the period of active use of the landfill. The table indicates many different types of hazardous wastes, including chlorinated and non-chlorinated solvents, heavy metals, PCBs, paints and paint strippers, IWTP sludge, cadmium contaminated blast media, mercury, and asbestos, plus many others.

Table 1

Partial* Summery of Waste Disposed of in Landfill #5

Number of Containers	Size of Container	Waste Material Identification
965	55-gal	beryllium contaminated material from of aircraft brakes
10	box	mercury wastes
27	55-gal	trichloroethylene
278	55-gal	trichloroethane
171	55-gal	oils and greases
6	55-gal	methanol
1	55-gal	toluene
11	55-gal	epoxies
12	55-gal	hydraulic fluid
15	55-gal	methylene chloride
16	55-gal	asbestos
27	55-gal	Freon
21	55-gal	chromate paint residue
79	55-gal	unknown paint residue
477	55-gal	paint remover / stripper waste
32	55-gal	alcohol wastes
376	55-gal	organic solvents
7	each	PCB contaminated transformers
66	55-gal	outdated 2,4,5,trichlorophenoxyacetic acid herbicide
10	55-gal	methyl ethyl ketone waste
38	55-gal	lacquer thinner
21	55-gal	penetrant (dirty)
144	55-gal	styrofoam contaminated barrels (mostly empty)
27	55-gal	waste sealer
7232	tons	IWTP sludge
998	tons	cadmium contaminated sand blast media
1	55-gal	tirchloro-trifluoromethane
291	55-gal	Si Sulfa Sol waste
12	55-gal	alkaline paint stripper
95	55-gal	slop paint
12	55-gal	cleaner waste
4	55-gal	dichloromethane (contaminated)
12	55-gal	chromate wastes
4	55-gal	etchant
1	each	asbestos insulated boiler
369	$yard^3$	JP-4 impregnated foam

* this summary is not a complete list of all items in the landfill; it should be fairly complete for the most common items found in the landfill. It was compiled from the operating record.

The landfill was operated prior to land disposal restrictions (LDR) which now prohibits the disposal of liquid hazardous waste in landfills. Consequently, the unlined landfill contains over 2,000 55-gallon drums of liquid hazardous waste. Due to the highly caustic nature of the local alkaline soil the metal 55-gallon drums have likely rusted through. Many of the drums disposed of in the landfill were contaminated empties. This poses the possibility of collapse of the drums when they rust through and subsequent settling of the cap.

A complete list of the waste materials that were disposed of in the Landfill #5 cells is provided in Appendix A. The lists in Appendix A are very detailed. They show a plan view of the upper and lower disposal layers of each cell. The lists detail each container (size, container material, and type of waste) and its exact location in the cell (cross referenced to the plan-views mentioned above. Due to the fact that all wastes were generated by the Air Force, transported by the Air Force, and disposal was done by Air Force personnel (who also maintained the waste inventory lists), it is presumed that the waste inventory lists are accurate.

The use of Landfill No. 5 as a disposal site was discontinued in 1983. It was closed under conditions specified in the Post-Closure Permit and Closure Plan for Hazardous Waste Landfill/Storage Area, issued by the Executive Secretary of the Utah Solid and Hazardous Wastes Committee on July 15, 1988.

Since closure: 1) the low permeability RCRA cap, and security fences installed during closure have been inspected and maintained, and 2) the groundwater beneath the landfill has been monitored, in accordance with provisions of the Post-Closure Permit.

There is sufficient distance (at least 2 miles) from the actual target range to ensure that no inadvertent bombing will occur at the Landfill No. 5 site. The area is not used for livestock grazing, nor is agriculture practiced here. The Landfill No. 5 area will not be used after closure or during the post-closure period. It will remain fenced for this entire period.

2.2.2 Past and Present Treatment, Storage and/or Disposal Practices for Wastes

Materials disposed of in the hazardous waste landfill were transported from Hill AFB to the site and stored in an unpaved fenced storage area, (Container Storage Area) located adjacent to the landfill on the South side, prior to burial in the landfill. The IWTP sludges (F006) were placed directly into the landfill with out being stored.

There was never any treatment of wastes done at the site prior to disposal. All wastes (except the IWTP sludges) were containerized prior to transportation to the site and the containers were not opened prior to disposal.

No waste has been placed in the landfill after 1983, and the landfill was permanently closed in 1988.

2.2.3 Description of Regulated Units

Hazardous waste Landfill #5 (Figure 3) consisted of six cells (A-1, A-2, A-3, A-4, B-1 and B-2) and an associated fenced storage area. The fenced storage area was located at the southern edge of the landfill. Drums were accumulated in the storage area prior to being placed in the landfill. The landfill cells were approximately 150 feet long by 90 feet wide by 15 feet deep (Figure 4). Cells were excavated and used as needed without any type of liners being installed. A 5-foot-thick layer of native soil was placed over the entire disposal area and was graded to direct surface run-off away from the site. The soil was end-dumped and bladed in two 2-1/2-foot-thick layers. Compaction of each layer with a sheepsfoot compactor followed placement.

There are two other RCRA regulated units at the UTTR. These two units each have their own groundwater monitoring systems in operation. One is a solid waste landfill, located 4.5 miles to the south of Landfill #5, on the east side of the Oasis Complex. This landfill has one up-gradient and two down-gradient groundwater monitoring wells. This landfill receives municipal waste from the administrative buildings at the Oasis Complex.

The other RCRA regulated unit is the Thermal Treatment Unit (TTU), which is an interim status open burn / open detonation (OB/OD) treatment facility. The TTU is located directly across the county road from Landfill #5, to the east. This OB/OD facility has one up-gradient and one down-gradient groundwater monitoring well. These two wells are approximately 1.0 and 1.5 miles northeast of Landfill #5. They are completed in the same aquifer as the groundwater monitoring wells at Landfill #5 and provide useful information about the groundwater gradient in the vicinity of Landfill #5. Information about these wells will be incorporated into this report in the relevant sections that follow.

The TTU is an active interim status OB/OD facility utilized for the treatment (burning or detonating) of waste explosives and bulk military propellants. The final Part B Permit is anticipated to be issued by the DEQ during calender year 2000. The TTU is the largest OB/OD facility operated by the Air Force and is possibly the largest one within all of the DOD. They routinely detonate 30,000 lbs to 40,000 lbs of explosives at a time. Detonations or burns occur only once per day, Monday through Thursday, during the summer season. The TTU does not operate during the winter "atmospheric inversion" months.

2.3 Description of Other Facility Components That Could Effect Groundwater Quality

There are only two facilities that have a possibility of impacting groundwater in the vicinity of Landfill # 5, the TTU, an OB/OD facility and a small abandoned landfill (TTU Residual Pits) that was used to dispose of ash and scrap metal residue from the TTU. These two facilities are located approximately one to one-and-a-half miles northeast and up the groundwater gradient from the landfill (Figure 2). The waste managed at the TTU is exclusively DOO3 explosive characteristic waste. The bullet cartridges and bullet tips can contain some Pb, Cr, and Cd. The waste at the Residual Pits is expected to be only the heavy metal constituents with a possibility of some diesel range hydrocarbons resulting from the use of diesel based fuels as an initiator for the open burning of waste small munitions and other small military explosive items. These types of waste are largely different from the wastes in Landfill # 5 so, contaminants from the two different sources should be easily discernable. In addition, it appears that the groundwater flow from the TTU area is to the east, away from Landfill #5.

Two factors contribute to minimize the possible impact of the TTU on the groundwater beneath Landfill # 5: 1) the depth to groundwater at the TTU is approximately 600 feet below the surface, and 2) there is no disposal of waste at the TTU, it is strictly a treatment facility. The TTU Residual Pits, which are located on Sedal Pass, are approximately 700 feet above groundwater. Any heavy metal contamination at the site is probably fairly immobile in the local alkaline soils. As a result, there is a low likelihood that any release from the TTU area could make it to groundwater. The TTU Residual Pits and old Burn Trench at the TTU were investigated as part of the UTTR RFI during the summer of 1998 and 1999.

As described later in this report, it appears that Landfill #5 is located on the crest of a broad groundwater divide. Therefore, it is unlikely that any other facility components could effect the groundwater under Landfill #5.

2.4 Regulatory Status for Landfill #5

The hazardous waste landfill is being monitored under the requirements of the Post-Closure Permit and Closure Plan for Hazardous Waste Landfill/Storage Area issued July 15, 1988.

The landfill was closed according to conditions specified in the Post-Closure Permit. Closure of the landfill included: 1) the construction of a low permeability cap that covers all landfill cells, 2) the installation of elevation monuments on the cap to monitor settling of the waste in the cells and subsidence of the overlying cap, 3) the installation of a security fence with "KEEP OUT" signs, and 4) the installation of six groundwater monitoring wells.

The landfill is considered to be in detection monitoring under the terms of the Post-Closure Permit. Some parameters have exceeded their detection limits. However, resampling of the wells during the next regularly scheduled event has not confirmed the presence of contamination.

Maintenance of the cap, to fill in some small erosional gullies and rodent burrows was completed during the summer of 1998. During the spring and summer of 1999: 1) the perimeter fence and "KEEP OUT" signs were replaced, 2) new elevation monuments on the cap were installed to replace the original PVC ones, and 3) the cap was hydro-seeded to try to develop an erosion resistant cover.

3.0 Regional Geology / Hydrogeology

3.1 Regional Geology

The facility is situated in the Basin and Range Physiographic Province. Prominent geologic and topographic features in this province are controlled by block faulting. Mountain ranges are horst blocks, uplifted by late Cenozoic normal faulting. They generally consist of Paleozoic sedimentary rocks which were folded and deformed during the Seiver Orogeny. The mountain ranges are composed of thick sequences of mainly carbonate rock. The bedrock in the Lakeside Mountains is from the Great Blue Limestone and Humbug formations. The Great Blue Limestone outcrops on the mountainsides immediately north and south of the TTU. This formation, which predominates in the North Valley area, is described by Doeling as a thick-bedded to massive, dark gray limestone containing occasional beds of sandstone, shale, and fossiliferous limestone (Doeling 1980).

The basins are grabens; blocks that have been down-dropped by late Cenozoic normal faulting. These basins have been, and are being, filled with sediments from the adjacent ranges. The alluvium which fills the basins generally grades from coarser sediment at the base of ranges from which the sediment is derived, to fine sediment near the center of the basin. The valley fill sediments are thick (up to several thousand feet) sequences of unconsolidated and partially consolidated sediments of Quaternary and Tertiary age (68 million years old to present). The older Tertiary sediments are thought to be part of the Salt Lake Group which Everett and Kalliser described as moderate to poorly consolidated accumulations of sand, gravel, silt, and clay with an abundance of volcanic ash.

The alluvium is frequently overlain, or interbedded at a shallow depth, by Lake Bonneville sediments. The Lake Bonneville sediments were deposited in a Pleistocene lake that covered most of northern and central Utah, approximately 15,000 years ago. Tertiary volcanic rock is often found near the flanks of the ranges. These extrusives are likely migrating toward the surface along the fault zones that flank the ranges. The Basin and Range is classified as an area of high seismic potential.

3.2 Regional Hydrogeology

The Basin and Range physiographic province is a closed basin for which there is no external drainage. The three types of aquifers found in the Northern Great Salt Lake region of the Basin and Range are alluvial fan aquifers, alluvium aquifers (aka. valley fill aquifers), and shallow aquifers (which commonly contain brine).

The alluvial fan aquifers, located along the base of the ranges, generally have the best water quality of the three aquifers and good hydraulic conductivity. The amount of water procurable, however, is generally small. The productivity of these aquifers is locally dependent on three main factors; 1) their distance from the adjacent range, 2) the size of the adjacent range which has a direct impact on the size of the alluvial fan and, 3) the type and gradation of the sediments contained in the alluvial fan. Many of these alluvial fans were submerged by Lake Bonneville during the last ice age. In these cases the alluvial fans contains a lacustrine interbeds (commonly lower permeability than the surrounding alluvial sediments) that can disrupt the normal flow regime.

Aquifers in the valley alluvial fill sediments are generally confined systems. Discharge from these systems is primarily through evaporation, transpiration, and upward leakage, because they lie in the closed basins of the basin and range province. The water in these aquifers is generally slow moving and of poor quality since residence time is long. Hydraulic conductivity ranges from very low to very high.

The shallow aquifers are the third type of aquifer. In the Great Salt Lake Desert they're often referred to as Shallow Brine Aquifers. These aquifers are in Lake Bonneville sediments and can be confined or water table systems (Stevens). The hydraulic conductivity varies from very low to moderate. The effective velocity of the groundwater is small because the hydraulic gradient is flat. Discharge from this system can be through evaporation, transpiration, or pumping. The quality of the water is poor and usage is limited.

All three aquifer systems exist in the region where UTTR is located. In the specific area where Landfill #5 is located the shallow brine aquifer is not present at all. Well log data indicates that the alluvial fan aquifer in this area is either non-existent or very poorly developed. This is consistent with the fact that topographically the site is near the upper edge of the alluvial fan coming off the Lakeside Range. Consequently the only known aquifer beneath Landfill #5 is the valley fill aquifer. This aquifer is approximately 400 feet below ground surface at this location.

Regionally, groundwater in the alluvium aquifer is confined, of very poor quality, slow moving, and discharging into the present day Great Salt Lake Basin. Landfill #5 lies between the Great Salt Lake, to the east, and the Bonneville Salt Flats / West Desert, to the west. Consequently there are two potential discharge directions for the alluvium aquifer beneath Landfill #5.

An investigation was conducted by Dames and Moore for the Utah Water Resources Division (1985) to determine if the ponds in the West Desert created by the Great Salt Lake Pumping Project would influence the regional flow system. Data from the study indicated that very little water from the ponds was infiltrating, and that the water table in the immediate area of the ponds was not being affected.

3.3 Owner/Operator Information

3.3.1 Stratigraphy and Water Bearing Characteristics

In their Part B Permit Application and "Demonstration of Low Potential for Migration" documents, UTTR partially characterized the Geology and Hydrogeology of the region.

A summary of that characterization follows:
Utah Test and Training Range is located in the northeastern part of the Basin and Range physiographic province. The province is characterized by isolated, roughly parallel, north-south treading, partly dissected, fault block mountain ranges separated by desert basins or valleys.

Thick deposits of Paleozoic sedimentary rocks occur in the northern Lakeside/Grassy Mountains. Considerable amounts of unconsolidated quaternary alluvial and elluvial deposits cover the slopes of the hills and form geologic features characteristic of the valley floor.

UTTR is located within the confines of ancient Lake Bonneville. The geomorphology of the area may be divided into three parts; pre-Lake Bonneville landforms, landforms created by Lake Bonneville, and post-Lake Bonneville landforms.

Pre-Lake Bonneville landforms include thrust faulting, domal uplift, volcanism, and Basin and Range faulting. Landforms created by Lake Bonneville are wave cut terraces (lake levels), sea caves, spits, and barrier bars. Post-Lake Bonneville landforms include the present drainage patterns, outwash materials from occasional flash flooding, deposits of windblown silt and sand, and minor amounts of outwash materials from ravines through normal weathering and runoff.

In the mountains near the landfill most of the rock units present were formed during the paleozoic era and include the following formations: Madison Limestone *(massive fossiliferous limestone, dolomite, w/minor chert) Deseret Limestone (dark gray limestone, dolomite, w/abundant chert), Humbug Formation (quartzitic sandstone, w/minor limestone and dolomite), Great Blue Limestone (light to dark gray pure and cherty limestone), Doughnut Formation (dark grey limestone and shale), Manning Canyon Shale (black shale w/ minor dark limestone, quartzite, and grit), Oquirrh Formation (quartzite, limestone, dolomite, sandstone, and shale) and Kirkman Limestone (dark, thin-bedded, brecciated limestone).*

Quaternary deposits, upon which the landfill is located, consist of lake bed sediments of mostly clay and dust. These sediments are poorly drained, and generally have a high enough salt content to prohibit agriculture.

3.4 Other Available Information

The following is a summary of information from Hydrologic Reconnaissance of the Northern Great Salt Lake Desert and Summary Hydrologic Reconnaissance of Northwestern Utah, Technical publication No. 42, State of Utah, Department of Natural Resources, 1974.

There are three aquifers present in most of the northern Great Salt Lake Desert. One consists of an aquifer comprised of crystalline salt and jointed lakebed deposits at and just beneath the land surface. This aquifer averages 25 feet in thickness and yields brine. An aquifer of unknown thickness and extent is present in surficial and buried alluvial fans along the mountain flanks and yields fresh to moderately saline water. The most extensive aquifer underlies the entire area where consolidated rocks are not exposed and is made up of unconsolidated to partly consolidated valley fill.

Generally water under the desert floor contains 150,000 mg/l or more of dissolved solids. Locally in the mountains and peripheral alluvial slopes, fresh to moderately saline groundwater is present.

Shallow Brine Aquifer

As the shallow brine aquifer is not part of the Hydrogeologic Regime at the site, it will not be discussed.

Alluvial Fan Aquifer

An "Apron" of unconsolidated alluvium borders much of the floor of the northern Great Salt Lake Desert (Plate 1). These surficial alluvial deposits, together with underlying unconsolidated to well-cemented older alluvium that was also *deposited3 as fans or aprons along the mountain flanks, comprises an aquifer referred to as the "alluvial-fan aquifer".*

<u>Valley-Fill Aquifer</u>

The largest groundwater reservoir in the northern Great Salt Lake Desert is in unconsolidated to partly consolidated valley fill alluvium (listed as Quaternary older alluvium and Salt Lake Formation). The total thickness of the valley fill ranges from zero where older Paleozoic Rocks crop out to 1,385 feet at Lemay and at least 1,644 feet in the Bonneville Salt Flats area.

Volcanic rocks underlying the unconsolidated sediment may also constitute a part of the major groundwater reservoir. If these rocks are included, the total thickness of the reservoir rocks may be more than 5,000 feet throughout much of the area.

Water moves laterally into the valley-fill aquifer from the alluvial-fan aquifer. The lack of reliable water-level data throughout most of the northern Great Salt Lake Desert precludes any precise determination of the direction of groundwater movement within the valley-fill aquifer.

3.5 Adequacy of Owner/Operator Information

UTTR has provided as complete a description of the regional geology and hydrology as can be expected. The northern Great Salt Lake Desert is an isolated, remote area for which little regional hydrogeologic data exists. Their summary reports include information from all available published documents.

The information on wastes disposed of in the landfill is very complete, by any standard. The operating record (Appendix A) contains information on all waste types, volume of each type of waste, and the exact location of all waste disposed of in each landfill cell.

4.0 Site Geology / Hydrogeology

Northern Sink Valley, where the Landfill #5 is located, is bounded on the west by the bedrock outcrops on Homestead Knoll. To the east lies the Lakeside mountain range, again, made up of outcropping bedrock. The valley forks about one mile northeast of Landfill #5, and about one mile further northeast it terminates at two saddles, one at the end of each of the two forks. The underlying bedrock surface becomes shallower towards the north fork where the Sink Valley terminates at a saddle between Homestead Knoll and Death Ridge, which is part of the Lakeside Range (see Figure 2). The other fork of Sink Valley terminates to the east at Sedal Pass, which lies between Death Ridge on the north and the main Lakeside Mountain Range on the south. The valley opens to the south-west, and all surface drainage is in that direction.

The shallow sediments in the upper portion of the Sink Valley are alluvial fan deposits derived from the erosion of the adjacent bedrock outcrops on the Lakeside Range and Bug Hill. Alluvial fan sediments, in a setting like this, would be expected to consist of interbedded sands and gravels that were deposited by braided stream channels. These channel networks form multiple small distributory stream beds that cris-cross each other in random patterns. Unlike lacustrian or marine sedimentary sections there is rarely well developed bedding in this type of depositional environment. Due to the fact that Landfill #5 sits near the proximal portion of the alluvial fan it would be expected to contain more coarsely graded sediments. Thus, gravels and sands rather than silts and clays should make up most of the sedimentary section.

The typical alluvial fan depositional environment was interrupted during the Pleistocene epoch, when Lake Bonneville covered the region. The Lake Bonneville sediments in this area consist of two main types. Near the mountain ranges, in areas that were above the lake level, there are deltas and spits. These areas typically accumulate gravels, sands, and silts. Away from the ranges, are found lacustrine deposits consisting of finer grained silts and clays.

Deep circulation of groundwater through faults and joints in the local bedrock has not been reported. The limestone bedrock in the area is assumed to have lower permeability than the valley fill sediments. This fact has lead previous authors to assume that the upper (northern) end of Sink Valley was closed off to northward groundwater flow through the colluvial sediments into the bedrock. If the bedrock is highly fractured, the bedrock could provide sufficient permeability to allow groundwater flow from the northern Sink Valley toward the Great Salt Lake to the east.

Groundwater quality in the main valley fill aquifer is considered poor with total dissolved solids in the 1,500 to 5,000 mg/L range. This makes the groundwater unuseable for human consumption without treatment.

4.1 Owner Operator Information

4.1.1 Stratigraphy of Shallow Sediments

Results of a subsurface investigation performed during the drilling of two observation wells at the landfill in 1983 showed unconsolidated materials extending to a depth of between 83 and 86 feet. Below this depth the subsurface materials appeared to be consolidated, consisting of cemented conglomerate or sandstone. This was the information that was available at the time the post-closure permit application was written.

In October of 1986, Wells "E" and "F" were drilled to depths of 460 feet and 520 feet below ground surface. About a year later, in December of 1987, Well "J" was drilled to a depth of 463 feet. During January and February of 1988, Wells "G", "H", and "I" were drilled in preparation for issuance of the Post-Closure Permit, which received final signatures in July of 1988. The original Well "J" had to be re-drilled in 1996, after the Grundfuss down-hole pump and 200 feet of stainless steel pipe was dropped 200 feet down the hole while the pump was being removed for replacement.

As a result of these drilling efforts there are now a total of seven RCRA groundwater monitoring well-logs on file to provide information on the stratigraphy of the shallow sediments in the vicinity of Landfill #5. There are two additional RCRA groundwater monitoring wells in the Sedal Pass area. These two wells were drilled in January 1990 to monitor the RCRA Open Burn / Open Detonation facility that is located on the west side of Sedal Pass (the same side where Landfill #5 is). The well logs from the two Sedal Pass wells plus those around Landfill #5 provide a fairly good description of the shallow sediments in the area. The well logs for each of the wells is included in Appendix B.

A review of these well logs show that the shallow sediments in the vicinity of Landfill #5 are primarily interbedded sands and gravels, with some silts and very rarely clay. There are numerous notations of calcite cementing, particularly in the gravels and some caliche deposits. The grains are most commonly limestone with some sandstone grains also found in the gravels. The grain shapes are mostly angular with less frequent references to rounded grains. Grain size is usually noted in the 0.2 to 0.4 inch grain size range. In the lower portions of the wells there are frequent references to calcite cemented gravels and some conglomerates. The sand to gravel mix is commonly 60% to 80% sand and 20% to 40% gravel. The well at Sadel Pass has one marked difference from the other wells in the area. That well ran into a dark yellowish orange rhyolitic tuff at 400 feet below ground surface (bgs) that continued to the bottom of the well at 700 feet bgs. Although never stated as such, it is possible that this material is either bedrock or of a volcanic deposit directly on bedrock.

4.1.2 Contaminant Pathways through Vadose Zone

The Air Force requested a variance from the requirement to perform groundwater monitor as part of post-closure care. Their justification for this request was a very limited study of the vadose zone hydrogeologic characteristics. The report, entitled Time of Travel (TOT) in the Vadose Zone is included in Appendix C. This report concluded that it would take contaminants approximately 1,300 years to travel through the vadose zone before reaching the upper most aquifer. There were several poorly supported assumptions and a very limited number of data points (only three) that made the request unapprovable.

The greatest problem with the Air Forces approach is that the analytical solution requires that the soils at the site are homogeneous. This assumption is only plausible when: 1) there is evidence that homogeneity actually exists and, 2) the depth to groundwater is shallow. The greater the depth to groundwater the more difficult it is to assume homogeneity. At Landfill #5 the well logs (see Appendix B) indicate that the soils are heterogeneous over the 400 feet to groundwater. The information on the location of the samples used was inadequate. The write-up only stated that the samples came from the "upper unconsolidated portion at depths less than 50 feet." There was no information at all on the method of sample collection or the handling of the samples prior to analysis. In addition, there wasn't even a simple field geologic description of the soil material used for analysis, only that "all contain mixtures of gravel, sand, and silt."

The shallow stratigraphy in the area around Landfill #5 (where the soil samples for the vadose zone modeling were collected) contains Pleistocene epoch lacustrine deposits consisting of finer grained silts and clays. These Lake Bonneville sediments are much finer grained than the underlying alluvial fan deposits. Consequently, it is very likely that the calculations made using these sediment samples represent a unrealistically long travel time for contaminant migration through the vadose zone.

In addition, there is a growing amount of data that indicates that DNAPLs, of which there are several types disposed of in Landfill #5 (see Table 1), travel through the vadose zone in a "finger" style flow pattern and not as a homogeneous wetting front as has previously been assumed. This new understanding of vadose zone contaminant transport appears to render the basic conceptual model for the analytical model inconsistent with present day theory. This "finger" style of flow can significantly increase the rate of flow through the vadose zone. This increased flow rate would significantly shorten the contaminant transport time to the aquifer.

Another complication which has not been investigated, is the interplay between the expected "finger" style of contaminant flow and the braided channel pattern in the vadose zone sediments typically found in alluvial fans.

4.1.3 Site Hydrology

The landfill is located in what Price (1970) described as North Sink Valley Subdistrict. The principal aquifer within this local area is contained in the silty sand and gravel deposits of the older valley fill. Groundwater in this aquifer occurs under both unconfined and confined conditions (CH2MHill 1988). Groundwater in this aquifer is considered poor because of high total dissolved solids (TDS), which range from 1,000 to 5,000 mg/L. The groundwater drawn from this aquifer for use at the Oasis Complex, 5.5 miles to the south-southwest, must be treated by reverse osmosis before it is fit for human consumption.

CH2MHill found that the groundwater quality decreases towards the center of the valley (CH2MHill 1988). Their investigation found that the most potable water in the North Sink Valley Subdistrict was found closer to the mountains and at shallower depths. This agrees with Price, (Price 1970) which suggests that the concentration of TDS generally increases with depth in the Sink Valley basin.

Price and Bolke suggest that groundwater may flow to the northwest, toward the Salt Flats but don't rule out flow to the east toward the Great Salt Lake (Price 1970). CH2MHill indicated that the groundwater beneath Landfill #5 flows to the south and then west toward the Great Salt Lake Desert (CH2MHill 1988).

Doeling estimates that only one percent of the precipitation that falls in the Sink Valley contributes to the groundwater system (Doelling 1980). His conclusion was drawn from: 1) low average precipitation (generally less than 6 inches), 2) expected evapotranspiration of about 44 inches per year, 3) fine-grained, low-permeability lake bed deposits (Pleistocene Lake Bonneville) at or near the surface which would inhibit infiltration. The main aquifer is thought to occur adjacent to the mountains where coarser-grained sediments are present. Another recharge mechanism is precipitation on the surrounding mountains which infiltrates through bedrock fractures then enters the valley fill aquifer through deep underflow.

4.1.4 Water Bearing Characteristics

The depth to the uppermost aquifer directly beneath the landfill is approximately 400 feet. Table 2 summarizes information that describes the uppermost aquifer at each well location at the site. The uppermost aquifer beneath the landfill is probably not contained in a single stratigraphic interval or sedimentary unit as evidenced by the variations in the aquifer descriptions listed in Table 2. Valley fill materials under the landfill exhibit steeply dipping beds and lateral facies changes as well as paleo-stream channeling.

Groundwater in the uppermost water bearing strata is under artisan pressure, between 20 to 40 feet above the top of the aquifer, in all wells at the site. No single distinct confining unit has been correlated between wells at the site. It is possible that the confining layer above the aquifer is formed by a calcite cemented zone that crosscuts different stratigraphic units but forms a continuous low permeability boundary.

Aquifer thickness varies between each well location (Table 2). Generally, the uppermost aquifer is not one thick consistent geologic material, but instead is comprised of interbedded sand and gravel deposits. The total thickness of water bearing strata was estimated using geophysical logs and varies from 19 feet in Well J to 5 feet in Well G (Table 2).

4.1.5 Potentiometric Surface

Historical Perspective of Potentiometric Surface

According to the Part B Permit Application for Closure and Post-Closure Care of Landfill #5, the potentiometric head data indicates highly variable head differences within short lateral distances. Therefore, the existing data at that time did not clearly indicate up-gradient and down-gradient directions. The hydraulic head differences were originally attributed to the fact that the wells at the site were known to be completed in varying geologic materials. Some wells may penetrate deeper, more confined water-bearing strata and thus exhibit higher static water levels. The documentation that was available indicated that some wells installed prior to 1986 penetrated deeper into water-bearing strata and are screened adjacent to longer sections of water-bearing strata. The

Table 2

SUMMARY OF LANDFILL # 5 AQUIFER CHARACTERISTICS

Well No	Aquifer Thickness (ft)	Aquifer Description
E	8	Sand, gravel with clay, sand is fine to coarse, gravels are <0.4" diameter, consist of limestone, sandstone, and calcite. Drilling was hard.
F	15	Gravel with sand, gravels <0.5-inch diameter, black and gray limestones, some tan and orangish sandstone, sand is fine grained and pale brown. Drilling is hard with soft spots indicating inter-bedding.
G	5	Coarse sand and gravel, no fine sand or silt, gravel is angular, <0.5 inch diameter and consists of gray and black limestone. Drilling very hard.
H	8	Sand and cemented sands, sand is fine to coarse with no gravels or silt, cemented sand is fine to very fine grained and moderately cemented. Drilling very soft and smooth.
I	10	Sand and gravel, sand is fine to coarse grained, contains some silt, gravel is fine to medium, black and brown limestone.
J	19	Sand with minor silt and gravel, sand is fine to medium grained, single grained, multicolored brown and gray. Silt is light brown. Gravels are limestone. Drilling moderately soft.

wells have static water level elevations in the 4219 to 4220 foot (above mean sea level) range. Wells installed in 1986 or later by CH2M HILL do not penetrate significantly different depths into the water-bearing strata. These wells still exhibit water levels that vary 4 to 5 feet between well locations. Therefore, water levels in the first 40 feet of water bearing materials may vary locally across the site.

Again, according to the Part B Permit Application it was determined that due to the complex bedding of strata in the valley fill beneath Landfill #5 the monitoring wells are known to be completed in geologic materials of varying hydraulic conductivity. Wells E, F, G, and J are screened adjacent to materials with saturated hydraulic conductivities of less than 7 ft/day. Wells E, G, and J have static water levels that are 1 to 5 feet lower than other wells surrounding the landfill, particularly Wells H and I. Wells H and I are screened adjacent to materials having hydraulic conductivities of about 15 ft/day. Well F, although screened adjacent to lower conductivity material, has water levels similar to Wells H and I. Geologic materials with higher hydraulic conductivities may act as preferential pathways for water flow and may exhibit higher static water levels. It should be noted that many of these historical interpretations have changed, see "Current Perspective" below.

The hydraulic gradient in the immediate vicinity of the landfill is not clearly defined. The suspected groundwater flow path in the vicinity of the site, based on the physiographic setting of the site, is down valley from north to south. It was this information that was used to design the groundwater monitoring system that has been in operation at Landfill #5 for the first ten years of operation.

In January 1990, after completion of all groundwater monitoring wells at Landfill #5, the Air Force drilled two additional RCRA groundwater monitoring wells at the TTU. The TTU is located about one and a half miles northeast of Landfill #5. Well number TTU-1 was drilled at Sedal Pass, on the east side of the TTU, and TTU-2 was drilled on the down-slope, west edge of the TTU.

Unfortunately, the groundwater elevations measured in these two new wells increased the complexity, or confusion, in the understanding of the potentiometric surface in the Northern Sink Valley. Prior to these wells the data, although not completely consistent, generally indicated a groundwater flow direction to the southwest, coincident with the slope of the local physiographic surface. The new TTU wells clearly indicated a flow direction to the east.

The level of confusion is depicted in a comparison of the groundwater flow maps that the Air Force submitted to the Division in 1995, 1996 and 1997 (see Figures 5, 6, and 7). They show the groundwater flow direction going in three different directions in three successive years. This is particularly true for the 1995 data which shows north, south, and west groundwater flow directions within less than 1,000 feet of each other, all at the same time. In 1996 the flow direction was shown to be only to the south, and in 1997 the flow direction was shown to be only to the north.

There are several possible explanations for the confusing and conflicting groundwater flow directions. One is the groundwater elevations measured in the wells around Landfill #5 are incorrect. This could be caused by either bad down well measurement techniques, by incorrectly surveyed well tops, or due to wells that were not exactly plumb. Alternatively, Landfill #5 could sit at or near a groundwater high or divide. This setting would produce true groundwater flow away from a local groundwater high (either dome or ridge) in two or more directions. For this to be true the site must be a recharge zone. The physiographic setting of Landfill #5 is not that of a typical groundwater recharge zone.

Current Perspective on Potentiometric Surface

Up until 1996 static water level measurements were obtained by use of dedicated water sounders. These were non-stretch measuring tapes that were calibrated and then left down each well. This was done to eliminate the need to lower a single tape down each well (a distance of about 400 feet), take the measurement, pull it back up the 400 feet, then decontaminate it prior to reuse on the next well. After taking measurements using the dedicated tapes on March 8, 1996 a second set of measurements were made using a single non-dedicated measuring tape that was decontaminated between each use. The differences in measurements represent errors in prior readings of static groundwater. The errors were all significant.

Well E	was off by	-1.29 feet,
Well F	was off by	-0.38 feet,
Well G	was off by	-0.42 feet,
Well H	was off by	-1.40 feet,
Well I	was off by	+8.99 feet.

The cause of the errors is likely a combination of incorrect initial calibration and tape stretch over time. Unfortunately, this means that a single correction factor can not be used to correct all past measurements, because there is no way of knowing when the tape stretch occurred.

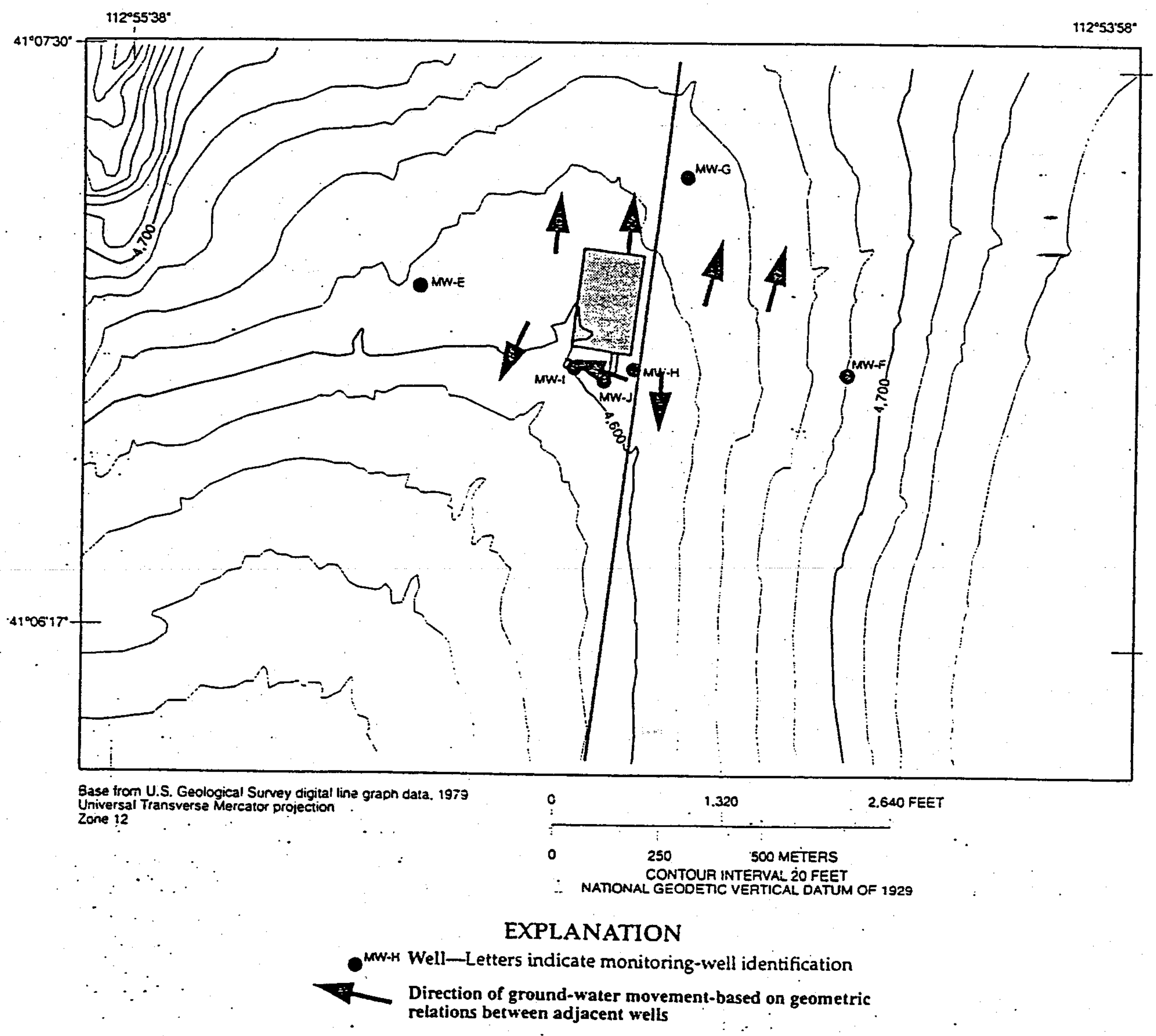
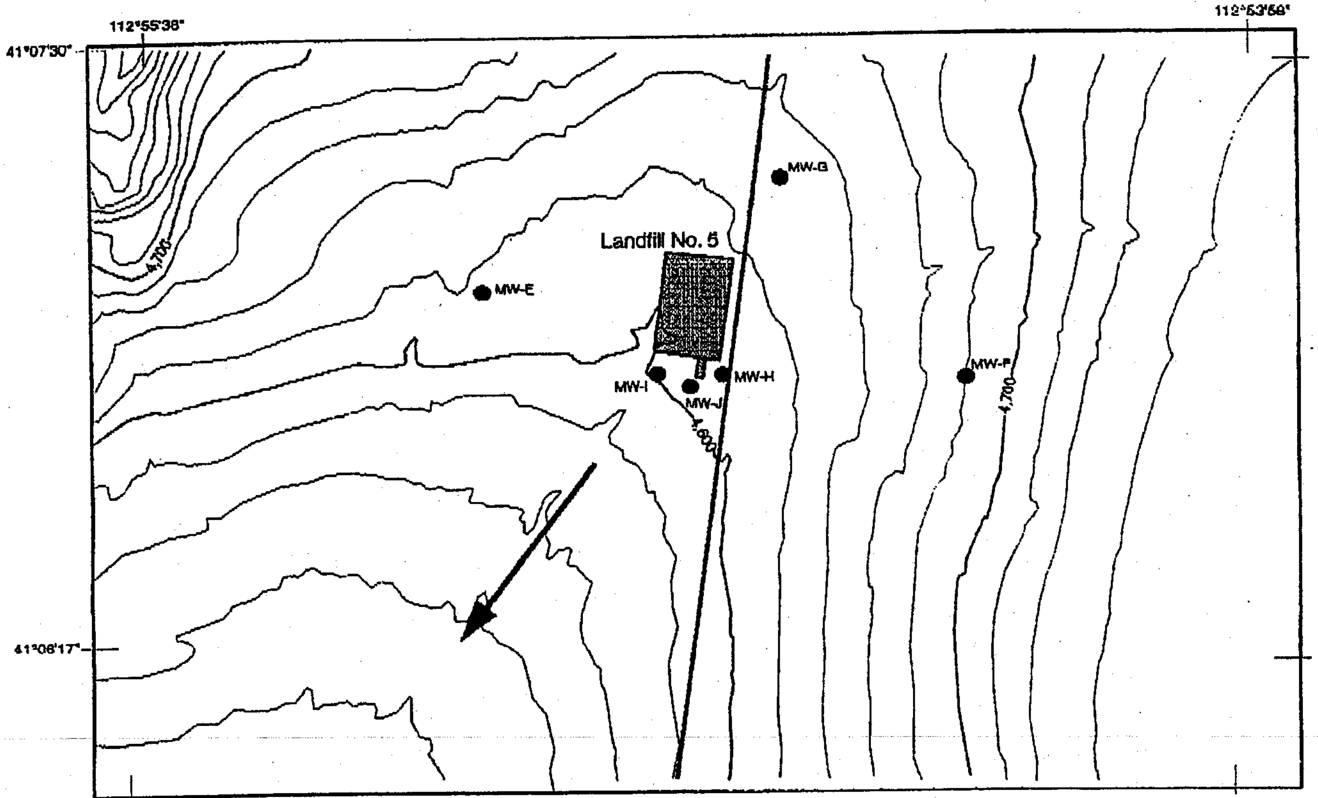


FIGURE 5 Groundwater Flow-direction Map 1995



Base from U.S. Geological Survey digital line graph data, 1979
Universal Transverse Mercator projection
Zone 12

0 1,320 2,640 FEET

0 250 500 METERS

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

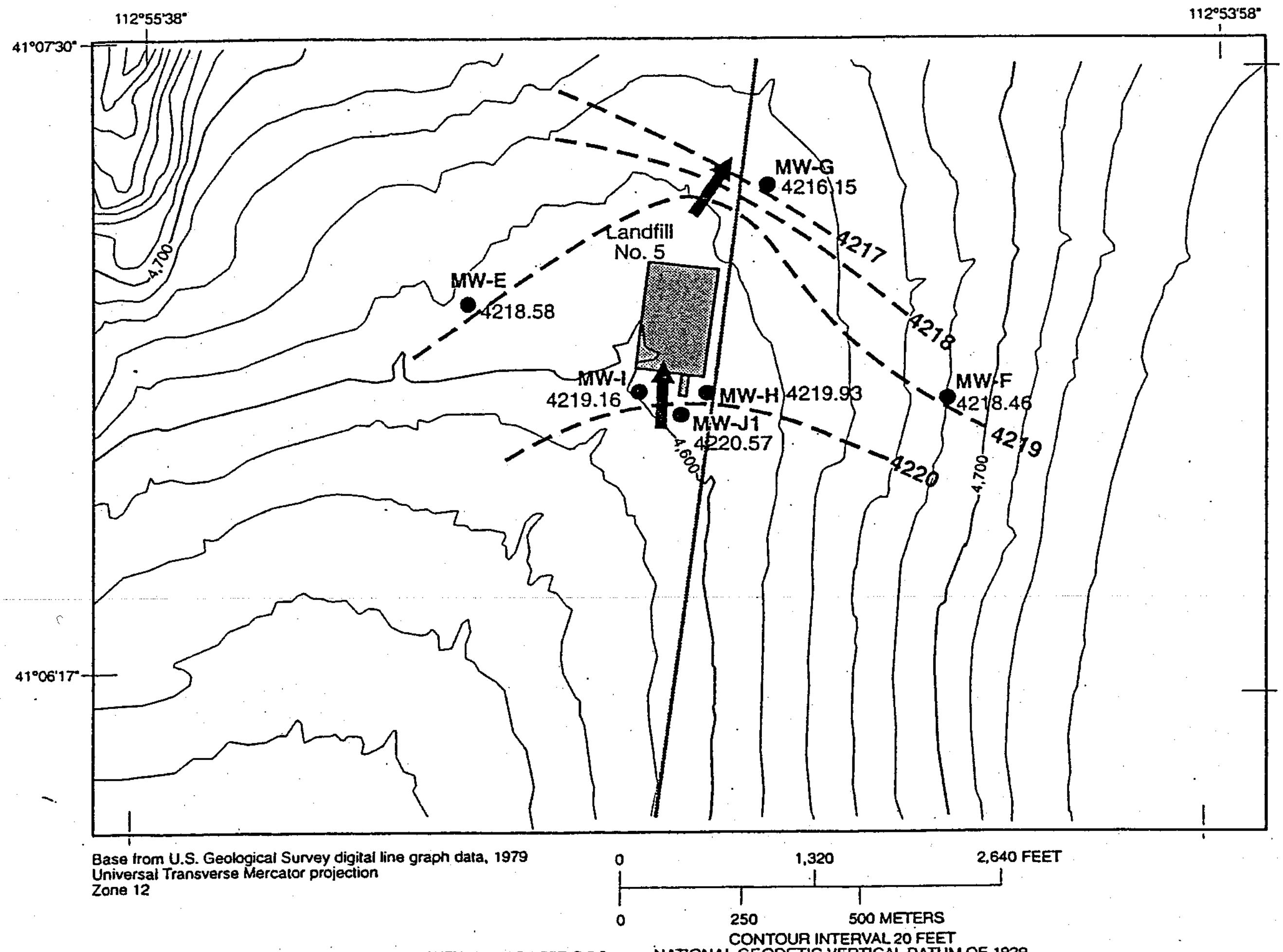
EXPLANATION

Direction of ground-water movement determined from regional potentiometric surface and ground-water quality data.

MW-J **Well—Letters indicate monitoring-well identification**

Location of Landfill No. 5 and monitoring wells, and direction of ground-water movement in Utah Test and Training Range, Box Elder County, Utah.

FIGURE 6 Groundwater Flow-direction Map 1996



EXPLANATION

⬅	**Direction of ground-water movement determined from water levels measured in October 1997**
—4220— —	**Elevation of water level (potentiometric surface). Contour interval 1 foot. Dashed where approximate. Datum is sea level**
●	**Observation well**
MW–F	Well identification number
4218.46	Water table altitude

FIGURE 7 Groundwater Flow-direction Map 1997

On February 27, 1998 the top of each well was re-surveyed to insure that no errors in static water level measurements were being introduced from the reference points that were used by the down well measuring tapes. This survey confirmed that the measurement point altitudes of the wells had not changed significantly since the last survey on March 17, 1995.

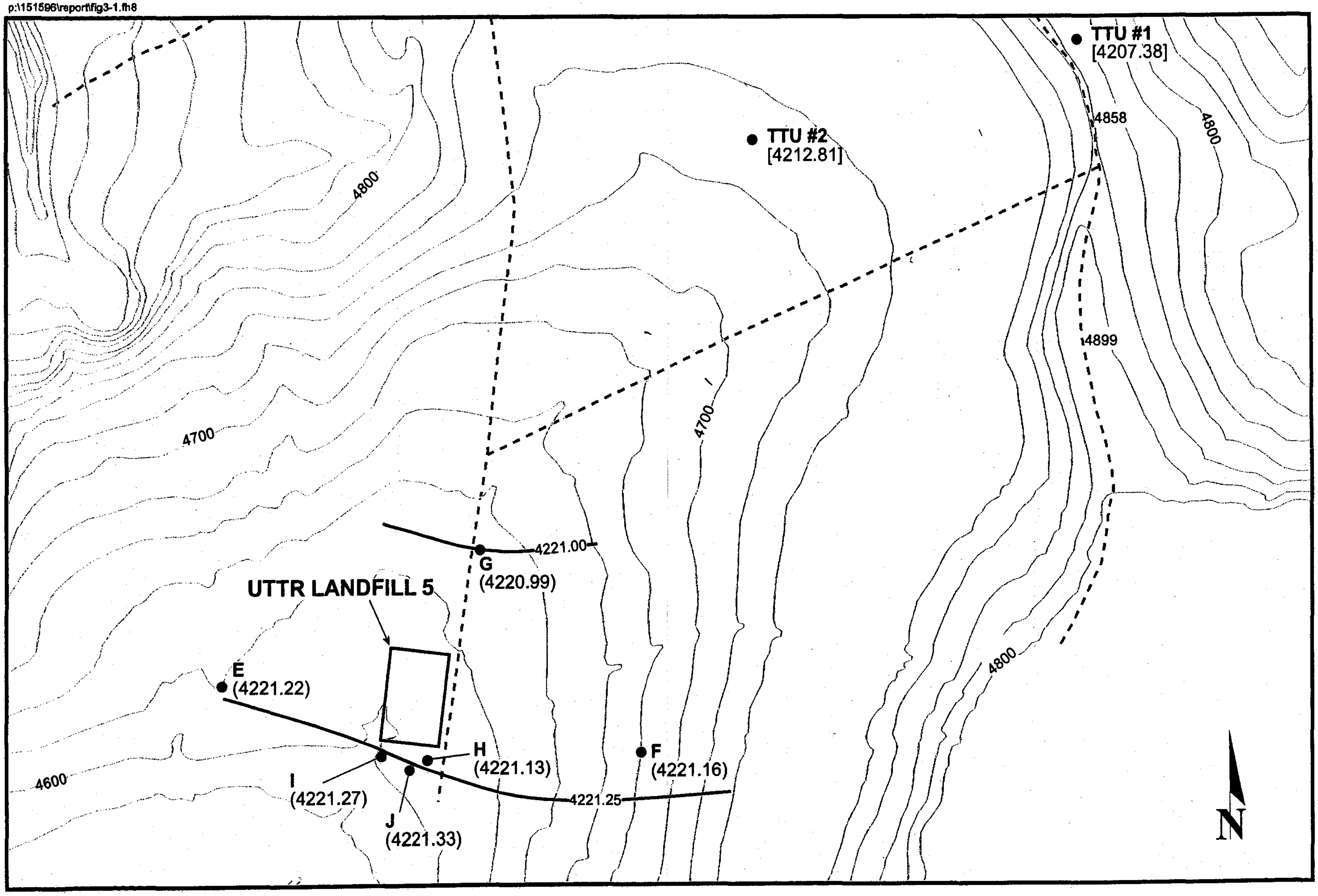
On April 2, 1999 the Air Force had an inclination survey conducted on monitoring wells E, F, G, H, I, and J1. To do this the dedicated down well pumps, control cables, discharge and water level piping was removed from each well. Century Geophysical Corp. of Elko, NV performed the inclination survey. Starting at top of casing (TOC) northing and easting, azimuth, slope angle of inclination, slope angle bearing, horizontal distance from plumb and true depth were recorded each 0.25 feet. Several other geophysical parameters were recorded as well. These were gama, resistivity, and spontaneous potential logs.

The data from this survey indicated that none of the Landfill #5 monitoring wells were vertically plumb. When a well is not plumb the down hole measurement is always longer than the true depth to groundwater, because down hole measurements are along the hypotenuse of a triangle and not down the vertical leg. These errors, which are rarely measured in RCRA groundwater monitoring wells, are all significant.

Well #	Vertical Error	Horizontal Offset
Well E	3.02 ft	45.0 ft
Well F	2.79 ft	47.2 ft
Well G	6.09 ft	66.0 ft
Well H	1.22 ft	22.8 ft
Well I	3.30 ft	45.2 ft
Well J1	0.59 ft	21.0 ft

The inclination measurements were used to correct the static groundwater elevations, and then to generate a corrected piezometric surface contour map. Figure 8 shows the final corrected groundwater elevations and interpreted piezometric surface. The gradient slopes to the north, up valley, and then east through Sedal Pass. The wells at the TTU were not included in the inclination survey, so their groundwater elevations are not corrected. However, the expected elevation corrections for these wells (estimating from the average correction found for the Landfill #5 wells) is not sufficient to change the groundwater flow direction. It should be noted, that the final corrected data does show a very flat gradient of only 0.00018 feet/foot in the vicinity of Landfill #5.

p:\151596\report\fig3-1.fh8



Notes:
1) Contour Interval: 20 feet.
2) Base map digitized from USGS 7.5' series maps: Sally Mountain, Utah 1983 and Strongs Knob, Utah 1969.

LEGEND

● Existing Monitoring Well Location

(4221.22) Corrected Groundwater Elevations

[4212.81] Uncorrected Groundwater Elevations

- - - Road

—— Ground Water Contour

0 1000 2000 ft.

FIGURE 8 Groundwater Contour Map 1999

Before this flow direction is considered for compliance purposes, additional semiannual monitoring events need to be conducted to verify the first round of truly accurate measurements.

4.1.6 Uppermost Aquifer Parameters

Aquifer Description

Table 2 summarizes information that describes the uppermost aquifer at each well location at the site. The well locations are shown in Figure 8. The depth to the uppermost aquifer directly beneath the landfill is about 400 feet below the surface.

The uppermost aquifer beneath Landfill # 5 does not appear to be contained in a single stratigraphic interval or sedimentary unit. This is evidenced by the aquifer descriptions provided in Table 2. The valley fill materials under the landfill exhibit steeply dipping beds and lateral facies changes. The aquifer materials described for Wells H, I, and J are significantly different in composition. By contrast, the aquifer material in Wells E, F, and G is somewhat similar in composition. Gamma logs from Wells E, F, and G also indicate these wells are completed in similar geologic materials. In these wells, the aquifer is within bedded older valley fill deposits of uncemented and partially cemented gravel and sand deposits. The gravels are comprised primarily of black and gray microcrystalline limestones, probably derived from the Great Blue Limestone and the Humbug Formation. The gravels also consist of dolomite, quartzite and calcite. Colors of the gravels range from black and gray to white, tan, orange, and red.

Groundwater in the uppermost water bearing strata is under artesian pressures in all wells at the site. Water level rises in Wells E, F, G, H, I, and J are between 20 and 40 feet above the top of the aquifer. In addition, Wells 1, 2, A, B, and D are also reported to have penetrated artesian conditions at the time they were drilled.

Effective porosity values for sand and gravel mixes range from 0.10 to 0.35. Hydraulic conductivity values have been previously determined to range from 3 to 15 ft/day for geologic materials at the site. The hydraulic gradient, however, has not been determined in the vicinity of the site and the groundwater velocity cannot be estimated.

The aquifer thickness varies between each well location. Generally, the uppermost aquifer is not one thick consistent geologic material, but instead is comprised of inter-bedded sand and gravel deposits. The water yielding strata range from 2 to 5 feet in thickness. Each well is completed adjacent to several zones which produce water. The total thickness of water bearing strata was estimated using geophysical logs and varies from 19 feet in Well J to 5 feet in Well G.

Aquifer Properties

Aquifer pump tests were conducted in Wells E, F, G, H, I, and J to determine the saturated hydraulic properties of the uppermost aquifer. Two analytical methods were used to interpret the aquifer pump test data. The standard Theis non-equilibrium solution for aquifer recovery data was the primary method used to estimate transmissivity for each well. The Cooper and Jacob semi-log method was also used to interpret the aquifer drawdown data for Wells I and J. The slug recovery test in Well E was analyzed using the method described by McWhorter and Sunada (1977). Table 3 summarizes the results of aquifer pump tests.

Transmissivity estimates range from 12 to 150 ft^2/day for the uppermost aquifer at the site. These values are relatively low and are several orders of magnitude less than transmissivity estimates from wells farther south in Sink Valley. Transmissivity values between 10 and 100 ft^2/day are considered fair for domestic water supply purposes.

Results of the Jacob semi-log analysis of Well I show that the drawdown data follow a straight line solution until time is greater than 10 minutes. After 10 minutes the drawdown is less than that predicted using the Theis solution. This deviation can be caused by leakage from underlying aquifers. Results from Well J also show a flattening out of drawdown at times greater than 15 minutes into the test. This test also indicates recharge or leakage from adjacent aquifers.

Hydraulic Conductivity

Saturated hydraulic conductivity (K_s) values can be estimated from transmissivity data using the relationship

$$K_s = T / b$$

where T = aquifer transmissivity (ft^2/day)
b = saturated aquifer thickness (ft)

The aquifer transmissivity data came from slug and pump tests. Those data are listed in Table 3. The saturated aquifer thickness was estimated from geophysical logs for the wells, and is summarized on Table 2.

Table 3

SUMMARY OF PRINCIPAL AQUIFER DATA AT THE UTTR LANDFILL # 5

Well No.	Transmissivity (ft^2/day) Slug Recovery Data	Constant Pumping Recovery Data	Jacob Semi-log Pumping Well Data	Estimated Saturated Hydraulic Conductivity
E	12	24		3
F		104		7
G		35		7
H		110		14
I		150	78	15
J		94	33	5

Storativity Estimate Ranges:

S = about 10^{-3} to 10^{-4}
S = pgbe (assuming compressibility of water is negligible)

where:

pg = Gravity x density of water (62.4 lbs/ft^3)
b = Aquifer thickness (Table 2)
e = Aquifer compressibility

Ranges:

Loose sand 2.5 - 5.0 x 10^{-6} ft^2/lb
Dense sand 6.2 x 10^{-7} - 1.0 x 10^{-6} ft^2/lb
(Freeze and Cherry, 1979, p. 55)

Saturated hydraulic conductivities range from 3 to 15 ft/day for aquifer materials at the site (see 3). These values are representative of silty sands to fine sand and gravel deposits (Freeze and Cherry, 1979). The lower hydraulic conductivities were found in Wells E, F, G, and J. Wells H and I are characterized by hydraulic conductivities about 2 to 3 times higher than other wells at the site.

Storage Coefficient

Single well aquifer pump and recovery tests do not allow for a reliable calculation of the aquifer storage coefficient. The aquifer storage coefficient was therefore, estimated using the relationship.

$$S = p\,g\,b\,e$$

where:

p	=	density of water (62.4 lbs/ft)
b	=	aquifer thickness (Table 2)
g	=	gravitational constant
e	=	aquifer compressibility

Aquifer compressibilities for a range of geologic materials are listed in Freeze and Cherry (1979). Representative values for fine and dense sands were used to estimate aquifer storage coefficient.

Table 3 shows the range of aquifer storage coefficient to be 10^{-3} to 10^{-4}. These values are within the range reported by Todd (1980) and Freeze and Cherry (1979) for confined aquifer systems and are therefore considered representative.

The aquifer storage coefficient has merit in the characterization of groundwater systems for water supply development; however, it is not needed in determining groundwater flow direction and velocity.

4.1.7 Uppermost Aquitard Parameters

Two types of confining units may exist within the valley fill sediments. Both types consist of calcium carbonate cement. The first type of cementation occurred at the time of deposition. These confining units are suspected to be localized and discontinuous consisting of interbedded carbonate muds and cemented sands and gravels. The second type is aerially extensive and cuts across sedimentary units. These confining units are related to paleo-water levels in the valley fill sediments.

The carbonate cementation that immediately overlies the first water bearing zone at the site is probably a combination of the two types described. The confining unit at the site is known to cut across geologic units regardless of the aquifer material or the overlying geologic materials.

4.1.8 Background Water Quality

Chemical analysis of the water from the potable wells at the range complex show that it is excessively high in iron, manganese, sodium, potassium, magnesium, sulfates, chlorides, fluorides, and total solids. Total dissolved solids (TDS) range from 1,000 mg/L to 5,000 mg/L. The groundwater is alkaline, with pH ranging from 7.5 to 8.1. Chloride concentrations in the water from the wells near Oasis Complex exceed the Utah Secondary Drinking Water Standard MCL of 250 mg/L. All water used for culinary purposes at the Oasis Complex must be run through a reverse osmosis water treatment system before it can be used.

4.2 Other Available Information

Water Quality, From tech pub #42, State of Utah, Dept. of Natural Resources, 1974.

Water from the northern Great Salt Lake Desert ranges from fresh to briny. Fresh water might be encountered in the subsurface locally in perched water zones in sand dunes and at shallow depths in the alluvium. Such areas would probably be of small extent, however, and they would contain relatively small volumes of water.

In general, groundwater under the desert floor contains 150,000 mg/l or more of dissolved solids, which precludes its use for nearly anything except mineral production or uses following after desalinization.

4.3 Adequacy of Owner/Operator Information

With the completion of the re-surveying of all groundwater well tops and determination of the inclination angle of all wells, the data used to elevate the peziometric surface is as accurate as present day technology can provide. This data is better than is normally available for RCRA groundwater monitoring systems.

The data on aquifer parameters is dated and shows wide variations in values (see Table 3) for the techniques used to obtain the data. More accurate data on aquifer parameters could be obtained by designing and conducting a carefully planned and executed inter-well pump test.

There is now additional information (geophysical logs from inclination survey and a new well log for Well J1) on the stratigraphic section that lies between the landfill and the aquifer. This data has not been put to full use to characterize the vadose zone. The data could be used to generate a more complete characterization of the contaminant pathway through the vadose zone, between the landfill and the primary aquifer at the site. It is very likely that the local stratigraphy is quite complicated due to the expected meandering channels that are typical in the depositional environment that existed when the sediments were laid down. However, a carefully constructed fence diagram or similar inter-well plot could provide a valuable outline of, at a minimum, the major stratigraphic layers in the area and could possibly provide a good degree of detail on the site stratigraphy.

The site stratigraphy needs to be known in adequate detail so that, with a high degree of confidence, the main contaminant pathway is understood. Only after this information is available can a decision be made as to ability of the groundwater monitoring system to detect a release of contamination from the regulated unit.

This characterization of the vadose zone stratigraphy is the weakest link in the present monitoring system that is in place to detect the presence of a release of hazardous contaminants from Landfill #5.

5.0 Groundwater Monitoring System Evaluation

The objective of any groundwater monitoring system is to insure that quality groundwater samples can be obtained on a regular basis from properly constructed wells. These wells must be located to insure that any release of contamination from the facility being monitored will be detected. They must also be spatially arranged to insure that an accurate direction and flow rate for groundwater movement can be determined. The final criteria for a RCRA groundwater monitoring system is that there be down-gradient wells that will detect the migration of contamination past the compliance point for a regulated unit.

5.1 Design

The first set of monitoring wells (1, 2, 3 and 4) were installed at the site in the summer and fall of 1983. On September 23, 1983, the Bureau of Solid and Hazardous Waste (now the Division) received analytical results from the first set of groundwater samples taken at these wells.

A second set of RCRA monitoring wells (A, B, C and D) were installed during the fall of 1984. Three of these wells were later deepened (A, B and D) in December of 1984. The casing in well C was broken during emplacement of the gravel pack. Consequently, it was never sampled.

On May 23, 1985, a Groundwater Compliance Evaluation with EPA oversight was conducted by the Bureau at the Range. Both the EPA and Bureau Inspection Reports found the existing monitoring wells at the facility to be inadequate. The subsequent set of wells (Wells E through J) were located using information gained from the previous wells. The original two sets of wells (Wells 1 through 4, and Wells A through D) have all been abandoned. The only wells presently in operation at Landfill #5 are Wells E through J.

The present monitoring system was installed in accordance with conditions defined in the original Post-Closure Permit, which was written twelve years ago (issued July 1988). The system consists of three upgradient wells (E, F and G) and three downgradient, compliance point wells (H, I and J). At the time of permit issuance, UTTR was unable to definitively determine a peziometric surface for the aquifer. Consequently, the groundwater flow path was largely based on the physiographic setting of the site and was assumed to be down valley from the north to the south in the vicinity of the landfill.

As has been indicated previously in this report, the data from the most recent round of sampling indicates that upgradient and downgradient are probably opposite from what was originally thought to be in 1989. These data are significantly more accurate than what was available at the time of permit issuance back in 1989. The validation of these data by additional sampling rounds is necessary before any final conclusions can be made.

5.2 Construction Details

5.2.1. Drilling Methods

Upgradient wells E and F were drilled in the fall of 1986 using Conventional Air Rotary with Airfoam and EZ mud according to the boring logs (Appendix B). Wells G (upgradient), H, I and J (downgradient) were drilled in late 1987 and early 1988 using Air Rotary with foam and water injection. The wells range in depth from 450 feet (well H) to 520 feet (well F).

Well J1 was drilled in September 1996 as a replacement for Well J, which was damaged during removal of a non-functioning pump. The replacement well was drilled with a combination of reverse air circulation and mud rotary drilling techniques. The well log for this well is included in Appendix B.

5.2.2. Well Construction Methods

Each of the original wells has an eight-inch steel surface casing that was driven to a depth of approximately 100 feet in the seven and seven/eighths inch diameter boreholes. Well J1 had a 9-inch triple wall conductor casing driven to 50 feet bgs. Below that depth the casing could not be driven further due to cobbles and boulders in the subsurface.

The original set of six monitoring wells, E, F, G, H, I, and J were constructed of four-inch-diameter schedule 40 PVC pipe with a twenty-foot 0.010 slot screens and a size 16 sand pack. The remainder of the borehole was filled with granulated bentonite and bentonite cement plugs. Figure 9 shows the construction details for a typical monitoring well at Landfill #5.

After the monitoring wells were completed, Grundfos stainless steel submersible pumps were installed. The 1-1/2 hp dedicated pumps were originally installed on 1-inch

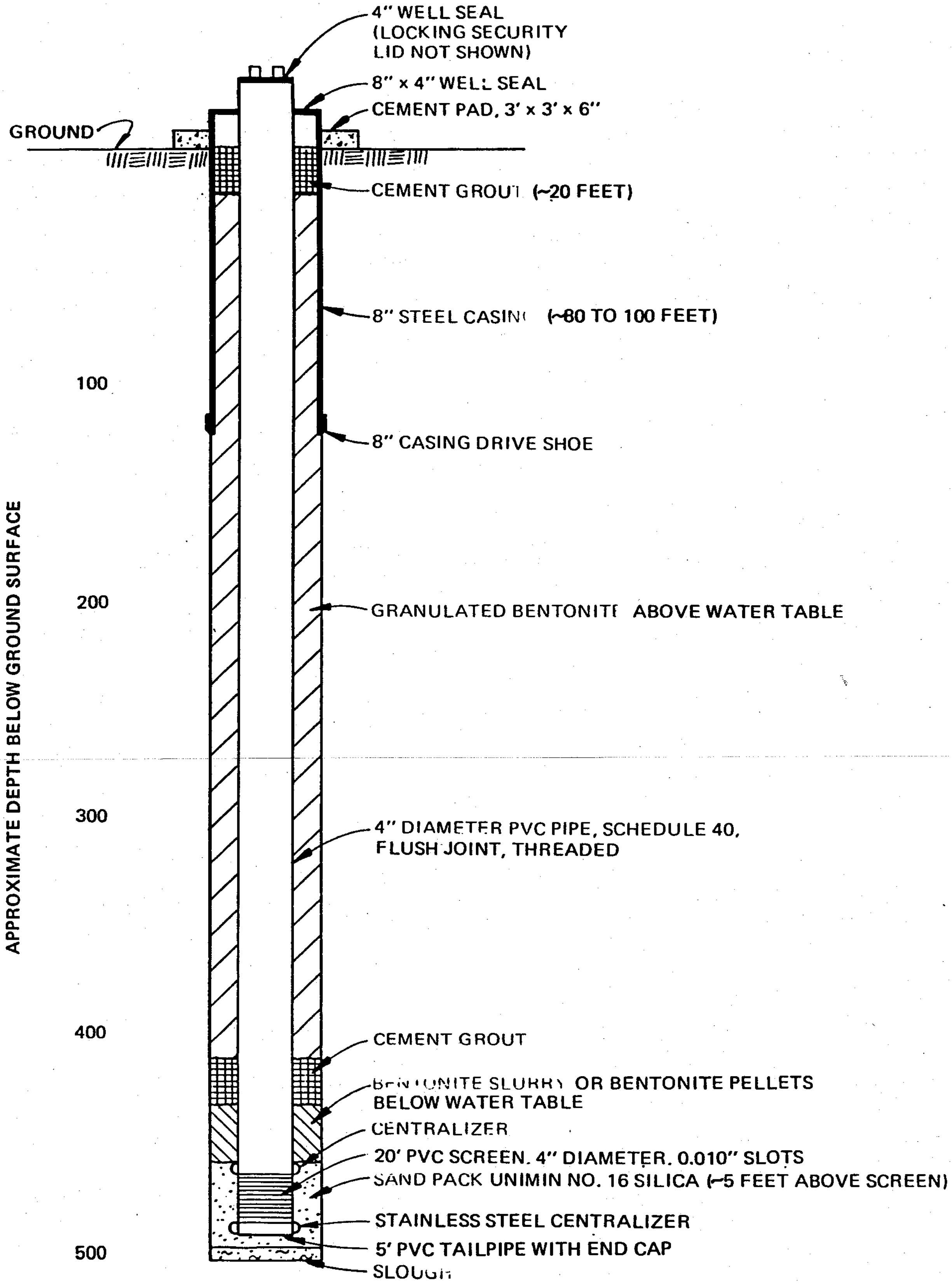


FIGURE 9 Typical 4-Inch Monitoring Well Installation

CH2M HILL

threaded and coupled schedule 80 PVC discharge pipe. All of these original wells have since been refitted with stainless steel discharge piping.

The well casing for well J1 consists of flush threaded, 4-inch-diameter, Schedule 40 PVC pipe with a 20 foot long 0.010-inch slot screen located at 420 to 440 feet bgs. The filter pack consists of 10-20 environmental-grade silica sand. Figure 10 shows the well construction for this well.

5.2.3. Well Development

Development of the original six wells needs to be researched to provide accurate information on the development techniques used.

Initial well development of Well J1 was performed on October 3, 1996. The well was surged using a 10-foot-long, 3-inch-diameter stainless steel bailer. The surging mobilized solid material (formation material, bentonite, and filter sand) that had settled to the bottom of the well. Approximately 200 gallons of groundwater was removed during this operation. The solids steadily decreased and the development was discontinued when the bailed water appeared free from solids, but was still cloudy.

The final well development was performed after the dedicated submersible pump was installed on October 4, 1996. During this phase of development 410 gallons of groundwater were removed from the well. A single purge volume is estimated to be approximately 50 gallons. By the time this phase of development was completed the pH, conductivity, and temperature had all stabilized and the water was reported as "clearing."

5.3 Past Performance

Quarterly sampling of wells E, F, G, H, I and J commenced pursuant to Module V of the Post-Closure Permit and Closure Plan for Hazardous Waste Landfill/Storage Area in October of 1988.

The sampling protocol contained in the permit requires quarterly sampling for Class 1 and Class 2 parameters the first year with semi-annual sampling thereafter unless there is an exceedence of the method detection limit.

To date, the Air Force has submitted Semi-Annual Groundwater Sampling Reports through 1999.

PROJECT NUMBER	BORING NUMBER		
132115.WL	J-1	SHEET 1	OF 1

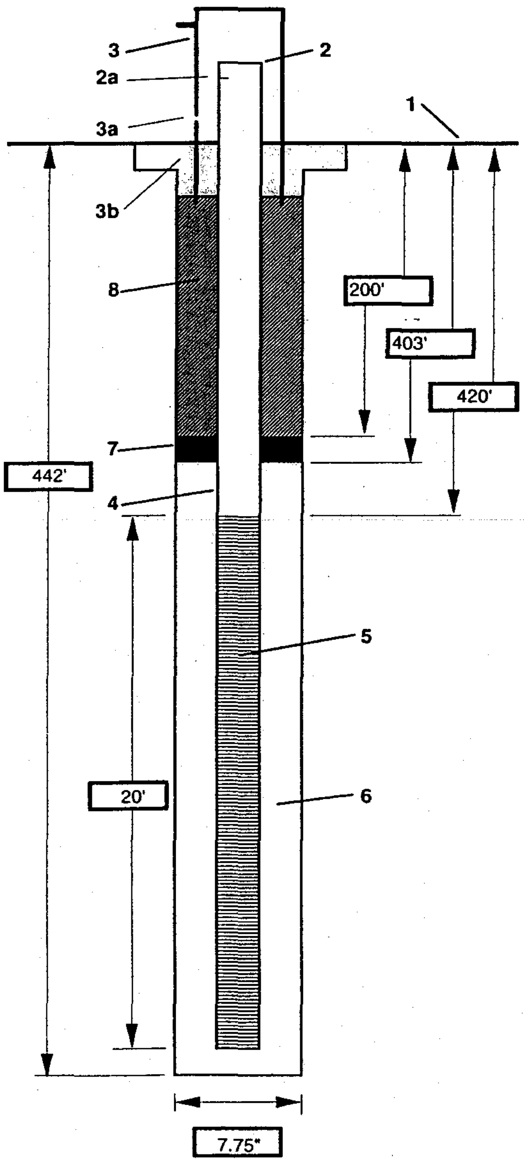
WELL COMPLETION DIAGRAM

PROJECT : **Monitoring Well J Replacement** LOCATION : **UTTR Landfill 5**

ELEVATION : **Top of Casing 4605.45** DRILLING CONTRACTOR : **Foundex Pacific**

DRILLING METHOD AND EQUIPMENT USED : **Air/Mud Rotary**

WATER LEVELS : **385.3 below top of casing on 10/4/96** START : **9/27/96** END : **9/29/96** LOGGER : **M.Cox**



1- Ground elevation at well: 4603.0

2- Top of casing elevation: 4605.45

3- Wellhead protection cover type: Above Ground, 8-inch steel with posts
- a) weep hole?: No
- b) concrete pad dimensions: 4 Feet By 4 Feet

4- Diameter/type of well casing: 4-inch, Schedule 40 PVC

5- Type/slot size of screen: Machine-Cut, 4-inch, Schedule 40 PVC .010 Slot, 420 to 440 ft bgs

6- Type screen filter
- a) Quantity used: 442-414 feet, 10/20 Silica, 10 bags; 414-403 feet, 16/40 Silica, 4 bags

7- Type of seal
- a) Quantity used: Bentonite Grout

8- Grout
- a) Grout mix used: Aqua-Guard, no cement
- b) Method of placement: Tremie
- c) Quantity of well casing grout: Bentonite Grout 403-200 feet; Bentonite Chips 200-0 feet

Pump
- a) Pump type: Grundfos 5S15-27, 230 volt
- b) Intake Depth: 425 feet bgs

Discharge Pipe: 3/4-inch type 304 stainless steel

Water Level Probe Pipe: 3/4-inch, flush-threaded, Schedule 80, PVC pipe

FIGURE 10 Well Completion Diagram, Well J-1

NOTE: All depths in feet below ground surface

5.4 Adequacy of Detection Monitoring System

Potential Problems associated with UTTR's current monitoring include the following:

1) The direction of groundwater flow at the site now appears to be to the north. This means that the down gradient compliance wells are actually up gradient.
2) The use of submersible centrifugal pumps could bias volatile organic results to lower than actual values due to heat and turbulence.
3) New cross-sections or fence diagrams should be drawn to correlate stratigraphy between the wells, and improve our understanding of the vadose zone.
4) An inter-well pump test should be conducted to develop a better understanding of the hydrology of the confined aquifer beneath Landfill #5.

5.5 Groundwater Sampling and Analysis Inspection

On April 6, 7, and 8, 1998, groundwater samples were collected by both the DSHW and representatives from the UTTR at monitoring wells G, H, I and J1 at Landfill #5. This sampling was done as a follow-up after Freon 113 was detected, at very low concentrations, at wells J1 and H during the previous sampling round. Samples were also collected for perchlorate analysis by the DSHW. The perchlorate sampling was done to see if there was any evidence of groundwater contamination from the open-burning / open-detonation of perchlorate based rocket motors at the TTU.

5.5.1 Participants

Date	In	Out	Participants	Weather
4/6/98	1030	1940	Bronson Hawley (DSHW) Walter Wilson (Hill AFB) Michael Enright (USGS) Katina Wilson (USGS)	Cold, light rain, heavy overcast.
4/7/98	1030	1940	Bronson Hawley (DSHW) Walter Wilson (Hill AFB)	High overcast, windy and cold.

			Michael Enright (USGS) Katina Wilson (USGS)	
4/8/98	1030	1940	Bronson Hawley (DSHW) Walter Wilson (Hill AFB) Michael Enright (USGS) Katina Wilson (USGS)	Clear sky, scattered clouds, no wind.

5.5.2 Sampling and Analysis Plan

The Sampling and Analysis plan that is currently being used at Landfill #5 is the one that is included in the Post-Closure Permit. It is included in Appendix D. The Sampling and Analysis Plan appeared to be adequate. The Sampling and Analysis Team followed the protocol outlined in the Sampling and Analysis Plan.

5.5.3 Sampling and Analysis

Water level measurements were taken at all wells (E, F, G, H, I, J-1, TTU-1 and, TTU-2) prior to well evacuation and sampling. All water level measurements were taken to the one-hundredth foot accuracy.

Total well depth measurements were not made during this sampling round. The permit requires that they be made only on a yearly basis (not during each sampling event).

Well purging and sampling were accomplished by connecting a generator to the leads of the submersible pumps and evacuating three casing volumes from each well prior to sample collection. The gas-powered generator was located down wind from the sampling area to insure that exhaust from the generator would not contaminate the samples. The pump at Well E would not work, so no samples were taken from this well. The problem was reported to Hill AFB environmental management so a repair work order could be initiated.

Throughout the purge process, field water parameters (pH, temperature and specific conductivity) were measured. The instruments used to monitor the field parameters were calibrated according to manufacture's specifications prior to taking measurements at the wells. All wells, except for Well TTU-2, were purged by continuous pumping until at least three well volumes were removed. Well TTU-2, located at Sedil Pass, is a slow water producer. Therefore, TTU-2 is purged until dry, allowed to refill with the pump off and purged again, until three well volumes are removed.

Water samples were collected from Wells H and J-1on April 6,1998, from I and TTU-1 on April 7, 1998, and from G, F and TTU-2 on April 8, 1998. As mentioned earlier, Well E could not be sampled because the pump would not function.

Samples were then collected in the following order:

Volatile Organic Compounds
Nutrients (nitrate and phosphorus)
Dissolved Metals (filtered with in-line filter)
Semi-volatile Organic Compounds
Pesticides & PCBs
Physical properties (pH, temperature, specific-conductivity)

The well purging and well sampling sequence was consistent with the schedule in the Sampling and Analysis Plan. Purge water was collected in the large tanks maintained adjacent to each well. Disposal is based on the analytical results.

Samples containers are laboratory prepared. Consequently, the addition of preservatives in the field is not required. Sample containers are maintained on ice after sample collection is complete. Chain of Custody methodologies consistent with those found in the Sampling and Analysis Plan were employed. Six QA/QC water samples were collected, including trip blank, duplicate, ambient blank, equipment blank, matrix spike, and matrix spike duplicate.

5.5.4 Analytical Results

Analytical results for the samples that were run at the Utah State Health Laboratory are included in Appendix E of this report. Overall, analytical results from State of Utah split-samples compare favorably with the facilities' submitted results. According to quarterly water quality reports submitted by UTTR, statistical evaluations provide no significant evidence to indicate contamination exists in any of the facilities' monitoring wells.

6.0 Conclusions and Recommendations

Based on observations made by the DSHW inspector during the sampling visit and a review of information submitted by the facility, the following conclusions and recommendations are made.

6.1 Subsurface (vadose zone) geology

1) A more thorough evaluation of the vadose zone should be made. There is now additional information (geophysical logs from the inclination survey and a new well log for Well J1) on the stratigraphic section that lies between the landfill and the aquifer. This data has not been put to full use to characterize the vadose zone. The data should be combined with all previous geophysical logs and well logs to generate a more complete characterization of the contaminant pathway through the vadose zone. Carefully constructed fence diagrams or other similar inter-well plots would be a good first step in more fully utilizing the existing information on the site stratigraphy.

2) There is no vadose zone monitoring system in place at Landfill # 5. With out such a monitoring system there will be a 400 foot thick section of contaminated soil to remediate before the first indication of a problem is identified by the present groundwater monitoring system.

6.2 Uppermost aquifer characterization

1) An inter-well pump test should be conducted to develop a better understanding of the hydrology of the confined aquifer beneath Landfill #5. This could be accomplished fairly easily by utilizing the three closely spaced wells (Well H, I, J-1) along the southern boundary of the landfill.

2) The new information (geophysical logs from the inclination survey and a new well log for Well J1) on site stratigraphy, that pertains to the aquifer, should be used in conjunction with existing and new pump-test data to improve the characterization of the aquifer.

6.3 Groundwater monitoring system

The direction of groundwater flow at the site now appears to be to the north northeast. This means that the down gradient "compliance wells" now appear to be up gradient. Consequently, the present system appears to be unable to detect if a release of hazardous contaminants has occurred. If the northerly groundwater flow direction is confirmed by future rounds of semi-annual groundwater monitoring, a revised approach to monitoring needs to considered. The revised approach could take the form of new downgradient groundwater monitoring wells or a vadose zone monitoring system.

2) The twenty (20) foot long screens that are installed in all of the present monitoring wells are longer than is normally considered appropriate. This may result in several different problems. The screens may be intersecting different portions of the aquifer in different wells, resulting in inconsistent aquifer properties being documented for different wells. The wide screen can result in dilution of higher contaminant-concentration zones in the aquifer.

6.4 Groundwater sampling program

The use of submersible centrifugal pumps could bias volatile organic results to lower than actual values due to heat and turbulence produced by the submersible pumps.

6.5 Laboratory analytical program

The laboratory analytical program appears to be adequate and is being conducted properly. Although still valid, some of the analytical methods listed in the Post-Closure Permit or outdated. These methods should be reviewed to determine if there are more appropriate methods available.

6.6 Interpretation of analytical results

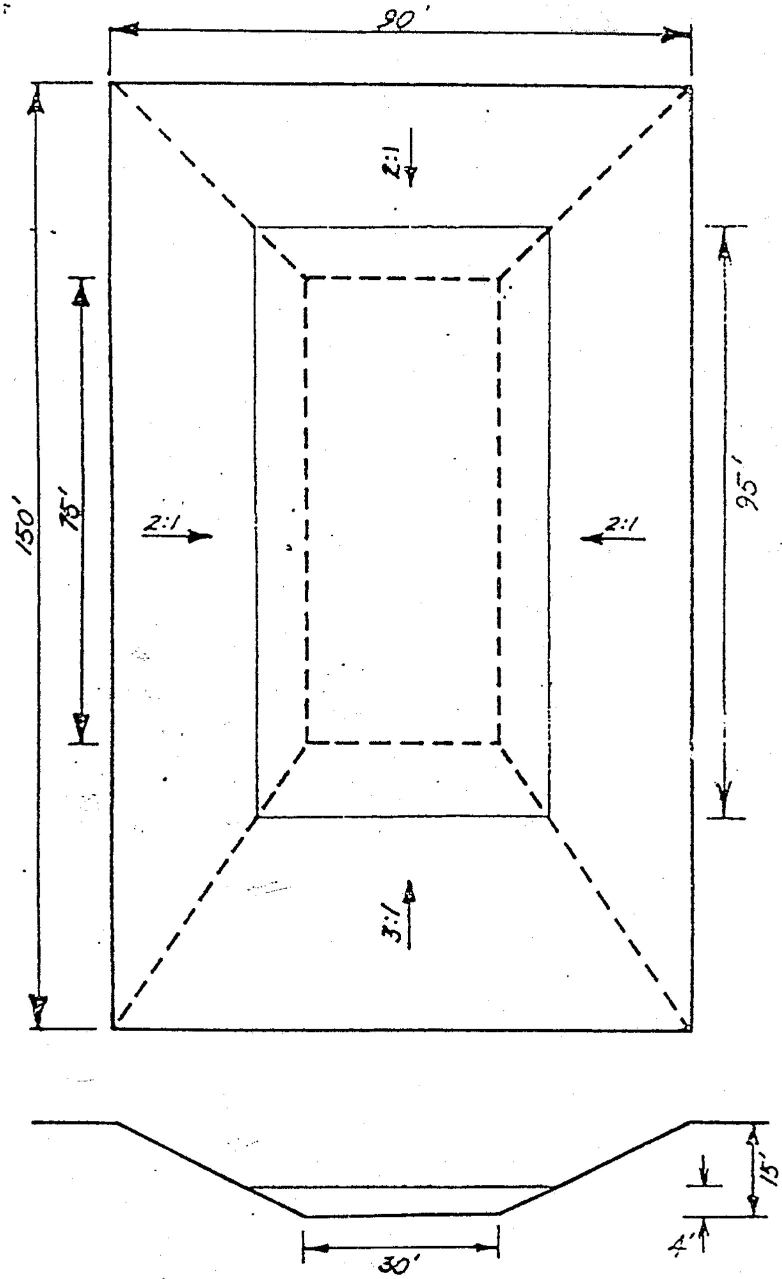
The interpretation of analytical results is very good. The Air Force and their contractor (the USGS) are doing a good job of evaluating and interpreting the analytical results.

APPENDIX A

Operating Record for Landfill #5

Cell A-1

Lower Level



Material: Industrial Waste Treatment Plant sludge

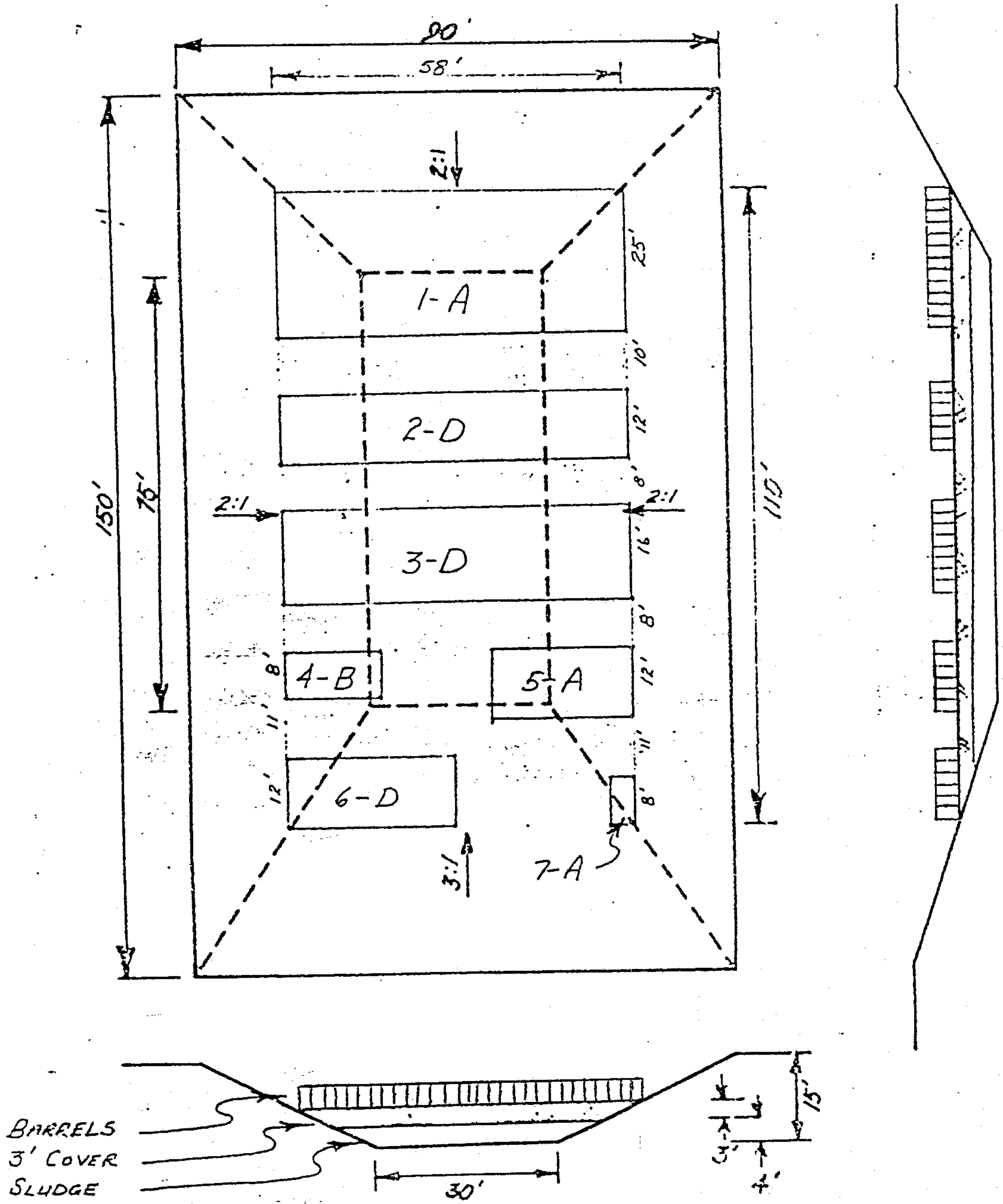
Amount: 1,249 tons (net weight). 4 feet thick in bottom of cell

Burial Date: November, 1976

Mode of Trans.: Hauled by truck under Contract # 600 DE-6301 7023

CELL A-1

UPPER LEVEL



CELL A-1
UPPER LEVEL

SECTION	WASTE CATEGORY	MATERIAL	NO. OF CONTAINERS	SIZE OF CONTAINERS	NO. OF PALLETS	DATE SHIPPED FROM BASE
1	A	Beryllium contaminated materials (MA)	205	55		Aug '76
2	D	Dirty Trichloroethane	18	55	4 1/2	1 Mar '77
		Trichloroethylene	10	55	2 1/2	1 Mar '77
		Paint Strippers	8	55	2	1 Mar '77
		Various Organic Solvents	72	55	18	8 Mar 77
3	D	Paint Remover Laquer	9	55	2 1/4	15 Mar 77
		Trichloroethane	44	55	13	15 Mar 77
		Calibrating Fluid	8	55	2	15 Mar 77
		Oils and Grease	17	55	5	15 & 18 Mar 77
		Grease	3	5	1	16 Mar 77
		Methanol	2	55	1	15 Mar 77
		Paint Residue	24	10	2	18 Mar 77
		Epoxies	12	5	1	15 Mar 77
		Epoxies	2	2	"	18 Mar 77
		Epoxies	1	1	"	18 Mar 77
		Rust Stripper	3	55	1	18 Mar 77
		Sealing Compound	9	10	1	18 Mar 77
		Toulene	1	55	1	18 Mar 77
		Hydraulic Fluid	1	55	"	18 Mar 77
		Cooling Water Control Formula	1	55	"	18 Mar 77
		Various Organic Solvents	64	55	16	11 Mar 77
4	B	Cyanate Residue (drums are otherwise empty)	32	55	8	1 Mar 77
		Etchant	4	55	1	16 Mar 77
5	A	Beryllium Contaminated Materials (MA)	72	55	18	Mar 77

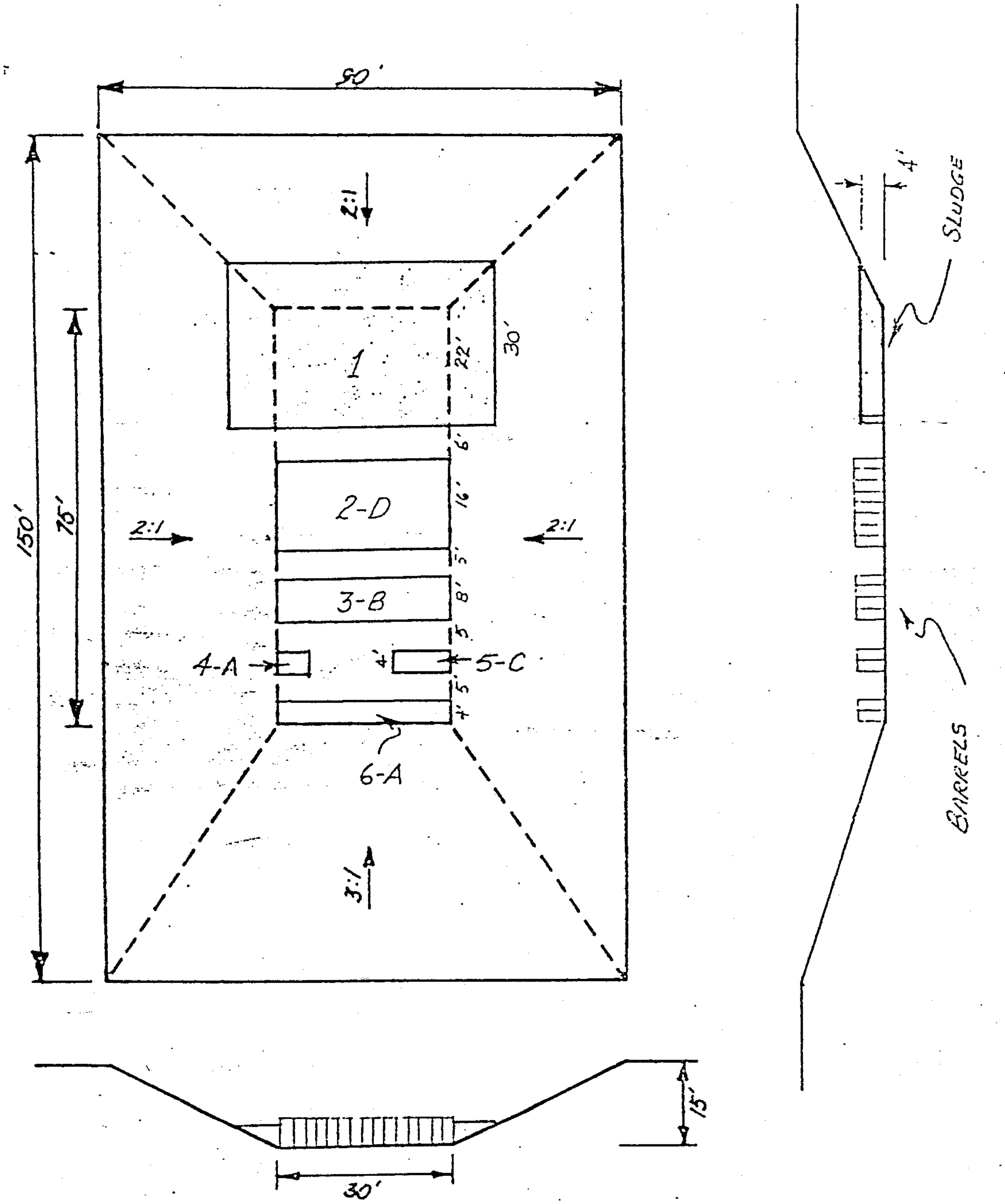
CELL A-1
UPPER LEVEL

SECTION	WASTE CATEGORY	MATERIALS	NO. OF CONTAINERS	SIZE OF CONTAINERS	NO. OF PALLETS	DATE SHIPPED FROM BASE
6	D	Paint Residue	6	55	2	16 Mar 77
	..	Paint Residue	168	5	7	16 Mar 77
		Paint Residue	1	10	1	16 Mar 77
		Paint Residue	2	20	"	16 Mar 77
		Methylene Chloride	7	55	2	16 Mar 77
		Trichloroethane	12	55	3	16 Mar 77
		Paint Stripper	8	55	2	16 Mar 77
		Carbon Remover	4	55	1	16 Mar 77
		Solvent	24	5	1	16 Mar 77
7	A	Pesticide Containers	20	5	1	18 Mar 77
		Asbestoes	1	55	1	18 Mar 77
		Asbestoes	1	10	"	18 Mar 77

CELL CLOSED - SUMMER 1977

CELL A-2

LOWER LEVEL



SECTION:	1
MATERIAL:	Industrial Waste Treatment Plant sludge
AMOUNT:	550 tons (wet weight), 4 feet thick on end of cell
BURIAL DATE:	June 1977
MODE OF TRANS.:	Hauled by truck under Contract F4[illegible]-77-3[illegible]

CELL A-2

LOWER LEVEL

Section	Waste Category	Material	No. of Containers	Size of Containers	No. of Pallets	Date Shipped From [illegible]
2	D	Paint Stripper Waste	4	55	1	3 Apr. 77
		Paint Remover	3	55	3/4	3 Apr 77
		Base "C" Oil	1	55	1/4	3 Apr 77
		Organic Solvent	1	55	1/4	3 Apr 77
		Trichloroethylene	2	55	1/2	3 Apr 77
		Alcohol Waste	1	55	1/4	3 Apr 77
		Various Organic Solvents	40	55	10	17 May 77
		Paint Stripper Wastes	10	55	2 1/2	15 June 77
		Dirty Trichloroethane	11	55	2 3/4	15 June 77
		Freon	1	55	1/4	15 June 77
		Paint Residue	17	5	1	15 June 77
		Paint Residue	21	5	2	29 Aug 77
		Chromate Paint Residue	4	5	1	29 Aug 77
		Alcohol	6	10	1	29 Aug 77
		Trichloroethane	3	55	1	29 Aug 77
		Isopropyl - Empty Containers	22	5	1	29 Aug 77
		Waste Oil	1	55	1	29 Aug 77
		Alcohol	1	55	1	29 Aug 77
3	B	Si Sulfa Sol	20	55	5	17 May 77
		Barrels contaminated with Cyanide Residue (empty)	6	55	2	15 June 77
		Si Sulfa Sol	6	55	2	15 June 77
		Si Sulfa Sol	8	55	3	29 Aug 77
4	A	3'x4'x3' Crate of Beryllium wastes	1		1	29 Aug 77
		Asbestos insulation	1	55	1	29 Aug 77
5	C	Chromate Wastes	8	55	2	17 May 77
6	A	Beryllium Contaminated Materials (MA)	28	55	7	Apr 77

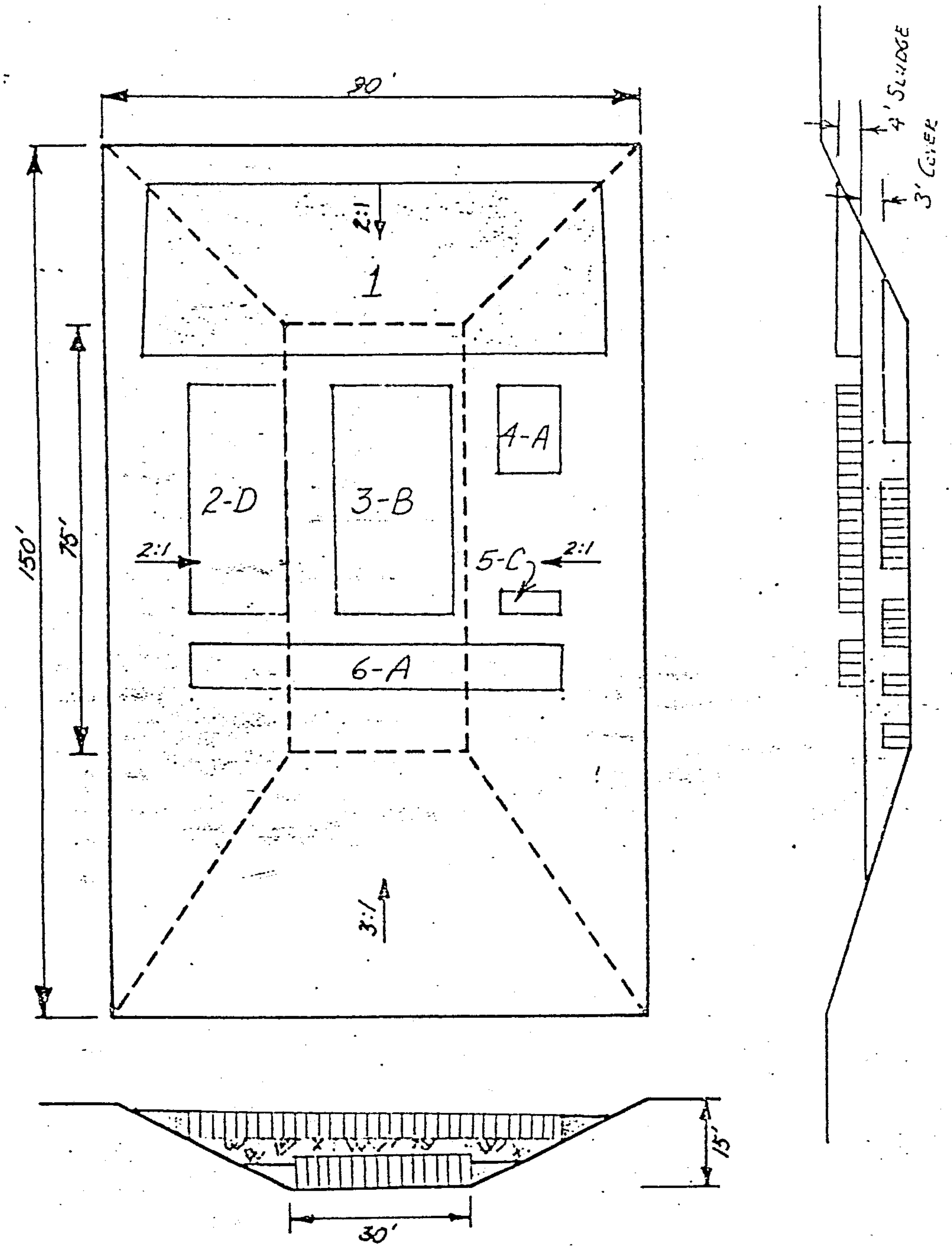
CELL A-2
UPPER LEVEL

Section	Waste Category	Material	No. of Containers	Size of Containers	No. of Pallets	Date Shipped From Base
2	D	Paint Remover	7	55	2 1/3	3 Oct 77
		Stripper Wastes	10	55	3	3 Oct 77
		Trichloroethane Wastes	2	55	1	3 Oct 77
		Alcohol	1	55	1/3	3 Oct 77
		Freon	1	55	1/3	3 Oct 77
		Propanol	4	55	1	3 Oct 77
		Stripper Wastes	3	55	1	27 Oct 77
		Organic Solvents	3	55	2	11 Nov 77
		Paint Stripper Wastes	8	55	2 2/3	11 Nov 77
		Trichloroethane Waste	1	55	1/3	11 Nov 77
		Stripper Wastes	2	5	1	11 Nov 77
		" "	1	20		
		Paint Residue	1	10	1	11 Nov 77
		Chromate Paint Residue	3	5	1	11 Nov 77
		Base "C" Oil	3	55	1	11 Nov 77
		Contaminated Barrels (empty)	2	55	1	11 Nov 77
		Paint Stripper	27	55	7	20 Dec 77
		Paint Stripper	12	55	4	12 Jan 78
		Trichloroethane	2	55	2/3	12 Jan 78
		Alcohol Wastes	1	55	1/3	12 Jan 78
		Paint Residue	27	5	3	12 Jan 78
		Dirty Emulsifier	2	55	2/3	12 Jan 78
		Dirty Penetrant	1	55	1/3	12 Jan 78
3	B	Empty Drums with Cyanide Residue	21	55	6	3 Oct 77
		~~Si Sulfa Sol~~	6	55	2	3 Oct 77
		Unknown	4	55	1	25 Oct 77
		Si Sulfa Sol	8	55	2	27 Oct 77
		Si Sulfa Sol	14	55	4	11 Nov 77
		Styrofoam and Cyanide Contaminated (mostly empty)	30	55	7	20 Dec 77
		Si Sulfa Sol	15	55	4	12 Jan 78
		Styrofoam Contaminated Barrels (empty)	16	55	4	12 Jan 78

2

CELL A-2

UPPER LEVEL



SECTION: 1

MATERIAL: Industrial Waste Treatment Plant sludge

AMOUNT: 1019 tons (wet weight), 4 feet thick on end of cell

BURIAL DATE: November 1977

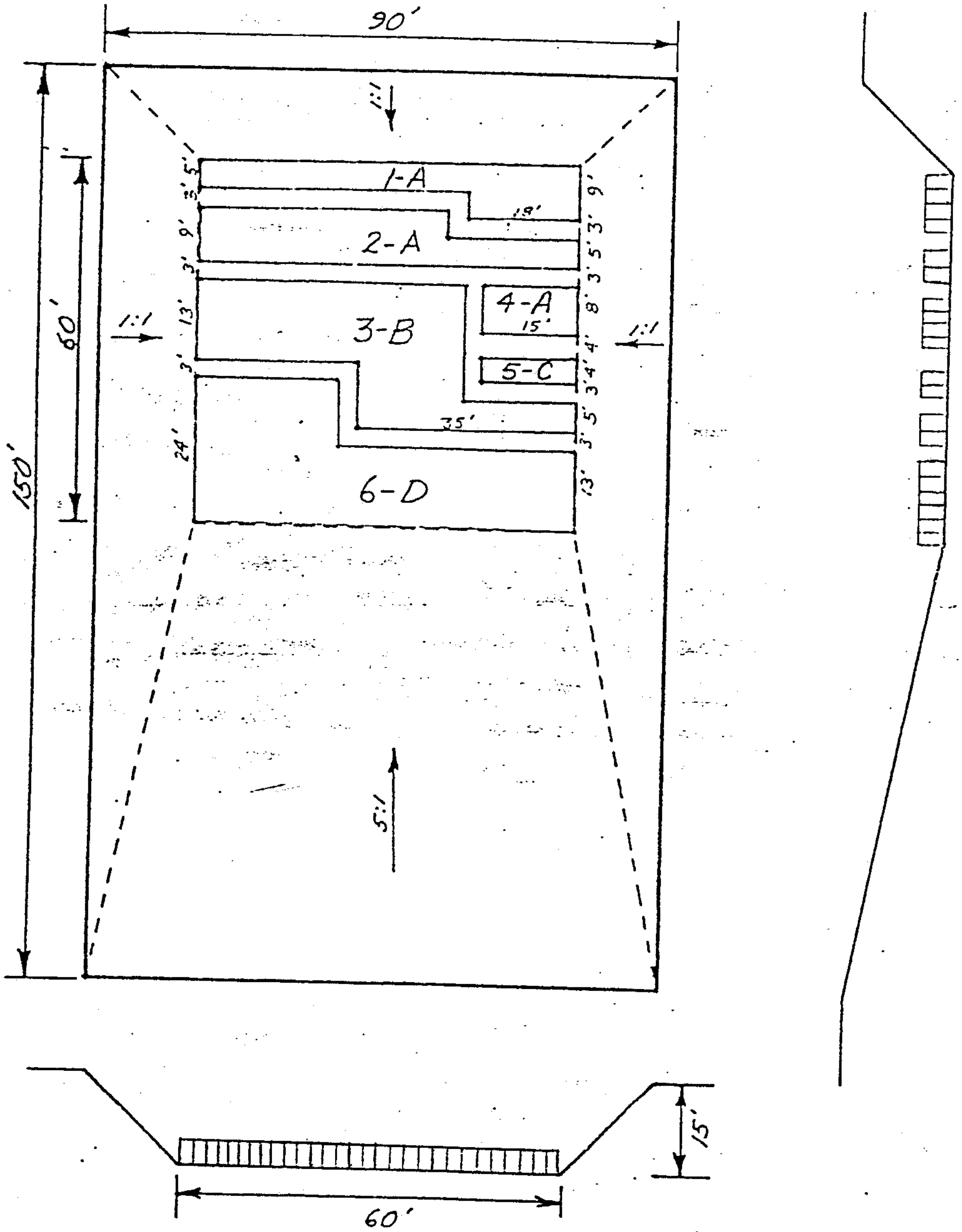
MODE OF TRANS.: Hauled by truck under Contract F42650-78-M0031

CELL A-2

UPPER LEVEL

SECTION	WASTE CATEGORY	MATERIAL	No. of CONTAINERS	SIZE of CONTAINERS	No. of PALLETS	DATE SHIPPED FROM BASE
4	A	Iron Scale	4	25	1	3 Oct 77
		Empty Pesticide Cans	5	5	1	25 Oct 77
		Mercury Wastes	1	Box	1	11 Nov 77
		Beryllium Wastes	1	Box	1	20 Dec 77
		Mercury Wastes	2	Boxes	1	12 Jan 78
5	C	Chrome Waste	6	5	1	20 Dec 77
		CELL CLOSED - SPRING 1978				

CELL A-3
LOWER
LEVEL



CELL A-3
LOWER LEVEL

Section	Waste Category	Material	No. of Containers	Size of Containers	No. of Pallets	Date Shipped	Final Case
1	A	Outdated 2,4,5 T (2,4,5 Trichlorophenoxyacetic Acid Herbicide) Toxic: 10 mg/M^3	66	55			
2	A	Beryllium Contaminated Materials (MA)	~92	55	13		
3	B	Si Sulfa Sol	24	55	7	7 Feb 78	
		Styrofoam Contaminated Barrels (empty)	11	55	3	7 Feb 78	
		Styrofoam Contaminated Barrels (empty)	32	29 55 3·5	6	27 Feb 78	
		Si Sulfa Sol	15	55	5	27 Feb 78	
		Waste Chromate	3	55	1	27 Feb 78	
		Si Sulfa Sol	18	55	18	7 Mar 78	
		Stripper Waste	7	55	3	7 Mar 78	
		Styrofoam Contaminated Barrels (empty)	6	55	1	7 Mar 78	
		Si Sulfa Sol	~20	55	5	13 Apr 78	
		Si Sulfa Sol	9	55	3	1 May 78	
		Penetrant	3	55	1	22 May 78	
		Styrofoam Contaminated Barrels empty	7	55	[illegible]	22 May 78	
4	A	Old Transformers - PCB Contaminated	~6		6	13 Apr 78	
		Old Transformers - PCB Contaminated	1		1	24 Apr 78	
		Pesticide Contaminated Containers	3	2-55 1-5	1	22 May 78	
5	C	Phosphoric Acid	1	10	½	7 Mar 78	
		Paint Residue	22	5	½	7 Mar 78	
		Neutralizing Agent (70% Sodium [illegible])	3	15	1	7 Mar 78	
		Acid Descaler Waste	4	55	1	5 May 78	

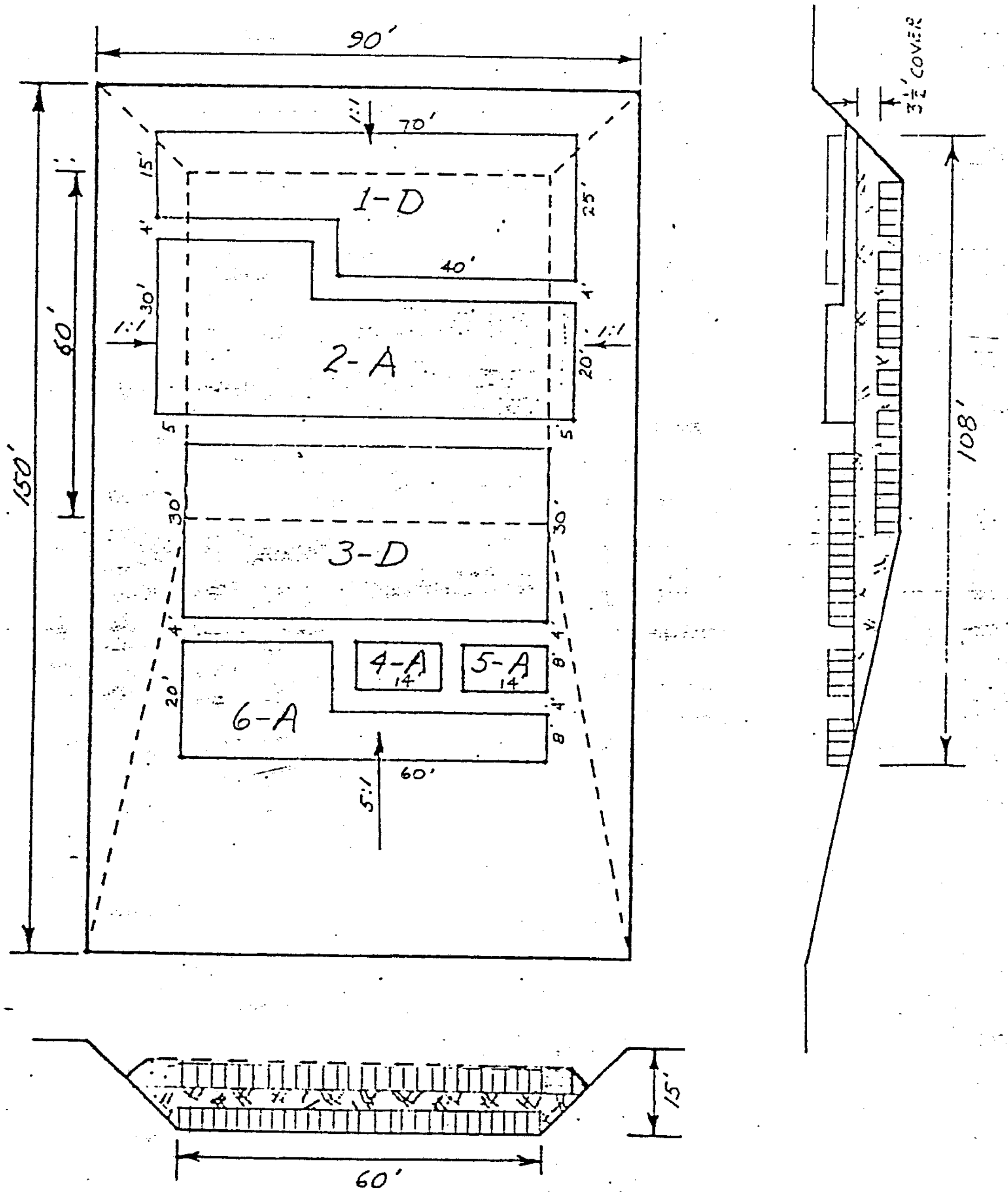
CELL A-3
LOWER LEVEL

SECTION	WASTE CATEGORY	MATERIAL	No. of CONTAINERS	SIZE of CONTAINERS	No. of PALLETS	DATE SHIPPED FROM BASE
6	D	Stripper	4	55	1	7 Feb 78
		Methyl Ethyl Ketone Waste	1	25	1	7 Feb 78
		Polyethane Enamel	2	25		
		Scotch Seal (Industrial Sealant)	1	25		
		Paint Residue	6	5	1	7 Feb 78
		Paint Primer and Sealants	6	20	1	7 Mar 78
		Sealants Adhesives (Test Samples)	2	Boxes	2	7 Mar 78
			1	10		
		Waste Chromate Paint	4	55	1	7 Mar 78
		Stripper Sludge	4	55	1	7 Mar 78
		Contaminated Oil	≈16	55	4	18 Apr 78
		Alcohol	≈4	55	1	18 Apr 78
		Rust Stripper	≈4	55	1	18 Apr 78
		Trichloroethylene Waste	≈4	55	1	18 Apr 78
		Contaminated Oils	40	55	10	24 Apr 78
		Trichloroethylene	4	55	1	24 Apr 78
		Paint Residue and Chromate Paint Residue	12	5	2	24 Apr 78
		Waste Hydraulic Fluid	2	55	1	1 May 78
		Paint-Stripper Wastes	15	55	4	1 May 78
		Solvent	4	55	1	1 May 78
		Methyl Chloride	4	55	1	1 May 78
		Thinner Waste	4	55	1	1 May 78
		Paint Residue	23	5	2	1 May 78
		Epoxy Resin	4	55	1	5 May 78
			2	10		
			10	5		
		Trichloroethane Waste	8	55	2	5 May 78
		Si Sulfa Sol	3	55	1	5 May 78
		~~Paint Residue~~	3	55	1	5 May 78
		Empty and Contaminated with Base C Oil	5	55	2	5 May 78
		Waste Adhesives	2	55	1	5 May 78

CELL A-3
LOWER LEVEL

SECTION	WASTE CATEGORY	MATERIAL	NO. OF CONTAINERS	SIZE OF CONTAINERS	NO. OF PALLETS	DATE SHIPPED FROM BASE
6	D	Photochemical Wastes; 5-5gal cans and Numerous Boxes of Developer	1	Crate	1	5 May 78
		Si Sulf. Sol	13	55	4	22 May 78
		Paint Stripper	4	55	1	22 May 78
		Trichloroethane Wastes (4 empties)	8	55	2	22 May 78
		El Dorado Cleaner Waste	2	55	1	22 May 78
		Resin	4	55	1	22 May 78
		Lacquer Thinner	4	55	1	22 May 78
		Paint Remover	5	55	2	22 May 78
			1	5		
		Cleaning Solution Contaminated Barrels	2	55	1	22 May 78
		Dirty Penetrant	2	55	1	22 May 78

CELL A-3
UPPER LEVEL



SECTION: 2 and a thin layer (≈2') under 1

MATERIAL: Industrial Waste Treatment Plant Sludge

AMOUNT: 1600 tons or approx 600 cu. yds. (½ in June ½ in Sept.)

BURIAL DATE: September 1978

MODE OF TRANS: Hauled by truck under contract
Contract # F42650-78-M5433 (Sept. Contract)

CELL A-3
UPPER LEVEL

SECTION	WASTE CATEGORY	MATERIAL	No. OF CONTAINERS	SIZE OF CONTAINERS	No. OF PALLETS	DATE SHIPPED FROM BASE
1	D	JP-4 Impregnated Reticulated Foam	24	1cuyd	4	29 June 78
		" " " "	22	1cuyd	4	23 Aug 78
		" " " "	18	1cuyd	5	5 Oct 78
		" " " "	56	1cuyd	14	11 Jan 79
		" " " "	10	1cuyd	3	30 Jan 79
3	D	Paint Remover Waste	14	55	4	21 June 78
		Stripper Waste	13	55	4	21 June 78
		Si Sulfa Sol	19	55	5	21 June 78
		Trichloroethane and Alcohol Waste	7	55	2	21 June 78
		Slop Thinner	2	55	1	21 June 78
		Slop Oil	4	55	1	21 June 78
		Paint Residue	24	5	[illegible]	29 June 78
		Si Sulfa Sol	3	55	1	29 June 78
		Contaminated Drums (Empty)	11	55	3	29 June 78
		Paint Stripper Waste	15	55	4	1 Aug 78
		Paint Residue	13	5	2	1 Aug 78
		Si Sulfa Sol	12	55	3	1 Aug 78
		MEK, Lacquer, Solvent, Adhesives (DSFSPC)	10	10	[illegible]	1 Aug 78
		Trichloroethane Wastes	6	55	2	28 Aug 78
		Paint Stripper Wastes	12	55	3	28 Aug 78
		Fire Extinguishing Agent	4	55	2	28 Aug 78
		Si Sulfa Sol	5	55	2	29 Aug 78
		Methylene Chloride Wastes	4	55	1	23 Aug 78
		Freon Waste	1	55	½	3 Oct 78
		Trichloroethane Waste	11	55	3½	3 Oct 78
		Paint Stripper Waste	5	55	2	3 Oct 78
		Trichloroethylene Waste	3	55	1	3 Oct 78
		Contaminated TURCO Stripper	4	55	2	3 Oct 78
		Unidentified Paints	[illegible]	[illegible]	1	3 Oct 78
		Paints and Sealants	[illegible]	1cuyd	1	3 Oct 78

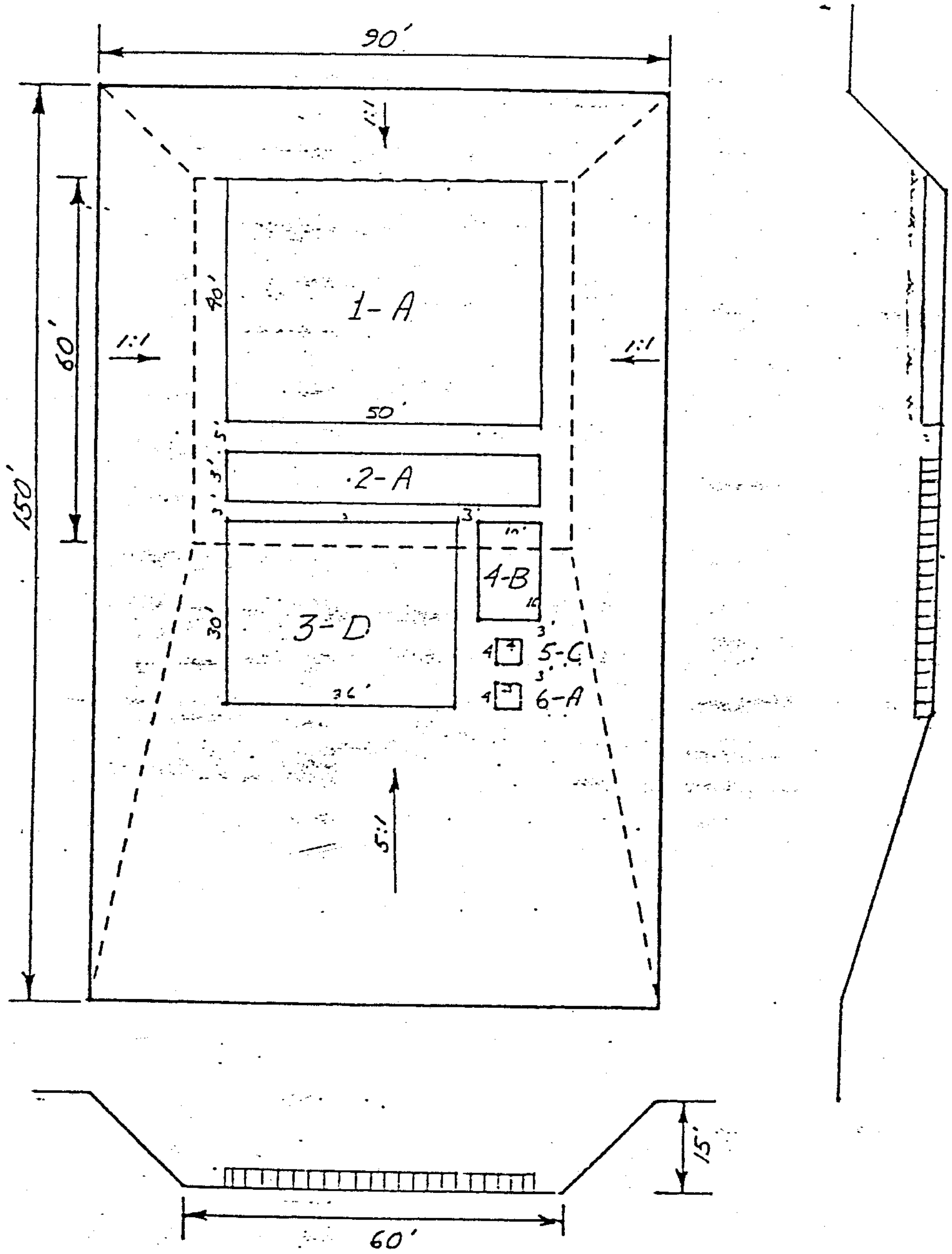
CELL A-3
UPPER LEVEL

SECTION	WASTE CATEGORY	MATERIAL	No. OF CONTAINERS	SIZE OF CONTAINER	No. OF PALLETS	DATE SHIPPED FROM BASE
3	D	Cordemned Chemicals, Aliphat.. Naptha, Alcohol Xylene.	1	55	1	3 Oct 78
		Si Sulfa Sol	4	55	2	3 Oct 78
		Paint Residue & Thinner Waste	20	5	1	3 Oct 78
		Si Sulfa Sol	6	55	3	5 Oct 78
		Trichloroethane Waste	4	55	1	5 Oct 78
		Stripper Waste	7	55	2	5 Oct 78
		Paint Residue	12	5	3	5 Oct 78
			2	10		
		Various Sealants and Resins	3 boxes	Small	1	5 Oct 78
		Paint Residue	11	5	2	21 Nov 78
		Paint Residue	3	55	1	21 Nov 78
		Si Sulfa Sol	8	55	4	21 Nov 78
		Various Sealants and Resins	4 [illegible]	[illegible]	1	21 Nov 78
		Trichloroethane Wastes	2	55	1	21 Nov 78
		Sodium Chromate Residue	2	55	1	21 Nov 78
		Paint Stripper Wastes	15	55	4	21 Nov 78
		Paint Stripper Wastes	18	55	6	22 Dec 78
		Unidentified	2	55	1	22 Dec 78
		Slop Thinner	1	55	1	22 Dec 78
		Various Sealants and Resins	9	10	2	22 Dec 78
		Paint Residue	22	5	2	22 Dec 78
		" "	9	10	1	22 Dec 78
		" "	3	55	1	22 Dec 78
		Si Sulfa Sol	2	55	1	22 Dec 78
			3	10		
		Sodium Chromate Residue	2	55	1	22 Dec 78
		Paint Stripper Wastes	12	55	3	30 Jan 79
		Paint Residue	11	5	2	30 Jan 79
		Trichloroethane Waste	1	55	1/2	30 Jan 79
		Alcohol Waste	1	55	1/2	30 Jan 79

SECTION	WASTE CATEGORY	MATERIAL	No. OF CONTAINERS	SIZE OF CONTAINERS	No. OF PALLETS	DATE SHIPPED FROM BASE
3	D	Si Sulla Sol	5	55	2 1/2	30 Jan 79
		Trichloroethane Waste	1	55	1/2	30 Jan 79
		Contaminated Oil	3	55	1	30 Jan 79
		Aqua Chem Contaminated Barrels (Empty)	3	55	1	30 Jan 79
		Cutting Water Slop	8	55	2	30 Jan 79
4	A	Asbestos Insulated Boiler	1		1	29 June 78
5	A	Mercury and Beryllium Waste	2	1'x1'x3'	1	21 June 78
		Asbestos Scrapes	1	crate	1	29 June 78
		Empty Pesticide Containers	3	55	1	1 Aug 78
			6	5		
			2	1		
		Assorted Containers Contaminated with Pesticide and Weed Killer and some Asbestos Tile sheets			1	3 Oct 78
		Mercury Waste Residue	3	1'x1'x3'	1	3 Oct 78
6	A	Beryllium Contaminated Materials (MA)	192	55	48	

CELL A-3 CLOSED MAY/JUNE 1979

CELL A4
LOWER LEVEL



SECTION: 1

MATERIAL: Industrial Waste Treatment Plant Sludge

AMOUNT: ≈ 1,300 tons

BURIAL DATE:

MODE OF TIME:

42 cm X 34 cm = 1,428 cm²

$\frac{1,428 \text{ cm}^2}{2,142 \text{ cm}^2} \times 1956 \text{ tons} = 1304 \text{ tons}$

CELL A-4
LOWER LEVEL

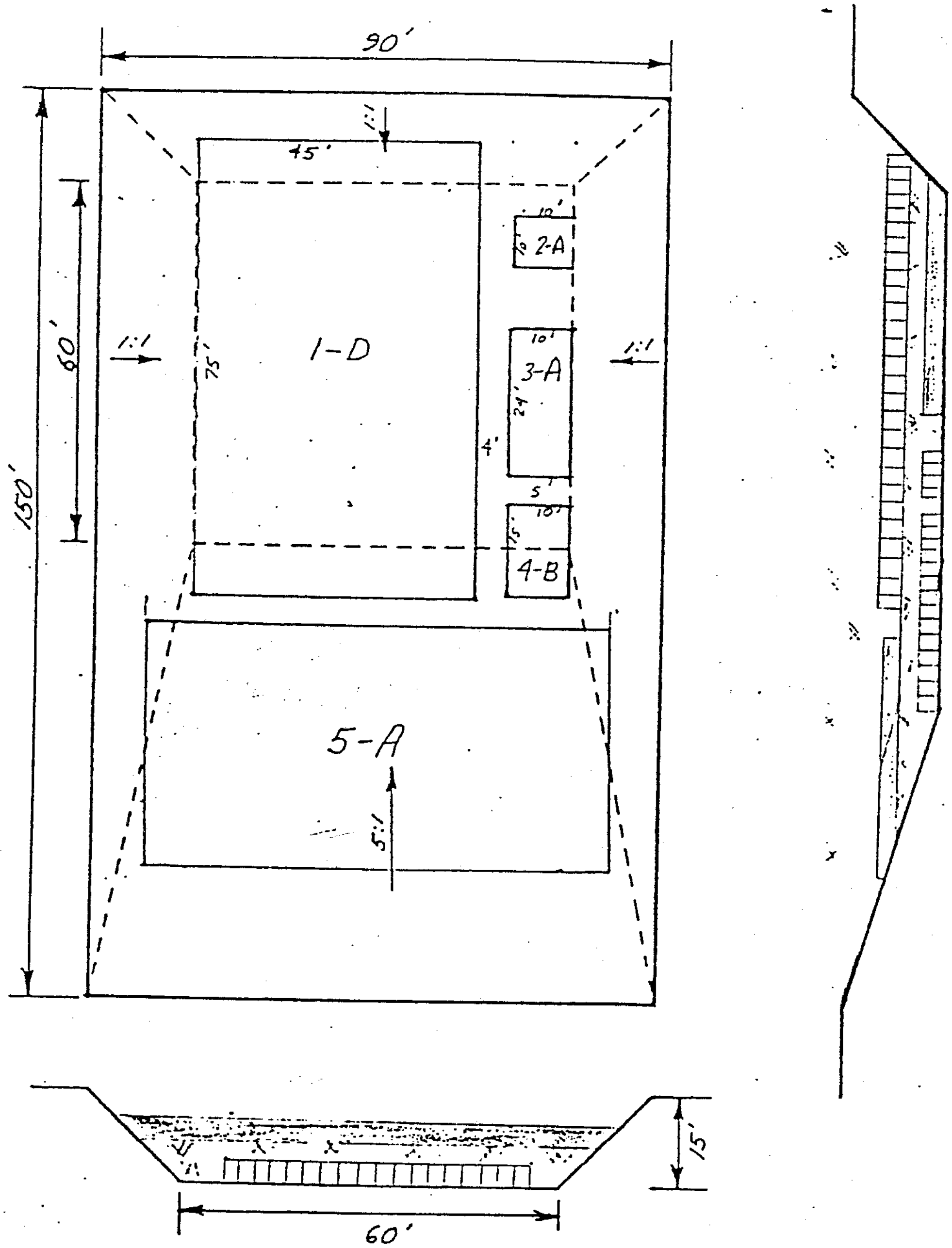
Section	Waste Category	Material	No. of Containers	Size of Containers	No. of Pallets	Date Stored
3	D	Paint Stripper Waste	36	55	9	4 Apr 79
		Trichloroethane	2	55	1	4 Apr 79
		Waste Penetrant	4	55	1	4 Apr 79
		Slop Thinner	6	55	2	4 Apr 79
		Spray Paint Cans	4	55	1	4 Apr 79
		Si Sulfa Sol	5	55	2	4 Apr 79
		Sealants & Epoxies	2	55	1	4 Apr 79
			4	5		
		Paint Stripper Waste	21	55	6	17 Apr 79
		Trichloroethane	1	55	1	17 Apr 79
		Unidentified	2	55		
		Radiological Decontamination Fluid / DS-2	41	5	2	17 Apr 79
		Alcohol	1	55	1	17 Apr 79
		Solvent	1	55		
		Trichloroethane and Si Sulfa Sol	2	55	1	17 Apr 79
		Paint Waste Residue	19	-	-	17 Apr 79
		Contaminated [illegible] ML	10	[illegible]	-	17 Apr 79
		Paint Stripper Waste	4	55	1	30 Apr 79
		Trichloroethane	9	55	4	30 Apr 79
		Penetrant Emulo	7	55	2	30 Apr 79
		Thinner	5		3	30 Apr 79
		Last-a-Foam	2	55	1	30 Apr 79
		Freon	1	55	1	30 Apr 79
		Paint Remover	2	55	1	30 Apr 79
		JP-4 Impregnated Foam	[illegible]	[illegible]	5	30 Apr 79
		JP-4 Impregnated Foam	[illegible]6	[illegible]	5	3 May 79
		Waste Paint Strippers	4	55	1	3 May 79
		Contaminated Empties	4	55	1	3 May 79
		Si Sulfa Sol	2	55	1	3 May 79
		Trichloroethane	2	55	2	3 May 79
		Miscellaneous Resins Sealants & Kits (Opened & Outdated)	2	[illegible]	-	3 May 79

CELL A-4
LOWER LEVEL

Section	Waste Category	Material	No. of Containers	Size of Containers	No. of Pallets	Date Shipped From Bldg
3	D	Dirty Solvent - Trichloroethane, Alcohol [illegible]	5	55	2	15 May 79
		Trichloroethane	4	55	1	15 May 79
		Contaminated Oil	3	55	1	15 May 79
		Resins, Adhesives & Solvents	7	5	2	15 May 79
		"	[illegible]	[illegible]		
		"	3	20		
		"	2	[illegible]	2	15 May 79
		Slope Thinner	3	55	1	15 May 79
		Waste Paint	24	5	1	15 May 79
		Decontaminating Agent	24	-	1	15 May 79
		Miscellaneous Solvents - small quantities	1	[illegible]	1	15 May 79
		Alcohol	1	55	1	23 May 79
		Solvent	1	55		
		Trichloroethane	1	55		
		Trichloroethane	12	55	4	23 May 79
		Dirty Solvent	3	55	1	23 May 79
		Paint Stripper	4	55	1	23 May 79
		Slope Thinner	3	55	1	23 May 79
		Paint Residue	4	55	2	23 May 79
			24	-	1	23 May 79
		ATP Primer	4	[illegible]		23 May 79
		Die [illegible]	4	55	1	25 May 79
		Resin	4	55	1	23 May 79
		Oil	9	55	3	23 May 79
		Various solvents & Primers put into Drums	4	55	1	23 May 79
2	B	Beryllium Contaminated Materials (MA)	96	55	24	

SECTION	WASTE CATEGORY	MATERIAL	No. of Containers	Size of Containers (Gals)	No. of Pallets	Date Shipped From Base
4	B	Styrofoam Contaminated Drums	3	55	1	4 Apr 79
		Styrofoam Contaminated Drums	6	55	2	17 Apr 79
		Polyphenylene Polyisocyanate	4	55	1	30 Apr 79
		Styrofoam Contaminated Drums	3	55	1	3 May 79
		Styrofoam Contaminated Drums	13	55	4	15 May 79
5	C	TF Etchant	3	55	1	30 Apr 79
6	A	Beryllium Contaminated Rinse Water	1	55	1	17 Apr 79
		Alodine	1	55		
		Beryllium Contaminated Rinse Water	4	55	1	15 May 79
		Mercury Contaminated Containers (Metal)	2	[illegible]	1	15 May 79

Cell A-4
Upper Level



Section: 5
Material: Industrial Waste Treatment Plant Sludge
Amount: 800 Tons
Burial Date: August 1980
Mode of Trans: Truck

CELL A-4
UPPER LEVEL

SECTION: 5 CONT.

MATERIAL: IWTP Sludge & Cadmium Contaminated Sand Blast Media
532 / 532

AMOUNT: 1065 Tons

DATE: 14 TO 19 April 1981

MANIFEST NUMBERS: 81-93-1 TO 81-93-7
81-106-1 TO 81-106-3
81-107-1
81-108-1 TO 81-108-19
81-109-20 TO 81-109-24

MATERIAL: IWTP Sludge

AMOUNT: 91 TONS

DATE: 29 August 1981

MANIFEST NUMBERS: 81-241-1 TO 81-241-7

800
1065
91
1956 tons

63cm x 34cm = 2,142 cm²

UPPER LEVEL
CELL A-C

SECTION	WASTE CATEGORY	MATERIAL	NO. OF CONTAINERS	SIZE OF CONTAINERS	NO. OF PALLETS	DATE SHIPPED FROM BASE
1	D	Waste Paint	4	55	1	29 Oct 79
		Si Sulfa Sol	2	55	1	29 Oct 79
		Freon Waste	1	55		
		Si Sulfa Sol, Trichloroethane, Alcohol	3	55	1	29 Oct 79
		Adehesives, Petroleum, Solvents	7	55	2	3 Dec 79
		Stripper	13	55	5	3 Dec 79
		Trichlororethane	5	55	2	3 Dec 79
		Slop Thinner	15	55	5	3 Dec 79
		Contaminated Mineral Oil	4	55	1	3 Dec 79
		Slop Paint	1	55	1	3 Dec 79
		Sodium Chromate Contaminated Empties	5	55	1	3 Dec 79
		Trichloroethane Waste	3	55	1	21 Jan 80
		Paint Stripper & Water Waste	18	55	6	21 Jan 80
		Trichloroethane, Alcohol, Si Sulfa Sol Waste	2	55	1	21 Jan 80
		Slop Paint	8	55	2	21 Jan 80
		Waste Cleaning Compound	2	55	1	21 Jan 80
		Slop Thinner	4	55	2	21 Jan 80
		Alcohol Waste	1	55	1	21 Jan 80
		Hydraulic Fluid Waste	2	55	1	21 Jan 80
		JP-4 Impregnated Foam	56	boxes	7	31 Jan 80
		Slop Paint	16	55	4	11 Mar 80
		Oil Waste	15	55	4	11 Mar 80
		Cleaning Liquid	2	55	2	11 Mar 80
		Solvent (Waste)	18	55	5	11 Mar 80
		Trichloroethane Waste	8	55	2	11 Mar 80
		Paint Stripper	3	55	1	11 Mar 80
		Trichloroethane, (4) Si Sulfa Sol, (4) Alcohol Waste	9	55	3	1 Apr 80
		Freon Waste	6	55	2	1 Apr 80
		Thinner & Solvent	2	55	1	1 Apr 80
		Paint Stripper & Water	18	55	6	1 Apr 80
		Cleaner Waste	4	55	1	1 Apr 80

UPPER LEVEL
CELL A-4

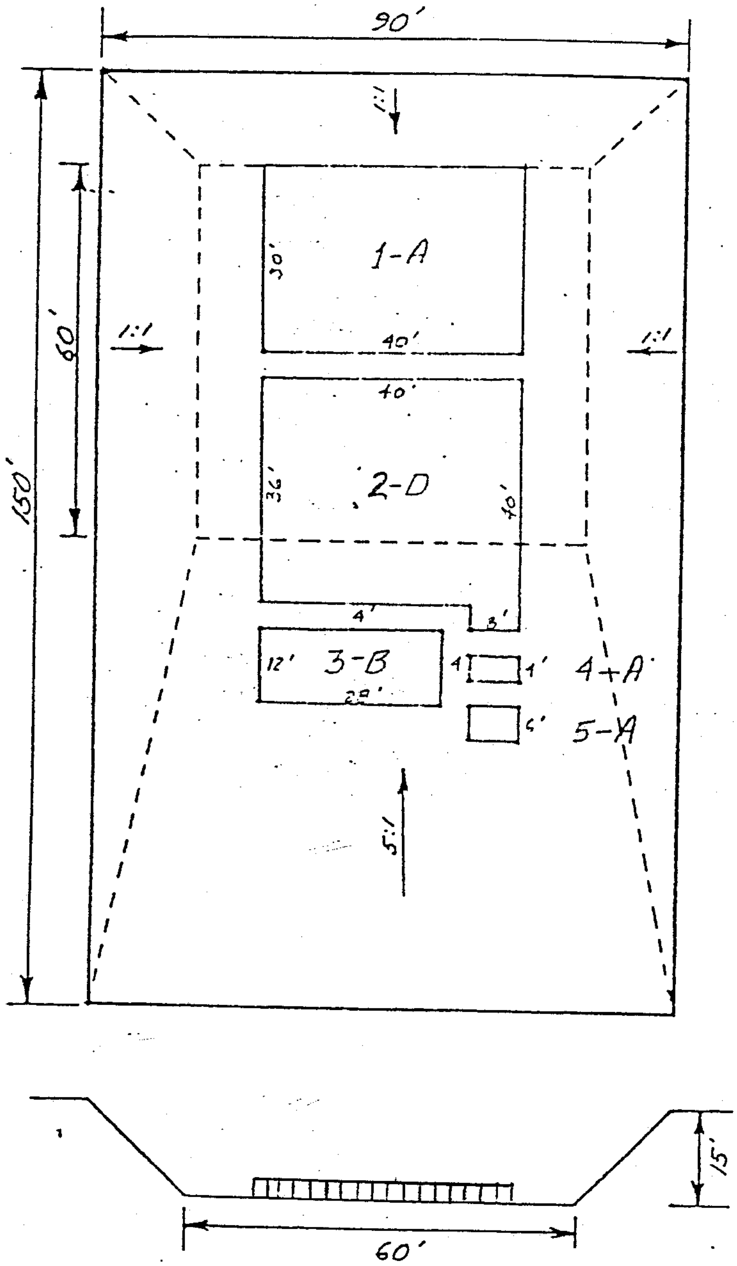
SECTION	WASTE CATEGORY	MATERIAL	No. of CONTAINERS	SIZE OF CONTAINERS	No. OF PALLETS	DATE SHIPPED FROM BASE
1	D	JP-4 Impregnated Foam	24	boxes	6	25 June 79
		Paint Stripper	4	55	1	25 Jun 79
		Trichloroethane and Si Sulfa Sol	12	55	3	25 Jun 79
		Paint Stripper	8	55	2	10 July 79
		Trichloroethylene	4	55	1	10 Jul 79
		Dichloromethane (Contaminated)	4	55	1	10 Jul 79
		Waste Cleaning Compound	4	55	1	10 Jul 79
		Base Oil ("C")	4	55	1	10 Jul 79
		Waste Thinner	10	55	3	10 July 79
		Trichloroethane - Alcohol Waste	2	55	1	10 Jul 79
		Trichloroethane - Si Sulfa Sol Waste	5	55	2	10 Jul 79
		Waste Paint	18	5	2	10 Jul 79
		Various Solvents	≈60	55	16	14 Sep 79
		JP-4 Impregnated Foam	37	boxes	9	23 Oct 79
		Paint Stripper Waste	13	55	4	29 Oct 79
		Si Sulfa Sol, Trichloroethane, Alcohol Waste	7	55	2	29 Oct 79
		Waste Oil Sludge	3	55	1	29 Oct 79
		Trichloroethane Waste	5	55	2	29 Oct 79
		Waste EDM Oil	3	55	1	29 Oct 79
		Stripper	3	55	1	29 Oct 79
			1	20		
		Paint Waste	17	5	2	29 Oct 79
		Slop Thinner	9	55	3	29 Oct 79
		Trichloroethane Waste	6	55	2	29 Oct 79
		Sodium Chromate Waste	4	55	1	29 Oct 79
		Slop Thinner	10	55	3	29 Oct 79
		RV adhesive plus Miscellaneous Solvents	12	55	3	29 Oct 79
			6	20	1	29 Oct 79
		Paint Residue	38	5	2	29 Oct 79
		Methanol Contaminated	4	55	1	29 Oct 79
		Sodium Chromate Contaminated Rags.	2	55	1	29 Oct 79

UPPER LEVEL
CELL A-4

SECTION	WASTE CATEGORY	MATERIAL	No. OF CONTAINERS	SIZE OF CONTAINERS	No. OF PALLETS	DATE SHIPPED FROM BASE
1	D	Point Thinner Waste	4	55	1	1 Apr 80
		Slop Thinner	4	55	1	1 Apr 80
		Oil Waste	6	55	2	1 Apr 80
		Waste Solvent	4	55	1	1 Apr 80
2	A.	Vapam - 16 gallons				27 Jun 80
		Kapone Bait Paste - 22 pounds				27 Jun 80
3	A	Asbestos (6'x6'x6' box)	1	box	1	29 Oct 79
4	B	Styrofoam Contaminated Drums	10	55	3	10 July 79
		Caustic	1	55	1	29 Oct 79
		Styrofoam Contaminated Drums	6	55	2	29 Oct 79
		" " "	2	5		
		Styrofoam Contaminated Drums	8	55	2	3 Dec 79
		Styrofoam Contaminated Drums	12	55	3	21 Jan 80

CELL CLOSED - September 1981

CELL B-1
LOWER LEVEL

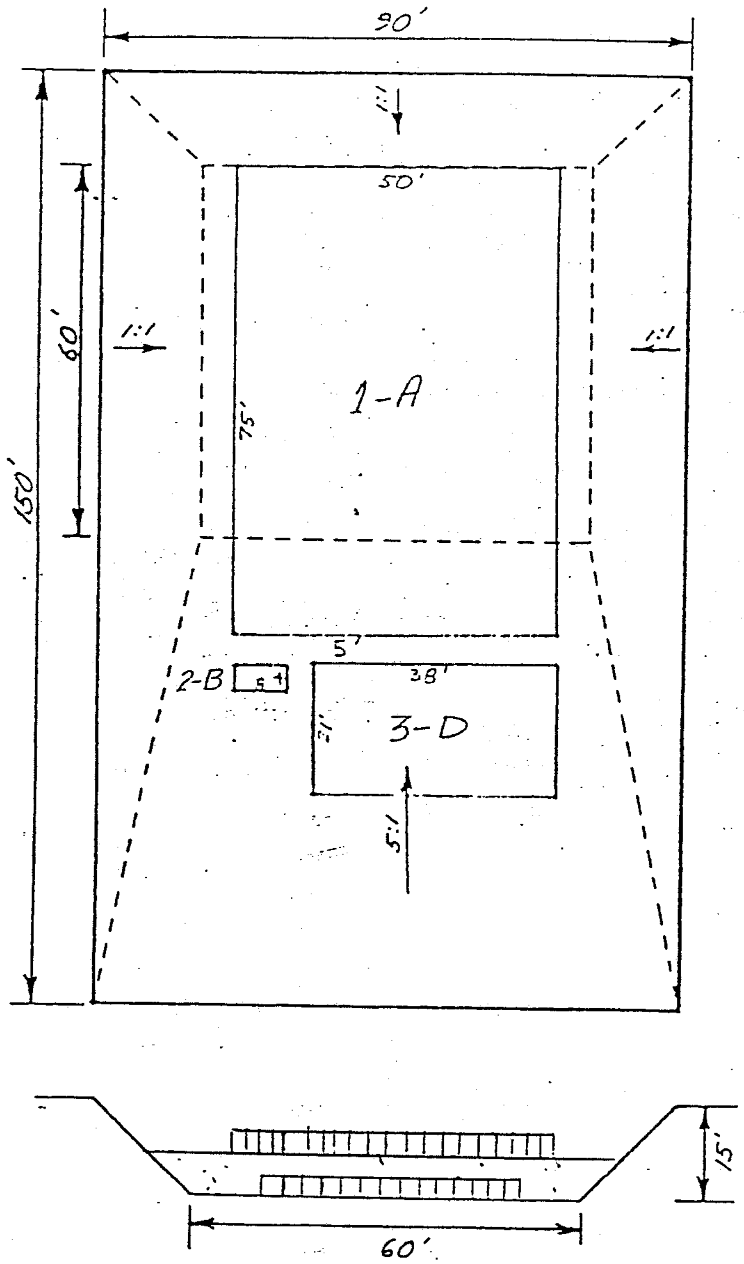


LOWER LEVEL
CELL B-1

SECTION	WASTE CATEGORY	MATERIAL	No. OF CONTAINERS	SIZE OF CONTAINERS	No. OF PALLETS	DATE SHIPPED FROM BASE
1	A	Beryllium and Beryllium Contaminated Materials - Approximate Quantity	280	55	70	Summer & Fall 80
2	D	Paint Stripper Waste	26	55	7	15 Jul 80
		Freon Waste	2	55	1/2	15 Jul 80
		Alcohol Waste	1	55	1/4	15 Jul 80
		Trichloroethane Waste	5	55	1 1/4	15 Jul 80
		Paint Slop & Thinner	4	55	1	15 Jul 80
		Sodium Chromate Waste	3	55	1	15 Jul 80
		Spent Strippers	4	55	1	15 Jul 80
		Waste Solvents	4	55	1	15 Jul 80
		Trichloroethane, Alcohol, S:Sulfa Sol	4	55	1	15 Jul 80
		Trichloroethane	1	55	1/2	15 Jul 80
		MEK and Paint Waste	1	55	1/2	15 Jul 80
		Oil Sludge	4	55	1	15 Jul 80
		Trichloroethane Contaminated Empties	4	55	1	15 Jul 80
		Trichloroethane, Alcohol Waste	3	55	1	18 Jul 80
		Slop Thinner	11	55	3	18 Jul 80
		NXG (unknown)	7	55	2	18 Jul 80
		Trichloroethane, Freon Waste	3	55	1	18 Jul 80
		Paint Stripper	18	55	5	7 Aug 80
		Unknown Sludge	4	55	1	15 Sep 80
		Waste Solvent	3	55	1	15 Sep 80
		Trichloroethane, Alcohol S:Sulfa Sol Waste	15	55	4	15 Sep 80
		Penetrant Oil Contaminated Empty	1	55	1/2	15 Sep 80
		Trichloroethane Contaminated Empty	1	55	1/2	15 Sep 80
		Slop Paint and Paint Sludge	7	55	2	15 Sep 80
		Freon Waste	6	55	1 1/2	15 Sep 80
		Paint & Polyurethane Thinner Waste	1	55	1/4	15 Sep 80
		Trichloroethane Waste	1	55	1/4	15 Sep 80

[illegible] CELL B-1

SECTION	WASTE CATEGORY	MATERIAL	No. OF CONTAINERS	SIZE OF CONTAINERS	No. OF PALLETS	DATE SHIPPED FROM BASE
2	D	Oil Sludge	3	55	1	15 Sep 80
		MEK Waste	4	55	1	15 Sep 80
		Used Trichloroethone	6	55	2	15 Sep 80
		Trichloroethane Waste	8	55	4	16 Sep 80
		Alcohol, Trichloroethane, SiSulfaSol Waste	5	55	2	16 Sep 80
		Freon Waste	4	55	1	16 Sep 80
		Silicone Waste	17	5	1	16 Sep 80
		Paint Stripper	5	55	2	16 Sep 80
		Waste Paint & Paint Residue	2	boxes	1	16 Sep 80
		" " " "	60	cans		
		Hydraulic Fluid Waste	3	55	1	16 Sep 80
		Incindiory Oil Thickener	1	55	1	16 Sep 80
		Sealing Compound	12	[illegible]	1	16 Sep 80
		Turcoform	4	55	1	16 Sep 80
		JP-4 Impregnated Foam	68	Cu Yd [illegible]	11	26 Sep 80
3	B	Styrofoam Contaminated Barrels	8	55	2	15 Jul 80
		Styrofoam Contaminated Barrels	3	55	1	18 Jul 80
		Alkaline Stripper Waste	4	55	1	15 Sep 80
		Styrofoam Contaminated Barrels	4	55	1	15 Sep 80
4	A	Asbestos Materials	14	55	4	7 Aug 80
5	A	Chromate Waste	4	55	1	16 Sep 80
		2,4 D Empty Cans	5	20	1	16 Sep 80



SECTION: 1
MATERIAL: Cadmium Contaminated Sand Blast Media
AMOUNT: 186 Tons
DATE 23 TO 30 July 1981
MANIFEST NUMBERS: 81-204-1 TO 81-204-5
81-209-1 TO 81-209-4
81-210-1 TO 81-210-4
81-211-1 TO 81-211-3

CELL B-1
UPPER LEVEL

SECTION 1 CONT.

MATERIAL: JP-4 Impregnated Foam
AMOUNT: < 1 Ton (30 cu yrd ?)
DATE: 31 July 1981
MANIFEST NUMBERS: 81-212-1

MATERIAL: Cadmium Contaminated Sand Blast Media
AMOUNT: 280 Tons
DATE: 3 TO 25 August 1981
MANIFEST NUMBERS:
81-215-1 TO [illegible]
81-216-1 TO [illegible]
81-217-1 TO [illegible]
81-218-1 TO [illegible]
81-229-1 TO [illegible]
81-230-1 TO [illegible]
81-231-1
81-237-1

MATERIAL: IWTP Sludge
AMOUNT: 91 Tons
DATE: 29 & 30 August 1981
MANIFEST NUMBERS: 81-241-8 TO 81-241-14

CELL B-1

SECTION	WASTE CATEGORY	MATERIAL	No. of CONTAINERS	SIZE of CONTAINERS	No. of PALLETS	DATE SHIPPED FROM BASE
2	B	Alkaline Paint Strippers	8	55	2	17 Nov 80
3	D	Trichloroethane Waste	16	55	4	12 Nov 80
		Solvent	8	55	2	12 Nov 80
		Slop Paint	28	55	7	12 Nov 80
		Hydraulic Fluid	4	55	1	12 Nov 80
		Waste Oil	16	55	4	12 Nov 80
		Slop Paint & Thinner	44	55	11	14 Nov 80
		Stripper Waste	8	55	2	14 Nov 80
		Various Solvents	4	55	1	14 Nov 80
		Waste Paint	4	55	1	14 Nov 80
		Waste Sealer	4	55	1	14 Nov 80
		Paint & Polyurethane Waste	1	55	1/4	14 Nov 80
		Trichloroethane Waste	3	55	3/4	14 Nov 80
		Waste Oil	4	55	1	14 Nov 80
		Alcohol, SiSulfo Sol, Trichloroethane Waste	10	55	2 1/2	17 Nov 80
		Freon Waste	2	55	1/2	17 Nov 80
		Paint Residue	12	5	Egg Crate	17 Nov 80
		Unknown Solvents	4	55	1	17 Nov 80
		Alcohol, SiSulfoSol Trichloroethane Waste	3	55	3/4	17 Nov 80
		Freon Waste	1	55	1/4	17 Nov 80
		Trichloroethane Waste	4	55	1	17 Nov 80
		Resin Contaminated Containers	9	55	3	17 Nov 80
			4	5		
		Paint Residue	36		3	17 Nov 80
		Trichlorotrifluoromethane	1	55	1	17 Nov 80
		Deicing Fluid	5	10	1	17 Nov 80

CELL CLOSED - Sept 1981

APPENDIX B

Monitoring Well Logs

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL E		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE - UTTR LANDFILL LOCATION Lakeside, Utah

ELEVATION ~4613 ft. above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE ______ START 10/21/86 FINISH 10/23/86 LOGGER Harrison/Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	~~STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	0				11:30	Silt, sand, and gravel, sand is fine grained, ls gravel, angular, <0.5" dia, silt and sand are l. brown to tan, slightly moist, calcareous.		Drilling dry (no foam) Driving 8" steel casing; interbedded sand + silt
	5					Sand and silt with trace gravels, fine to med. grained, light brown to tan, single grained		
	10					Sand and silt with trace gravel, fine to coarse grained, light brown to tan		Moist clay layer @ 15'
	15				1220	Sand, gravel and silt, fine grained to coarse sand as above. Gravel is black and grey ls, some gravels show calcite cement, tan to buff sandstone (siltstone), <0.5" dia.		Drilling very soft and fast
	20				1245	Sand and silt, fine to med. grained, single grained, light brown to tan; sand layer @ 25 ft.		Alternating interbedded sand + silt. Some hard layers are not consolidated.
	25					Sand, silt, and gravel, fine grained to medium, single grained, light brown to tan, gravel is <0.25" dia., some well rounded SS, ls is mostly angular.		Ls frags increase
	30							

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CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL E		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE - UTTR LANDFILL LOCATION Lakeside, Utah

ELEVATION ~4613 ft. above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE START 10/21/86 FINISH 10/23/86 LOGGER Harrison / Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	30					Sand with trace gravel, fine to medium grained, single grained, light brown to gray tan, gravels are <0.25" dia., some poorly cemented sandstone/siltstone.		
	35				1323	Sand, fine to med. grained, single grained, light brown to grayish-brown,		increase in SS gravel @ 39
	40				1350	Gravel conglomerate, ls is grey and black, microcrystalline, SS is tan, calcareous, well cemented, all gravel <0.75" dia, with some sand/silt		Air drilling with Foam
	45					same as above		
	50					Sand and gravel, fine to coarse grained sand, gray to black, caliche, gravel <0.125" dia., with clay.		2" sand stringer @ 55
	55				1420	Same as above, gravel <0.5" dia.		
	60							

CH2M HILL

PROJECT NUMBER B19376.B0 | **BORING NUMBER** WELL E | **SHEET** ___ **OF** ___

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE - UTTR LANDFILL **LOCATION** Lakeside, Utah
ELEVATION ~4613 ft. above MSL **DRILLING CONTRACTOR** Hiddleston Drilling and Pump Co.
DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam and EZ Mud
WATER LEVEL AND DATE ___ **START** 10/21/86 **FINISH** 10/23/86 **LOGGER** Harrison / McKell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	~~STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	60				1455	Same as above		
	65					Sand and gravel with some silt/clay. Fine to coarse grained sand, gray to black brown, gravel is < 0.5" dia		67-69 Drilling soft sand or clay zone
	70					Sand and gravel as above ls and ss gravel <0.5" dia		
	75					Sand and gravel as above ls and ss gravel		
	80				1525 1555	Gravel and sand, ls and ss gravel <0.5" dia, sand is fine to coarse with some silt/clay. (Conglomerate)		
	85			10/21/86 10/22/86	1605 915	Gravel and sand, with silt as above (conglomerate), contains some red fine grained siltstone that is non-reactive with HCl.		Drilling hard, rig bouncing.
	90							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL E		

SOIL BORING LOG

PROJECT: HILL AIR FORCE BASE – UTTR LANDFILL LOCATION: Lakeside, Utah

ELEVATION: ~4613 ft. above MSL DRILLING CONTRACTOR: Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT: Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE: START: 10/21/86 FINISH: 10/23/86 LOGGER: Harrison / Mikels

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	90					Gravel and sand same as above		Drilling hard
	95				9:35	Gravel and sand as above, more sand than above, gravel is <0.4" dia		95-99' Drilling softer
	100				1000	Sand and gravel with clay as above gravel is primarily black and gray microcrystalline ls, some light tan ss, some calcite, some red claystone (unreactive to HCL)		Drilling hard in spots 6" to 3' beds
	105					same as above		
	110					same as above gravel <0.4" dia		
	115				1045	Gravel and sand gravel <0.75" dia, most is smaller		116-119' Drilling hard rig bouncing casing driving very hard END 8" STEEL CASI[NG]
	120							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL E		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE - UTTR LANDFILL LOCATION Lakeside, Utah
ELEVATION ~4613 ft. above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.
DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam and EZ Mud
WATER LEVEL AND DATE ______ START 10/21/86 FINISH 10/23/86 LOGGER Harrison / McKell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	~~STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
120					1155	Sand and gravel, as above gravel < 0.5" dia		Drilling soft 120-122'
	125					Sand and gravel with clay gravel < 0.4" dia		Drilling soft with occasional hard spots
	130					Sand and gravel, as above		
	135					conglomerate cemented		137-138' Drilling hard
	140				1130	Gravel and sand, conglomerate		Drilling hard 140-144
	145					conglomerate		146-147' Drilling hard
	150							

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CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL E		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE - UTTR LANDFILL LOCATION Lakeside, Utah

ELEVATION ~4613 ft. above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE ______ START 10/21/86 FINISH 10/23/86 LOGGER Harrison/Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	150					sand with silt/clay.		
						cemented conglomerate		6" very hard drilling
	155					Sand with gravel, mostly sand, coarse, light brown to black, single grained, gravel very small < 0.125" dia		
					1202			
	160					Sand; clay and trace gravels gravels < 0.25" dia.		Drilling soft
	165							
	170					Sand and Gravel Conglomerate, with some clay sized particles. gravel < 0.4" dia., poorly cemented.		Drilling hard 170-179'
	175					same as above, gravel is angular ~~with~~ cemented sides.		
	180							increase in clay content

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CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.BO	WELL E		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE - UTTR LANDFILL LOCATION Lakeside, Utah

ELEVATION ~4613 ft. above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE ______ START 10/21/86 FINISH 10/23/86 LOGGER Harrison/MiKel

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	~~STANDARD PENETRATION TEST RESULTS~~ TIME	SOIL DESCRIPTION (NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL)	SYMBOLIC LOG	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION)
	180				1220	Sand w/ gravel and clay. gravel <0.25" dia, ls, ss, dolomite. (conglomerate)		Drilling generally soft.
	185					Sand and gravel as above.		Hard drilling ~1 ft.
	190							Fines increases 190 to 200 ft. Hard drilling ~1 ft.
	195					Sand Layer		Soft spot
	200				1251 1300	Sand and Gravel conglomerate cemented. Ls is dominant gravel type, with do, ss.		Hard drilling, very hard 200-206 ft.
	205					Same as above with clay and silt.		Drilling soft
	210							

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CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL E		

SOIL BORING LOG

PROJECT: HILL AIR FORCE BASE - UTTR LANDFILL LOCATION: Lakeside, Utah

ELEVATION: ~4613 ft. above MSL DRILLING CONTRACTOR: Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT: Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE: START: 10/21/86 FINISH: 10/23/86 LOGGER: Harrison / McKell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	~~STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	210					Sand, clay, and gravel. gravel <0.25" dia		
	215							3" Hard Drilling
								3" Hard Drilling
					1325	gravel <0.25" dia		No Returns 214-219
	220					Sand and gravel conglomerate, cemented, gravel <0.25" dia, subangular to subrounded		Hard Drilling ~1 ft.
								Hard Drilling 224-231 ft.
	225					Cemented conglomerate ↓		
	230							
						Cemented conglomerate ↓		Hard Drilling 233-237 ft.
	235							
	240				1405	Conglomerate		Hard Drilling

CH2M HILL

PROJECT NUMBER: B19376.B0

BORING NUMBER: WELL E

SHEET ___ OF ___

SOIL BORING LOG

PROJECT: HILL AIR FORCE BASE - UTTR LANDFILL   LOCATION: Lakeside, Utah

ELEVATION: ~4613 ft. above MSL   DRILLING CONTRACTOR: Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT: Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE: ___   START: 10/21/86   FINISH: 10/23/86   LOGGER: Harrison / Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	240–245					Sand w/ clay and silt and trace gravels.		Possible water, blew w/ air. Water did not develop.
	245–250					Sand and silt w/ thin cemented conglomerate interbeds.		Drilling hard in spots 247-250 ft.
	250–255					Sand and gravel conglomerate as above. Contains siltstone, tan, poorly cemented. Caliche.		Drilling soft and smooth 250-260 ft.
	255–260				1500	gravel < 0.4" dia.		
	260–265				1510	Sand, Clay and thin cemented conglomerate interbeds, gravel <0.4" dia.		Hard Drilling ~2 ft. increase in clay/silt in returns
	265–270					Same as above but gravel smaller <0.25" dia		Hard Drilling ~2"-6" intermittent.

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CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL E		

SOIL BORING LOG

PROJECT: HILL AIR FORCE BASE - UTTR LANDFILL LOCATION: Lakeside, Utah

ELEVATION: ~4613 ft. above MSL DRILLING CONTRACTOR: Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT: Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE: ______ START: 10/21/86 FINISH: 10/23/86 LOGGER: Harrison / McKell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
270						Sand and clay/silt with gravels gravels <0.125" dia., sand is coarse. (Cemented conglomerate)		Hard spot
275								Intermittent 6-inch Hard stringers
280						Sand and gravel, med. to coarse sand, subangular, gravel is <0.125" dia, black and gray microcrystalline ls, tan SS, vein calcite, caliche.		
285						gravel <0.75" dia		
290						Cemented sand and gravel conglomerate.		Hard drilling ~3"
295						Sand w/ Clay and gravel.		Smooth and soft drilling
300					1535			

CH2M HILL

PROJECT NUMBER B19376.B0 | BORING NUMBER WELL E | SHEET OF

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE - UTTR LANDFILL LOCATION Lakeside, Utah

ELEVATION ~4613 ft. above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE START 10/21/86 FINISH 10/23/86 LOGGER Harrison/Mikell

DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
300					Sand, Clay, and Gravel.		
305					Cemented sand and gravel conglomerate.		Hard Spots in drilling 307-310 ft.
310					Well cemented conglomerate, gravel < 0.4" dia		Very hard drilling 310-312
315				1600	Sand w/ clay and cemented conglomerate interbeds gravel < 0.25" dia. Sand, fine to med. grained, light brown to tan.		- Hard spot ~2" @ 317'. Hard spot ~2" @ 319'
320					same as above, sand layer @ 321		
325					Cemented sand and gravel conglomerate. abundant calcite cement, white crumbley.		Drilling hard. Drilling very hard 327-334'
330							

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CH2M HILL

PROJECT NUMBER B19376.B0

BORING NUMBER WELL E **SHEET** **OF**

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE - UTTR LANDFILL **LOCATION** Lakeside, Utah

ELEVATION ~4613 ft. above MSL **DRILLING CONTRACTOR** Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE **START** 10/21/86 **FINISH** 10/23/86 **LOGGER** Harrison / Mikell

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	~~STANDARD PENETRATION TEST RESULTS~~ ~~6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
330				1700	Sand and gravel, fine to coarse grained sand, l. brown to tan, gravel <0.125" dia, mostly black and gray ls, some ss and caliche (calcite) cement, angular		
335					same as above (conglomerate)		Drilling very hard 335-337 ft.
340			10/22	1720			
			10/23	1115	as above w/ less sand and larger gravel <0.5" dia.		(Added 1gal. EZ mud) Drilling hard ~3" Drilling hard ~3"
345					same as above		Drilling very hard 346-355 ft.
350					Sand and gravel conglomerate, gravel <0.4" dia ↓		very few returns
355							few returns Drilling very hard 358-360 ft.
360							

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER B19376.B0 | **BORING NUMBER** WELL E | **SHEET** | **OF**

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE - UTTR LANDFILL **LOCATION** Lakeside, Utah

ELEVATION ~4613 ft. above MSL **DRILLING CONTRACTOR** Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE **START** 10/21/86 **FINISH** 10/23/86 **LOGGER** Harrison / McKell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	~~STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION (NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL)	SYMBOLIC LOG	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION)
	360				1140			Drilling very hard @ 360 ft. Drilling hard 364-366'
	365					Sand and gravel conglomerate. angular gravel <0.4" dia, with clay beds 6-inches to 2-feet thick		Intermittent hard and soft spots - usually 6" to 2' thick. Generally hard drilling
	370					Same as above		Very hard. Very hard
	375					Gravel and sand. gravels <0.5" dia.		Very hard [increase in gravels in returns]. Drilling soft 378-380'
	380					Sand and gravel with calcite cement.		Drilling hard
	385							Drilling soft
	390							

CH2M HILL

PROJECT NUMBER: B19376.B0 | BORING NUMBER: WELL E | SHEET ___ OF ___

SOIL BORING LOG

PROJECT: HILL AIR FORCE BASE - UTTR LANDFILL LOCATION: Lakeside, Utah

ELEVATION: ~4613 ft. above MSL DRILLING CONTRACTOR: Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT: Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE: ______ START: 10/21/86 FINISH: 10/23/86 LOGGER: Harrison / Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	390–395					Sand with clay and gravel. gravel <0.4" dia.		Drilling hard Decrease in returns @ 388
	395–400				1255	Gravel and sand. gravel <0.25" dia, abundant calcite cement, soft, white.		↑ Drilling hard ↓
	400–405					Sand and Gravel conglomerate.		Drilling slow but smooth Smooth and fast 405-406 ft.
	405–410				1325	Sand and gravel with clay content increased. Vein calcite, ls, and ss gravel.		Hard Drilling @ 406 Drilling hard hard spot Drilling very soft 409-415 ft.
	410–415							
	415–420				1343	Sand and gravel with clay. gravel <0.4" dia., Sand is fine to coarse, l. brown to tan. abundant calcite cement.		Drilling hard 416-419 ft. soft and smooth

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL E		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE - UTTR LANDFILL LOCATION Lakeside, Utah

ELEVATION ~4613 ft. above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE ______ START 10/21/86 FINISH 10/23/86 LOGGER Harrison / McKeli

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	~~STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	420				1357	Sand and gravel, fine to coarse sand, single grained, gravel is <0.125" dia		Add ½ coffee can EZ. Drilling smooth but few returns
	425					Same as above, with abundant calcite sand and small gravel.		Hard stringer ~3"
	430					Sand w/ some clay and only trace gravels. gravels are ≤0.06" dia.		Very few gravel returns
	435					Same as above with larger gravel, <0.25" dia.		
	440				1447 1534	Sand, gravel, clay. gravel is <0.4" dia, subrounded, ls, ss, calcite.		Blew w/air ~~1448~~ to 1504 hole produced 1 gal H_2O in 7 minutes.
	445					Sand and Gravel as above. cemented conglomerate.		Hard Drilling ~~446-450'~~ increased gravels in returns
	450							

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CH2M HILL

PROJECT NUMBER B19376.B0 **BORING NUMBER** WELL E **SHEET** **OF**

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE – UTTR LANDFILL **LOCATION** Lakeside, Utah

ELEVATION ~4613 ft. above MSL **DRILLING CONTRACTOR** Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam and EZ Mud

WATER LEVEL AND DATE **START** 10/21/86 **FINISH** 10/23/86 **LOGGER** Harrison / McKell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	~~STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
450						Gravel and sand, gravel <0.4" dia.		Drilling soft and smooth Drilling hard
455					1601	Sand, clay, gravel conglomerate. gravel <0.5" dia, sand is fine to coarse, lt brown to tan, with calcite sand.		Drilling very hard Drilling hard 456-458 ft. Drilling very hard 458-460 ft.
460					1620	Total depth = 460 feet.		

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL F		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill LOCATION Lakeside, Utah

ELEVATION ~4670 ft above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE ______ START 10/28/86 FINISH 11/5/86 LOGGER L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	~~STANDARD PENETRATION TEST RESULTS~~ ~~6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	0				1325	Silt and sand with gravel, grey, dry, single grained, gravel 3-inch minus.		Drilling soft
	2					Sand and silt, fine grained, well sorted, tan to grey, single grained, with ls frags <0.2" diameter		
	5					sand and silt, fine to med. grained, well sorted, tan to grey, single grained, dry, with ls frags <0.2" diameter		Drilling soft and smooth
	10							
						sand, fine grained, well sorted, dry, single grained, light brown with white, no gravel.		
	15					Sand and silt with ls frags, fine to med. grained, grey to tan with white (caliche), frags are <0.2", Limestone boulder at 16-17 feet.		Boulder 16-17' Drilling soft
	20					Sand and silt, very fine grained, well sorted, dry, single grained, light brown to whitish.		Drilling hard in spots 22 to 36'
	25					Silt and clay with sand, fine to medium grained, some ls frags <0.2" diameter		Hard @ 26'
	30				1425			

CH2M HILL

PROJECT NUMBER: B19376.B0

BORING NUMBER: WELL F

SHEET ___ OF ___

SOIL BORING LOG

PROJECT: HILL AIR FORCE BASE UTTR Landfill LOCATION: Lakeside, Utah

ELEVATION: ~4670 ft above MSL DRILLING CONTRACTOR: Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT: Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE: ______ START: 10/28/86 FINISH: 11/5/86 LOGGER: L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
30					1425	Sand and silt w/ ls and ss frags, fine grained, dry, well sorted, light brown to whitish		hard @ 30'
	35				1442	Sand and silt w/ gravel, fine to coarse grained, dry, single grained light brown, ls and ss frags are mostly <0.25" diameter some larger <1.0" diameter		Drilling soft 38' - casing driving very hard
	40				1525	Sand and silt w/ gravel, fine to coarse grained, single grained, light brown and gray, ls frags are <0.2"		Ls Boulder - drilling hard - surface casing to Drilling softer
	45				1545	sand and silt w/ gravel. similar to above but finer grained.		47-48' moist sand drilling through and drier below ∴ not producing water. - firm Below 48 ft drilling soft
	50					Sand and gravel, fine to med. single grained, light brown (no gray) frags are rounded and <0.4" diameter They are both ls and cemented fined grained SS.		
	55					silty Sand, fine to med. grained, very few gravels, light brown (no gray) to green brown.		
	60							

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL F		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill LOCATION Lakeside, Utah

ELEVATION ~4670 ft above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE ______ START 10/28/86 FINISH 11/5/86 LOGGER L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	~~STANDARD PENETRATION TEST RESULTS~~ ~~6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	60					Sand, fine to med. grained, trace of gravel, light brown to green brown.		
	65					Sand, fine to coarse grained, trace of gravel, fines are light brown, coarse sand is ls and ss frags mostly black ls, some white.		increase coarse sand content
	70					Sand, fine to med. grained, light brown, silty.		increase fines
	75					Sand and silt, fine grained, light brown		
	80				1650			STOP DRILLING FOR NIGHT
					820	Sand and silt, fine and med. grained, light brown to green brown		10 minutes required to get circulation of foam
	85					Same as above, no frags		
	90				835			

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER B19376.B0 **BORING NUMBER** WELL F **SHEET** **OF**

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill **LOCATION** Lakeside, Utah

ELEVATION ~4670 ft above MSL **DRILLING CONTRACTOR** Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE ______ **START** 10/28/86 **FINISH** 11/5/86 **LOGGER** L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS ~~6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	90–95					Sand, fine to med. grained, silty brown to light brown, ls and ss frags in returns <0.5" diameter. Frags show rounded sides. ss is fine grained well cemented. ls is black microcrystalline.		Drilling hard 90 to 93' rig jumping
	95–100				838	same as above, frags more numerous and larger <1.0" diameter, some caliche 50% frags - ls and ss		
	100–105				845	Sand and gravel, fine to coarse grained, brown, some caliche frags are <0.25" 25% frags		
	105–110				849	limestone gravel, sand, and silt, gravel is angular, <0.5" dia, black and grey, microcrystalline, fine grained sand, light brown to gray. (conglomerate)		Drilling hard - minor rig jumping
	110–115				854	gravel and sand as above 75% gravel frags 25% fine to med. sand (conglomerate)		rig jumping
	115–120				858	gravel and sand as above 80% frags <0.75" dia 20% sand - fine to med. grained l. brown to gray (conglomerate)		rig jumping

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL F		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill LOCATION Lakeside, Utah

ELEVATION ~4670 ft above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE ______ START 10/28/86 FINISH 11/5/86 LOGGER L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	120				900	gravel and sand as above. ls and ss frags are angular and <0.75" dia 80% frags 20% sand		
	125				904	same as above		
	130				907	gravel and sand as above ls and ss <0.75" dia 80% frags 20% sand - light brown to grey f. to med. grained		
	135				911	sand and gravel, med. to coarse sand, some caliche, light brown to brown. Gravel is ls and ss, <0.5" dia, 60% sand 40% frags		Drilling very hard rig jumping. Rig jumping, hard.
	140				915 / 918	gravel and sand, ls and ss. 70% gravel <0.75" dia 30% sand, fine to coarse, gray		Rig jumping, hard.
	145				922	gravel and sand, as above 80% gravel 20% sand		
	150				926			

CH2M HILL

PROJECT NUMBER B19376.B0

BORING NUMBER WELL F

SHEET OF

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill LOCATION Lakeside, Utah

ELEVATION ~4670 ft above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE START 10/28/86 FINISH 11/5/86 LOGGER L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
150					926	Gravel and sand as above 60% gravel 40% sand		Hard @152
155					931			
						Gravel and sand, ls and ss gravel, <0.75" dia. sand is fine grained, light brown and gray 90% gravel 10% sand		
160					935			
					938	Gravel and sand as above 70% gravel 30% sand		
165					942			
						Gravel and sand as above 90% gravel 10% sand		
170					946			
						Gravel and sand as above 80% gravel 20% sand		Hard @172
175					950			
						Gravel and sand as above 70% gravel 30% sand		
180					955			

CH2M HILL

PROJECT NUMBER B19376.B0

BORING NUMBER WELL F

SHEET OF

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill LOCATION Lakeside, Utah

ELEVATION ~4670 ft above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE START 10/28/86 FINISH 11/5/86 LOGGER L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	~~STANDARD PENETRATION TEST RESULTS~~ ~~6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
180					959 1006	Sand and gravel, coarse sand, brown to gray brown with silt. Gravel is <0.25" dia. 95% sand and silt 5% gravel		
	185				1012	Gravel and sand as above 50% gravel 50% sand		
	190				1017	Sand and gravel 60% sand 40% gravel		Rig jumping - slowed drilling rate
	195				1022	Gravel and sand and clay 80% gravel - black and grey microcrystalline ls and calcite cemented sandstone, <0.5" dia 20% sand, fine grained, light brown with silt and clay		
	200				1033	Gravel and sand and clay. black and grey ls, calcite cemented ss, calcite chips, calcite coated on ls 80% gravel <0.5" dia 20% sand, brown, fine with clay		Broke down gear on drill rig
	205				1223 1223	Gravel and sand 85% gravel as above 15% sand, fine grained, brown		
	210							no returns after drilling 5 ft.

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CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
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SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill LOCATION Lakeside, Utah
ELEVATION ~4670 ft above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.
DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam
WATER LEVEL AND DATE ________ START 10/28/86 FINISH 11/5/86 LOGGER L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	210				1223	Gravel and sand, Gravel, <0.25" dia, same types as above 60%. sand and silt, fine to coarse, brown to gray brown 40%		sharp soil change. rig jumping, hard
	215				1231	Gravel and sand, 80% gravel, black and gray ls, ≤0.4" tan calcite ss, calcite coatings. 20% sand, fine to coarse, brown to gray		very few returns
	220				1237 / 1241	Gravel and sand as above 60% gravel, ≤0.3" dia, angular calcite coatings. 40% sand, med to coarse, brown gray, black.		rig jumping - minor
	225				1249	Gravel and sand as above 70% Gravel, ≤0.4" dia 30% sand		rig jumping
	230				1254	Gravel and sand as above 90% Gravel, <0.5" dia 10% sand		Very few cutting returns - only frags. Drilling soft
	235				1300	Sand and Gravel 70% sand and silt, brown to dark brown and orange 30% gravel, <0.25" dia,		Sharp soil change
	240				1306			

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CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL F		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill LOCATION Lakeside, Utah

ELEVATION ~4670 ft above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE ______ START 10/28/86 FINISH 11/5/86 LOGGER L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	240				1308 – 1314	Sand and gravel 70% sand and silt, brown to dark brown, 30% gravel, ls and calcite ss, <0.25 to 0.125" dia		
	245				1319	Sand and gravel 90% sand, med to coarse, brown to orange brown 10% gravel as above, <0.125" dia		rig jumping minor Drilling very soft
	250				1325	Sand, fine w/some coarse, well sorted almost clean, light brown to grayish brown		Drilling soft
	255				1331	Sand, clean, fine, light brown to gray brown, with calcite and ls sand		returns are very thick and heavy Drilling soft
	260				1335 – 1339	Sand, fine to coarse, light brown to tan, with calcite sand		very little returns Drilling soft
	265				1350	Sand, as above		Having difficulty circulating returns out of hole Drilling soft
	270							

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL F		

SOIL BORING LOG

PROJECT: HILL AIR FORCE BASE UTTR Landfill LOCATION: Lakeside, Utah

ELEVATION: ~4670 ft above MSL DRILLING CONTRACTOR: Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT: Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE: START: 10/28/86 FINISH: 11/5/86 LOGGER: C. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	270–275				1357	Sand w/ gravel 90% sand, fine to coarse, brown to gray brown 10% gravel, <0.75" dia, ls and calcite ss, calcite coatings		
	275–280				1403	Sand and gravel, as above 70% sand 30% gravel, <0.75" dia most <0.4" dia		returns are very watery
	280–285				1407 1411	Sand and gravel 60% sand 40% gravel, <0.5" dia.		rig jumping - minor
	285–290				1418	Sand and gravel as above 50% sand 50% gravel		Drilling soft
	290–295				1425	Sand and silt, fine to med. grained, light brown to gray brown to tan		rig jumping, hard
	295–300				1432	Gravel and sand, 60% gravel, <0.125" dia 40% sand		

CH2M HILL

PROJECT NUMBER: B19376.B0

BORING NUMBER: WELL F

SHEET ___ OF ___

SOIL BORING LOG

PROJECT: HILL AIR FORCE BASE UTTR Landfill LOCATION: Lakeside, Utah

ELEVATION: ~4670 ft above MSL DRILLING CONTRACTOR: Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT: Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE: ___ START: 10/28/86 FINISH: 11/5/86 LOGGER: L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	300				1440	Gravel and sand, as above. 70% gravel, <0.25" dia ls and calcite ss, black, gray, white. 30% sand, fine to coarse, gray brown		
	305				1443	Gravel and sand as above		drilling hard
	310					Gravel, <0.75" dia, ls, black and grey, microcrystalline, ss, some friable some well cemented, yellow brown to tan, fine grained, angular with rounded sides		
	315				1451	Gravel and sand, with clay. 80% gravel, <0.75" dia, as above. 20% sand, coarse to fine, light gray brown, with clay		Drilling soft
	320				1454 / 1459	Gravel and sand, as above. 60% Gravel, <0.25" dia. 40% sand with some clay		soft drilling; rig jumping, hard.
	325				1305	Gravel and sand, as above. 60% gravel, <0.4" dia. 40% sand		
	330				1310			

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER B19376.BO | **BORING NUMBER** WELL F | **SHEET** ___ **OF** ___

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill **LOCATION** Lakeside, Utah

ELEVATION ~4670 ft above MSL **DRILLING CONTRACTOR** Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE ______ **START** 10/28/86 **FINISH** 11/5/86 **LOGGER** L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	330							
					1513	Gravel, sand, clay as above. More clay than above.		very few returns just frags
	335							
					1515	Gravel and sand 70% gravel, <0.25" dia 30% sand, fine to med.		very few returns just frags
	340				1521			
					1526	Gravel and sand 70% gravel, <0.5" dia 30% sand, fine to med.		very few returns frags
	345							
					1529	Gravel and sand as above 90% gravel, <0.5 inches dia very angular 10% sand		very few returns frags
	350							
					1532	Sand, fine to med grained, light brown to gray.		rig jumping, hard.
	355							
					1537	Sand, fine to med. grained same as above		drill returns very wet and sandy
	360							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL F		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill LOCATION Lakeside, Utah

ELEVATION ~4670 ft above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE ______ START 10/28/86 FINISH 11/5/86 LOGGER L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
360					1542	Sand w/ trace of gravel fine to med. grained, light brown to gray		
	365				1549			
						Gravel and sand 50% gravel, <0.25" dia. 50% sand, fine and coarse grained		sharp soil change
	370				1556			
						Gravel and sand, as above 70% Gravel, ls, black and gray calcite ss, tan, < 0.25" dia 30% sand, fine to coarse, brown-tan, gray brown.		
	375				1600			
						Gravel and sand, as above 50% Gravel 50% sand.		circulate cuttings out of hole until 1615 EOD
	380				1604			
					847	Sand and gravel 80% sand, fine to med. grained light brown to tan 20% gravel, <0.75" dia, ls and calcite ss		drilling hard
	385				857			
						Gravel and sand 50% gravel, <0.5" dia 50% sand, fine to med., light brown to tan, gray		hard very hard hard
	390				856			

REV 11/82 FORM D1586

CH2M HILL	**PROJECT NUMBER** B19376.B0
	BORING NUMBER WELL F — SHEET OF

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill **LOCATION** Lakeside, Utah

ELEVATION ~4670 ft above MSL **DRILLING CONTRACTOR** Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE ______ **START** 10/28/86 **FINISH** 11/5/86 **LOGGER** L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	~~STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION (NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL)	SYMBOLIC LOG	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION)
	390 – 395				902	Gravel and sand 70% gravel, <0.4" dia 30% sand, light brown, fine to med.		hard drilling hard
	395 – 400				908	Gravel and sand as above 60% gravel 40% sand		hard somewhat every 6" or so.
	400 – 405				920 924	Sand and gravel 60% sand, light brown to tan fine 40% gravel, <0.25" dia, rounded		soft hard soft changed rubber slight back pressu when driller discon nected drill stem - told him to blow hole with air - no water returns
	405 – 410				930	Sand and gravel 50% sand 50% gravel, <0.4" dia		hard
	410 – 415				936	Same as above		hard w/ 6" soft spots
	415 – 420				941	Sand and gravel 60% sand, v. l. brown, fine to coarse 40% gravel, <0.25" dia		hard w/ soft spots very hard

CH2M HILL

PROJECT NUMBER: B19376.BO
BORING NUMBER: WELL F
SHEET ____ OF ____

SOIL BORING LOG

PROJECT: HILL AIR FORCE BASE UTTR Landfill
LOCATION: Lakeside, Utah
ELEVATION: ~4670 ft above MSL
DRILLING CONTRACTOR: Hiddleston Drilling and Pump Co.
DRILLING METHOD AND EQUIPMENT: Conventional Air Rotary with Airfoam
WATER LEVEL AND DATE: ____
START: 10/28/86
FINISH: 11/5/86
LOGGER: L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
420					950 956	Sand and gravel 60% sand 40% gravel, <0.25 to .125" dia.		hard soft hard
425					1004	Sand with some gravel 80% sand, fine to coarse grained light brown to tan 20% gravel, <0.125" dia		soft
430					1015	Sand w/ trace gravels 95% sand, fine, light brown to pale brown		
435					1020			
440					1057 1105	Sand and gravel 80% sand, fine, light brown to whitish pale brown 20% gravel, <0.25" dia, most smaller		hard soft w/ only a few hard spots
445					1112	Gravel and sand 60% gravel, <0.4" dia, black and gray ls, tan calcite ss. 40% sand, fine, v. light brown		hard very hard
450								

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL F		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill LOCATION Lakeside, Utah

ELEVATION ~4670 ft above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE ______ START 10/28/86 FINISH 11/5/86 LOGGER L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
450–455					1116	Gravel and sand 70% gravel, <0.5" dia. 30% sand, fine to coarse, brown to gray brown		very hard hard
455–460					1121	Sand and gravel 70% sand, fine to coarse, light brown to gray brown. 30% gravel, <0.25 to 0.125" dia		hard w/ soft spots
460–465					1133 1137	Sand and gravel, as above 60% sand 40% gravel, ≤ 0.5" dia		soft ↓
465–470					1144	Sand and gravel 80% sand 20% gravel, <0.25" dia		hard soft hard soft
470–475					1149	Sand and gravel 50% sand 50% gravel, <0.5" dia		
475–480					1154	Sand, 95%, fine to coarse grained, l. brown or tan 5% trace gravels, <0.25" dia.		hard

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.B0	WELL F		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill LOCATION Lakeside, Utah

ELEVATION ~4670 ft above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Air foam

WATER LEVEL AND DATE ________ START 10/28/86 FINISH 11/5/86 LOGGER L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	480				1210	Sand and gravel 80% sand, fine to med., brown or gray brown 20% gravel, <0.4" dia		soft w/ occasional hard spots
	485				1215	Gravel and some sand 90%+ gravel, ≤0.5" dia., ls is black and grey, ss is tan or orangish, angular 10% sand, fine grained, pale brown		first water show in returns very hard
	490				1221	Gravel and sand, as above 90% gravel, < 0.4" dia 10% sand		hard w/ some soft spots
	495				1225	Gravel and sand, as above 60% gravel 40% sand		Very hard, rig bouncing ↓ switch over to EZ mud
	500				1230 1245	Gravel and sand, as above 60% gravel 40% sand		Very hard ↓ hard very hard
	505				1253	Gravel and sand 50% gravel 50% coarse sand		↓
	510				1382			

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.BO	WELL F		

SOIL BORING LOG

PROJECT HILL AIR FORCE BASE UTTR Landfill LOCATION Lakeside, Utah

ELEVATION ~4670 ft above MSL DRILLING CONTRACTOR Hiddleston Drilling and Pump Co.

DRILLING METHOD AND EQUIPMENT Conventional Air Rotary with Airfoam

WATER LEVEL AND DATE ____ START 10/28/86 FINISH 11/5/86 LOGGER L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
510								
					1306	Gravel and sand 50% gravel, <0.25" dia. 50% coarse sand, brown to dark gray brown		soft drilling
	515				1310	Gravel and sack 70% gravel, <0.4" dia 30% coarse sand		↓ very hard
	520					Gravel and sand as above more ss		

CH2M HILL

PROJECT NUMBER B19376.C0 **BORING NUMBER** Well G **SHEET** 1 **OF** 5

SOIL BORING LOG

PROJECT UTTR Landfill No. 5 **LOCATION** Lakeside, Utah

ELEVATION ______ **DRILLING CONTRACTOR** Hiddleston and Son, Inc.

DRILLING METHOD AND EQUIPMENT Air Rotary 7 7/8 inch / Speed Star

WATER LEVEL AND DATE 415 ft to steel 1/12/88 **START** 12/8/87 **FINISH** 1/13/88 **LOGGER** C. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0					1300	Silt, light brown, soft, dry, powdery.		HNu = 0.5 = background in cuttings and pit. Rad = 0.1
	10							
						-15 ft. Silt as above with trace gravels		
					1315	-18 ft. Gravel layer, ls gravels, dark gray to black.		
	20				1420	Gravel, sand, and silt, gravel is black and gray, coated with calcite, sand fine to coarse, single grained, multi colored		HNu = bg (0.5) Rad = 0.1
	30							
						Gravel, sand, silt as above. White caliche frags in returns, gravels are 1-inch dia. in returns.		-32' drilling hard probably boulder
	40				1450 / 1605			HNu = bg Rad = 0
	50					Gravel, sand with silt as above. Occasional partially cemented sands.		
	60				1630			Rad = 0 HNu = bg

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
B19376.CO	Well G	SHEET 2 OF 5

SOIL BORING LOG

PROJECT UTTR Landfill No. 5 LOCATION Lakeside, Utah

ELEVATION ______ DRILLING CONTRACTOR Hiddleston and Son, Inc.

DRILLING METHOD AND EQUIPMENT Air Rotary 7 7/8 inch / Speed Star

WATER LEVEL AND DATE 415 ft to steel 1/12/88 START 12/8/88 FINISH 1/13/88 LOGGER C. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	60				1040	Gravel, sand, silt. Partially cemented sands can be broken by hand, Ls gravels are gray to black, approx. 1-inch diameter in returns, are coated with calcite, sand is very coarse to fine, with adundant white caliche		HNu=bg Rad=0.1
	70							
						-76ft cemented sand beds less than 2-inches thick.		
	80				1135			
					1250	Gravel, sand silt as above.		HNu=bg Rad=0.1
					1325			→Bottom steel 98 ft.
	100			1/10/88	915	Sand, gravel with silt. Silt is gray ~~brown~~, sand fine to coarse, multi-colored. Ls and quartzite gravels		HNu= bg(0.7) Rad= 0.
					930			
	120				932	Gravel and sand, gravels show rounded edges, up to 1-inch diameter, sand fine to very coarse, gravels are coated with calcite.		HNu= bg Rad= 0
					950			
	140				954			
					1007	Sand, silt, gravel. 60% sand 30% silt, 10% gravel.		drilling very soft
	160							

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
B19376.CO	Well G	SHEET 3 OF 5

SOIL BORING LOG

PROJECT UTTR Landfill No. 5 LOCATION Lakeside, Utah

ELEVATION ______ DRILLING CONTRACTOR Hiddleston and Son, Inc.

DRILLING METHOD AND EQUIPMENT Air Rotary 7 7/8 inch / Speed Star

WATER LEVEL AND DATE 415 ft to steel 1/12/88 START 12/8/88 FINISH 1/13/88 LOGGER C. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	160				1012	Sand, gravel, silt as above		
					1028			
	180				1035	Sand, gravel and silt. Sand is fine to coarse, single grained, gravels are calcite coated, silt is light brown.		HNu=bg on samples
					1050			
	200				1055	Sand, gravel, silt, more sand fine sand, some partially cemented sand 206-210'.		HNu=bg
					1110			
	220				1115	Sand, gravel, silt, more gravels coated with calcite, adundant white coarse sand (broken caliche)		HNu=bg
					1142			
	240				1150			
					1215			
	260				1253	Sand and gravel, well cemented sands, larger gravel than above, some cemented conglomerate, contains fine sand and silt.		263 to 272 very hard drilling.
					1315			
	280							

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
B19376.CO	Well G	SHEET 4 OF 5

SOIL BORING LOG

PROJECT UTTR Landfill No. 5 LOCATION Lakeside, Utah
ELEVATION ______ DRILLING CONTRACTOR Hiddleston and Son, Inc.
DRILLING METHOD AND EQUIPMENT Air Rotary 7 7/8 inch / Speed Star
WATER LEVEL AND DATE 415 ft to steel 1/12/88 START 12/8/88 FINISH 1/13/88 LOGGER C. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	280				1320 1340	Sand, gravel, silt, less cemented sand, fine sand and silt and above.		hard drilling with soft spots.
	300				1338	Sand and Silt, sand and fine sand, gray and light brown, trace gravels		Softer drilling 300 to 315 ft.
	315 320				1350 1355 1408	Sand, gravel, silt, some chert (red) and quartzite (white) gravels, mainly gray to black ls.		322' - hard gravel 335' hard drilling for the remainder of the hole.
	340				1415 1432	Gravel, sand, and silt, ls gravels ½-inch dia with light brown sand and silt.		
	360				1446 1505	Coarse sand and gravel, very little silt, gravels are coated ls frags <½-inch diameter, sand is multi-colored.		drilling hard and very hard in spots rig torqueing
	380				1515	C. sand and gravel		
	400				1610			

REV 11/82 FORM D1586

PROJECT NUMBER	BORING NUMBER	SHEET
B19376.CO	Well G	5 OF 5

SOIL BORING LOG

PROJECT: UTTR Landfill No. 5 — LOCATION: Lakeside, Utah

ELEVATION: — DRILLING CONTRACTOR: Hiddleston and Son, Inc.

DRILLING METHOD AND EQUIPMENT: Air Rotary 7 7/8 inch / Speed Star

WATER LEVEL AND DATE: 415 ft to steel 1/12/88 — START: 12/8/88 — FINISH: 1/13/88 — LOGGER: C. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	400				1616	Coarse Sand and gravel, no fine sand or silt.		drilling hard and very hard
								Blew hole dry-no apparent water @420
	420			1/11/88	1640 / 1040			
	440				1123	Coarse sand and gravel, very little silt, no cemented sands, gravel is crushed and broken, very angular, <1/2-inch diameter, mainly gray and black ls		Blew hole dry-no apparent water → H_2O at 442 ft.
	460				1355			Blew hole-appears to make 3-5 gpm HNu=bg drilling hard and very hard
	480				1420 / 1608			drilling hard rig torqueing
	500				1629	TOTAL DEPTH=504 ft.		

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
B19376.CO	Well H	1 OF 4

SOIL BORING LOG

PROJECT UTTR Landfill No.5 LOCATION Lakeside, Utah

ELEVATION ______ DRILLING CONTRACTOR Hiddleston and Son, Inc.

DRILLING METHOD AND EQUIPMENT Air Rotary 7⅞-inch hole / Speed Star

WATER LEVEL AND DATE 388 ft to steel 1/26/88 START 1/21/88 FINISH 1/26/88 LOGGER C. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	0				1310	Silt, light brown, slightly moist, powdery, soft.		HNu = 0 Explo = 0 O_2 = 20.5% Rad = 0
	9'					Silt with gravel, light brown to gray silt with small rounded gravels		
	20				1328 / 1425	Silt and clay with gravel. small clay balls in cuttings.		HNu = 0 Explo = 0 O_2 = 20.5% Rad = 0
	25'					Sand, gravel, with silt. Poorly sorted sand and silt with rounded gravels. Gravels are less than 1-inch diameter.		Soft 30-40'
	40				1445 / 1600			HNu = 0 Explo = 0 O_2 = 20.5% Rad = 0
								EOD
	60		1/22/88		1623 / 1615	Sand, gravel with silt. Fine to coarse sand, poorly sorted. Silt is light brown. Gravels are mainly limestone, black to tan.		Broken hammer 0800 - 1600
								75' hard drilling EOD
	80		1/23/88		1632 / 1005			HNu = 0 Rad = 0
	100				1018 / 1025	Gravel, sand with silt. Gravels are coated with calcite cement. Gravel consists of ls frags and cemented sands. Silt is light brown. Sands are poorly sorted		HNu = 0 Rad = 0
	120				1048			

REV 11/82 FORM D1586

PROJECT NUMBER	BORING NUMBER	
B19376.CO	Well H	SHEET 2 OF 4

CH2M HILL

SOIL BORING LOG

PROJECT UTTR Landfill No. 5 LOCATION Lakeside, Utah

ELEVATION ______ DRILLING CONTRACTOR Hiddleston and Son, Inc.

DRILLING METHOD AND EQUIPMENT Air Rotary 7 7/8-inch hole / Speed Star

WATER LEVEL AND DATE 388 ft to steel 1/26/88 START 1/21/88 FINISH 1/26/88 LOGGER C. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	120				1055	Gravel, sand, with silt. as above with high silt content.		Easy firm drilling HNu = bg Rad = 0
	130'					Gravel and sand, gravel consists of limestone, black to gray. Gravels are less than 0.5-inch diameter and have calcite coatings. Sands are poorly sorted with abundant coarse grains and some cemented sands.		
	140				1110 / 1117			
	160				1135 / 1141			HNu = bg Rad = 0
	180				1205 / 1246	Gravel and sand as above.		HNu = bg Rad = 0
	200				1305 / 1310			HNu = bg (0.5) Rad = 0
	205'					Sand and gravel, sandier than above with some silt.		
	220				1325 / 1333			HNu = bg Rad = 0
	225					Sand and silt with gravel. Fine sand and silt, light brown, poorly sorted. Occasional gravels at 230 feet.		soft drilling 225-230
	240				1345			

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
B19376.C0	Well H	3 OF 4

SOIL BORING LOG

PROJECT UTTR Landfill No. 5 LOCATION Lakeside, Utah

ELEVATION ______ DRILLING CONTRACTOR Hiddleston and Son, Inc.

DRILLING METHOD AND EQUIPMENT Air Rotary 7 7/8-inch hole / Speed Star

WATER LEVEL AND DATE 388 ft to steel 1/26/88 START 1/21/88 FINISH 1/26/88 LOGGER C. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N) TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	240				1350			Drilling soft
	245					Sand and gravel, poorly sorted sands are fine to coarse grained, gravels are less than 1-inch diameter		Drilling hard, rig torquing. HNu=0.5 Rad=0
					1405			
	260				1412			
	270					Sand and gravel as above but gravels consist of white to buff colored limestone.		270 drilling firm but soft
					1428			
	280				1434	Sand and gravel as above no white limestone		HNu=0 Rad=0
					1451			298 to 302 soft
	300				1456	Sand and gravel, coarse to fine sand with silt, light brown silt, sands are multi-colored. Gravel less than 0.5-inch diameter, mainly black and gray limestone, contains some white ls and greenish tinted cemented mudstone.		
					1528			
	320				1533			HNu=0.5 (bg) Rad=0
					1550			
	340				1555	Sand and gravel as above		
	360				1612			

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.CO	Well H	4	4

SOIL BORING LOG

PROJECT UTTR Landfill No. 5 LOCATION Lakeside, Utah

ELEVATION DRILLING CONTRACTOR Hiddleston and Son, Inc.

DRILLING METHOD AND EQUIPMENT Air Rotary 7 7/8-inch hole / Speed Star

WATER LEVEL AND DATE 388 ft to steel 1/26/88 START 1/21/88 FINISH 1/26/88 LOGGER C. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	360				1618 1638	Sand and gravel, poorly sorted sands with gravels.		drilling hard
	380			1/24/88	1120 1134	Sand, cemented sand, with gravels, fine to medium grained sand, light brown, well cemented sands, with small (<1/4-inch) gravel		Dry ~~hole - no water~~
	400				1149 1152	Sand and cemented sand sand is fine to coarse with no gravels or silt, cemented sand is fine to very fine grained.		dry hole - no water very soft drilling HNu = bg (0.5) Rad = 0 → H_2O found between 415 and 420 ft.
	420							
	435 440				1205 TD = 450 ft	Gravel and sand, sand is poorly sorted, fine to coarse grained, gravels are mainly limestone less than 1/2-inch diameter.		hard drilling, rig torqueing.

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET 1 OF 8
B19379.CO	I	

SOIL BORING LOG

PROJECT HILL AFB UTTR LANDFILL NO. 5 LOCATION SW CORNER OF LANDFILL

ELEVATION ______ DRILLING CONTRACTOR Hiddleston INC. Mtn. Home Idaho

DRILLING METHOD AND EQUIPMENT AIR ROTARY

WATER LEVEL AND DATE ______ START 2/1/88 FINISH ______ LOGGER C. FEAST

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS ~~6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
					1550	0-8' Logged from pit escavation silt, uniform beige color dry		
						8-13' - same as above		
	10'							
						silt as above with occasional gravels		
					1620			INSIDE CASING H·NU = .6
	20'				1650	silt, sand and gravel, med.-light brown, gravel dark gray to black limestone		
	30					same as above smoother, less gravel		
					1720	EOD (2/1/88)		INSIDE CASING HNU: 1.2
	40			2/2?	0900	sand and gravel, coarse gvls lime sand, gravels of L.S., qtz		Rad = .02 mR/HR
					0905			Hammer frozen 0905-0940
					0940	clayey and sandy gravel interbedded, clay is offwhite, gravels brown to dark gray		
	50					L.S. and Qtzite, angular, > 3/8"		
						coarse gravels w/ little clay minor sands		HNU inside casing = 1.0
	60				1015			RAD = .02 mR/HR

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
B19379.CO	I	2 OF 8

SOIL BORING LOG

PROJECT HILL AFB UTTR LANDFILL NO. 5 LOCATION SW CORNER OF LANDFILL

ELEVATION ______ DRILLING CONTRACTOR Hiddleston INC. Mtn. Home Idaho

DRILLING METHOD AND EQUIPMENT AIR ROTARY

WATER LEVEL AND DATE ______ START 2/1/88 FINISH ______ LOGGER C. FEAST

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS ~~6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	60				1100	GRAVEL fine to COARSE, ANGULAR, L.S. and Qtzite dark gray to black and browns. MINOR SAND + silt, NO clay NOTED UNTIL last 2' then v. little white sandy clay balls in cuttings		
	70							
	80				1130			HNU INSIDE CASING = .8 HAMMER FROZEN
					1245	GRAVEL, SANDY, + silty, gravel is ANGULAR to ROUNDED, black-brown + gray LS + Qtzite (minor) SAND is FINE to MED. some CEMENTED SANDS IN cuttings.		
	90					JAR sample indicates minor clay present @ less than 10%. As Above, drilled hard + soft		Bottom of 8" steel casing @ 98'
	100				1340	AS Above		
						AS Above, SOME ROUNDED gravels		
	110				1440	AS Above, gravels finer		
						AS Above, hard, more Qtzite AND CEMENTED fine SAND		
	120				1450			

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
B19379.CO	I	3 OF 8

SOIL BORING LOG

PROJECT HILL AFB UTTR LANDFILL NO. 5 LOCATION SW CORNER OF LANDFILL

ELEVATION ____ DRILLING CONTRACTOR Hiddleston Inc. Mtn. Home Idaho

DRILLING METHOD AND EQUIPMENT AIR ROTARY

WATER LEVEL AND DATE ____ START 2/1/88 FINISH ____ LOGGER C. FEAST

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS ~~6"-6"-6"~~ ~~(N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	120				1450	GRAVEL AND poorly CEMENTED SAND (conglomerate?) gravels fine to COARSE AND ARE SEMI ROUND. SAND IS FINE to MED. light brown. LAYERED harder + softer ZONES		HNU at well head = .6 RAd = .02 mR/HR
	130					As Above ↓		
	140				1510			
					1515	As Above ↓		
	150							
	160				1528	GRAVELS LESS ROUNDED		HNU @ background Rad @ background
					1535	As Above ↓		
					164	SANDY, silt, some clay, gravelly at 170', soft		
	170					GRAVEL and SAND, GRAVEL IS LS + QTZITE, ANGULAR and is brown and greenish BROWN, less black + gray ↓		
	180				1549			RAd = Bkgnd HNU = Bkgnd

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
B19379.CO	I	4 OF 8

SOIL BORING LOG

PROJECT: HILL AFB UTTR LANDFILL NO. 5 LOCATION: SW CORNER OF LANDFILL

ELEVATION: DRILLING CONTRACTOR: Hiddleston Inc. Mtn. Home Idaho

DRILLING METHOD AND EQUIPMENT: AIR ROTARY

WATER LEVEL AND DATE: START: 2/1/88 FINISH: LOGGER: C. FEAST

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS ~~6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	180				1553	Gravel and gravelly sand, gravel is angular, LS + Qtzite browns + brownish gray, some green coatings. Sand is med. to fine light brown. Section alternates between sand w/gravel + gravel w/sand		HNU = 1.2 from well; .6 - breathing zone
	190							
	200				1617 / 1623	Soft, sandy, white sandstone + gray black LS gravels. Sandstone white + greenish brown, soft ↓		HNU + Rad = bkgnd
	210					Gravel, sandy, gravel is angular black, brown + gray, LS w/some Qtzite, some cemented sand stringers 199-200		
	220				1636	As above. Sandstone and Ash (tuff), SS is lite brown + greenish brown, fine to medium, tuff is bone white and hard.		HNU + Rad @ bkgnd
	230					Gravel w/sand + tuff, gravels are brown to black, sand is brownish to greenish brown		
	240				1650			

EOD

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
B19379.CO	I	5 OF 8

SOIL BORING LOG

PROJECT HILL AFB UTTR LANDFILL NO. 5 LOCATION SW CORNER OF LANDFILL

ELEVATION DRILLING CONTRACTOR Hiddleston Inc. Mtn. Home Idaho

DRILLING METHOD AND EQUIPMENT AIR ROTARY

WATER LEVEL AND DATE START 2/1/88 FINISH LOGGER C. FEAST

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS ~~6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	240			2/3?	0830	GRAVEL, SANDY, GRAVELS ROUNDED dark gray to black + brown ↓		HNU = .6 RAD = <.02 mR/HR
	250					Becoming more Sandy ↓		
						Sandstone, gravelly, poorly cemented. Gravels -3/8", sand is fine to medium gray brown		
	260					As above		HNU = .6 RAD = <.02 mR/HR
						GRAVEL, SANDY, fine gravels -3/8" LS angular, black + brown		
	270					as above		
						As above but sandier		
	280				0928	Sandstone + gravel. Sand is fine to med., brown, moderately cemented gravel is black + brown, angular - rounded LS + Qtzite ↓		Noticeable color change from gray to brown @ 280'
	290					as above but less cementation in the sand and more gravel ↓		
	300				0947			

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
B19379.CO	I	6 OF 8

SOIL BORING LOG

PROJECT HILL AFB UTTR LANDFILL NO. 5 LOCATION SW CORNER OF LANDFILL

ELEVATION ______ DRILLING CONTRACTOR Hiddleston Inc. Mtn. Home Idaho

DRILLING METHOD AND EQUIPMENT AIR ROTARY

WATER LEVEL AND DATE ______ START 2/1/88 FINISH ______ LOGGER C. FEAST

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS ~~6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	300				0953	GRAVEL AND SAND, gravel is FINE AND ANGULAR, SAND IS FINE to MED. poorly CEMENTED. BROWN AS Above, harder at 306; less SAND AND MORE GRAVEL ↓		HNU + Rad @ bkgnd
	310					AS Above, SAND INCREASING AND GRAVELS GETTING SMALLER. drilling hard + SOFT		
	320				1007 / 1013	SAND, MED to COARSE w/ FINE GRAVEL, MED. brown		
						Sand + GRAVEL, SAND IS FINE to MED., BROWN, GRAVEL FINE to COARSE black + brown ROUNDED		
	330					AS Above		
						AS Above, SAND CEMENTATION INCREASING		HNU + Rad @ bkgnd
	340				1027 / 1032	SAND poorly CEMENTED, FINE to MEDIUM w/ FINE GRAVEL BROWN		
						SAND + GRAVEL, GRAVEL IS ANGULAR, black + brown SAND IS FINE to MED., SOFT + hard		
	350					AS Above, VERY SANDY		
						AS Above		
	360				1046			

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
B19379.CO	I	SHEET 7 OF 8

SOIL BORING LOG

PROJECT HILL AFB UTTR LANDFILL NO. 5 LOCATION SW CORNER OF LANDFILL

ELEVATION ______ DRILLING CONTRACTOR Hiddleston INC. Mtn. Home Idaho

DRILLING METHOD AND EQUIPMENT AIR ROTARY

WATER LEVEL AND DATE ______ START 2/1/88 FINISH ______ LOGGER C. FEAST

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS ~~6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	360				1053	SAND AND GRAVEL, poorly sorted, brown ↓ SAND INCREASING		
	370					SAND, fine, silty, minor fine gravel to coarse sand, soft, brown ↓		
					1105			
	380				1110	SAND, fine silty, v. minor fine gravel/coarse sand, soft brown		
						SAND, fine silty + clayey, v. minor fine gravel/coarse sand, brown		
	390					As above		
						Gravelly fine sand		
					1121	Fine sand, silty, clayey w/very minor fine gravel + coarse sand		
	400					SAND AS ABOVE		
						AS ABOVE		
	410					AS ABOVE		
						AS ABOVE, A FEW THIN hard spots (gravels) from 418'		
	420				1138			

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
B19379.CO	I	8 OF 8

SOIL BORING LOG

PROJECT HILL AFB UTTR LANDFILL No. 5 LOCATION SW CORNER OF LANDFILL

ELEVATION ____ DRILLING CONTRACTOR Hiddleston INC. Mtn. Home Idaho

DRILLING METHOD AND EQUIPMENT AIR ROTARY

WATER LEVEL AND DATE ____ START 2/1/88 FINISH ____ LOGGER C. FEAST

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS ~~6"-6"-6" (N)~~ TIME	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	420				1143	SAND, FINE to MED., silty, clayey w/minor FINE gravel + COARSE SAND brown		
						SAND + gravel, hard zones gravel is FINE to medium black + brown Hole is making water		Water @ 427'
	430					Sand + gravel, sand more prominant, gravel smaller, sand is FINE to med. brown		
					1153	As above, becoming siltier		Hnu + Rad = bkgnd
	440				1158	SAND + gravel, SAND IS FINE to COARSE, GRAVEL IS FINE to medium, brown, Hole makes water		
						As above		
	450					As above		
					2/3/88? 1209	As above		TD @ 460' @ 1209
	460							

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
B19376.C0	Well J	1 OF 5

SOIL BORING LOG

PROJECT UTTR Landfill No. 5 LOCATION Lakeside Utah

ELEVATION ______ DRILLING CONTRACTOR Hiddleston and Son, Inc.

DRILLING METHOD AND EQUIPMENT Speed Star Air Rotary 7 7/8-inch hole

WATER LEVEL AND DATE 390.8' top of steel 12/5/87 START 12/2/87 FINISH 12/16/1987 LOGGER C. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						Silt, gravel with clay, brown.		HNu=0 Explo=0
	2''					Silt, light brown, soft, dry, powdery, with fine sand.		Drilling smooth and easy.
	10'					Silt with gravel, light brown silt, soft, sparse gravel, ls frags, 1/2-inch dia. Silt, gravel, sand. More gravel than above.		
	20'	X	SS #1	18"/24"		Sand, gravel, silt, med. to coarse sand, dry, single grained. Gravel subangular to rounded, <1-inch dia. ls frags, with stinky yellow silt.		Bit grinding, drilling easy. HNu=bg Explo=0
	26'					Sandy Clay, gray to l. brown slightly moist, soft, sticky, balls in cuttings, with fine to med. sand.		Drilling smooth and easy.
	29' 30					Gravel, sand, and silt, ls gravels <1-inch dia, fine to coarse sand, multi-colored, with l. brown silt.		Bit grinding, drilling easy
	40	X	SS #2	12"/12"		Sand and gravel, sand in multi-colored, orange, white, black, coarse to very coarse, single grained, ls gravels. are dark gray to black, <2-inches dia.		HNu=bg Explo=0
	50							

CH2M HILL

PROJECT NUMBER B19376.CO | **BORING NUMBER** Well J | **SHEET** 2 **OF** 5

SOIL BORING LOG

PROJECT UTTR Landfill No. 5 **LOCATION** Lakeside, Utah
ELEVATION ______ **DRILLING CONTRACTOR** Hiddleston and Son, Inc.
DRILLING METHOD AND EQUIPMENT Speed Star - Air Rotary 7 7/8-inch hole
WATER LEVEL AND DATE 390.8' to top steel **START** 12/2/87 **FINISH** 12/16/87 **LOGGER** L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION (NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL)	SYMBOLIC LOG	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION)
	50					Sand, gravel, with clay. Sand and gravel as above. Clay is dry, hard, brown, very dense.		
						Sand and gravel. Coarse, multi-colored sands with broken gravels		
	60	X	SS #3	6"/6"	150			HNu=3 on cuttings.
						70 - gray clay layer		color change to more gray
								EOD 12/3/87
	80					Sand, gravel w/ silt. Poorly sorted, brown, single grained, fine to coarse sand. Gravel is ls frags, with l. brown silt. Some cemented sands and calcite coated gravels.		HNu=1.0 (bg) drilling firm.
					09 33			
	100				10 20	Clay with interbedded sands, clay light brown to tan.		drilling very soft
						Gravel, sand, with silt as above. gravel shows partial cementing as a white coating, multi colored, poorly sorted sands.		drilling hard with soft spots
					1110			HNu=bg (0.5)
	120				1130	Coarse Sand and Gravel. Some cemented sands, tan to brown. Gravels are coated.		
					1205			
	140				1250	Gravel, sand, interbedded and cemented in places, contains gray silt.		
					1315			
	160							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
B19376.C0	Well J	3	5

SOIL BORING LOG

PROJECT: UTTR Landfill No. 5   LOCATION: Lakeside, Utah

ELEVATION: ______   DRILLING CONTRACTOR: Hiddleston and Son, Inc.

DRILLING METHOD AND EQUIPMENT: Speed Star - Air Rotary 7 7/8-inch hole

WATER LEVEL AND DATE: 390.8' to top steel   START: 12/2/87   FINISH: 12/16/87   LOGGER: L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	160				1323 1345	Gravel and sand as above with silt		
	180				1400 1422	As above.		HNu=0.5 inside casing
	200					Sand, gravel, with silt. Sand fine to coarse grained, multi colored, with gravels generally less than 0.5-inches diameter. Gravel is mainly ls but contains red chert and white quartzite		
	220					-230- cuttings contain white calcite chunks the size of coarse sand, soft, gravels are coated.		HNu=0.5 inside casing
	240				1459 1523	Sand, gravel with silt as above. Gravel is black, gray, and tan limestone frags.		HNu=0.5 (bg)
	260				1534 1555	-270- same as above but cuttings show more sand and silt with slightly less gravels		HNu=0.5 (bg) EOD
	280							

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
B19376.C0	Well J	4 OF 5

SOIL BORING LOG

PROJECT UTTR Landfill No. 5 LOCATION Lakeside, Utah

ELEVATION DRILLING CONTRACTOR Hiddleston and Son, Inc.

DRILLING METHOD AND EQUIPMENT Speed Star - Air Rotary 7 3/8-inch hole

WATER LEVEL AND DATE 390.8' to top steel START 12/2/87 FINISH 12/16/87 LOGGER C. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	280				840	Sand, gravel with silt as above		
					912			
	300				920	Sand, silt, and gravel. Fine to medium grained sand with light brown silt. Less gravel and above		
						Sand, gravel with silt. Sand is fine to coarse grained, multicolored gray and brown.		314-317' Drilling hard
					945			
	320				950			321-330 Drilling hard
					1015			
	340				1022	Sand, silt, gravel, as above Sand is fine to coarse grained, poorly sorted with light brown silt. Some cemented sands that can be broken by hand. Gravels are generally less than 0.5-inches diameter, angular but with rounded sides, consist mainly of black and gray limestone but also chert and quartzite.		-358 hard spot
					1042			
	360				1046			
					1110			
	380				1115			
	400				1140			

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER B19376.C0 **BORING NUMBER** Well J **SHEET** 5 **OF** 5

SOIL BORING LOG

PROJECT UTTR Landfill No. 5 **LOCATION** Lakeside, Utah

ELEVATION ______ **DRILLING CONTRACTOR** Hiddleston and Son, Inc.

DRILLING METHOD AND EQUIPMENT Speed Star - Air Rotary 7 7/8-inch hole

WATER LEVEL AND DATE 390.8' to top steel **START** 12/2/87 **FINISH** 12/16/87 **LOGGER** L. Mikell

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	400					Gravel and sand with silt. Limestone gravels less than 1-inch diameter, very angular, crushed,		Drilling hard. No water during drilling. ~~413-417 Drilling hard~~ → H_2O @ 417 ft. Drilling firm but soft at 417 ft.
	420					Sand with gravel. Sand is fine to med. grained, single grained, multi-colored brown and gray. Very few gravels. Some silt, light brown.		HNu = 0.5 (bg)
	436 / 440				436	Clay with sand, gravel. Dense, sticky, gray clay. With fine to coarse sand and gravel.		Drilling soft.
	455 / 460					Gravel and sand.		455 drilling firm and hard.
						TD = 463 ft.		

REV 11/82 FORM D1586

PROJECT NUMBER	BORING NUMBER	
132115.WL	UTTR Landfill 5 Monitoring Well J-1	SHEET 1 OF 5

BORING LOG

PROJECT : UTTR Landfill 5 Monitor Well J Replacement DRILLING CONTRACTOR : **Foundex Pacific**

ELEVATION (ft): **4605.45** NORTHING: **289,070.40** EASTING: **1,612,033.40**

DRILLING METHOD AND EQUIPMENT USED : **Air/Mud Rotary**

WATER LEVELS (date/time): **385.3 feet bgs 10/4/96** START DATE: **9/18/96** END DATE: **9/26/96** LOGGER : **B. Jensen/M.Cox**

DEPTH BELOW SURFACE (FT)	RUN TIME	SAMPLE TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DRILLING RATE, TESTS, AND INSTRUMENTATION.
		SO	Silt, (ML), light brown, 7.5YR (6/4), slightly moist, firm	Start Using Triple-Tube Reverse Air
		SO	--at 17 feet, 3-foot thick gravelly Sandy Silt layer, cobbles to 3.5 feet	
20		SO	Sandy Silt, (ML), light brown 7.5YR (6/4), dry, firm, fine-grained --at 26 feet, trace gravel	
		SO		Soil too dense for downhole sampling
40		SO	Silty Sandy Gravel, (GM), light brown 7.5YR (6/4), dry, very dense -- at 44 feet, cemented, very dense	Difficult drilling To 45' 9/18/96
		SO		Conductor Casing set to 50 feet Switch to Air/Mud Rotary Method
60		SO	--at 60 feet, numerous gravels	
		SO		
80		SO	Sandy Gravel, (GP), brown 7.5YR (4/4), moist, very dense, numerous boulders	
		SO		To 100' 9/19/96
100				

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PROJECT NUMBER 132115.WL	BORING NUMBER UTTR Landfill 5 Monitoring Well J-1	SHEET 2 OF 5

BORING LOG

DEPTH BELOW SURFACE (FT)	RUN TIME	SAMPLE TYPE	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DRILLING RATE, TESTS, AND INSTRUMENTATION.
		SO	Sandy Gravel (cont.) --Becoming cemented, abundant limestone boulders	Difficult drilling Soil too dense for downhole sampling
120		SO		
		SO		
140		SO		
	1412 1420	SO		
160	1430 1442	SO		
	1458 1520	SO		
180	1458 1625	SO		
	1640 1720	SO		To 190' 9/20/96
200	915 924	SO		

PROJECT NUMBER	BORING NUMBER	
132115.WL	UTTR Landfill 5 Monitoring Well J-1	SHEET 3 OF 5

BORING LOG

DEPTH BELOW SURFACE (FT)	RUN TIME	SAMPLE TYPE	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DRILLING RATE, TESTS, AND INSTRUMENTATION.
	0942 1045	SO	Sandy Gravel (cont.)	
220	1101 1110	SO	--210 to 220 feet, less gravels	
	1125 1136	SO		Difficult drilling
240	1316 1359	SO		
	1423 1450	SO		
260	1500 1605	SO		
	1635 1716	SO		To 270' 9/21/96
280	1037 1121	SO	--at 270 feet, 5-foot-thick Silty Sand layer	
	1145 1210	SO	--Abundant boulders -- at 285 feet, 2-foot thick Sand layer	Very hard drilling
300	1312 1416	SO		

PROJECT NUMBER	BORING NUMBER	
132115.WL	UTTR Landfill 5 Monitoring Well J-1	SHEET 4 OF 5

BORING LOG

DEPTH BELOW SURFACE (FT)	RUN TIME	SAMPLE TYPE	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DRILLING RATE, TESTS, AND INSTRUMENTATION.
	1524 1555	SO	Sandy Gravel (cont.)	
320	1644 1837	SO	--at 314 to 319 feet, Sand layer	Dinner from 1715-1800
		SO		Difficult drilling
340		SO		To 340' 9/22/96
		SO		Start at 340' on 9/25/96
360		SO		
		SO		
380		SO		
		SO		
400	902 918	SO		

PROJECT NUMBER	BORING NUMBER	
132115.WL	UTTR Landfill 5 Monitoring Well J-1	SHEET 5 OF 5

BORING LOG

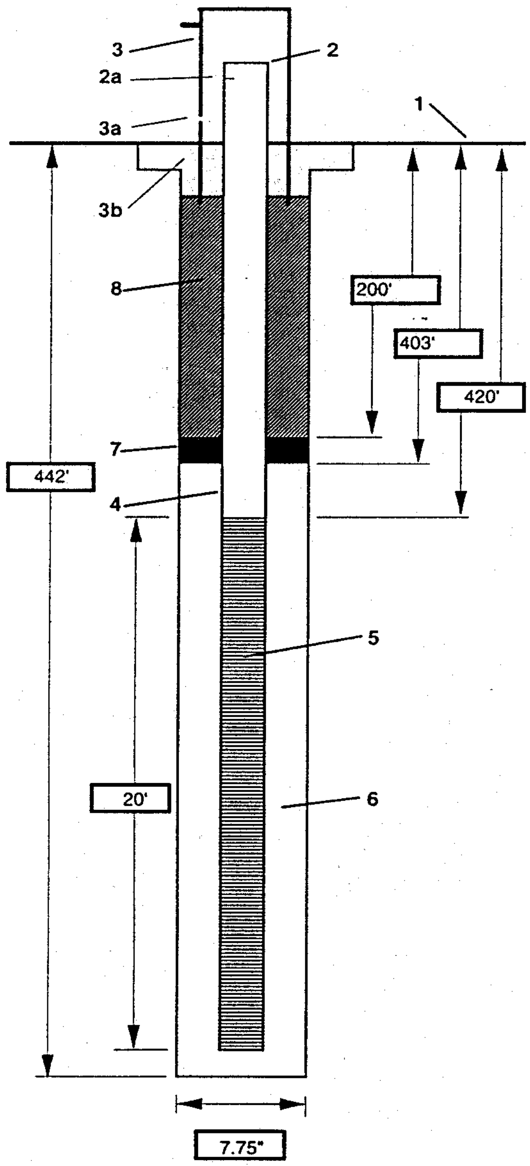
DEPTH BELOW SURFACE (FT)	RUN TIME	SAMPLE TYPE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DRILLING RATE, TESTS, AND INSTRUMENTATION.
	0940 0955	SO	Sandy Gravel (cont.)	Soil Sample Difficult drilling Soil Sample Soil too dense for downhole sampling
420	1009 1025	SO	--410 to 420 feet, scattered gravels	
	1039 1100	SO	Sand, (SP), brown 7.5YR (4/4), wet, very dense, coarse-grained, partially cemented	
440	1134 1208	SO	--at 435 feet, Silty Sand layer, 4 feet thick	
			Boring to 442 feet Monitoring Well Installed	
460				
480				
500				

SLC\132115\reports\J1BLog

PROJECT NUMBER	BORING NUMBER		
132115.WL	J-1	SHEET 1	OF 1

WELL COMPLETION DIAGRAM

PROJECT : **Monitoring Well J Replacement**	LOCATION : **UTTR Landfill 5**
ELEVATION : **Top of Casing 4605.45**	DRILLING CONTRACTOR : **Foundex Pacific**
DRILLING METHOD AND EQUIPMENT USED : **Air/Mud Rotary**	
WATER LEVELS : **385.3 below top of casing on 10/4/96**	START : **9/27/96** END : **9/29/96** LOGGER : **M.Cox**



1- Ground elevation at well: 4603.0

2- Top of casing elevation: 4605.45

3- Wellhead protection cover type: Above Ground, 8-inch steel with posts
- a) weep hole? No
- b) concrete pad dimensions: 4 Feet By 4 Feet

4- Diameter/type of well casing: 4-inch, Schedule 40 PVC

5- Type/slot size of screen: Machine-Cut, 4-inch, Schedule 40 PVC .010 Slot, 420 to 440 ft bgs

6- Type screen filter
- a) Quantity used: 442-414 feet, 10/20 Silica, 10 bags; 414-403 feet, 16/40 Silica, 4 bags

7- Type of seal
- a) Quantity used: Bentonite Grout

8- Grout
- a) Grout mix used: Aqua-Guard, no cement
- b) Method of placement: Tremie
- c) Quantity of well casing grout: Bentonite Grout 403-200 feet; Bentonite Chips 200-0 feet

Pump
- a) Pump type: Grundfos 5S15-27, 230 volt
- b) Intake Depth: 425 feet bgs

Discharge Pipe: 3/4-inch type 304 stainless steel

Water Level Probe Pipe: 3/4-inch, flush-threaded, Schedule 80, PVC pipe

Figure 1 - Construction Details for Monitoring Well J-1

NOTE: All depths in feet below ground surface

CH2MHILL

WELL DEVELOPMENT LOG

Installation: HAFB UTTR		Site: LANDFILL 5
Project No.: 132115.WL	Client/Project: Monitoring Well J Replacement	
Contractor: RC Drilling	Dev. Contractor: RC Drilling + M. Augustyn, Inc.	
Dev.. Start: 10/3/96 (09:32 m)	Dev. End: 10/4/96 (15:25 m)	Casing Dia.: 4"
Developed By: M. Augustyn	Well No.: J-1	Dev. Rig (Y/N) Y

Dev. Method BAILING AND SURGING. STARTED USING A (10' x 3" SS BAILER) TO SURGE WELL. SURGE WELL FOR 30 MINUTES, BAIL WELL UNTILL RELATIVELY CLEAN, INSTALL PUMP AND PUMP UNTIL PARAMETERS STABILIZE.

Equipment 10' x 3" SS BAILER, Grundfos 5S15-27, 230V Dedicated pump.

Pre-Dev. SWL 385.3 Maximum drawdown during pumping 5 ft at 5.3 gpm

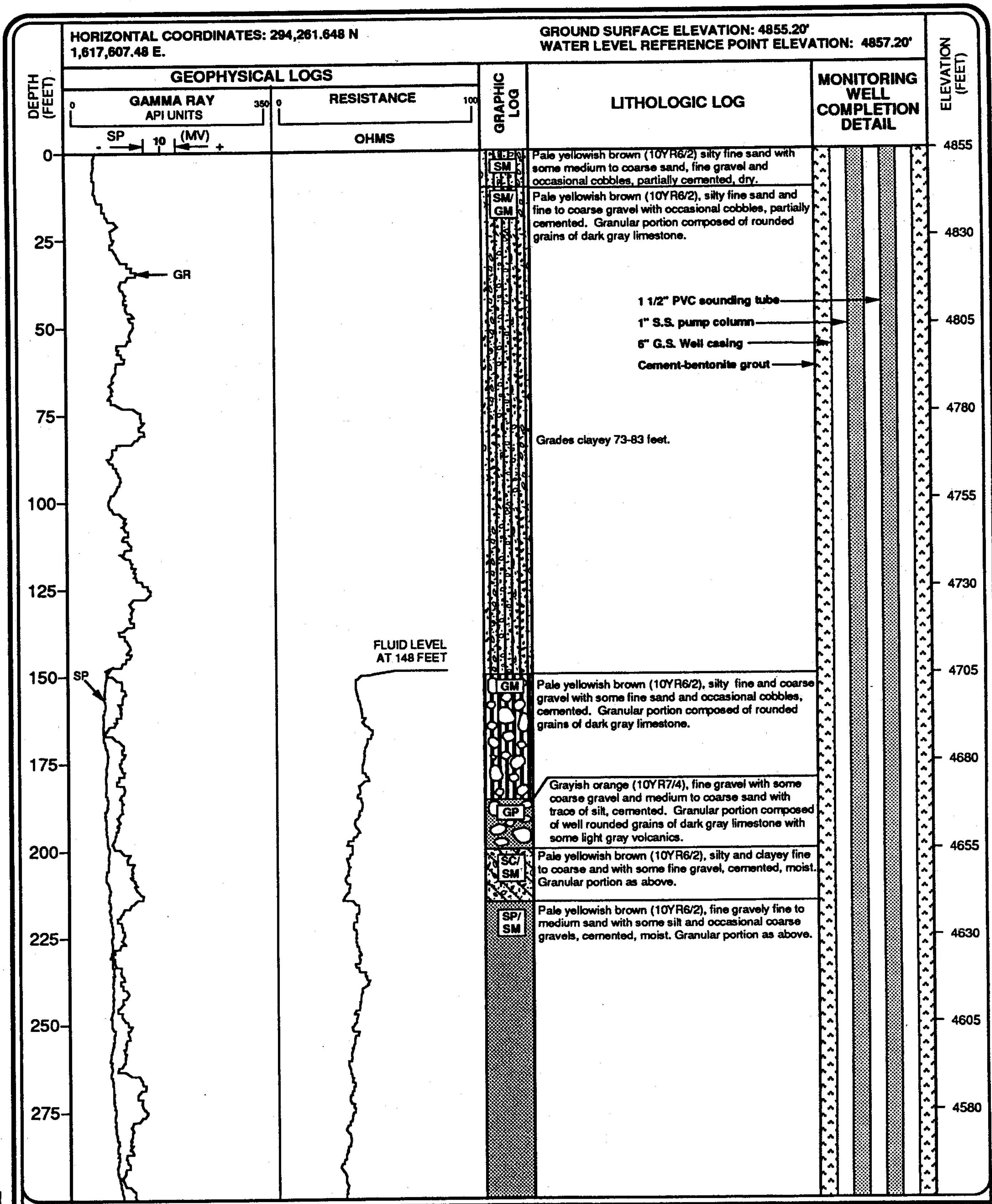
Range and Average discharge rate 0-5 GPM, 5 gpm gpm

Total quantity of material bailed 200 GALLONS

Total quantity of water discharged by pumping 410 GALLONS

Disposition of discharge water PUMP TO ADJACENT GROUND SURFACE AS PER SCOPE OF WORK.

Time	Volume Removed (gal)	Water Level ft. BTOC	Turbidity	Clarity/ Color	Temp. °C	pH	Conductivity	Remarks
10/3/96								
0950								BEGAN SURGING
1030								
1057	0.0	385.3	—	CLOUDLY	—	—	—	COMPLETED SURGING
1132	55	—	—	CLOUDLY	—		—	STARTED BAILING. DEVELOPMENT WATER CONTAINED RESIDUAL GROUT, WITH TRACE SAND.
1200	100	—	—	CLOUDLY	—	—	—	WATER CLEARING
1235	150	—	—	CLOUDLY	—	—	—	WATER CLEARING
1300	200	—	—	CLOUDLY	—	—	—	WATER CLEARING, BAILING COMPLETED, WILL SET PUMP ON 10/4/96 AND CONTINUE DEVELOPMENT
10/4/96 1403		385.3						PUMP SET AT 425' PUMP RATE of 5GPM
1410	35	387.2	—	CLOUDLY	24	6.98	800	
1417	70	389.0	—	CLOUDLY	16.7	6.92	700	
1424	105	389.0	—	CLEARING	16.2	6.90	500	CLEARING
1438	175	389.0	—	CLEARING	16.3	6.89	500	
1455	260	389.0	—	CLEARING	16.2	6.87	400	
1505	310	389.0	—	CLEARING	16.0	6.89	400	
1525	410	389.0	—	CLEARING	16.0	6.88	400	COMPLETE DEVELOPMENT. BEGIN SAMPLING AT 1525.



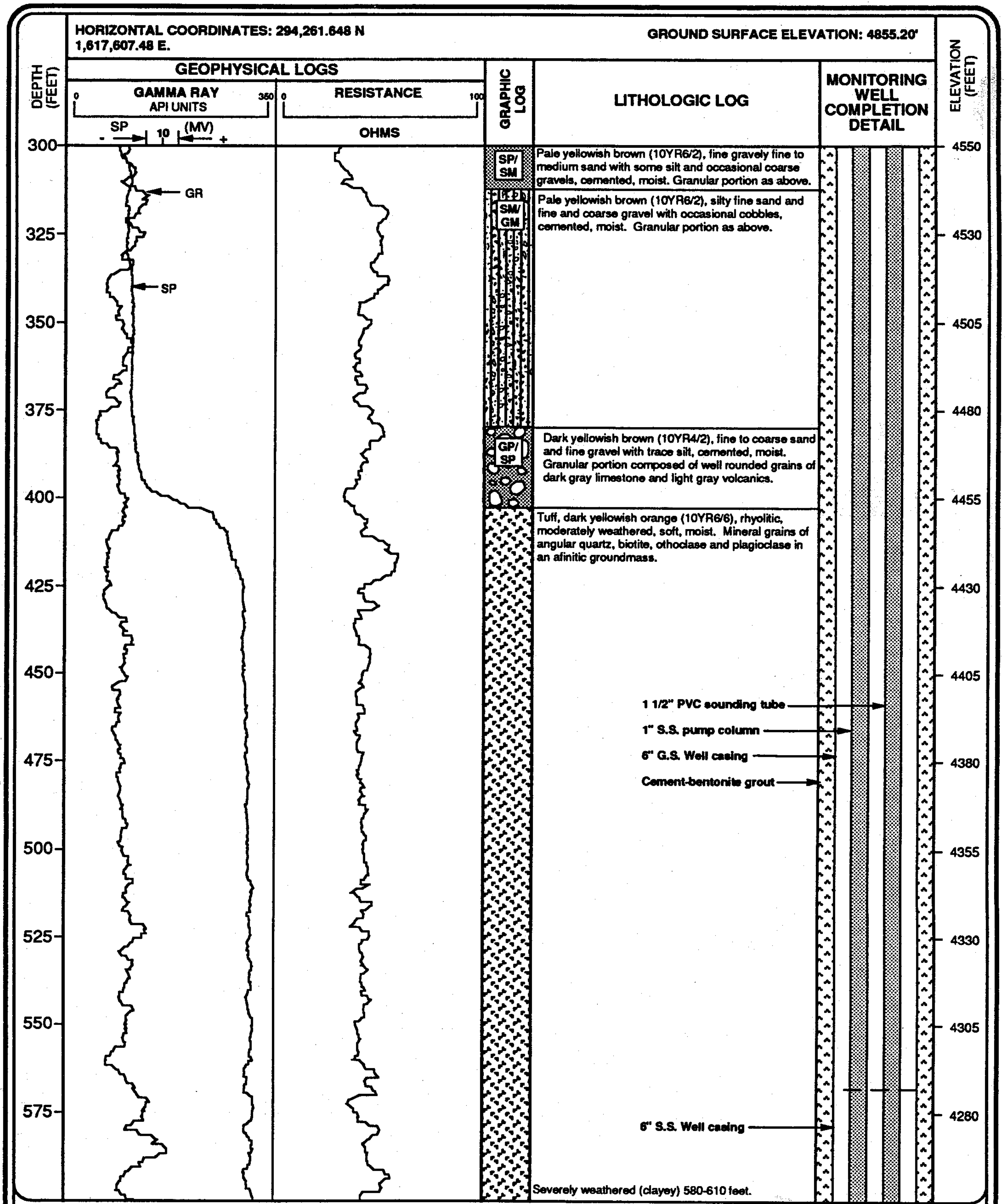
JMM James M. Montgomery
Consulting Engineers Inc.

At Sedal Pass

MONITORING WELL
JMM-TTU-1

FIGURE 2-1

PROJECT NO. 2208.0241



PROJECT NO. 2208.0241

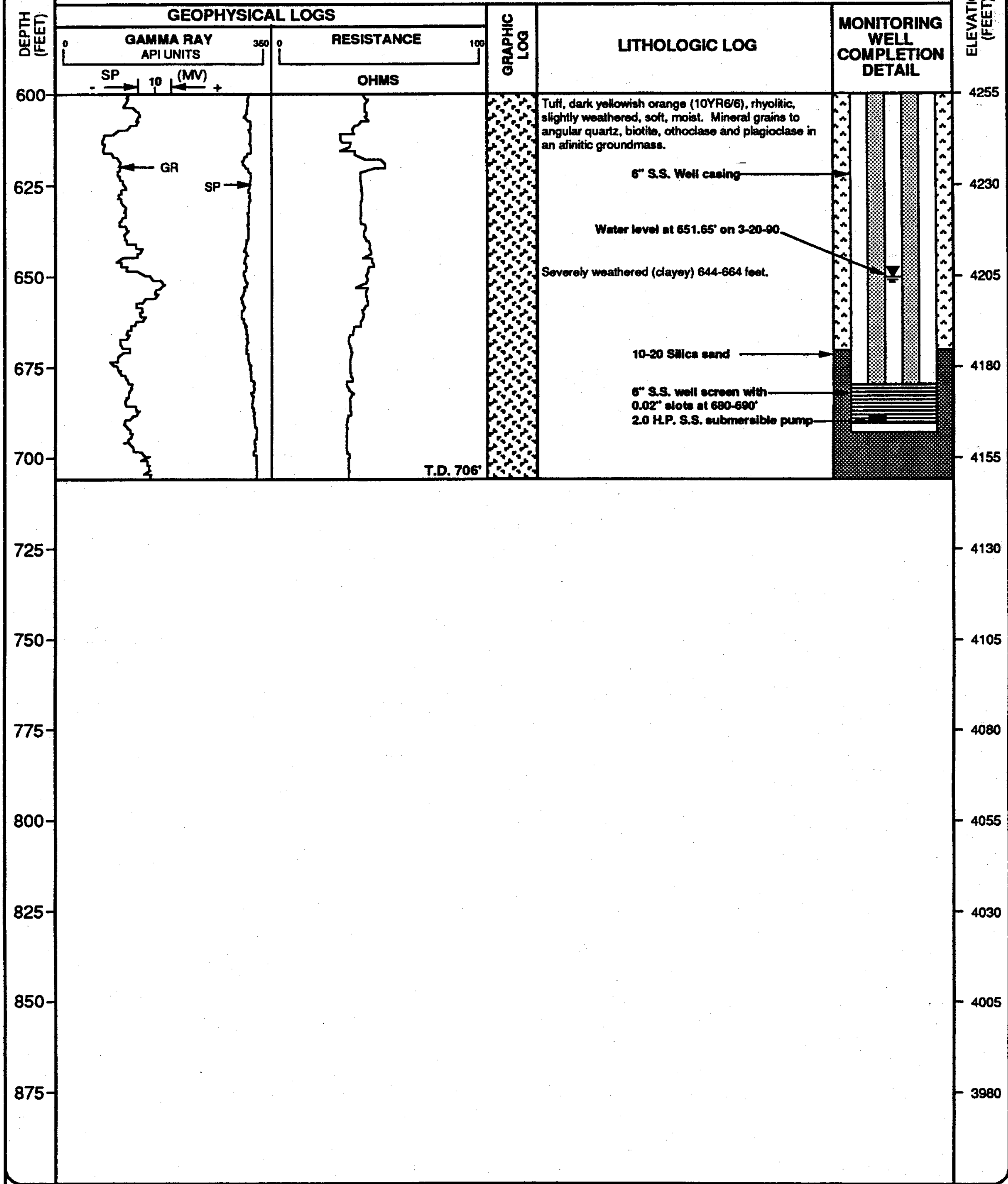
JMM James M. Montgomery
Consulting Engineers Inc.

MONITORING WELL
JMM-TTU-1

FIGURE 2-1

HORIZONTAL COORDINATES: 294,261.648 N
1,617,607.048 E.

GROUND SURFACE ELEVATION: 4855.20'

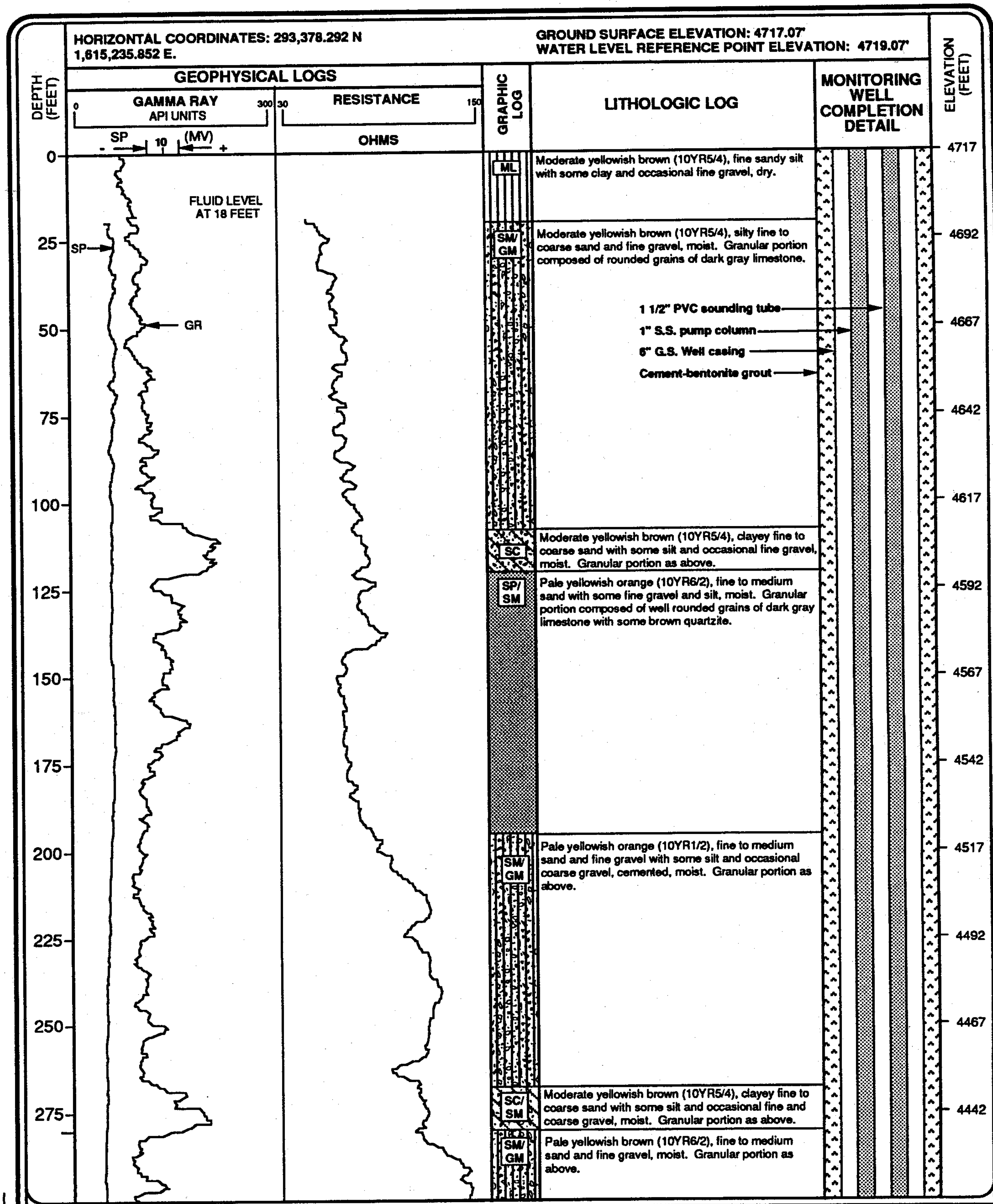


PROJECT NO. 2208.0241

JMM James M. Montgomery
Consulting Engineers Inc.

MONITORING WELL
JMM-TTU-1

FIGURE 2-1



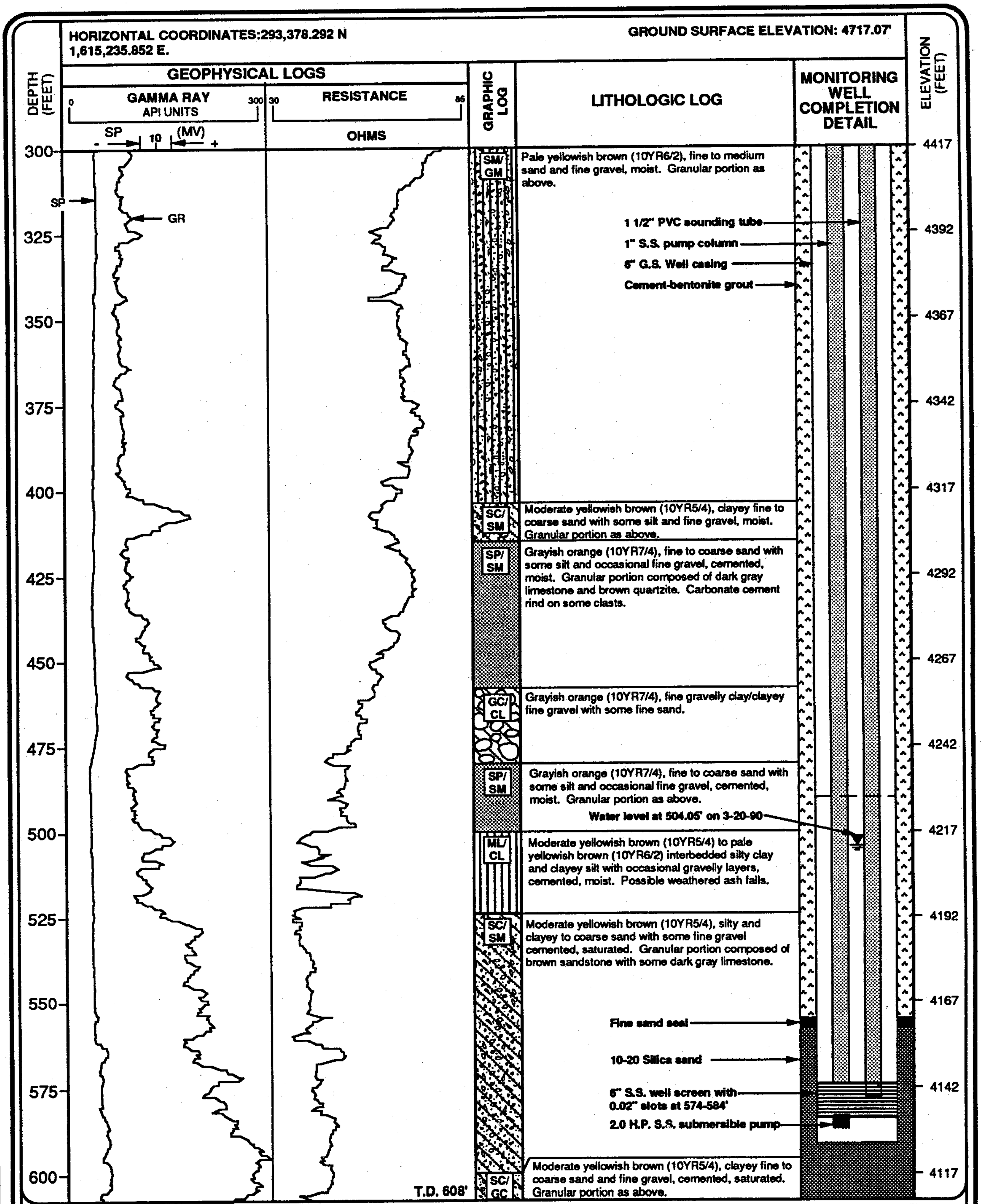
PROJECT NO. 2208.0241

JMM James M. Montgomery
Consulting Engineers Inc.

Below TTU

MONITORING WELL
JMM-TTU-2

FIGURE 2-2



JMM James M. Montgomery
Consulting Engineers Inc.

MONITORING WELL
JMM-TTU-2

FIGURE 2-2

PROJECT NO. 2208.0241

APPENDIX C

Vadose Zone Travel Time Calculation

Attachment 1

TIME OF TRAVEL (TOT) IN THE VADOSE ZONE

An analytical solution was used to calculate travel time for soil moisture movement through the unsaturated zone at Landfill No. 5. The solution used is presented in the U.S.EPA guidance document entitled "Criteria for Identifying Areas of Vulnerable Hydrogeology Under the Resource Conservation and Recovery Act, Appendix C--Technical Methods for Calculating Time of Travel in the Unsaturated Zone."

The basis for choosing this method is that it provides a relatively simple and cost effective analytical solution for flow through the vadose zone. The solution assumes that soils are homogeneous in composition and that soil water movement is predominantly controlled by gravity such that the hydraulic gradent = 1. Neither of these assumptions is perfectly valid at the site; however, solutions that account for heterogeneous soils and water flow under capillary forces lead to longer estimates of travel time. Thus, the solution that is presented gives a conservative estimate (faster travel time) for the time required for soil moisture (contaminants) to reach the uppermost aquifer.

Computer models were not used to calculate TOT because 1) detailed soils information for the entire 400 foot thick vadose zone was not available for input to the model, and 2) the time and cost of calibrating and simulating the problem could not be justified based on limited amount of soils information available.

Soil samples were obtained from the shallow vadose zone (approximately 500 feet deep) in December 1987. The samples were analyzed for their saturated and unsaturated hydraulic properties. Three soil samples were chosen to represent the type of soil encountered during drilling from the base of the landfill to the top of the aquifer. Geologic materials over the 400+ foot vadose zone can vary greatly in composition, but generally consist of interbeds of gravel and sand containing variable amounts of silt. The three representative soil samples used in TOT calculations all contain mixtures of gravel, sand, and silt.

All soil samples obtained from the shallow vadose zone borings at the site were from the upper unconsolidated portion at depths less than 50 feet. Based on geologic logs from drilling, portions of the lower vadose zone are partially consolidated (cemented) and therefore permeabilities may decrease somewhat with depth. Soil samples have not been obtained from the lower portion of the vadose zone. However, soils with lower permeabilities would lead to estimates of longer travel times.

The length of travel used in the TOT calculation is 400 feet. Travel length is based on the average depth to the top of the aquifer in the vicinity of the landfill of 420 feet, minus the 20 foot depth to the excavated bottom of the landfill cells. The depth to the aquifer is about 30 feet greater than the depth to water due to the confined nature of the aquifer. The low permeability of the confining unit was not considered in calculating TOT.

Additional assumptions used by this solution are that a constant water recharge rate of 1 inch per year is being supplied to the system and that contaminants move at the same rate as soil moisture (water) through the system. The steady recharge rate of 1 inch per year was estimated using the HELP model (see Appendix M, Landfill No. 5 Closure/Post-Closure Plan). Results from the HELP model indicated that between 2 and 10 percent of the annual precipitation is able to infiltrate beneath the evaporative soil zone at the site. Annual precipitation at the site is estimated to be 10 inches, therefore, a long term steady recharge rate of 1 inch/year was assumed as a worst case. The assumption of contaminants moving at the same rate as soil moisture is conservative since most contaminants are generally retarded (slowed) relative to water movement. Contaminant movement is generally retarded by absorption onto soil particles and by biodegradation.

Calculation sheets are attached showing the method used to determine the TOT. Table 1 summarizes input data and predicted travel times. Results of the analyses for the 3 soil samples indicate TOT estimates of 1,288, 1,298, and 1,422 years. The three estimates are in very good agreement and indicate the TOT at the site, under the assumptions used, is on the order of 1,000 years. In conclusion, the landfill is located in a arid area where minimal contaminant migration is expected to occur.

SLC120/170

Table 1
SUMMARY OF PHYSICAL PROPERTIES OF SOILS
CONTAINING SAND AND GRAVEL AND
PREDICTED TRAVEL TIMES
UTTR LANDFILL NO. 5

Sample Designation	K_{sat} (cm/sec)	Saturated Moisture Content (vol./vol.)	-b	M m=1/2b+3	Predicted Travel Time (years)
B1-#7	$9.3x10^{-5}$	0.456	4.7	0.0806	1,298
B1-#8	$1.6x10^{-4}$	0.419	5.3	0.0735	1,288
B4-#1	$3.7x10^{-6}$	0.406	7.1	0.0581	1,422

SLC119/d.503

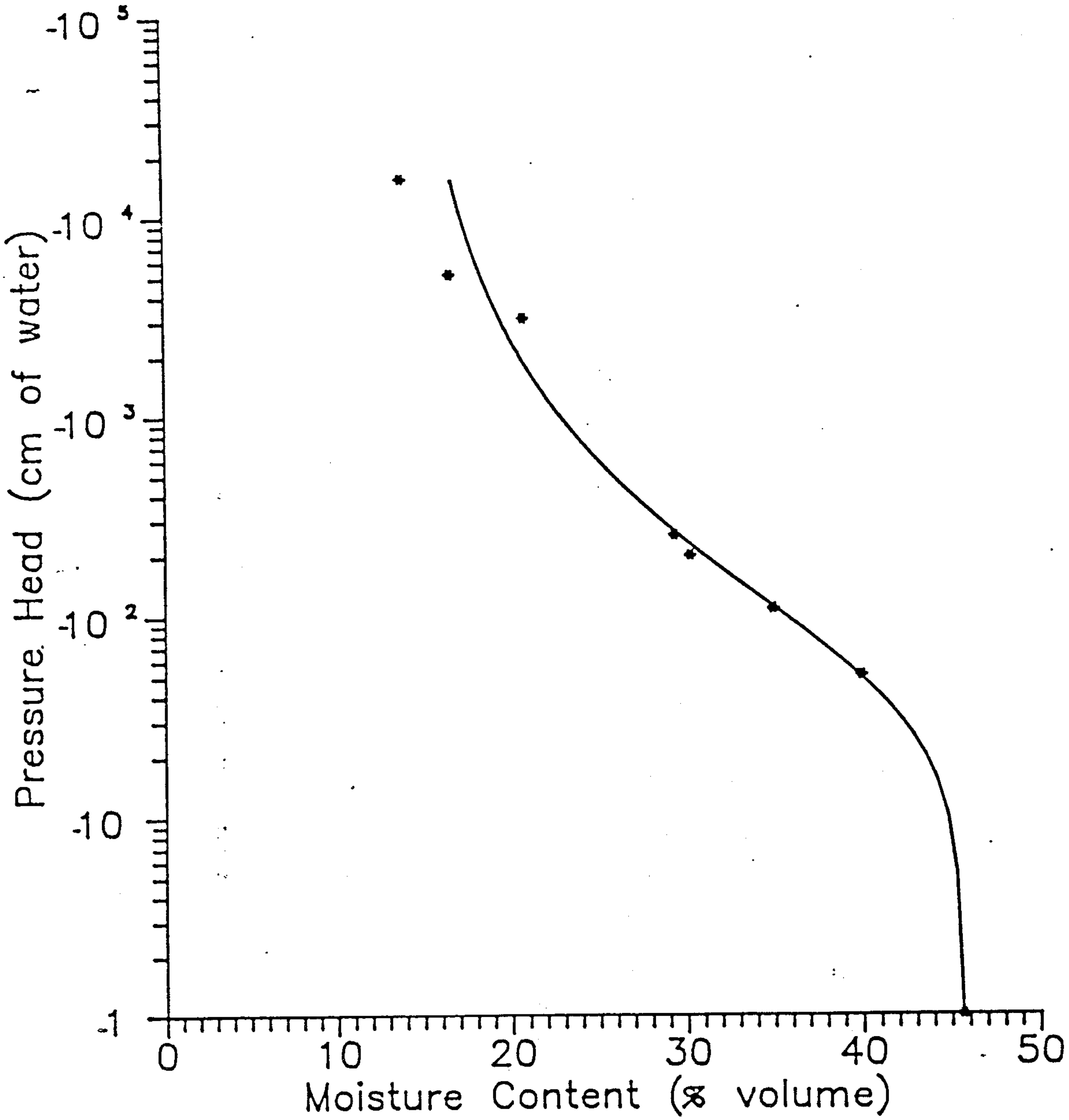


FIGURE NUMBER:	Pressure Head (cm of water) vs Moisture Content (% volume) Sample No B1-7			
FOR: CH2M-HILL-HILLAFB-01	PROJECT NO: 88-L-010	DATE: 2/23/88	PLOTTED BY: SLS	CHECKED BY: WBC

DANIEL B. STEPHENS & ASSOCIATES, INC.

CH2M HILL

SUBJECT Time of Travel Calculation for Vadose Zone at Landfill No. 5 BY Chris Mitch DATE 6/19/90

SHEET 2 OF

PROJECT NO. B19376.C0

Estimated Time of Travel using Sample B1-#7.

Step 1 - Calculate m

$$m = \frac{1}{2b+3} = \frac{1}{2(5.3)+3} = \underline{\underline{0.0735}}$$

Step 2 - Calculate steady-state moisture content (θ).

$$\theta = \left(\frac{q}{K_{sat}}\right)^{m} \theta_{sat} = \left(\frac{8.1 \times 10^{-8}\ cm/sec}{9.3 \times 10^{-5}\ cm/sec}\right)^{0.0735} \times 0.456 \left(vol/vol\right) =$$

$$\underline{\underline{\theta = 0.272}} \left(vol/vol.\right)$$

Step 3 - Calculate Travel Time (T)

$$T = \frac{L\theta}{q} = \frac{(12{,}192\ cm)(0.272\ vol/vol)}{(8.1 \times 10^{-8}\ cm/sec)} = 4.094 \times 10^{10}\ sec.$$

$$\underline{\underline{T = 1{,}298\ years}}$$

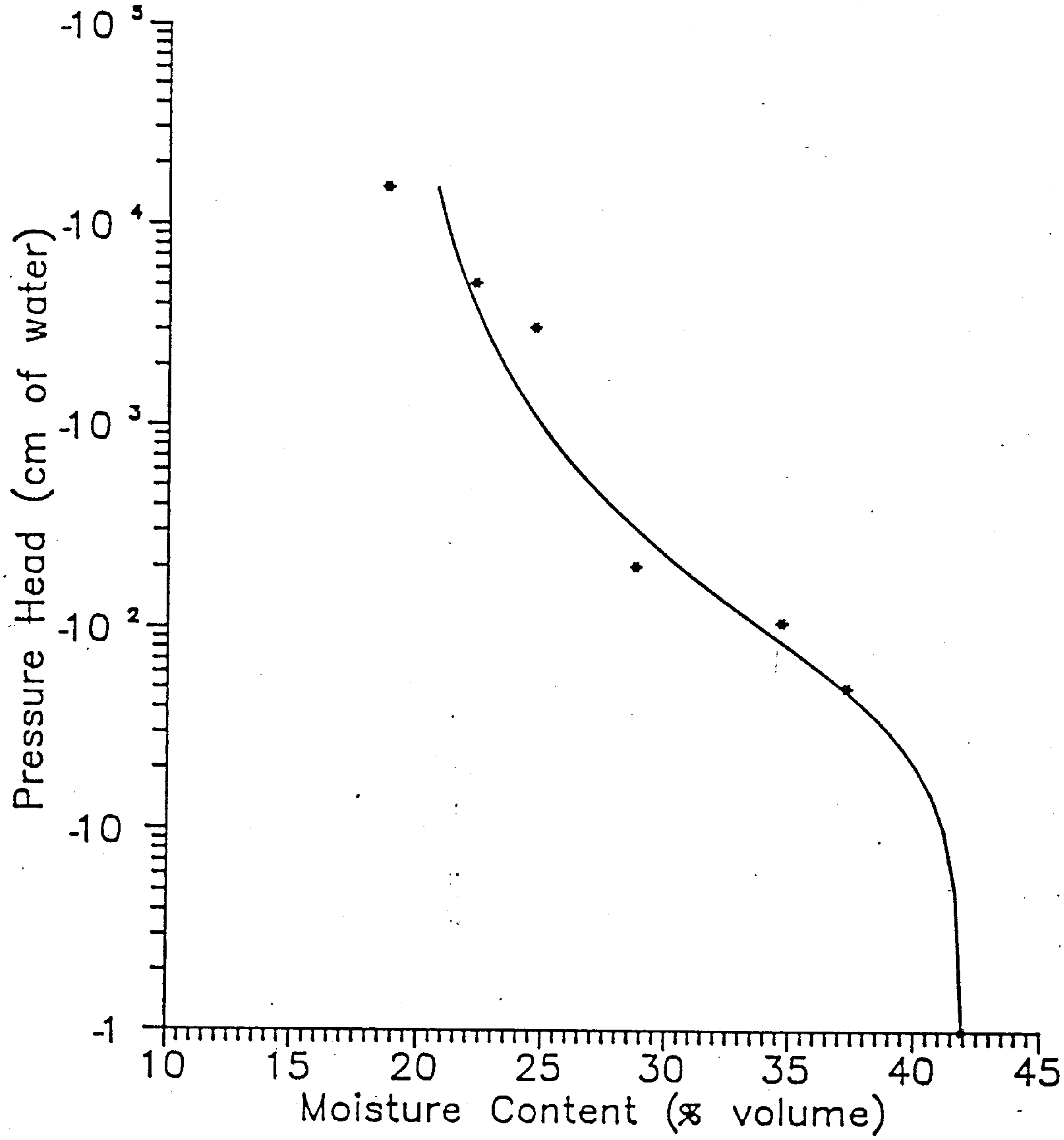


FIGURE NUMBER:	Pressure Head (cm of water) vs Moisture Content (% volume) Sample No B1-8				DANIEL B. STEPHENS & ASSOCIATES, INC.
FOR: CH2M-HILL-HILLAFB-01	PROJECT NO: 88-L-010	DATE: 2/23/88	PLOTTED BY: SLS	CHECKED BY: WBC	

SUBJECT Time of Travel Calculation for Vadose Zone at Landfill No. 5

BY Chris Mikell DATE 6/14/88

SHEET 3 OF

PROJECT NO. B19376.60.09

Estimated Time of Travel using Sample B1-#8

Step 1 - Calculate m

$$m = \frac{1}{2b+3} = \frac{1}{2(7.1)+3} = \underline{\underline{0.0581}}$$

Step 2 - Calculate steady-state moisture content (θ)

$$\theta = \left(\frac{q}{K_{sat}}\right)^m \theta_{sat} = \left(\frac{8.1 \times 10^{-8}\ cm/sec}{1.6 \times 10^{-4}\ cm/sec}\right)^{0.0581} \times 0.419 =$$

$$\underline{\underline{\theta = 0.270\ (vol./vol.)}}$$

Step 3 - Calculate Travel Time (T)

$$T = \frac{L\,\theta}{q} = \frac{(12{,}192\ cm)(0.270\ vol./vol.)}{8.1 \times 10^{-8}\ cm/sec} = 4.064 \times 10^{10}\ sec$$

$$\underline{\underline{T = 1{,}288\ years}}$$

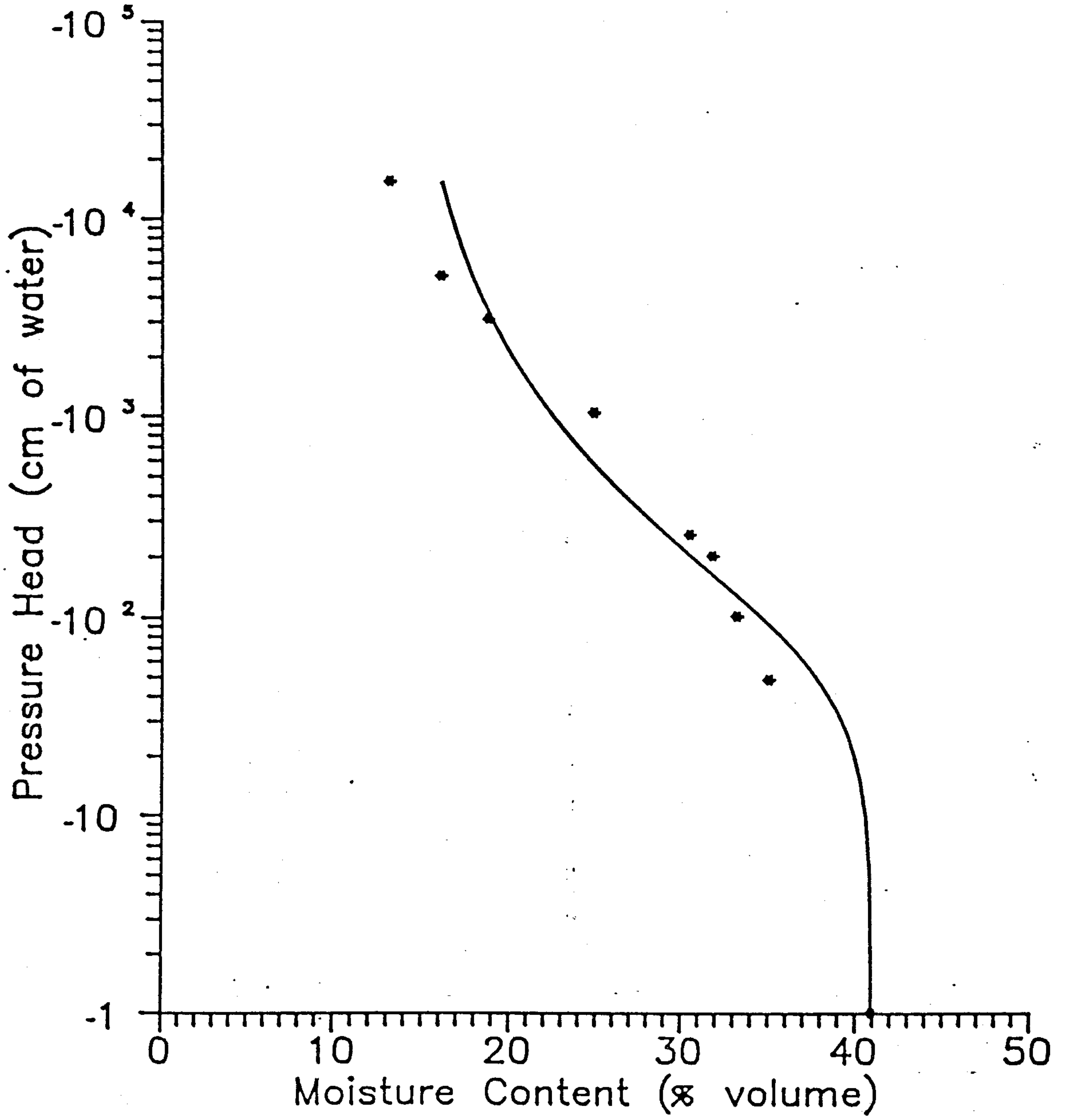


FIGURE NUMBER:	Pressure Head (cm of water) vs Moisture Content (% volume) Sample No B4-1				DANIEL B. STEPHENS & ASSOCIATES, INC.
FOR: CH2M-HILL-HILLAFB-01	PROJECT NO: 88-L-010	DATE: 2/23/88	PLOTTED BY: SLS	CHECKED BY: WBC	

Estimated Time of Travel using Sample B4-#1

Step 1 - Calculate m

$$m = \frac{1}{2b+3} = \frac{1}{2(4.7)+3} = 0.0806$$

Step 2 - Calculate steady-state moisture content (θ)

$$\theta = \left(\frac{q}{K_{sat}}\right)^m \theta_{sat} = \left(\frac{8.1 \times 10^{-8} \text{ cm/sec}}{3.7 \times 10^{-6} \text{ cm/sec}}\right)^{0.0806} \times 0.406 =$$

$$\theta = 0.298 \left(\text{vol/vol}\right)$$

Step 3 - Calculate Travel Time (T)

$$T = \frac{L\,\theta}{q} = \frac{(12{,}192 \text{ cm})(0.298 \text{ vol/vol.})}{8.1 \times 10^{-8} \text{ cm/sec}} = 4.485 \times 10^{10} \text{ sec}$$

$$T = 1{,}422 \text{ years}$$

APPENDIX D

Sampling Procedure Manual

SAMPLING PROCEDURES

HAFB will employ sampling procedures designed to collect the most representative sample possible from the uppermost aquifer under the site. Proper sampling procedures include the following elements:

- Sample collection
- Sample preservation and handling
- Chain-of-custody control
- Analytical procedures
- Field and laboratory QA/QC

Prior to purging or sampling the well, the elevation of the groundwater will be determined. The well cap will be unlocked and removed. An electric tape water-level measuring device will be used to determine the depth to groundwater. Dedicated water level probes will be used whenever possible. If any change in probes occurs, it will be noted in the sample log book. Prior to lowering the probe down the well, the end of the probe that will contact the water will be rinsed with distilled water. Each well will be equipped with an access port on top of the casing cap. The probe will be lowered through this access port and down a 3/4-inch PVC pipe that extends down to groundwater. This pipe is designed to prevent the probe from becoming tangled in the dedicated pumping equipment in the wells. Once the depth to groundwater is determined, the probe will be removed from the well and the end of the probe will again be rinsed with distilled water. Groundwater elevations will be measured to the nearest 0.1 foot.

The well elevation relative to mean sea level has been related to a fixed reference point on the well casing. When the water table map is reevaluated annually, the measured water levels will be converted to elevations and used in this determination.

The detection monitoring wells will be equipped with dedicated pumps for purging. Pumps installed will be Grundfos all-stainless-steel submersible pumps, or equivalent. The pumps will be set in the center of the well screen in each well. Three well volumes will be evacuated to purge the well prior to obtaining water samples. The volume of the well will be estimated from the highest water-level measurement on record for that well. The amount of time necessary to purge three well volumes will be dependent on the maximum well volume and the sustainable yield for each well.

Purge water will be stored in 55-gallon drums or other suitable containers. The results from the sample analysis will be used to determine the appropriate method for disposal of the purge water.

After well purging, the sample containers used for volatile constituents will be filled first. These samples will be collected so as to prevent loss of the constituent during the sample collection process. The pumping rate will be throttled back so a slow, steady, non-aerated stream of water is available for filling sample containers.

Samples are to be collected semi annually. New wells will be sampled quarterly for the first year after they are completed. During the first year of quarterly sampling, it will be necessary to collect replicate water samples at each well to establish background water quality data. The replicate sample will be collected directly from the pump discharge by filling each bottle one-fourth of the way full, rotating between bottles until all are filled.

Three parameters, temperature, pH, and specific conductivity will be measured in the field on the initial pump discharge and each one-half casing volume thereafter. Water for these determinations will be collected in pre-rinsed one-liter bottles. An aliquot of this water will be used for each determination. Discarded aliquots will be stored and disposed of in the same manner as purge water

Normal laboratory procedures will be followed in measuring these parameters. All meters will be allowed to warm up before being used. The pH meter will be standardized with pH 7 to 10 buffers. The meter will also be corrected for temperature before the pH is read. The pH standardization will be determined repeatedly until the reading agrees within 0.1 pH unit.

The conductivity meter will be calibrated with 0.01 N KC1 before use. The temperature of the sample will be measured as soon as it is collected.

Sample Preservation and Handling.

Sample containers and preservatives required for the sampling event will be provided by the contract laboratory. All sample bottle preconditioning, such as baking or acid washing, will be done by the contract laboratory. The type of sample containers and preservation techniques used will follow EPA's RCRA Groundwater QA/QC Compliance Checklist. and applicable portions of SW-846. Sample bottle, sample holding times preservation techniques and analytical methods may change as new procedures are developed and approved.

All samples will be preserved in the field. The sampling procedures described above will be consistent throughout the sampling program. In addition to the well samples, the sampling will also include the use of field blanks and trip blanks. These are discussed later in the QA/QC portion of this section.

Chain-of-Custody Control.

The groundwater monitoring program will include chain-of-custody control to ensure against contamination of samples. HAFB will use chain-of-custody record forms that are equivalent to the EPA Office of Enforcement chain-of-custody forms and the chain-of-custody form found in SW-846.

The sequence of events for controlling chain of custody will be as follows. When the sample bottles are delivered from the laboratory, the sender and receiver both sign and date the chain-of-custody form and specify on the form what has changed hands. From that point on, every time the sample bottles, whether empty or full, change hands, both parties sign and date the transfer. When sample bottles are delivered to the laboratory, a copy of the chain-of-custody form will be retained for HAFB files.

The following information is included:

- Sample number
- Signature of sampler
- Date of collection (time logged in field log book)
- Place and address of collection
- Type of sample
- Number and type of container
- Inclusive dates of possession
- Signature of receiver

In addition to the chain-of-custody form, other components of chain-of-custody will include sample labels, sample seals, field log book, sample analysis request sheet, and the laboratory log book.

1. Sample Label. A sample label will be affixed to each sample bottle to provide the sample number.

2. Sample Seals. A seal will be affixed to each sample shipping container (not each bottle). This seal will have a serial number that corresponds to the number on the chain-of-custody form for that container. The seal will be secured to the locking mechanism or lid of the shipping container immediately after sampling and will be broken at the laboratory under chain-of-custody procedures.

3. Field Logbook. A bound field log book will be kept for each sampling event. A copy of the field log book will be kept at HAFB and will be available for inspection. The format for the field log book includes:

   - Facility name and address

   - Name and signature of sample collector

- Purpose of sample and type (for example, required analyses for initial background data, routine detection monitoring, and resampling)

- Location(s) or source of sampling (such as the monitoring well number)

- Time and date of sampling

- Pertinent well data (such as depth, water surface elevation, pumping schedule, and method)

- Sampling method (for example, submersible pump, bladder pump)

- Log number of each sample

- Appearance of each sample (such as color, turbidity, sediment, and oil on surface)

- Field observations / sampling conditions (such as weather)

- Sample temperature upon sampling

- Air temperature upon sampling

- Analyses performed in the field

- pH

- Specific conductance

- Others

- Sample storage, location and conditions (such as heat and light; and number of sample seals)

- Name and location of laboratory performing analyses

4. Sample Analysis Request Sheets. Analysis request sheets will be provided to the laboratory, with a copy kept with the field log book.

5. Laboratory Log Book. Laboratory control records will be attached to the chain-of-custody form and a copy is retained at the facility.

Once all of the samples are collected, prepared, and the chain-of-custody forms are filled out, the samples will be prepared for shipment. The sample containers will be packed with appropriate cushioning material. The chain-of-custody forms will be packed inside the shipping containers. Frozen blue ice or similar material will also be placed in the containers to keep the samples cold. The shuttle lids will then be secured and sealed with a chain-of-custody tag. The containers will then be shipped to the contract laboratory in a timely manner to insure holding times are not exceeded.

Upon receipt of the samples the laboratory will check the shipment. Any shuttles that have broken or missing chain-of-custody tags will be noted and reported to the facility contact. The following procedures will then be followed:

- o The sample and seal information will be checked to ensure that they match the chain-of-custody record.
- o The chain-of-custody record will be checked for a signature.
- o The request of analysis will be checked to determine the analyses requested.
- o A laboratory sample number will be assigned.
- o The sample will then be stored in a secure area to await analysis.

The analytical procedures for groundwater quality analyses will be identical to procedures outlined in EPA Document SW-846. Detection limits will equal or exceed (be lower than) detection limits reported in SW-846.

Quality Assurance / Quality Control

The objective of quality assurance and quality control is to assure that groundwater analytical results truly represent groundwater chemical and physical composition. Overall quality assurance will be the responsibility of the HAFB sampling manager. Actual coordination of QA/QC activities will be through the HAFB contractor for sampling and the analytical laboratories.

Components of the QA/QC program are as follows:

- o Laboratory: The analytical laboratory will provide all shipping containers, sampling containers and preservatives, chain-of-custody forms, labels, and seals. A full laboratory QA/QC report will accompany each data report and will be kept on file at HAFB.
- o Sample Collection: Sampling personnel under the supervision of the HAFB facility manager will conduct all QA/QC procedures. A standardized field log book will be kept for each sampling event following the format described in the preceding chain-of-custody section. It will include all label and seal numbers and documentation of all QA/QC procedures related to sample collection. It will be

standard procedure to include field, lab, and trip blanks, and blind and spiked samples in each sampling event for appropriate parameters.

- Field Blanks. Field blanks will consist of a separate set of sample containers, preservatives, and chain-of-custody forms. The containers will be opened during routine sampling and sealed upon completion of sampling. The water in the containers (ultra-pure water provided by the laboratory) will have been exposed to ambient conditions to which the groundwater samples were subjected. Field blanks will be used to assess the potential for externally introduced error factors during the sampling event.

- Trip Blanks. Trip blanks will accompany each sealed sample container. They will be analyzed for volatiles to assess the level of potential contamination that may have occurred during sample transport.

- Lab Blanks. Analysis of the water used to prepare the field and trip blank containers will be completed. This water has never left the laboratory. Lab blank data are used to establish the baseline quality of water used in all of the QA/QC blanks.

o QA/QC of Raw Data: Another important component of the QA/OC program is the evaluation of the analytical data as reported by the analytical laboratory. The raw data as reported will be reviewed to make sure that it is correct and accurately reported.

Trend line graphs will be prepared for all wells for indicator parameters and other chemical constituents at the discretion of HAFB. The issue of outliers will be evaluated using trend line graphical procedures.

Additional QA/QC data evaluation procedures will be routinely performed and documented in the facility files as needed. These activities include review of all aspects of sampling, analysis, and data reporting.

Statistical Analysis

For Class 1 parameters, positive confirmation of contaminant presence will be confirmed when three consecutive samples exceed the practical quantitation level (PQL) established for that method and analyte.

When sufficient data has been collected and evaluated, a statistical method will be proposed for Class 1 and Class 2 parameters.

Record Keeping and Reporting

The record keeping and reporting requirements as specified by UHWMR 7.3.5 will be met. In summary, these requirements are:

1. Maintain water chemistry and groundwater elevations data throughout the closure post closure period.

2. Semiannually prepare and submit to the Executive Secretary a Groundwater Sampling Report describing the results of each round of groundwater sampling required by the Post-Closure Permit. This report will evaluate water chemistry, water level elevations, and any maintenance required to keep the groundwater monitoring system fully operational. Maintain this report in the files.

3. Annually prepare and submit a summary report to the Executive Secretary evaluating direction of groundwater flow in the vicinity of Landfill #5. Maintain this report in the files.

APPENDIX E

Analytical Results

Project #	Project Name	Cost Code

Use black ink only
Print except where designated

TRACKING RECORD

State of Utah
Department of Health
Division of Laboratory Services
46 North Medical Drive
Salt Lake City, Utah 84113-1105 (801) 584-8400

Sampler Signature: Bronson W. Hawley

Person to Address Report / Questions To: Bronson W. Hawley

Agency: DEQ DSHW

Street:

Cty,St,Zip: Phone: 538-6945

Field ID#	Date	Time	Type	Location	8260	8270	METALS	Perchlorate	Chloride	Sulfate	Minerals Ca+/Mg+/K+/Na	TDS		Tamper Evident Seal Intact (Y or N)	Comments	DLS Sample Number
Well G	4-8-98	10:55a	Liq	3 bottles VOA	X											9802507
Well G	4-8-98	10:55a	Liq	5 bottles			X	X	X	X	X	X				|
TTU-2	4-8-98	5:05p	Liq	5 bottles			X	X	X	X	X	Y				9802508

DLS USE ONLY

Use this space for comments:

Please report FREON 113 w/8260 analysis

Important: Use Signatures Below This Point

Dispatched By: (For Mailing/Shipping)	Date	Time	Courier Company Name	Invoice/Airbill #	
Relinquished By: (For Transfer to Intermediate Custodian)	Date	Time	Recieved By:	Date	Time
Relinquinshed to DLS By: (For Transfer to Lab by Hand)	Date	Time	Recieved for DLS By:	Date	Time

\tcl\coc-9408.rc Revised February 1996 Expires February 1997

Type Codes: 04 Grab 30 Sludge 40 Sediment 50 Soil C Composite

EPA Method P/T/8260/(GC/MS)
GC/MS Purgeables

Lab No: 98-2507

Send Report To:	Bronson Hawley
Name or Agency:	UDEQ/DSHW
Address:	288 North 1460 West
City, State,Zip:	Salt Lake, Utah 84114
Phone #:	

Utah Division of Laboratory Services
46 N. Medical Drive
Salt Lake City, Utah 84113
(801-584-8400)

Field #		Matrix:	Water	Cost Code:	365
Collected By:	BH	Date coll'd:	4/8/98	Time col'ed:	
Description:	Well G				
Analyst:	JO	Dat Rc'd:	10-Apr	Date Exted:	
Aliquot Purged:	1 ml	F E Vol:		Date Analed:	15-Apr

2

Name	MDL/Results ug/L		Name	MDL/Results ug/L	
1,1-Dichloropropene	1	U	Vinyl Chloride	1	U
1,1-Dichloroethane	1	U	Benzene	1	U
1,1,1,2-Tetrachloroethane	1	U	Carbon Tetrachloride	1	U
1,1,2-Trichloroethane	1	U	1,2-Dichloroethane	1	U
1,1,2,2-Tetrachloroethane	1	U	Trichloroethylene	1	U
1,2-Dichloropropane	1	U	1,1-Dichloroethylene	1	U
1,2,3-Trichloropropane	1	U	p-Dichlorobenzene	1	U
1,3-Dichloropropane	1	U	1,1,1-Trichloroethane	1	U
1,1-Dichloropropene C/T	1	U	Ethylene dibromide (EDB)	1	U
2,2-Dichloropropane	1	U	1,2-Dibromo-3-Chloropropane	1	U
Bromobenzene	1	U	1,2,3-Trichlorobenzene	1	U
Bromodichloromethane	1	U	1,2,4-Trichlorobenzene	1	U
Bromoform	1	U	1,2,4-Trimethylbenzene	1	U
Bromomethane	1	U	1,3,5-Trimethylbenzene	1	U
Chlorobenzene	1	U	Bromochloromethane	1	U
Chlorodibromomethane	1	U	n-Butylbenzene	1	U
Chloroethane	1	U	Dichlorodifluoromethane	1	U
Chloroform	1	U	Fluorotrichloromethane	1	U
Chloromethane	1	U	Hexachlorobutadiene	1	U
cis-1,2-Dichloroethylene	1	U	Isopropylbenzene	1	U
Dibromomethane	1	U	p-Isopropyltoluene	1	U
Dichloromethane	1	U	Napthalene	1	U
Ethylbenzene	1	U	n-Propylbenzene	1	U
m-Dichlorobenzene	1	U	sec-Butylbenzene	1	U
m-Xylene & p-Xylene	1	U	tert-Butylbenzene	1	U
o-Chlorotoluene	1	U			
o-Dichlorobenzene	1	U			
o-Xylene	1	U	Tentatively Identified Compounds		
p-Chlorotoluene	1	U			
Styrene	1	U	Freon 113	1	U
Tetrachloroethylene	1	U			
Toluene	1	U			
trans-1,2-Dichloroethylene	1	U			

U-Analyzed for but not detected.
B-Found in the blank

J-An estimated value

Analysis Certified by: ______ Date: 4/27

TRACKING RECORD

Use black ink only
Print except where designated

State of Utah
Department of Health
Division of Laboratory Services
46 North Medical Drive
Salt Lake City, Utah 84113-1105 (801) 584-8400

Project # / Project Name / Cost Code	
Sampler Signature	Bronson W. Hawley
Person to Address Report / Questions To:	Bronson Hawley
Agency: DEQ	DSHW
Street:	
Cty,St,Zip:	Phone: 538-6945

Field ID#	Date	Time	Type	Location	8260	8270	METALS	Perchlorate	Chloride	Sulfate	Minerals Ca+/Mg+/K+/Na	TDS		Tamper Evident Seal Intact (Y or N)	Comments	DLS Sample Number
Well-H	4-6-98	11:50a	Liq	3 bottles (VOA)	X											9802424
Well-J1	4-6-98	2:28p	Liq	3 bottles (VOA)	X											9802425
TTU-1	4-7-98	10:05a	Liq	5 bottles			X	X	X	X	X	X				9802426
Well-I	4-7-98	12:12p	Liq	3 bottles (VOA)	X											9802427

DLS USE ONLY

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Relinquinshed to DLS By: (For Transfer to Lab by Hand)	Date	Time	Recieved for DLS By:	Date	Time

\tcl\coc-9408.rc   Revised February 1996   Expires February 1997

Type Codes: 04 Grab   30 Sludge   40 Sediment   50 Soil   C Composite

UTAH STATE DEPARTMENT OF HEALTH
DIVISION OF LABORATORY SERVICES
Environmental Chemistry Analysis Report

UDEQ - DSHW
ATTN: Bronson W. Hawley
288 N 1460 W
PO BOX 144880
SLC UT 84114-4880 801-538-6170

Lab Number: 9802508 Sample Type: 04 Cost Code: 365
Description: TTU-2

Site ID:	Source No: 00	Organic Review:	
Sample Date: 04/08/98	Time: 17:05	Inorganic Review:	05/11/98
		Radiochemistry Review:	
		Microbiology Review:	

Tot. Cations:	553 mg/l	26.4 me/l
Tot. Anions:	871 mg/l	23.7 me/l
Grand Total:	1424 mg/l	%D = 5.4

TEST RESULTS:

D-Calcium	116 mg/l	D-Magnesum	56.8 mg/l
D-Potassum	35.4 mg/l	D-Sodium	345.0 mg/l
Chloride	750 mg/l	Sulfate	121.03 mg/l
TDS @ 180C	1786 mg/l	T-Aluminum	<30 ug/l
T-Arsenic	7.0 ug/l	T-Barium	0.06 mg/l
T-Cadmium	<1 ug/l	T-Chromium	<5.0 ug/l
T-Copper	<12.0 ug/l	T-Iron	0.0551 mg/l
T-Lead	<3.0 ug/l	T-Mangan	<5.0 ug/l
T-Mercury	<0.2 ug/l	T-Selenium	7.0 ug/l
T-Silver	<2.0 ug/l	T-Zinc	75.0 ug/l
Perchlorat	<4 ug/l		

QUALIFYING COMMENTS (*) on test results: NO COMMENTS

END OF REPORT

UTAH STATE DEPARTMENT OF HEALTH
DIVISION OF LABORATORY SERVICES
Environmental Chemistry Analysis Report

UDEQ - DSHW
ATTN: Bronson W. Hawley
288 N 1460 W
PO BOX 144880
SLC UT 84114-4880 801-538-6170

Lab Number: 9802507 Sample Type: 04 Cost Code: 365
Description: WELL G

Site ID: Source No: 00
Sample Date: 04/08/98 Time: 10:55

Tot. Cations:	423 mg/l	19.0 me/l
Tot. Anions:	595 mg/l	16.3 me/l
Grand Total:	1018 mg/l	%D = 7.6

Organic Review: 04/28/98
Inorganic Review: 05/11/98
Radiochemistry Review:
Microbiology Review:

TEST RESULTS:

D-Calcium	27.4 mg/l	D-Magnesum	16 mg/l
D-Potassum	11.9 mg/l	D-Sodium	368.0 mg/l
Chloride	535 mg/l	Sulfate	60.46 mg/l
TDS @ 180C	1166 mg/l	T-Aluminum	4350 ug/l
T-Arsenic	15.5 ug/l	T-Barium	0.12 mg/l
T-Cadmium	<1 ug/l	T-Chromium	7.0 ug/l
T-Copper	15.5 ug/l	T-Iron	2.56 mg/l
T-Lead	17.0 ug/l	T-Mangan	80.0 ug/l
T-Mercury	<0.2 ug/l	T-Selenium	9.5 ug/l
T-Silver	<2.0 ug/l	T-Zinc	115.0 ug/l
Perchlorat	<4 ug/l		

QUALIFYING COMMENTS (*) on test results: NO COMMENTS

END OF REPORT

UTAH STATE DEPARTMENT OF HEALTH
DIVISION OF LABORATORY SERVICES
Environmental Chemistry Analysis Report

UDEQ - DSHW
ATTN: BRONSON HAWLEY
288 N 1460 W
PO BOX 144880
SLC UT 84114-4880 801-538-6170

Lab Number: 9802426 Sample Type: 04 Cost Code: 365
Description: TTU-1

Site ID:	Source No: 00	Organic Review:	
Sample Date: 04/07/98	Time: 10:05	Inorganic Review:	05/14/98
		Radiochemistry Review:	
Tot. Cations: 414 mg/l	18.7 me/l	Microbiology Review:	
Tot. Anions: 162 mg/l	3.4 me/l		
Grand Total: 576 mg/l	%D = 69.2		

TEST RESULTS:

D-Calcium	59.8 mg/l	D-Magnesum	24.8 mg/l
D-Potassum	35.4 mg/l	D-Sodium	294.0 mg/l
Sulfate	161.7 mg/l	TDS @ 180C	1184 mg/l
ChlorideIC	425.0 mg/l	Perchlorat	<4 ug/l

QUALIFYING COMMENTS (*) on test results: NO COMMENTS

END OF REPORT

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State of Utah
Department of Health
Division of Laboratory Services
46 North Medical Drive
Salt Lake City, Utah 84113-1105 (801) 584-8400

Project #	Project Name	Cost Code
Sampler Signature	Bronson W. Hawley
Person to Address Report / Questions To:	Bronson Hawley
Agency: DEQ	DSHW
Street:	
Cty,St,Zip:	Phone: 538-6945

Field ID#	Date	Time	Type	Location	8260	8270	METALS	Perchlorate (total)	Chloride	Sulfate	Minerals $Ca^+/Mg^+/K^+/Na$	TDS		Tamper Evident Seal Intact (Y or N)	Comments	DLS Sample Number
Well-H	4-6-98	11:50a	Liq	3 bottles (VOA)	X											9802424
Well-J1	4-6-98	2:28p	Liq	3 bottles (VOA)	X											9802425
TTU-1	4-7-98	10:05a	Liq	5 bottles			X	X	X	X	X	X				9802426
Well-I	4-7-98	12:12p	Liq	3 bottles (VOA)	X											9802427

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Important: Use Signatures Below This Point

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Relinquished By: (For Transfer to Intermediate Custodian)	Date	Time	Recieved By:	Date / Time
Relinquinshed to DLS By: (For Transfer to Lab by Hand)	Date	Time	Recieved for DLS By:	Date / Time

Type Codes
04 Grab 30 Sludge 40 Sediment 50 Soil C Composite

EPA Method P/T/8260/(GC/MS)
GC/MS Purgeables

Lab No: 98-2424

Send Report To: **Bronson Hawley**
Name or Agency: UDEQ/DSHW
Address: 288 North 1460 West
City, State,Zip: Salt Lake, Utah 84114
Phone #:

Utah Division of Laboratory Services
46 N. Medical Drive
Salt Lake City, Utah 84113
(801-584-8400)

Field #:
Matrix: Water
Cost Code: 365
Collected By: BH
Date coll'd: 4/6/98
Time col'ed:
Description: Well H

Analyst: JO
Dat Rc'd: 7-Apr
Date Exted:
Aliquot Purged: 1 ml
F E Vol:
Date Analed: 8-Apr
Dilution Factor: 2

Name	MDL/Results ug/L		Name	MDL/Results ug/L	
1,1-Dichloropropene	1	U	Vinyl Chloride	1	U
1,1-Dichloroethane	1	U	Benzene	1	U
1,1,1,2-Tetrachloroethane	1	U	Carbon Tetrachloride	1	U
1,1,2-Trichloroethane	1	U	1,2-Dichloroethane	1	U
1,1,2,2-Tetrachloroethane	1	U	Trichloroethylene	1	U
1,2-Dichloropropane	1	U	1,1-Dichloroethylene	1	U
1,2,3-Trichloropropane	1	U	p-Dichlorobenzene	1	U
1,3-Dichloropropane	1	U	1,1,1-Trichloroethane	1	U
1,1-Dichloropropene C/T	1	U	Ethylene dibromide (EDB)	1	U
2,2-Dichloropropane	1	U	1,2-Dibromo-3-Chloropropane	1	U
Bromobenzene	1	U	1,2,3-Trichlorobenzene	1	U
Bromodichloromethane	1	U	1,2,4-Trichlorobenzene	1	U
Bromoform	1	U	1,2,4-Trimethylbenzene	1	U
Bromomethane	1	U	1,3,5-Trimethylbenzene	1	U
Chlorobenzene	1	U	Bromochloromethane	1	U
Chlorodibromomethane	1	U	n-Butylbenzene	1	U
Chloroethane	1	U	Dichlorodifluoromethane	1	U
Chloroform	1	U	Fluorotrichloromethane	1	U
Chloromethane	1	U	Hexachlorobutadiene	1	U
cis-1,2-Dichloroethylene	1	U	Isopropylbenzene	1	U
Dibromomethane	1	U	p-Isopropyltoluene	1	U
Dichloromethane	1	U	Napthalene	1	U
Ethylbenzene	1	U	n-Propylbenzene	1	U
m-Dichlorobenzene	1	U	sec-Butylbenzene	1	U
m-Xylene & p-Xylene	1	U	tert-Butylbenzene	1	U
o-Chlorotoluene	1	U			
o-Dichlorobenzene	1	U			
o-Xylene	1	U			
p-Chlorotoluene	1	U			
Styrene	1	U			
Tetrachloroethylene	1	U			
Toluene	1	U			
trans-1,2-Dichloroethylene	1	U			

Tentatively Identified Compounds

Freon 113	0.2	J
Fluorotrimethyl silane	4.2	J
Trimethyl silanol	7.1	J

U-Analyzed for but not detected.
B-Found in the blank

J-An estimated value

Analysis Certified by: r Date: 4/13

EPA Method P/T/8260/(GC/MS)
GC/MS Purgeables

Lab No: 98-2425

Send Report To:	**Bronson Hawley**	**Utah Division of Laboratory Services**
Name or Agency:	UDEQ/DSHW	46 N. Medical Drive
Address:	288 North 1460 West	Salt Lake City, Utah 84113
City, State,Zip:	Salt Lake, Utah 84114	(801-584-8400)
Phone #:		

Field #		Matrix:	Water	Cost Code:	365
Collected By:	BH	Date coll'd:	4/6/98	Time col'ed:	
Description:	Well J1				
Analyst:	JO	Dat Rc'd:	7-Apr	Date Exted:	
Aliquot Purged:	1 ml	F E Vol:		Date Analed:	8-Apr
			Dilution Factor:	2	

Name	**MDL/Results** ug/L		**Name**	**MDL/Results** ug/L	
1,1-Dichloropropene	1	U	Vinyl Chloride	1	U
1,1-Dichloroethane	1	U	Benzene	1	U
1,1,1,2-Tetrachloroethane	1	U	Carbon Tetrachloride	1	U
1,1,2-Trichloroethane	1	U	1,2-Dichloroethane	1	U
1,1,2,2-Tetrachloroethane	1	U	Trichloroethylene	1	U
1,2-Dichloropropane	1	U	1,1-Dichloroethylene	1	U
1,2,3-Trichloropropane	1	U	p-Dichlorobenzene	1	U
1,3-Dichloropropane	1	U	1,1,1-Trichloroethane	1	U
1,1-Dichloropropene C/T	1	U	Ethylene dibromide (EDB)	1	U
2,2-Dichloropropane	1	U	1,2-Dibromo-3-Chloropropane	1	U
Bromobenzene	1	U	1,2,3-Trichlorobenzene	1	U
Bromodichloromethane	1	U	1,2,4-Trichlorobenzene	1	U
Bromoform	1	U	1,2,4-Trimethylbenzene	1	U
Bromomethane	1	U	1,3,5-Trimethylbenzene	1	U
Chlorobenzene	1	U	Bromochloromethane	1	U
Chlorodibromomethane	1	U	n-Butylbenzene	1	U
Chloroethane	1	U	Dichlorodifluoromethane	1	U
Chloroform	1	U	Fluorotrichloromethane	1	U
Chloromethane	1	U	Hexachlorobutadiene	1	U
cis-1,2-Dichloroethylene	1	U	Isopropylbenzene	1	U
Dibromomethane	1	U	p-Isopropyltoluene	1	U
Dichloromethane	1	U	Napthalene	1	U
Ethylbenzene	1	U	n-Propylbenzene	1	U
m-Dichlorobenzene	1	U	sec-Butylbenzene	1	U
m-Xylene & p-Xylene	1	U	tert-Butylbenzene	1	U
o-Chlorotoluene	1	U			
o-Dichlorobenzene	1	U			
o-Xylene	1	U	Tentatively Identified Compounds		
p-Chlorotoluene	1	U			
Styrene	1	U	Freon 113	1	U
Tetrachloroethylene	1	U			
Toluene	1	U			
trans-1,2-Dichloroethylene	1	U			

U-Analyzed for but not detected.
B-Found in the blank

J-An estimated value

Analysis Certified by: rz Date: 4/13

EPA Method P/T/8260/(GC/MS)
GC/MS Purgeables

Lab No: 98-2427

Send Report To: **Bronson Hawley**
Name or Agency: UDEQ/DSHW
Address: 288 North 1460 West
City, State,Zip: Salt Lake, Utah 84114
Phone #:

Utah Division of
Laboratory Services
46 N. Medical Drive
Salt Lake City, Utah 84113
(801-584-8400)

Field #: | Matrix: Water | Cost Code: 365
Collected By: BH | Date coll'd: 4/7/98 | Time col'ed:
Description: Well I

Analyst: JO | Dat Rc'd: 7-Apr | Date Exted:
Aliquot Purged: 1 ml | F E Vol: | Date Analed: 8-Apr
Dilution Factor: 2

Name	MDL/Results ug/L		Name	MDL/Results ug/L	
1,1-Dichloropropene	1	U	Vinyl Chloride	1	U
1,1-Dichloroethane	1	U	Benzene	1	U
1,1,1,2-Tetrachloroethane	1	U	Carbon Tetrachloride	1	U
1,1,2-Trichloroethane	1	U	1,2-Dichloroethane	1	U
1,1,2,2-Tetrachloroethane	1	U	Trichloroethylene	1	U
1,2-Dichloropropane	1	U	1,1-Dichloroethylene	1	U
1,2,3-Trichloropropane	1	U	p-Dichlorobenzene	1	U
1,3-Dichloropropane	1	U	1,1,1-Trichloroethane	1	U
1,1-Dichloropropene C/T	1	U	Ethylene dibromide (EDB)	1	U
2,2-Dichloropropane	1	U	1,2-Dibromo-3-Chloropropane	1	U
Bromobenzene	1	U	1,2,3-Trichlorobenzene	1	U
Bromodichloromethane	1	U	1,2,4-Trichlorobenzene	1	U
Bromoform	1	U	1,2,4-Trimethylbenzene	1	U
Bromomethane	1	U	1,3,5-Trimethylbenzene	1	U
Chlorobenzene	1	U	Bromochloromethane	1	U
Chlorodibromomethane	1	U	n-Butylbenzene	1	U
Chloroethane	1	U	Dichlorodifluoromethane	1	U
Chloroform	1	U	Fluorotrichloromethane	1	U
Chloromethane	1	U	Hexachlorobutadiene	1	U
cis-1,2-Dichloroethylene	1	U	Isopropylbenzene	1	U
Dibromomethane	1	U	p-Isopropyltoluene	1	U
Dichloromethane	1	U	Napthalene	1	U
Ethylbenzene	1	U	n-Propylbenzene	1	U
m-Dichlorobenzene	1	U	sec-Butylbenzene	1	U
m-Xylene & p-Xylene	1	U	tert-Butylbenzene	1	U
o-Chlorotoluene	1	U			
o-Dichlorobenzene	1	U			
o-Xylene	1	U			
p-Chlorotoluene	1	U			
Styrene	1	U			
Tetrachloroethylene	1	U			
Toluene	1	U			
trans-1,2-Dichloroethylene	1	U			

Tentatively Identified Compounds

Freon 113	1	U
Flurortrimethyl silane	4.4	J
Trimethyl silanol	10	J

U-Analyzed for but not detected.
B-Found in the blank

J-An estimated value

Analysis Certified by: R Date: 4/13

APPENDIX F

Photographs

APPENDIX G

CME Evaluation Worksheet

APPENDIX A

COMPREHENSIVE GROUND-WATER MONITORING EVALUATION WORKSHEET

The following worksheets have been designed to assist the enforcement officer/ technical reviewer in evaluating the ground-water monitoring system an owner/operator uses to collect and analyze samples of ground water. The focus of the worksheets is technical adequacy as it relates to obtaining and analyzing representative samples of ground water. The basis of the worksheets is the final RCRA Ground Water Monitoring Technical Enforcement Guidance Document which describes in detail the aspects of ground-water monitoring which EPA deems essential to meet the goals of RCRA. Appendix A is not a regulatory checklist. Specific technical deficiencies in the monitoring system can, however, be related to the regulations as illustrated in Figure 4.3 taken from the RCRA Ground-Water Monitoring Compliance Order Guide (COG) (included at the end of the appendix). The enforcement officer, in developing an enforcement order, should relate the technical assessment from the worksheets to the regulations using Figure 4.3 from the COG as a guide.

Comprehensive Ground-Water Monitoring Evaluation	Y/N
I. Office Evaluation Technical Evaluation of the Design of the Ground-Water Monitoring System	
A. Review of Relevant Documents 1. What documents were obtained prior to conducting the inspection: a. RCRA Part A permit application?	
b. RCRA Part B permit application?	
c. Correspondence between the owner/operator and appropriate agencies or citizen's groups?	
d. Previously conducted facility inspection reports?	
e. Facility's contractor reports?	
f. Regional hydrogeologic, geologic, or soil reports?	
g. The facility's Sampling and Analysis Plan?	
h. Ground-water Assessment Program Outline (or Plan, if the facility is in assessment monitoring)?	
i. Other (specify) ________________	

APPENDIX A

COMPREHENSIVE GROUND-WATER MONITORING EVALUATION WORKSHEET

The following worksheets have been designed to assist the enforcement officer/technical reviewer in evaluating the ground-water monitoring system an owner/operator uses to collect and analyze samples of ground water. The focus of the worksheets is technical adequacy as it relates to obtaining and analyzing representative samples of ground water. The basis of the worksheets is the final RCRA Ground Water Monitoring Technical Enforcement Guidance Document which describes in detail the aspects of ground-water monitoring which EPA deems essential to meet the goals of RCRA.

Appendix A is not a regulatory checklist. Specific technical deficiencies in the monitoring system can, however, be related to the regulations as illustrated in Figure 4.3 taken from the RCRA Ground-Water Monitoring Compliance Order Guide (COG) (included at the end of the appendix). The enforcement officer, in developing an enforcement order, should relate the technical assessment from the worksheets to the regulations using figure 4.3 from the COG as a guide.

I. Office Evaluation - Technical Evaluation of the Design of the Ground-water Monitoring System

A. Review of relevant documents:

1. What documents were obtained prior to conducting the inspection:

a. RCRA Part A permit application? (Y/N) Y
b. RCRA Part B permit application? (Y/N) Y
c. Correspondence between the owner/operator and appropriate agencies or citizen's groups? (Y/N) N
d. Previously conducted facility inspection reports? (Y/N) Y
e. Facility's contractor reports? (Y/N) Y
f. Regional hydrogeologic, geologic, or soil reports? (Y/N) Y
g. The facility's Sampling and Analysis Plan? (Y/N) Y
h. Ground-water Assessment Program Outline (or Plan, if the facility is in assessment monitoring)? (Y/N) Y
i. Other (specify) ______________________

B. Evaluation of the Owner/Operator's Hydrogeologic Assessment:

1. Did the owner/operator use the following direct techniques in the hydrogeologic assessment:

a. Logs of the soil borings/rock corings (documented by a professional geologist, soil scientist, or geotechnical engineer)? (Y/N) Y
b. Materials tests (e.g., grain size analyses, standard penetration tests, etc.)? (Y/N) Y
c. Piezometer installation for water level measurements at different depths? (Y/N) N
d. Slug tests? (Y/N) Y

e. Pump tests? (Y/N) Y
f. Geochemical analyses of soil samples? (Y/N) N
g. Other (specify) (e.g., hydrochemical diagrams and wash analysis) ____________

2. Did the owner/operator use the following indirect techniques to supplement direct techniques data:

a. Geophysical well logs? (Y/N) Y
b. Tracer studies? (Y/N) N
c. Resistivity and/or electromagnetic conductance? (Y/N) Y
d. Seismic Survey? (Y/N) N
e. Hydraulic conductivity measurements of cores? (Y/N) N
f. Aerial photography? (Y/N) N
g. Ground penetrating radar? (Y/N) N
h. Other (specify) ____________

3. Did the owner/operator document and present the raw data from the site hydrogeologic assessment? (Y/N) Y

4. Did the owner/operator document methods (criteria) used to correlate and analyze the information? (Y/N) Partial

5. Did the owner/operator prepare the following:

a. Narrative description of geology? (Y/N) Y
b. Geologic cross sections? (Y/N) N
c. Geologic and soil maps? (Y/N) Y
d. Boring/coring logs? (Y/N) N
e. Structure contour maps of the differing water bearing zones and confining layer? (Y/N) Y
f. Narrative description and calculation of ground-water flows? (Y/N) Y
g. Water table/potentiometric map? (Y/N) Y
h. Hydrologic cross sections? (Y/N) N

6. Did the owner/operator obtain a regional map of the area and delineate the facility? (Y/N) Y

If yes, does this map illustrate:

a. Surficial geology features? (Y/N) Y
b. Streams, rivers, lakes, or wetlands near the facility? (Y/N) Y
c. Discharging or recharging wells near the facility? (Y/N) Y

7. Did the owner/operator obtain a regional hydrogeologic map? (Y/N) N

   If yes, does this hydrogeologic map indicate:

   a. Major areas of recharge/discharge? (Y/N) ___
   b. Regional ground-water flow direction? (Y/N) ___
   c. Potentiometric contours which are consistent with observed water level elevations? (Y/N) ___

8. Did the owner/operator prepare a facility site map? (Y/N) Y

   If yes, does the site map show:

   a. Regulated units of the facility (e.g., landfill areas, impoundments)? (Y/N) Y
   b. Any seeps, springs, streams, ponds, or wetlands? (Y/N) Y
   c. Location of monitoring wells, soil borings, or test pits? (Y/N) Y
   d. How many regulated units does the facility have? 2
      If more than one regulated unit then,
      o Does the waste management area encompass all regulated units? (Y/N) N
        Or
      o Is a waste management area delineated for each regulated unit? (Y/N) Y

C. Characterization of Subsurface Geology of Site

1. Soil boring/test pit program:

   a. Were the soil borings/test pits performed under the supervision of a qualified professional? (Y/N) Y
   b. Did the owner/operator provide documentation for selecting the spacing for borings? (Y/N) Partial
   c. Were the borings drilled to the depth of the first confining unit below the uppermost zone of saturation or ten feet into bedrock? (Y/N) Y
   d. Indicate the method(s) of drilling:
      o Auger (hollow or solid stem) ___
      o Mud rotary X
      o Reverse rotary ___
      o Cable tool ___
      o Jetting ___
      o Other (specify) ___
   e. Were continuous sample corings taken? (Y/N) N

f. How were the samples obtained (checked method[s])
   - o Split spoon ✓
   - o Shelby tube, or similar ____
   - o Rock coring ____
   - o Ditch sampling ____
   - o Other (explain) ____

   Mostly Cuttings

g. Were the continuous sample corings logged by a qualified professional in geology? (Y/N) Y cuttings

h. Does the field boring log include the following information:
   - o Hole name/number? (Y/N) Y
   - o Date started and finished? (Y/N) Y
   - o Driller's name? (Y/N) Y
   - o Hole location (i.e., map and elevation)? (Y/N) Y
   - o Drill rig type and bit/auger size? (Y/N) Y
   - o Gross petrography (e.g., rock type) of each geologic unit? (Y/N) Y
   - o Gross mineralogy of each geologic unit? (Y/N) Y
   - o Gross structural interpretation of each geologic unit and structural features (e.g., fractures, gouge material, solution channels, buried streams or valleys, identification of depositional material)? (Y/N) N
   - o Development of soil zones and vertical extent and description of soil type? (Y/N) N
   - o Depth of water bearing unit(s) and vertical extent of each? (Y/N) Y
   - o Depth and reason for termination of borehole? (Y/N) Y
   - o Depth and location of any contaminant encountered in borehole? (Y/N) NA
   - o Sample location/number? (Y/N) —
   - o Percent sample recovery? (Y/N) —
   - o Narrative descriptions of:
     - -- Geologic observations? (Y/N) Y
     - -- Drilling observations? (Y/N) Y

i. Were the following analytical tests performed on the core samples:
   - o Mineralogy (e.g., microscopic tests and x-ray diffraction)? (Y/N) N
   - o Petrographic analysis:
     - - degree of crystallinity and cementation of matrix? (Y/N) N
     - - degree of sorting, size fraction (i.e., sieving), textural variations? (Y/N) Y

- rock type(s)? (Y/N) Y
- soil type? (Y/N) N
- approximate bulk geochemistry? (Y/N) N
- existence of microstructures that may effect or indicate fluid flow? (Y/N) N

o Falling head tests? (Y/N) N
o Static head tests? (Y/N) N
o Settling measurements? (Y/N) N
o Centrifuge tests? (Y/N) N
o Column drawings? (Y/N) N

D. Verification of subsurface geological data

1. Has the owner/operator used indirect geophysical methods to supplement geological conditions between borehole locations? (Y/N) Y
2. Do the number of borings and analytical data indicate that the confining layer displays a low enough permeability to impede the migration of contaminants to any stratigraphically lower water-bearing units? (Y/N) N
3. Is the confining layer laterally continuous across the entire site? (Y/N) likely
4. Did the owner/operator consider the chemical compatibility of the site-specific waste types and the geologic materials of the confining layer? (Y/N) unknown
5. Did the geologic assessment address or provide means for resolution of any information gaps of geologic data? (Y/N) N
6. Do the laboratory data corroborate the field data for petrography? (Y/N) NA
7. Do the laboratory data corroborate the field data for mineralogy and subsurface geochemistry? (Y/N) NA

E. Presentation of geologic data

1. Did the owner/operator present geologic cross sections of the site? (Y/N) N
2. Do cross sections:
   a. identify the types and characteristics of the geologic materials present? (Y/N) ___
   b. define the contact zones between different geologic materials?
   c. note the zones of high permeability or fracture? (Y/N) ___
   d. give detailed borehole information including:
      o location of borehole? (Y/N) ___
      o depth of termination? (Y/N) ___
      o location of screen (if applicable)? (Y/N) ___
      o depth of zone(s) of saturation? (Y/N) ___
      o backfill procedure?

3. Did the owner/operator provide a topographic map which was constructed by a licensed surveyor? (Y/N) Y
4. Does the topographic map provide:
   a. contours at a maximum interval of two-feet? (Y/N) N
   b. locations and illustrations of man-made features (e.g., parking lots, factory buildings, drainage ditches, storm drains, pipelines, etc.)? (Y/N) Y
   c. descriptions of nearby water bodies? (Y/N) NA
   d. descriptions of off-site wells? (Y/N) NA
   e. site boundaries? (Y/N) Y
   f. individual RCRA units? (Y/N) Y
   g. delineation of the waste management area(s)? (Y/N) Y
   h. well and boring locations? (Y/N) Y
5. Did the owner/operator provide an aerial photograph depicting the site and adjacent off-site features? (Y/N) N
6. Does the photograph clearly show surface water bodies, adjacent municipalities, and residences and are these clearly labelled? (Y/N) N

F. Identification of Ground-Water Flowpaths

1. Ground-water flow direction

   a. Was the well casing height measured by a licensed surveyor to the nearest 0.01 feet? (Y/N) Y
   b. Were the well water level measurements taken within a 24 hour period? (Y/N) Y
   c. Were the well water level measurements taken to the nearest 0.01 feet? (Y/N) Y
   d. Were the well water levels allowed to stabilize after construction and development for a minimum of 24 hours prior to measurements? (Y/N) Y
   e. Was the water level information obtained from (check appropriate one):
      - o multiple piezometers placed in single borehole? ____
      - o vertically nested piezometers in closely spaced separate boreholes? ____
      - o monitoring wells ✓

f. Did the owner/operator provide construction details for the piezometers? (Y/N) NA

g. How were the static water levels measured (check method(s).
- o Electric water sounder ✓
- o Wetted tape ___
- o Air line ___
- o Other (explain) ___

____

h. Was the well water level measured in wells with equivalent screened intervals at an equivalent depth below the saturated zone? (Y/N) Y

i. Has the owner/operator provided a site water table (potentiometric) contour map? If yes,
- o Do the potentiometric contours appear logical and accurate based on topography and presented data? (Consult water level data) (Y/N) Y
- o Are ground-water flow-lines indicated? (Y/N) Y
- o Are static water levels shown? (Y/N) Y
- o Can hydraulic gradients be estimated? (Y/N) Y

j. Did the owner/operator develop hydrologic cross sections of the vertical flow component across the site using measurements from all wells? (Y/N) N

k. Do the owner/operator's flow nets include:
- o piezometer locations? (Y/N) NA
- o depth of screening? (Y/N) N
- o width of screening? (Y/N) N
- o measurements of water levels from all wells and piezometers? (Y/N) N

2. Seasonal and temporal fluctuations in ground-water level

a. Do fluctuations in static water levels occur? (Y/N) N
- o If yes, are the fluctuations caused by any of the following:

-- Off-site well pumping (Y/N) ___
-- Tidal processes or other intermittent natural variations (e.g., river stage, etc.) (Y/N) ___
-- On-site well pumping (Y/N) ___
-- Off-site, on-site construction or changing land use patterns (Y/N) ___
-- Deep well injection (Y/N) ___
-- Seasonal variations (Y/N) ___
-- Other (specify) _______________

b. Has the owner/operator documented sources and patterns that contribute to or affect the ground-water patterns below the waste management? (Y/N) N

c. Do water level fluctuations alter the general ground-water gradients and flow directions? (Y/N) N

d. Based on water level data, do any head differentials occur that may indicate a vertical flow component in the saturated zone? (Y/N) N

e. Did the owner/operator implement means for gauging long term effects on water movement that may result from on-site or off-site construction or changes in land-use patterns? (Y/N) N

3. Hydraulic conductivity

a. How were hydraulic conductivities of the subsurface materials determined?
   - o Single-well tests (slug tests)? (Y/N) Y
   - o Multiple-well tests (pump tests) (Y/N) N
   - o Other (specify)

b. If single-well tests were conducted, was it done by:
   - o Adding or removing a known volume of water, or (Y/N) Y
   - o Pressurizing well casing (Y/N) N

c. If single well tests were conducted in a highly permeable formation, were pressure transducers and high-speed recording equipment used to record the rapidly changing water levels? (Y/N) NA

d. Since single well tests only measure hydraulic conductivity in a limited area, were enough tests run to ensure a representative measure of conductivity in each hydrogeologic unit? (Y/N) N

e. Is the owner/operator's slug test data (if applicable) consistent with existing geologic information (e.g., boring logs)? (Y/N) Y

f. Were other hydraulic conductivity properties determined? (Y/N) Y

g. If yes, provide any of the following data, if available:
   - o Transmissivity 12 → 150 ft²/day
   - o Storage coefficient $10^{-3} \rightarrow 10^{-4}$
   - o Leakage unknown
   - o Permeability K = 7 to 15 ft/day
   - o Porosity 0.10 → 0.35
   - o Specific capacity unknown
   - o Other (specify) ______________________

4. Identification of the uppermost aquifer

a. Has the extent of the uppermost saturated zone (aquifer) in the facility area been defined? If yes, (Y/N) N
   - o Are soil boring/test pit logs included? (Y/N) Y
   - o Are geologic cross-sections included? (Y/N) N

b. Is there evidence of confining (competent, unfractured, continuous, and low permeability) layers beneath the site? (Y/N) Y
   - o If yes, how was continuity demonstrated? Was not demonstrated

c. What is hydraulic conductivity of the confining unit (if present)? CM/Sec
   How was it determined? Unknown - May Vary

d. Does potential for other hydraulic communication exist (e.g., lateral incontinuity between geologic units, facies changes, fracture zones, cross cutting structures, or chemical corrosion/alteration of geologic units by leachage? (Y/N) Y
   If yes or no what is the rationale? facies changes

G. Office Evaluation of the Facility's Ground-Water Monitoring System

Monitoring Well Design and Construction:
These questions should be answered for each different well design present at the facility.

1. Drilling Methods

a. What drilling method was used for the well?
   - o Hollow-stem auger
   - o Solid-stem auger ____
   - o Mud rotary ✓
   - o Air rotary ✓
   - o Reverse rotary ____
   - o Cable tool ____
   - o Jetting ____
   - o Air drill with casing hammer ____
   - o Other (specify) ____

b. Were any cutting fluids (including water) or additives used during drilling? (Y/N) Y
   If yes, specify
   Type of drilling fluid E-Z mud
   Source of water used ____
   Foam Air Foam
   Polymers ____
   Other ____

c. Was the cutting fluid, or additive, identified? (Y/N) Y

d. Was the drilling equipment steam-cleaned prior to drilling the well? (Y/N) Y

Other methods ______________________

e. Was compressed air used during drilling? (Y/N) Y

o If yes, was the air filtered to remove oil? (Y/N) Unknown

f. Did the owner/operator document procedure for establishing the potentiometric surface? (Y/N) ___

o If yes, how was the location established?

____

g. Formation samples

o Were formation samples collected initially during drilling? (Y/N) Y

o Were any cores taken continuous? (Y/N) N

If not, at what interval were samples taken? ______________________

o How were the samples obtained?

- Split spoon ✓
- Shelby tube ___
- Core drill ___
- Other (specify) ___

o Identify if any physical and/or chemical tests were performed on the formation samples (specify) ______________________

2. Monitoring Well Construction Materials

a. Identify construction materials (by number) and diameters (ID/OD)

	Material	Diameter (ID/OD)
o Primary Casing	PVC	4"
o Secondary or outside casing (double construction)	Steel	8" to 100'
o Screen	PVC	4"

b. How are the sections of casing and screen connected?

o Pipe sections threaded Y

o Couplings (friction) with adhesive or solvent ___

o Couplings (friction) with retainer screws ___

o Other (specify) ______________________

c. Were the materials steam-cleaned prior to installation? (Y/N) Unknown
If no, how were the materials cleaned? ________

3. Well Intake Design and Well Development

a. Was a well intake screen installed? (Y/N) Y
o What is the length of the screen for the well? 20 feet
o Is the screen manufactured? (Y/N) Y

b. Was a filter pack installed? (Y/N) Y
o What kind of filter pack was employed? No. 16 Silica Sand
o Is the filter pack compatible with formation materials? (Y/N) Y
o How was the filter pack installed? Tremie Pipe
o What are the dimensions of the filter pack? 7 7/8" by 30'
o Has a turbidity measurement of the well water ever been made? (Y/N) Y
o Have the filter pack and screen been designed for the *in situ* materials? (Y/N) Y

c. Well development
Was the well developed? (Y/N) Y
o What technique was used for well development?
- Surge block ____
- Bailer ✓ first
- Air surging ____
- Water pumping ✓ second
- Other (specify) ________

4. Annular Space Seals

a. What is the annular space in the saturated zone directly above the filter pack filled with?
- Sodium bentonite (specify type and grit) ✓
- Cement (specify neat or concrete) ________
- Other (specify) ________
o Was the seal installed by?
- Dropping material down the hole and tamping ____
- Dropping material down the inside of hollow-stem auger ____
- Tremie pipe method ✓
- Other (specify) ____

b. Was a different seal used in the unsaturated zone? (Y/N) Y & N
If yes,
o Was this seal made with?
- Sodium bentonite (specify type and grit) ✓ Vadose Zone
- Cement (specify neat or concrete) ✓ — top of well and top of filter pack
- Other (specify) ________

o Was this seal installed by?
- Dropping material down the hole and tamping ______
- Dropping material down the inside of hollow stem auger ______
- Other (specify) Tremie pipe ______

c. Is the upper portion of the borehole sealed with a concrete cap to prevent infiltration from the surface? (Y/N) Y
d. Is the well fitted with an above-ground protective device and bumper guards? (Y/N) Y
e. Has the protective cover been installed with locks to prevent tampering (Y/N) Y

H. Evaluation of the Facility's Detection Monitoring Program

1. Placement of Downgradient Detection Monitoring Wells

a. Are the ground-water monitoring wells or clusters located immediately adjacent to the waste management area? (Y/N) Y
b. How far apart are the detection monitoring wells?
100 ft apart
These may now be upgradient?

c. Does the owner/operator provide a rationale for the location of each monitoring well or cluster? (Y/N) Y
d. Has the owner/operator identified the well screen lengths of each monitoring well or clusters? (Y/N) Y
e. Does the owner/operator provide an explanation for the well screen lengths of each monitoring well or cluster? (Y/N) N
f. Do the actual locations of monitoring wells or clusters correspond to those identified by the owner/operator? (Y/N) Y

2. Placement of Upgradient Monitoring Wells

a. Has the owner/operator documented the location of each upgradient monitoring well or cluster? (Y/N) Y
b. Does the owner/operator provide an explanation for the location(s) of the upgradient monitoring wells? (Y/N) Y
c. What length screen has the owner/operator employed in the background monitoring well(s)?
20'

d. Does the owner/operator provide an explanation for the screen length(s) chosen? (Y/N) N
e. Does the actual location of each background monitoring well or cluster correspond to that identified by the owner/operator? (Y/N) Y

I. Office Evaluation of the Facility's Assessment Monitoring Program

NA

1. Does the assessment plan specify:
   a. The number, location, and depth of wells? (Y/N) ___
   b. The rationale for their placement and identify the basis that will be used to select subsequent sampling locations and depths in later assessment phases? (Y/N) ___
2. Does the list of monitoring parameters include all hazardous waste constituents from the facility? (Y/N) ___
   a. Does the water quality parameter list include other important indicators not classified as hazardous waste constituents? (Y/N) ___
   b. Does the owner/operator provide documentation for the listed wastes which are not included? (Y/N) ___
3. Does the owner/operator's assessment plan specify the procedures to be used to determine the rate of constituent migration in the ground-water? (Y/N) ___
4. Has the owner/operator specified a schedule of implementation in the assessment plan? (Y/N) ___
5. Have the assessment monitoring objectives been clearly defined in the assessment plan? (Y/N) ___
   a. Does the plan include analysis and/or re-evaluation to determine if significant contamination has occurred in any of the detection monitoring wells? (Y/N) ___
   b. Does the plan provide for a comprehensive program of investigation to fully characterize the rate and extent of contaminant migration from the facility? (Y/N) ___
   c. Does the plan call for determining the concentrations of hazardous wastes and hazardous waste constituents in the ground water? (Y/N) ___
   d. Does the plan employ a quarterly monitoring program? (Y/N) ___
6. Does the assessment plan identify the investigatory methods that will be used in the assessment phase? (Y/N) ___
   a. Is the role of each method in the evaluation fully described? (Y/N) ___
   b. Does the plan provide sufficient descriptions of the direct methods to be used? (Y/N) ___
   c. Does the plan provide sufficient descriptions of the indirect methods to be used? (Y/N) ___
   d. Will the method contribute to the further characterization of the contaminant movement? (Y/N) ___
7. Are the investigatory techniques utilized in the assessment program based on direct methods? (Y/N) ___
   a. Does the assessment approach incorporate indirect methods to further support direct methods? (Y/N) ___
   b. Will the planned methods called for in the assessment approach ultimately meet performance standards for assessment monitoring? (Y/N) ___

No detections of contamination in groundwater have been made yet.

c. Are the procedures well defined? (Y/N) NA

d. Does the approach provide for monitoring wells similar in design and construction as the detection monitoring wells? (Y/N)

e. Does the approach employ taking samples during drilling or collecting core samples for further analysis? (Y/N)

8. Are the indirect methods to be used based on reliable and accepted geophysical techniques? (Y/N)

a. Are they capable of detecting subsurface changes resulting from contaminant migration at the site? (Y/N)

b. Is the measurement at an appropriate level of sensitivity to detect ground-water quality changes at the site? (Y/N)

d. Is the method appropriate considering the nature of the subsurface materials? (Y/N)

e. Does the approach consider the limitations of these methods? (Y/N)

f. Will the extent of contamination and constituent concentration be based on direct methods and sound engineering judgment? (Using indirect methods to further substantiate the findings) (Y/N)

9. Does the assessment approach incorporate any mathematical modeling to predict contaminant movement? (Y/N)

a. Will site specific measurements be utilized to accurately portray the subsurface? (Y/N)

b. Will the derived data be reliable? (Y/N)

c. Have the assumptions been identified? (Y/N)

d. Have the physical and chemical properties of the site-specific wastes and hazardous waste constituents been identified? (Y/N)

J. Conclusions

1. Subsurface geology

a. Has sufficient data been collected to adequately define petrography and petrographic variation? (Y/N) Y

b. Has the subsurface geochemistry been adequately defined? (Y/N) Y

c. Was the boring/coring program adequate to define subsurface geologic variation? (Y/N) Y

d. Was the owner/operator's narrative description complete and accurate in its interpretation of the data? (Y/N) Y

e. Does the geologic assessment address or provide means to resolve any information gaps? (Y/N) Y

2. Ground-water flowpaths

a. Did the owner/operator adequately establish the horizontal and vertical components of ground-water flow? (Y/N) Horizontal Y Vertical N

b. Were appropriate methods used to establish ground-water flowpaths? (Y/N) Y

c. Did the owner/operator provide accurate documentation? (Y/N) Y

d. Are the potentiometric surface measurements valid? (Y/N) Y

e. Did the owner/operator adequately consider the seasonal and temporal effects on the ground-water? (Y/N) Y

f. Were sufficient hydraulic conductivity tests performed to document lateral and vertical variation in hydraulic conductivity in the entire hydrogeologic subsurface below the site? (Y/N) N

3. Uppermost aquifer

a. Did the owner/operator adequately define the uppermost aquifer? (Y/N) Y

4. Monitoring Well Construction and Design

a. Do the design and construction of the owner/operator's ground-water monitoring wells permit depth discrete ground-water samples to be taken? (Y/N) Y

b. Are the samples representative of ground-water quality? (Y/N) Y

c. Are the ground-water monitoring wells structurally stable? (Y/N) Y

d. Does the ground-water monitoring well's design and construction permit an accurate assessment of aquifer characteristics? (Y/N) Y

5. Detection Monitoring

a. Downgradient Wells
Do the location, and screen lengths of the ground-water monitoring wells or clusters in the detection monitoring system allow the immediate detection of a release of hazardous waste or constituents from the hazardous waste management area to the uppermost aquifer? (Y/N) No

b. Upgradient Wells
Do the location and screen lengths of the upgradient (background) ground-water monitoring wells ensure the capability of collecting ground-water samples representative of upgradient (background) ground-water quality including any ambient heterogenous chemical characteristics? (Y/N) Y

6. Assessment Monitoring

a. Has the owner/operator adequately characterized site hydrogeology to determine contaminant migration? (Y/N) NA
b. Is the detection monitoring system adequately designed and constructed to immediately detect any contaminant release? (Y/N) ___
c. Are the procedures used to make a first determination of contamination adequate? (Y/N) ___
d. Is the assessment plan adequate to detect, characterize, and track contaminant migration? (Y/N) ___
e. Will the assessment monitoring wells, given site hydrogeologic conditions, define the extent and concentration of contamination in the horizontal and vertical planes? (Y/N) ___
f. Are the assessment monitoring wells adequately designed and constructed? (Y/N) ___
g. Are the sampling and analysis procedures adequate to provide true measures of contamination? (Y/N) ___
h. Do the procedures used for evaluation of assessment monitoring data result in determinations of the rate of migration, extent of migration, and hazardous constituent composition of the contaminant plume? (Y/N) ___
i. Are the data collected at sufficient frequency and duration to adequately determine the rate of migration? (Y/N) ___
j. Is the schedule of implementation adequate? (Y/N) ___
k. Is the owner/operator's assessment monitoring plan adequate? (Y/N) ___
   o If the owner/operator had to implement his assessment monitoring plan, was it implemented satisfactorily? (Y/N) ___

II. Field Evaluation

A. Ground-water monitoring system:
Are the numbers, depths, and locations of monitoring wells in agreement with those reported in the facility's monitoring plan? (See Section 3.2.3) (Y/N) Y

B. Monitoring well construction:
1. Identify construction material

	Material	Diameter
a. Primary Casing	4"	PVC
b. Secondary or outside casing	Steel	8" to 100'

2. Is the upper portion of the borehole sealed with concrete to prevent infiltration from the surface? (Y/N) Y

3. Is the well fitted with an above-ground protective device? (Y/N) Y

4. Is the protective cover fitted with locks to prevent tampering? (Y/N) Y

If a facility utilizes more than a single well design, answer the above questions for each well design.

III. Review of Sample Collection Procedures

A. Measurement of well depths elevation:

1. Are measurements of both depth to standing water, and depth to the bottom of the well made? (Y/N) Y

2. Are measurements taken to the 0.01 feet? (Y/N) Y

3. What device is used?

electric water sounder

4. Is there a reference point established by a licensed surveyor? (Y/N) Y

5. Is the measuring equipment properly cleaned between well locations to prevent cross contamination? (Y/N) Y

B. Detection of immiscible layers:

1. Are procedures used which will detect light phase immiscible layers? (Y/N) NA

2. Are procedures used which will detect heavy phase immiscible layers? (Y/N) NA

C. Sampling of immiscible layers:

1. Are the immiscible layers sampled separately prior to well evacuation? (Y/N) N

2. Do the procedures used minimize mixing with water soluble phases? (Y/N) N

D. Well evacuation:

1. Are low yielding wells evacuated to dryness? (Y/N) Y

2. Are high yielding wells evacuated so that at least three casing volumes are removed? (Y/N) Y

3. What device is used to evacuate the wells?
   Grundfus 1½ hp Stainless Steel pump

4. If any problems are encountered (e.g., equipment malfunction) are they noted in a field logbook? (Y/N) Y

E. Sample withdrawal:

1. For low yielding wells, are samples for volatiles, pH, and oxidation/reduction potential drawn first after the well recovers? (Y/N) Y

2. Are samples withdrawn with either flurocarbon/resins or stainless steel (316, 304 or 2205) sampling devices? (Y/N) submersible pump

3. Are sampling devices either bottom valve bailers or positive gas displacement bladder pumps? (Y/N) N

4. If bailers are used, is fluorocarbon/resin coated wire, single strand stainless steel wire, or monofilament used to raise and lower the bailer? (Y/N) NA

5. If bladder pumps are used, are they operated in a continuous manner to prevent aeration of the sample? (Y/N) NA

6. If bailers are used, are they lowered slowly to prevent degassing of the water? (Y/N) NA

7. If bailers are used, are the contents transferred to the sample container in a way that minimizes agitation and aeration? (Y/N) NA

8. Is care taken to avoid placing clean sampling equipment on the ground or other contaminated surfaces prior to insertion into the well? (Y/N) Y

9. If dedicated sampling equipment is not used, is equipment disassembled and thoroughly cleaned between samples? (Y/N) Y

10. If samples are for inorganic analysis, does the cleaning procedure include the following sequential steps:
    a. Dilute acid rinse (HNO_3 or HCl)? (Y/N) unknown

11. If samples are for organic analysis, does the cleaning procedure include the following sequential steps:
    a. Nonphosphate detergent wash? (Y/N) Y
    b. Tap water rinse? (Y/N) Y
    → from well

c. Distilled/deionized water rinse? (Y/N) Y
d. Acetone rinse? (Y/N) N
e. Pesticide-grade hexane rinse? (Y/N) N

12. Is sampling equipment thoroughly dry before use? (Y/N) N

13. Are equipment blanks taken to ensure that sample cross-contamination has not occurred? (Y/N) Y

14. If volatile samples are taken with a positive gas displacement bladder pump, are pumping rates below 100 ml/min? (Y/N) NA

F. In-situ or field analyses:

1. Are the following labile (chemically unstable) parameters determined in the field:
   a. pH? (Y/N) Y
   b. Temperature? (Y/N) Y
   c. Specific conductivity? (Y/N) Y
   d. Redox potential? (Y/N) N
   e. Chlorine? (Y/N) N
   f. Dissolved oxygen? (Y/N) N
   g. Turbidity? (Y/N) N
   h. Other (specify) ______________________

2. For in-situ determinations, are they made after well evacuation and sample removal? befor & after (Y/N) Y

3. If sample is withdrawn from the well, is parameter measured from a split portion? (Y/N) Y

4. Is monitoring equipment calibrated according to manufacturers' specifications and consistent with SW-846? (Y/N) Y

5. Is the date, procedure, and maintenance for equipment calibration documented in the field logbook? (Y/N) Y

IV. <u>Review of Sample Preservation and Handling Procedures</u>

A. Sample containers:

1. Are samples transferred from the sampling device directly to their compatible containers? (Y/N) Y

2. Are sample containers for metals (inorganics) analyses polyethylene with polypropylene caps? (Y/N) Y

3. Are sample containers for organics analysis glass bottles with fluorocarbonresin-lined caps? (Y/N) Y

4. If glass bottles are used for metals samples are the caps fluorocarbonresin-lined? (Y/N) unknown

5. Are the sample containers for metal analyses cleaned using these sequential steps?
   a. Nonphosphate detergent wash? (Y/N) NA
   b. 1:1 nitric acid rinse? (Y/N)
   c. Tap water rinse? (Y/N)
   d. 1:1 hydrochloric acid rinse? (Y/N)
   e. Tap water rinse? (Y/N)
   f. Distilled/deionized water rinse? (Y/N)

   Containers come from Lab ready to fill

6. Are the sample containers for organic analyses cleaned using these sequential steps?
   a. Nonphosphate detergent/hot water wash? (Y/N) NA
   b. Tap water rinse? (Y/N)
   c. Distilled/deionized water rinse? (Y/N)
   d. Acetone rinse? (Y/N)
   e. Pesticide-grade hexane rinse? (Y/N)

   Containers from Lab

7. Are trip blanks used for each sample container type to verify cleanliness? (Y/N) Y

B. Sample preservation procedures:
1. Are samples for the following analyses cooled to 4°C:
   a. TOC? (Y/N) Y
   b. TOX? (Y/N)
   c. Chloride? (Y/N)
   d. Phenols? (Y/N)
   e. Sulfate? (Y/N)
   f. Nitrate? (Y/N)
   g. Coliform bacteria? (Y/N)
   h. Cyanide? (Y/N)
   i. Oil and grease? (Y/N)
   j. Hazardous constituents (§261, Appendix VIII)? (Y/N)

2. Are samples for the following analyses field acidified to pH <2 with HNO_3:
   a. Iron? (Y/N)
   b. Manganese? (Y/N)
   c. Sodium? (Y/N)
   d. Total metals? (Y/N)
   e. Dissolved metals? (Y/N)
   f. Fluoride? (Y/N)
   g. Endrin? (Y/N)
   h. Lindane? (Y/N)
   i. Methoxychlor? (Y/N)
   j. Toxaphene? (Y/N)

   All preservatives come in the containers from the lab

k. 2,4, D? (Y/N) Y
l. 2,4,5, TP Silvex? (Y/N) Y
m. Radium? (Y/N) Y
n. Gross alpha? (Y/N) Y
o. Gross beta? (Y/N) Y

3. Are samples for the following analyses field acidified to pH <2 with H_2SO_4: (Y/N) Y
a. Phenols? (Y/N) Y
b. Oil and grease? (Y/N) Y

4. Is the sample for TOC analyses field acidified to pH <2 with HCl? (Y/N) N

5. Is the sample for TOX analysis preserved with 1 ml of 1.1 M sodium sulfite? (Y/N) NA

6. Is the sample for cyanide analysis preserved with NaOH to pH >12? (Y/N) Unknown

C. Special handling considerations:
1. Are organic samples handled without filtering? (Y/N) Y

2. Are samples for volatile organics transferred to the appropriate vials to eliminate headspace over the sample? (Y/N) Y

3. Are samples for metal analysis split into two portions? (Y/N) N

4. Is the sample for dissolved metals filtered through a 0.45 micron filter? (Y/N) Y

5. Is the second portion not filtered and analyzed for total metals? (Y/N) N

6. Is one equipment blank prepared each day of ground-water sampling? (Y/N) Y

V. Review of Chain-of-Custody Prodecures

A. Sample labels
1. Are sample labels used? (Y/N) Y

2. Do they provide the following information:
a. Sample identification number? (Y/N) Y
b. Name of collector? (Y/N) Y
c. Date and time of collection? (Y/N) Y
d. Place of collection? (Y/N) Y
e. Parameter(s) requested and preservatives used? (Y/N) Y

3. Do they remain legible even if wet? (Y/N) Y

B. Sample seals:

1. Are sample seals placed on those containers to ensure the samples are not altered? (Y/N) Y

C. Field logbook:

1. Is a field logbook maintained? (Y/N) Y

2. Does it document the following:
   a. Purpose of sampling (e.g., detection or assessment)? (Y/N) N
   b. Location of well(s)? (Y/N) N
   c. Total depth of each well? (Y/N) N
   d. Static water level depth and measurement technique? (Y/N) N
   e. Presence of immiscible layers and detection method? (Y/N) N
   f. Collection method for immiscible layers and sample identification numbers? (Y/N) N
   g. Well evacuation procedures? (Y/N) Y
   h. Sample withdrawal procedure? (Y/N) N
   i. Date and time of collection? (Y/N) Y
   j. Well sampling sequence? (Y/N) Y
   k. Types of sample containers and sample identification number(s)? (Y/N) Y
   l. Preservative(s) used? (Y/N) N
   m. Parameters requested? (Y/N) Y
   n. Field analysis data and method(s)? (Y/N) Y
   o. Sample distribution and transporter? (Y/N) unknown
   p. Field observations? (Y/N) Y
      o Unusual well recharge rates? (Y/N) Y
      o Equipment malfunction(s)? (Y/N) Y
      o Possible sample contamination? (Y/N) Y
      o Sampling rate? (Y/N) Y

D. Chain-of-custody record:

1. Is a chain-of-custody record included with each sample? (Y/N) Y
2. Does it document the following:
   a. Sample number? (Y/N) Y
   b. Signature of collector? (Y/N) Y
   c. Date and time of collection? (Y/N) Y
   d. Sample type? (Y/N) Y
   e. Station location? (Y/N) Y
   f. Number of containers? (Y/N) Y
   g. Parameters requested? (Y/N) Y
   h. Signatures of persons involved in the chain-of-possession? (Y/N) Y
   i. Inclusive dates of possession? (Y/N) Y

E. Sample analysis request sheet:

1. Does a sample analysis request sheet accompany each sample? (Y/N) Y

2. Does the request sheet document the following:
   a. Name of person receiving the sample? (Y/N) Y
   b. Date of sample receipt? (Y/N) Y
   c. Laboratory sample number (if different than field number)? (Y/N) Y
   d. Analyses to be performed? (Y/N) Y

VI. Review of Quality Assurance/Quality Control

A. Is the validity and reliability of the laboratory and field generated data ensured by a QA/QC program? (Y/N) Y

B. Does the QA/QC program include:

1. Documentation of any deviations from approved procedures? (Y/N) Y

2. Documentation of analytical results for:
   a. Blanks? (Y/N) Y
   b. Standards? (Y/N) Y
   c. Duplicates? (Y/N) Y
   d. Spiked samples? (Y/N) Y
   e. Detectable limits for each parameter being analyzed? (Y/N) Y

C. Are approved statistical methods used? (Y/N) Y

D. Are QC samples used to correct data? (Y/N) N

E. Are all data critically examined to ensure it has been properly calculated and reported? (Y/N) Y

VII. Surficial Well Inspection and Field Observation

A. Are the wells adequately maintained? (Y/N) Y

B. Are the monitoring wells protected and secure? (Y/N) Y

C. Do the wells have surveyed casing elevations? (Y/N) Y

D. Are the ground-water samples turbid? (Y/N) N

E. Have all physical characteristics of the site been noted in the inspector's field notes (i.e., surface waters, topography, surface features)? (Y/N) IN Reports

F. Has a site sketch been prepared by the field inspector with a scale, north arrow, location(s) of buildings, location(s) of regulated units, location of monitoring wells, and a rough depiction of the site drainage pattern? (Y/N) Detailed maps in Reports

VIII. Conclusions

A. Is the facility currently operating under the correct monitoring program according to the statistical analyses performed by the current operator? (Y/N) Y

B. Does the ground-water monitoring system, as designed and operated, allow for detection or assessment of any possible ground-water contamination caused by the facility? (Y/N) No

C. Does the sampling and analysis procedures permit the owner/operator to detect and, where possible, assess the nature and extent of a release of hazardous constituents to ground water from the monitored hazardous waste management facility? (Y/N) No