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ENVIRONMENTAL RESTORATION PROGRAM

Groundwater Quality Monitoring Well Installation for Waste Area Grouping 5 at Oak Ridge National Laboratory, Oak Ridge, Tennessee

J. A. Mortimore
M. L. Ebers

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ORNL/ER-26

Environmental Restoration Division
ORNL Environmental Restoration Program

Groundwater Quality Monitoring Well Installation for Waste Area Grouping 5 at Oak Ridge National Laboratory, Oak Ridge, Tennessee

J. A. Mortimore
M. L. Ebers

Date Issued—September 1994

Prepared for
U.S. Department of Energy
Office of Environmental Restoration and Waste Management
under budget and reporting code EW 20

Environmental Restoration and Waste Management Programs
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6285
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
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Author Affiliations

J. A. Mortimore is staff project manager with the Environmental Restoration Program, Oak Ridge National Laboratory, Martin Marietta Energy Systems, Incorporated. M. L. Ebers is a senior hydrogeologist with Ogden Environmental and Energy Services Co., Inc. (formally ERC Environmental and Energy Services Company).

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EXECUTIVE SUMMARY

This report documents the drilling and installation of 22 groundwater quality monitoring (GQM) wells on the perimeter of Waste Area Grouping (WAG) 5. WAG 5 is located south of the Oak Ridge National Laboratory main plant area in Melton Valley and includes 33 solid waste management units. The wells at WAG 5 were drilled and developed between July 1987 and March 1990. These wells were installed to characterize and assess the WAG in accordance with applicable Department of Energy, state, and Environmental Protection Agency regulatory requirements.

Well design and placement were performed by Martin Marietta Energy Systems, Inc. (Energy Systems) geologic staff and their subcontractors. The wells were drilled, installed, and developed by two drilling subcontractors (A. L. Clark Drilling Services and Geotek Engineering, Inc.) under contract with Energy Systems. The contract was administered by the Energy Systems Engineering Division for the Environmental Restoration (ER) Program. Hydrogeologic support was provided by an environmental subcontractor [ERC Environmental and Energy Services, Inc. (ERCE)] under contract with Energy Systems. (As of January 1, 1992, ERCE started operating under the name of Ogden Environmental and Energy Services Co., Inc.) This contract was administered by ER Division staff. Radiation protection and industrial hygiene support for the drilling program were provided by Energy Systems staff or their subcontractors.

The wells at WAG 5 were drilled with auger or air rotary rigs. Depending upon the hydrogeologic conditions present at each proposed well location, one of three basic installation methods was utilized. Detailed procedures for well construction were specified by the Engineering Division to ensure that the wells would provide water samples representative of the aquifer. In order to ensure conformance with the specifications, Energy Systems Construction Engineering and ERCE provided continuous oversight of field activities.

The purpose of the well installation program was to install GQM wells for groundwater characterization at WAG 5. Data packages produced during installation activities by the ERCE hydrogeologists are an important product of the program. These packages document the well drilling, installation, and development activities and provide valuable data for well sampling and WAG characterization. The forms contained in the packages include predrilling and postdrilling checklists, drilling and construction logs, development and hydraulic conductivity records, and quality control-related documents.

1. INTRODUCTION

The purpose of this report is to document the drilling and installation of the groundwater quality monitoring (GQM) wells on the perimeter of Waste Area Grouping (WAG) 5. Installation of GQM wells was required at Oak Ridge National Laboratory (ORNL) for regulatory compliance. Data obtained from these wells will be used to characterize and assess groundwater quality at the perimeter of each WAG in accordance with applicable Department of Energy, state, and Environmental Protection Agency regulatory requirements. Twenty one of the 22 wells in WAG 5 were drilled from July through September 1987. The drilling of the remaining well (no. 976) was delayed until August 1989 due to the high probability of encountering contamination. The wells were developed between December 1989 and March 1990.

1.1 THE WAG CONCEPT

At ORNL, the solid waste management units (SWMUs) include solid waste storage areas (SWSAs), pipelines, spill sites, buildings, ponds, and experimental test sites that are considered to be potential sources of contamination. The SWMUs are further grouped into WAGs, the boundaries of which are defined by watersheds that contain contaminants derived from similar assemblages of operating facilities and SWMUs. Basically, the wells are located on or near these boundaries to determine whether contaminants have been released from the WAGs.

1.2 DESCRIPTION OF WAG 5

WAG 5 is located directly south of the ORNL main plant area in Melton Valley [Fig. 1, map pocket (MMES map #C3E20004A080, Rev. C)]. WAG 5 includes 22 SMWUs. Of these, 13 are tanks containing liquid low-level waste (LLLW). The largest portion of the land area is devoted to SWSA 5 and the transuranic waste storage area. The remaining SWMUs are support facilities for ORNL's hydrofracture operations, two LLLW leak or spill sites, and an impoundment in SWSA 5 used to dewater sludge from the process waste treatment plant. Twenty two wells were installed on the perimeter of WAG 5 (Fig. 1, map pocket).

2. INSTALLATION METHODS

Four basic types of well construction were used during the GQM installation program at ORNL. Schematic diagrams of these four well types are shown on Fig. 2. Three of the four types (A, B, and D) were used at WAG 5. These three types are described in Sects. 4.1 through 4.3. The specific details of each well installation are included in the monitoring well narratives (Appendix A). The specifications for drilling and well installation were provided in the *Construction Specifications for Monitoring Wells Installation Construction Project*, K-4491G-G1.[1] The proposed well design criteria for the WAG 5 wells can be found in *Preliminary Geohydrologic Site Characterization and Proposed Water Quality Well Locations for WAGs 4, 5, 3, and SWSA 1*, ORNL/RAP/Sub-86/72139/1.[2] The actual completion data for wells in WAG 5 are listed in Table 1.

2.1 TYPE A WELL

The type A well boring is drilled to its total depth with solid-stem augers. On completion, the boring is bailed with a steel bailer to remove drill cuttings. The well is completed with 2-in.-diam stainless steel screen, casing, and a silt trap. Stainless steel centralizers are positioned at the top of the screen and every 20 ft along the casing. A sandpack is poured into the annular space from total depth to 1 ft above the screen. Pelleted bentonite is poured into the annular space to create a 2-ft seal above the sandpack. The top of the bentonite seal is measured with a stainless steel weighted tape. The annular space above the bentonite seal is then grouted to the surface through a tremie pipe.

2.2 TYPE B WELL

The first step in drilling the type B wells is to auger a boring from the surface to a depth of 4 ft. A steel diverter casing is installed and the annulus grouted up to ground level. The boring is then deepened with a tricone air rotary bit to a minimum depth of 10 ft total and 2 ft into bedrock. Next, a steel surface casing is installed and grouted into place. The air rotary method is used to drill the boring to the required depth. The well is completed with 4-in.-diam stainless steel screen and casing. A sandpack, a bentonite seal, and grout were installed in the annular space by the same procedures as used for the type A well.

2.3 TYPE D WELL

A type D well is a type A well with a diverter casing. If the auger encounters refusal before reaching total depth on a type A well, the boring is reamed with a larger auger to refusal and a steel diverter casing is installed. The annulus is grouted up to surface level. The boring is deepened with a tricone air rotary bit to total depth, and the well is completed with 2-in.-diam stainless steel screen and casing. A sandpack, a bentonite seal, and grout are installed in the annular space by the same procedures as those used for the type A well.

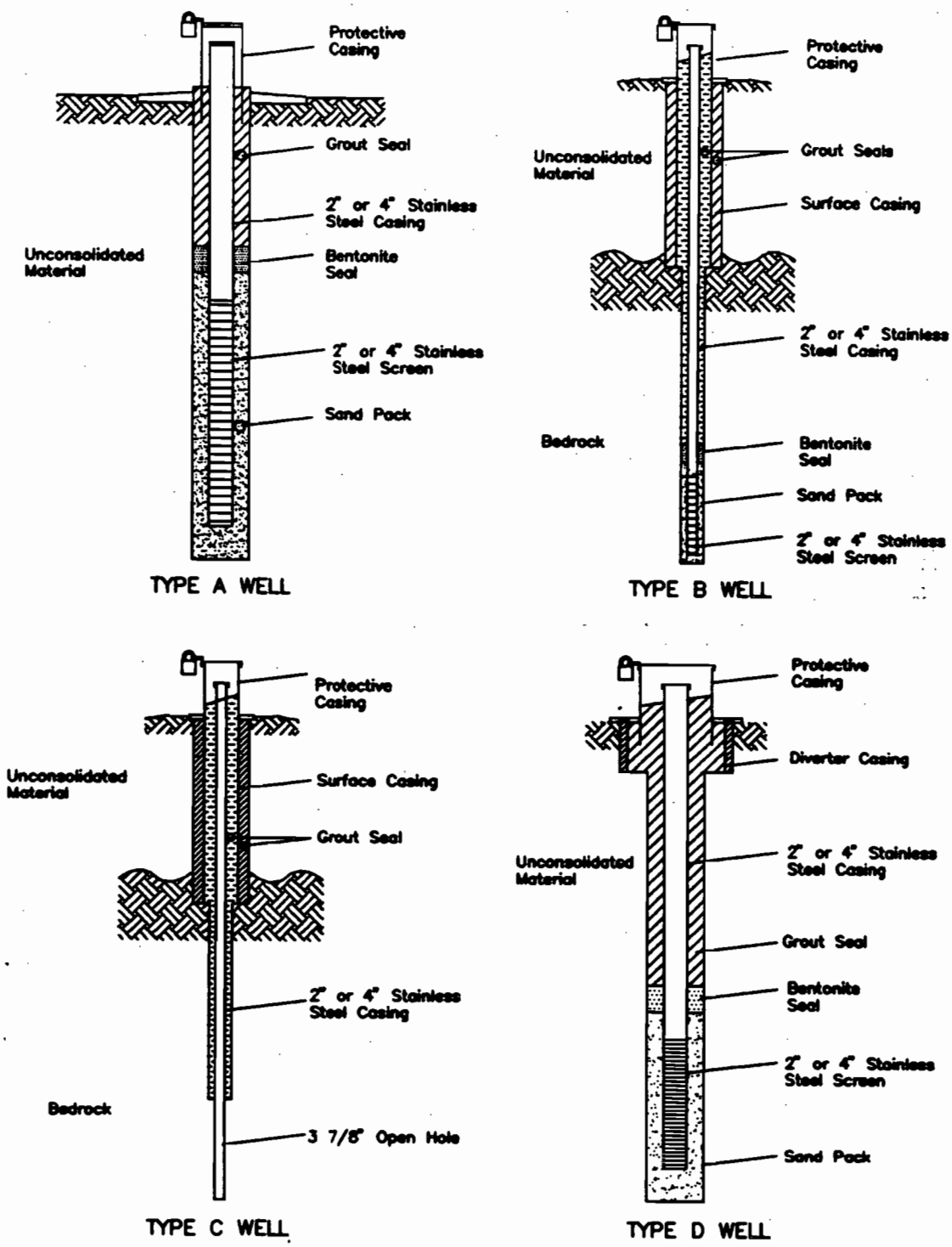


Fig. 2. The four types of well construction used during the Groundwater Quality Monitoring Well Installation Program at Oak Ridge National Laboratory.

Table 1. Actual completion data for WAG 5 wells

Well	Depth clean to (ft)[a]	SST casing diam (in.)	Well type	Screened interval (ft)	Water level (ft)[b]
963	95.0	2	D	64.8–94.8	-37.2
964	49.2	2	D	29.0–49.0	-19.5
965	28.5	2	A	18.3–28.3	-12.2
966	24.4	2	A	9.1–24.1	-2.4
967	60.0	4	B	29.7–59.7	-20.8
968	20.4	2	A	10.2–20.2	-2.5
969	15.6	2	A	5.3–15.3	-2.5
970	75.0	4	B	59.7–74.7	-2.2
971	14.9	2	A	9.7–14.7	-5.0
972	75.0	4	B	59.7–74.7	-3.4
973	15.5	2	A	10.3–15.3	-3.8
974	22.3	2	A	12.1–22.1	-6.7
975	28.3	2	A	18.0–28.0	-11.0
976	84.2	4	B	68.9–83.9	-14.0
977	19.8	2	A	4.5–19.5	-5.4
978	20.0	2	A	9.7–19.7	-5.2
979	49.6	4	B	34.3–49.3	-6.2
980	50.0	4	B	34.7–49.7	-2.3
981	20.0	2	A	9.7–19.7	-3.2
982	16.4	2	A	6.2–16.2	-2.4
983	25.0	2	A	9.7–24.7	-8.5
984	80.0	4	B	59.7–79.7	-5.9

[a]Total drilled depth may vary from clean-out depth. See data packages (Appendix A).

[b]Predevelopment water level; depth measured from ground surface. (Negative is below surface; positive, above surface.)

3. ENVIRONMENTAL, HEALTH, AND SAFETY REQUIREMENTS

All well drilling at WAG 5 was conducted in accordance with procedures outlined in *Health, Safety, and Environmental Protection Procedures for Excavating Operations*, ORNL/M-116/R1[3]. Among the procedures set forth by this document was a system for rating proposed well locations according to the degree of probability that contamination will be encountered. This rating determined the level of personnel training required and health and safety coverage to be used during drilling.

The Superfund Amendment Reauthorization Act required still more stringent health and safety measures for personnel working in waste areas. These workers were required to have 40 h of training for hazardous duty through an ORNL-approved course, 8 h of refresher training each year, 8 h of supervisor's training for field supervisors, a whole-body count, baseline urinalysis, respirator testing and fitting, and medical monitoring. Personnel were also required to take a construction-worker training course covering the basic fundamentals of radioactivity and other types of contamination as well as the other hazards that could be encountered at ORNL. The workers taught the proper procedures to follow in the event of an on-site emergency.

Special procedures were used during drilling. The ground surface at all drill sites was covered with polyethylene sheeting to prevent contact between the tools and the ground. The sheeting would also have protected the environment in the event of a hydraulic fluid release. Containment was required for all drill cuttings produced. During augering, a metal pan was used to hold cuttings until a health physicist (HP) could determine their proper disposition. During air rotary drilling, cuttings were diverted from the borehole to a special containment box designed by Martin Marietta Energy Systems, Inc. (Energy Systems). The box is a 500-gal, trailer-mounted tank with demister elements and high-efficiency particulate air filters at the air exhaust. In order that appropriate methods of disposal could be determined, the tank contents were checked by the HP for radioactive contamination and by the site hydrogeologist for volatile organics. The operating instructions that were followed for determining disposition of the cuttings and water produced during drilling and development are in Appendix B.

4. FIELD SUPPORT

The first 21 wells in WAG 5 were installed by the construction contractor A. L. Clark Drilling Company, Inc., whose contract began in January 1987. The last well (no. 976) was installed by Geotek Engineering, the construction contractor from 1989 through 1990. ORNL's Engineering Division administered the drilling contracts through Energy Systems Procurement.

The hydrogeologic support and installation record keeping were supplied through a contract with ERC Environmental and Energy Services Company (ERCE), formerly EDGe/MCI. An ERCE representative was present during all activities that affected the quality of the wells and advised Energy Systems on well construction. ORNL personnel or their subcontractors provided HP and industrial hygiene support.

Construction engineering support was supplied by Energy Systems personnel. Drawings, excavation permits, well placement in the field, and as-built surveying and calculations were done by the Energy Systems Civil and Architectural Department or by their subcontractor, Adams Craft Herz Walker Engineering Company. The as-built survey coordinates and elevations are on the well installation/completion form for each well (Appendix A). The as-built coordinates are also summarized in a table on the well location map (Fig. 1).

5. DRILLING RECORDS

A complete data package has been compiled for each of the 22 GQM wells drilled in WAG 5. These data packages are presented in numerical order in Appendix A. All original records are retained in the Environmental Restoration (ER) Division Records Control Data Base. The forms included in each well data package are listed here in the order in which they appear in the package:

1. monitor well narrative,
2. predrilling checklist for monitoring wells,
3. decontamination checklist for drilling equipment,
4. well log,
5. well installation/completion form,
6. monitoring well materials certification,
7. post-well completion checklist,
8. monitoring well development form,
9. monitoring well development progress,
10. hydraulic conductivity calculation,
11. nonconformance report (if necessary), and
12. chain of custody forms.

Two additional forms used in the field by the site hydrogeologist but not included in the published data packages are the monitoring well progress form and the hydraulic conductivity test field sheet. These forms are kept in the ER Division Records Control Data Base.

6. WELL DEVELOPMENT

Wells were developed by pumping. Wells with high initial turbidities were surged beforehand with a workover rig and a stainless steel surge block to facilitate removal of the sediment from the well. The contents of the wells were then pumped out using Geoguard airlift pumps and oilless air compressors. Development of a well was considered complete when at least three well volumes had been removed and the turbidity was measured at 5 nephelometric turbidity units (NTUs) or less. Several wells had turbidity ratings higher than 5 NTUs even after extensive pumping, but, in order to prevent the pulling in of groundwater from too far away, a maximum limit of 30 to 35 well volumes was determined by Energy Systems hydrogeologists to be the upper limit that should be removed. The contents of the wells were pumped out using Geoguard development pumps. The two-stage Geoguard pumps were converted to dedicated bladder pumps for sampling after development was complete. All development water was contained and disposed of according to the operating instructions in Appendix B.

Of the 22 wells in WAG 5, 18 wells had turbidity ratings of less than or equal to 5 NTUs. The number of well volumes removed ranged from 3 to 56, with an average of 17.4. The procedure for measuring turbidity included in ORNL/RAP/LTR-88/28[4] was replaced with a more accurate method. While the method previously used depended upon a visual comparison of the sample with prepared standards, the new method employs the Cole-Parmer turbidimeter, which measures NTUs by passing a lens-focused light beam through a test tube filled with a water sample. A photosensor detects the intensity of the exiting light beam, and an analog scale on the instrument displays the sample's turbidity.

7. SAMPLING DURING INSTALLATION

The ERCE hydrogeologist took samples of soil, rock, and drilling water during well installation and submitted them to the ORNL Analytical Chemistry Division for chemical analysis. Soil and rock samples were taken from the unsaturated and saturated zones. Samples of drilling water were collected from the water pump discharge on the drill rig when drilling with the air rotary took place. All samples were transferred using chain-of-custody forms, which are included in the data packages. The sampling procedures are explained in ORNL/RAP/LTR-88/28.[4] Soil samples were collected from each single well and from one well of each well pair. A drilling-water sample was collected from each air-rotary-drilled boring.

Analyses for 31 chemical elements, gross alpha, gross beta, and ^{40}K were routinely performed on the soil and water samples. The results from these analyses are found in the ER Division Records Control Data Base.

8. SPECIAL NOTES ON INSTALLATION AND DEVELOPMENT

The following special events took place during the drilling of the GQM wells in WAG 5.

- A predevelopment water sample showed 4,300,000 Bq/L tritium in well 969.
- A predevelopment water sample showed 26,000 Bq/L tritium in well 970.
- A predevelopment water sample showed 68,000 Bq/L tritium in well 971.
- Radioactivity levels ranging from 0.5 to 2.0 mR were detected in the borehole at 7 ft in well 972. A predevelopment water sample showed 91,000 Bq/L tritium.
- Radioactivity levels of 0.2 mR were detected in the borehole at 5.5 ft in well 973. A predevelopment water sample showed 23,000,000 Bq/L tritium. A development water sample showed 18,000,000 Bq/L tritium, and two containment box samples showed 43 and 90 Bq/L Beta.
- A predevelopment water sample showed 4,300,000 Bq/L tritium in well 974. A development water sample showed 3,500,000 Bq/L tritium.
- Radioactivity levels of 0.5 to 1.0 mR were detected in the borehole at 6 ft in well 975.

REFERENCES

1. *Construction Specifications for Monitoring Wells Installation Construction Project*, K-4491G-G1, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., August 1988, Rev. 2.

2. MCI Consulting Engineers, Inc., *Preliminary Geohydrologic Site Characterization and Proposed Water Quality Well Locations for WAG 4, 5, 3, and SWSA 1*, ORNL/RAP/Sub-86/72139/1, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., February 1987.

3. Environmental Compliance and Health Protection Division, *Health, Safety, and Environmental Protection Procedures for Excavating Operations*, ORNL/M-116/R1, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., March 3, 1988.

4. J. A. Mortimore, *Task Management Plan for Groundwater Quality Monitoring Well Installation*, ORNL/RAP/LTR-88/28, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., February 1988.

Appendix A

Data Packages

1.0 General Information

1.1 Well Location

Monitoring well number 963 is located in WAG 5. It is in the northwestern corner of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 19045.243, E 29700.017 (X-10 grid) or latitude 35° 55' 03.64" and longitude 84° 18' 54.48". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 963 was drilled by A.L. Clark Drilling Services, Inc. A Driltech air rotary rig was used to drill this boring for monitor well installation under the operation of Steve Clark with the assistance of Ray Clark. Drilling commenced on

7/21/87 and was finished on 7/28/87. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/ completion form. A synopsis of the drilling activity follows:*

7/21/87: The drill rig and tools were decontaminated. The rig was mobilized to the location and set up. Split spoon samples were taken from the surface to 4.0'. The hole was then drilled with a 14" auger from the surface to 20.0'.

7/22/87: Thirty five pounds of bentonite and 4 gallons of water were poured into the hole and 21.5' of 8 5/8" surface casing was installed and grouted in with 12 sacks of cement.

7/23/87: The well was deepened with a 6 1/2" tricone from 20' to 95'.

7/24/87: The well had 22' of water overnight. Thirty feet of 2" stainless steel screen and 65' of stainless steel casing were installed with a sandpack and bentonite seal.

7/28/87: The annular space from the top of the bentonite seal to the surface was grouted.

* This information was typed directly from field notes and was edited only when necessary for clarification.

This well was logged by ERC Environmental and Energy Services Co. (ERC/EDGe), hydrogeologist Michael L. Ebers. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak

Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

Two soil samples were collected during drilling, placed in an I-CHEM specialty cleaned glass container, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody form for these samples are included with this data package. Soil sample 0963S01 was collected in the split spoon interval from 2.0 feet to 2.2 feet on 7/21/87 and soil sample 0963S02 was collected in the augered interval at 13 feet on 7/21/87. A drill water sample was collected from the water pump on the drill rig on 7/23/87. Analytical results for the three samples described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type D well. A fourteen-inch diameter boring was augered from ground surface to 20.0 feet. An eight-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill a six-inch diameter boring to a total depth of 95.0 feet. A two-inch diameter stainless steel silt trap was installed from 94.8 to 95.0 feet. Above the silt trap, a two-inch diameter stainless steel screen was installed from 64.8 feet to 94.8 feet. A two-inch diameter stainless steel casing was installed above the screen at 64.8 feet and extended 1.72 feet above ground surface. A sandpack was then poured into the annular space from 56.0 to 95.0 feet, with a 4.0-foot bentonite seal poured into the annular space above the sandpack from 52.0 to 56.0 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 963 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 197 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 5.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 3/1/90 at a depth of 92.5 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 963 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Ommidata Datapod II data recorder. The hydraulic conductivity value of 1.45×10^{-6} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 963

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	7/21/87	MLE
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	7/21/87	MLE
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	7/24/87	MLE
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	7/21/87	MLE
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	7/21/87	MLE
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	7/21/87	MLE

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE [signature] 7/24/87

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 963

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE _____ 7/21/87

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 963

ORNL MONITORING WELL LOG

LOCATION: SWSA 5
DRILLER: Steve Clark
HELPER: Ray Clark
DRILL: Driltech

DATE: START: 7-21-87
FINISH: 7-24-87
LOGGED BY: Michael L. Ebers
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger and Air Rotary
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: Two
TYPE: Soil
CONTAINMENT TYPE: Auger Pan, Plastic and Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 4.0
DEPTH DRILLED IN ROCK: 91.0
TOTAL DEPTH OF WELL: 95.0

DRILLING FLUID SAMPLES:
TYPE: Drill Water DATE: 7-23-87

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	0.1		100	Topsoil and roots.
0.1	0.4		100	Loam, sandy and silty, dark yellowish brown.
0.4	0.5		100	Wood, tree root?
0.5	1.0		100	Loam, sandy, silty with siltstone remnants,
				mottled, yellowish orange and moderate brown,
				dry, friable.
1.6	4.0	0963S01	80	Siltstone and fine sandstone, dark yellowish
		@ 2.0-2.2'		orange and moderate brown, weathered, bedding
				75° to vertical, somewhat contorted, dry,
				friable.
	@4.0			Split spoon refusal - split spoon samples too
				friable for bulk density measurement.
4.0	12.0			Shale, very silty, dark olive gray, greenish
				gray and dark brown, weathered, iron stained.
12.0	14.0	0963S01		Shale, light greenish gray, weathered, damp,
		@ 13.0'		slightly silty.
14.0	20.0			Shale, very silty, dark brown and dark olive
				gray, dry, weathered.
20.0	66.0			Shale *
66.0	69.0			Limestone.
69.0	82.0			Shale.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 963

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
82.0	83.0			Cavity.
83.0	95.0			Shale.
	95.0			Total Depth
				*No detailed lithologic description available
				for the interval from 20.0' to 95.0' due to
				the use of a containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 963

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Michael L. Ebers

PROOFED BY: Bruce McMaster

DRILLING COMPANY: A. L. Clark Drilling Services

DRILLER: Steve Clark HELPER: Ray Clark

DRILLING METHOD:
- ☒ 14.0 INCH AUGER 20.0 L.F.
- ☐ _____ INCH AUGER _____ L.F.
- ☒ 6.5 INCH ROTARY 75.0 L.F.
- ☐ _____ INCH ROTARY _____ L.F.

LOCATION WAG 5

ORNL GRID COORDINATES
N 19,045.243
E 29,700.017

ELEV. GROUND 838.15

ELEV. TOP STAINLESS STEEL CASING 839.87

DRILLING DATES:
STARTED: 7-21-87
FINISHED: 7-28-87

MATERIALS USED

EST. VOL	USED VOL	
	35.0	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	20.0	FT. OF 8 5/8 IN. SURFACE CASING
9.2	12.0	SACKS OF CEMENT (SURFACE CASING)
	N/A	POUNDS OF POWDERED BENTONITE (SURFACE CASING)
	84.0	GALLONS OF WATER (SURFACE CASING)
	66.5	FT. OF 2 IN. DIA. STAINLESS STEEL CASING
	30.0	FT. OF 2 IN. DIA. STAINLESS STEEL SCREEN
5.8	7.0	SACKS OF SAND
56.0	50.0	POUNDS OF BENTONITE PELLETS
10.0	10.0	SACKS OF CEMENT (WELL CASING)
	20.0	POUNDS OF POWDERED BENTONITE (WELL CASING)
	70.0	GALLONS OF WATER (WELL CASING)
	2.81	FT. OF 8 5/8 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Spillage and irregular auger boring diameter.

SURFACE CASING TREMIE GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ☒ NO ☐

WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

SILT TRAP USED YES ☒ NO ☐

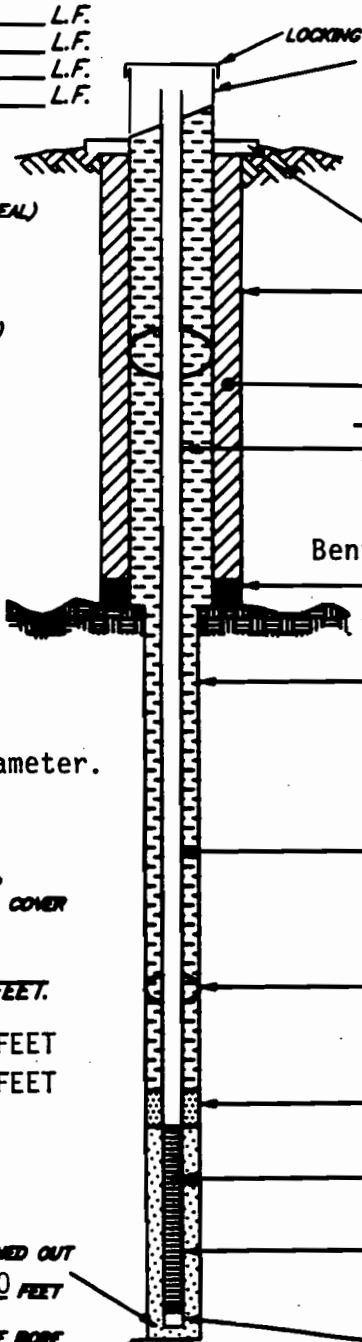
MONITORING WELL PUMP BASE SET AT 92.5 FEET.

CENTRALIZERS AT 3.0 FEET. 75.0 FEET
15.0 FEET. 95.0 FEET
35.0 FEET.
55.0 FEET

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT TO 95.0 FEET

BOTTOM OF BORE HOLE 95.0 FEET



TYPE D WELL

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 963

DATE: 7-24-87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		7-24-87	02
BENTONITE		7-24-87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	7-24-87	04
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	7-24-87	04
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	7-24-87	04
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	7-24-87	04
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	3-01-90	03
GROUT		7-22-87	08
WELL COVERS			
SURFACE CASING		7-22-87	01

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 7-24-87

Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 963

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	7-24-87	MLE
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	7-24-87	MLE
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	3-01-90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	7-24-87	MLE

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Michael L. Ebers 7-24-87

Michael L. Ebers

D. Charles Lytle 3-01-90

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 963

LOCATION: WAG 5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 2-15-90 TIME:

DEVELOPMENT ENDING DATE: 3-01-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 24.7 GALLONS

TOTAL GALLONS PUMPED: 197 TOTAL WELL VOLUMES PUMPED: 8.0

INITIAL pH: 7.7 FINAL pH: 7.3

INITIAL CONDUCTIVITY (uS): 878 FINAL CONDUCTIVITY (uS): 769

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 5.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☐ GROUND SURFACE
- ☐ STORM SEWERS
- ■ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 37.2 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D Charles Lytle 3-01-90

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 963
LOCATION: WAG 5
DATE: 2-15-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 24.7 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
2-15-90	1500	68	Cloudy	--	7.7	878	68	2.8	
2-16-90	1400	17	Cloudy	--	7.7	804	85	3.4	
3-01-90	1400	112	Clear	5.0	7.3	769	197	8.0	
RESULTS AT END OF DEVELOPMENT			Clear	5.0	7.3	769	197	8.0	

COMMENTS Poor producer, water finally cleared to 5 NTU, passed and moved off hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 3-01-90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 963

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 963 DATE OF TEST: 3/28/90

PROJECT NO.: e221-002 CLIENT: mmes

SITE LOCATION: wao 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 30.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 57.40 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 30.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .96 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR HO (FEET)
6.3459
6.3475

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SECV)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	7.310	6.350
20.00	7.310	6.350
30.00	7.300	6.340
40.00	7.300	6.340
50.00	7.290	6.330
60.00	7.290	6.330
75.00	7.280	6.320
90.00	7.270	6.310
105.00	7.260	6.300
120.00	7.240	6.280
150.00	7.220	6.260
180.00	7.200	6.240
240.00	7.150	6.190
300.00	7.110	6.150
360.00	7.060	6.100
420.00	7.020	6.060
480.00	6.980	6.020
540.00	6.950	5.990
600.00	6.900	5.940
720.00	6.830	5.870
840.00	6.760	5.800
960.00	6.690	5.730
1080.00	6.620	5.660
1200.00	6.560	5.600
1320.00	6.500	5.540
1440.00	6.440	5.480
1560.00	6.380	5.420
1680.00	6.320	5.360
1800.00	6.260	5.300
1920.00	6.200	5.240
2040.00	6.150	5.190
2160.00	6.090	5.130

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

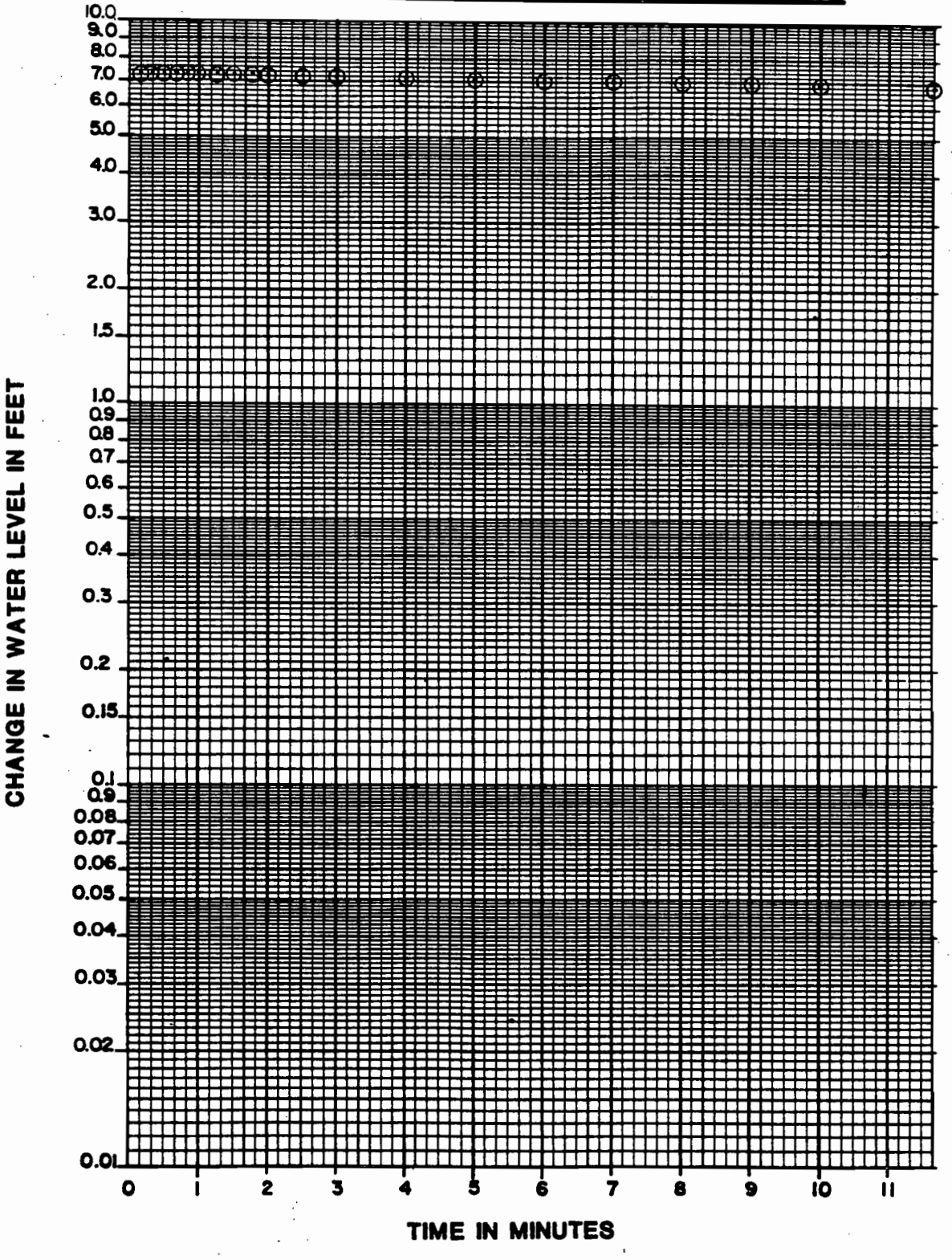
PERMEABILITY = 4.75E-08 FT/SECV = 1.45E-06 CM/SECV

TRANSMISSIVITY = 1.43E-06 FT**2/SECV

ERC / EDGE Environmental and Energy Services Co.

WELL No. 963

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0963501

WELL NO.: 0963

LOCATION: SWSA 5 @ 2.0-2.2'

TYPE: SOIL

SAMPLER: [signature] (SIGNATURE)

DATE: 7/21/87

TIME: 12:45 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME: (MT)	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	7/31/87	1:30 PM ~~[illegible]~~	MCI	Nancy Owen	7/31/87	1:30 pm	

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0963502

WELL NO.: 0963

LOCATION: SWSA 5 @ 13'

TYPE: SOIL

SAMPLER: [signature] (SIGNATURE)

DATE: 7/21/87

TIME: 1:30 P.M.

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	7/31/87	1:30 PM	MCI	Nancy Owen	7/31/87	1:30 pm	

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0963W01

WELL NO.: 0963

LOCATION: SWSA 5 @ 35'

TYPE: DRILL WATER

SAMPLER: [signature] (SIGNATURE)

DATE: 7/23/87

TIME: 9:20 A.M

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	7/31/87	1:30 PM	MCI	Nancy Oliver	7/31/87	1:30 pm	

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 964 is located in WAG 5. It is 40 feet south of the north boundary fence. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 18844.948, E 30100.9457 (X-10 grid) or latitude 35° 55' 04.20" and longitude 84° 18' 49.07". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 964 was drilled by A.L. Clark Drilling Services, Inc. A Driltech air rotary rig was used to drill this boring for monitor well installation under the operation of Steve Clark with the assistance of Steve Kirk. Drilling commenced on 7/28/87 and was finished on 7/30/87.

Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

7/24/87 & 7/27/87: The Driltech rig was steam cleaned.

7/28/87: The rig was moved on location and set up. The interval from 0.0' to 5.8' was split spooned. The boring was drilled from 0.0' to 20.0' with a 14" auger and 8 5/8" surface casing was set in the boring.

7/29/87: The surface casing was grouted.

7/30/87: The diverter head and containment box were installed and the boring was deepened with a 6 1/4" tricone roller bit from 20.0' to 50.0'. Stainless steel screen, casing, sandpack and bentonite were installed.

7/31/87: The annular space was partially grouted.

8/10/87: The remaining annular space was grouted to the surface.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist Michael L. Ebers. All well construction materials and supplies were from Martin Marietta Energy

* This information was typed directly from field notes and was edited only when necessary for clarification.

Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale,

Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

Two samples were collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 0964S01 was collected in the split spoon interval from 1.8 feet to 2.0 feet on 7/28/87 and soil sample 0964S02 was collected in the augered interval at 20.0 feet on 7/28/87. Drill water sample (0964W01) was collected from the water pump on the drill rig on 7/30/87. Analytical results for the three samples described above can be obtained from the Remedial Action Program data base at ORNL.

A bulk density soil sample was collected from the split spoon sample interval from 5.3 feet to 5.8 feet. The sample was measured and weighed, and a bulk density of 1.99 grams/cm^3 was calculated.

2.4 Installation and Development

2.4.1 Installation

This was a type D well. A fourteen-inch diameter boring was augered from ground surface to 20.0 feet. An eight-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill a six-inch diameter boring to a total depth of 50.0 feet. A two-inch diameter stainless steel silt trap was installed from 49.0 to 49.2 feet. Above the silt trap, a two-inch diameter stainless steel screen was installed from 29.0 feet to 49.0 feet. A two-inch diameter stainless steel casing was installed above the screen at 29.0 feet and extended 2.32 feet above ground surface. A sandpack was then poured into the annular space from 26.5 to 49.2 feet, with a 2.0-foot bentonite seal poured above the sand. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 964 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use
according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 137 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 5 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/8/90 at a depth of 46.5 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 964 was tested for the determination of hydraulic conductivity of the aquifer in the

vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 7.55×10^{-6} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 964

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	7/27/87	MLE
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	7/27/87	MLE
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	7/30/87	MLE
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	NA	
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	7/27/87	MLE
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	7/27/87	MLE
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	7/27/87	MLE

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 7/20/87

Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 964

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE [signature] 7/27/87
Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 964

ORNL MONITORING WELL LOG

LOCATION: WAG 5
DRILLER: Steve Clark
HELPER: Steve Kirk
DRILL: Driltech

DATE: START: 7/27/87
FINISH: 7/30/87
LOGGED BY: Michael L. Ebers
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger and air rotary
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: Two
TYPE: Soil
CONTAINMENT TYPE: Auger pan, plastic and containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 22.0
DEPTH DRILLED IN ROCK: 28.0
TOTAL DEPTH OF WELL: 50.0

DRILLING FLUID SAMPLES:
TYPE: Water
DATE: 7/30/87

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	0.1		100	Topsoil, moderate yellowish-brown, silty with
				grass roots
0.1	0.9		100	Clay, silty, pale yellowish-brown with medium
				brown speckles, loose and crumbly, dry, few
				roots
0.9	1.9	0964S01	100	Clay, light brown, dark yellowish-orange and
		@ 1.8-2.0'		reddish-brown, mottled, silty, medium stiff,
				dry, plastic
1.9	3.9		100	Shale, deeply weathered and clay, dark yellowish
				orange and moderate yellowish-brown, silty,
				very steeply dipping (70 to 90°), medium stiff,
				plastic
3.9	5.8		100	Thinly laminated siltstone and shale, weathered,
				moderate yellowish-brown, pale yellowish-brown
				and reddish-brown, dry, crumbly to semi-plastic
				dry
				Bulk density at 5.3-5.8' = 1.99 gms/cm^3
	@5.8			Split spoon refusal
5.8	20.0	0964S02		Siltstone and shale, weathered, dark yellowish
		@ 20'		brown, dry
20.0	22.0			Shale, soft*

ERC / EDGE Environmental and Energy Services Co.

WELL No. 964

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
22.0	24.0			Shale, medium hard
24.0	26.0			Shale, very soft
26.0	28.0			Shale, medium soft
28.0	28.5			Shale, very soft
28.5	30.0			Shale, medium hard
30.0	45.0			Shale, fairly soft
45.0	50.0			Fairly hard
	50.0			Total Depth
				* No detailed lithologic description available
				for the interval from 20.0' to 50.0' due to
				the use of a containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 964

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Michael L. Ebers
PROOFED BY: Bruce McMaster

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: Steve Clark HELPER: Steve Kirk

DRILLING METHOD:
- [x] 14.0 INCH AUGER 20.0 L.F.
- [ ] ____ INCH AUGER ____ L.F.
- [x] 6 1/4 INCH ROTARY 30.0 L.F.
- [ ] ____ INCH ROTARY ____ L.F.

LOCATION WAG 5
ORNL GRID COORDINATES
N 18844.9480
E 30100.9457
ELEV. GROUND 831.51
ELEV. TOP STAINLESS STEEL CASING 833.83

DRILLING DATES:
STARTED: 7/27/87
FINISHED: 7/30/87

MATERIALS USED

EST. VOL	USED VOL	
	25.0	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	20.0	FT. OF 8 5/8 IN. SURFACE CASING
9.1	10.0	SACKS OF CEMENT (SURFACE CASING)
	20.0	POUNDS OF POWDERED BENTONITE (SURFACE CASING)
	70.0	GALLONS OF WATER (SURFACE CASING)
	31.3	FT. OF 2 IN. DIA. STAINLESS STEEL CASING
	20.0	FT. OF 2 IN. DIA. STAINLESS STEEL SCREEN
3.7	5.5	SACKS OF SAND
25.0	25.0	POUNDS OF BENTONITE PELLETS
3.2	8.0	SACKS OF CEMENT (WELL CASING)
	16.0	POUNDS OF POWDERED BENTONITE (WELL CASING)
	56.0	GALLONS OF WATER (WELL CASING)
	3.4	FT. OF 8 5/8 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Cavities and spillage

SURFACE CASING TREMIE GROUTED YES [x] NO [ ]

STAINLESS STEEL CASING TREMIE GROUTED YES [x] NO [ ]

WELL COVER USED
- [x] LOCKING STEEL COVER
- [ ] FLUSH MOUNTED WELL COVER
- [ ] OTHER

SILT TRAP USED YES [x] NO [ ]

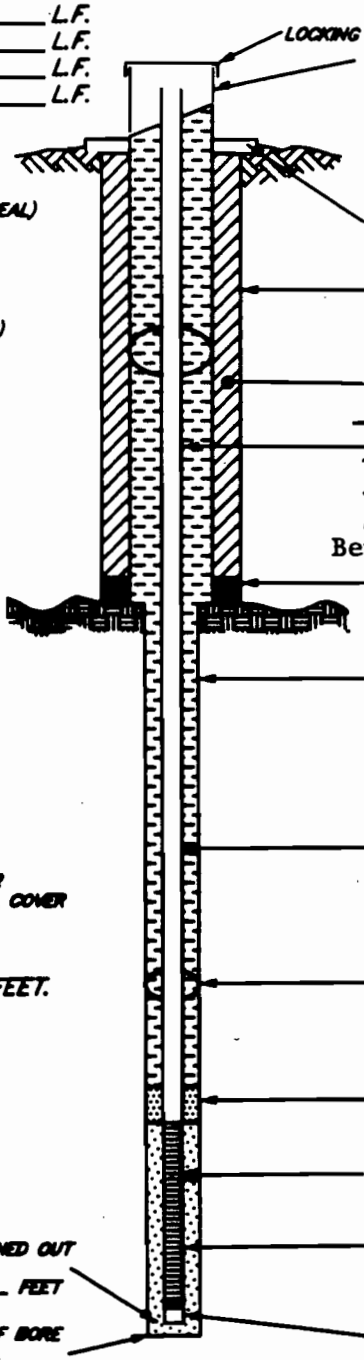
MONITORING WELL PUMP BASE SET AT 46.5 FEET.

CENTRALIZERS AT 5.0 FEET.
30.0 FEET.
50.0 FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT TO 49.2 FEET

BOTTOM OF BORE HOLE 50.0 FEET



LOCKING CAP
10 IN. DIA. SURFACE/PROTECTIVE CASING 3.39 FEET ABOVE GROUND SURFACE TO 20.0 FEET BELOW GROUND SURFACE
CONCRETE PAD
14 IN. DIA. BORE HOLE 0.0 TO 20.0 FEET
GROUT SEAL 0.0 TO 19.0 FEET
2 IN. STAINLESS STEEL CASING 2.32 FEET ABOVE GROUND SURFACE TO 29.0 FEET BELOW GROUND SURFACE
Bentonite SEAL 19.0 TO 20.0 FEET
BEDROCK LEVEL 22.0
6 1/4 IN. DIA. BORE HOLE
GROUT SEAL 0.0 TO 24.5 FEET
CENTRALIZER
BENTONITE PELLET SEAL 24.5 TO 26.5 FEET
SAND PACK 26.5 TO 49.2 FEET
2 IN. DIA. STAINLESS STEEL SLOTTED SCREEN 29.0 TO 49.0 FEET
2 IN. DIA. STAINLESS STEEL SILT TRAP/CAP 49.0 TO 49.2 FEET

TYPE D WELL

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 964

DATE: 7/27/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		7/30/87	02
BENTONITE		7/29/87	01
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	7/30/87	05
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	7/30/87	04
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	7/30/87	04
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	7/30/87	04
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	1/4/90	03
GROUT		7/29/87 7/31/87	08
		8/10/87	09
WELL COVERS			
SURFACE CASING		7/29/87	01

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers

Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 964

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	7/30/87	MLE
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	7/30/87	MLE
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/5/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	7/30/87	MLE

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Michael L. Ebers 7/30/87
Michael L. Ebers

D. Charles Lytle 1/5/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 964

LOCATION: WAG5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Pumping

DEVELOPMENT BEGAN DATE: 1/4/90 TIME:

DEVELOPMENT ENDING DATE: 1/5/90

DEVELOPMENT OBSERVED BY: D. Charles Lytle and Michael L. Ebers

ONE WELL VOLUME: 13.7 GALLONS

TOTAL GALLONS PUMPED: 137 TOTAL WELL VOLUMES PUMPED: 10.0

INITIAL pH: 6.3 FINAL pH: 6.8

INITIAL CONDUCTIVITY (uS): 979 FINAL CONDUCTIVITY (uS): 977

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 4.9 NTU's

WELL APPROVED BY: Michael L. Ebers

ODOR OF WATER: None

WATER DISCHARGED TO:
- ■ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 19.5' from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE: [signature] 1/5/90

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 964
LOCATION: WAG5
DATE: 1/4/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 13.7 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
1-4-90	4:00	76	Cloudy		6.3	979	76	5.5	
1-5-90	12:00	61	Clear	4.9	6.8	977	137	10.0	
RESULTS AT END OF DEVELOPMENT			Clear	4.9	6.8	977	137	10.0	

COMMENTS

OBSERVER SIGNATURE/DATE Michael L. Ebers 1/5/90
Michael L. Ebers

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 964 DATE OF TEST: 2/27/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 26.90 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .99 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

7.0164
7.0576

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	9.020	8.030
20.00	8.850	7.860
30.00	8.690	7.700
40.00	8.570	7.580
50.00	8.440	7.450
60.00	8.340	7.350
75.00	8.180	7.190
90.00	8.040	7.050
105.00	7.920	6.930
120.00	7.800	6.810
150.00	7.590	6.600
180.00	7.400	6.410
240.00	7.090	6.100
300.00	6.830	5.840
360.00	6.610	5.620
420.00	6.420	5.430
480.00	6.260	5.270
540.00	6.100	5.110
600.00	5.970	4.980
720.00	5.740	4.750
840.00	5.530	4.540
960.00	5.360	4.370
1080.00	5.210	4.220
1200.00	5.080	4.090
1320.00	4.960	3.970
1440.00	4.860	3.870
1560.00	4.760	3.770
1680.00	4.670	3.680
1800.00	4.590	3.600
1920.00	4.520	3.530
2040.00	4.450	3.460
2160.00	4.390	3.400

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

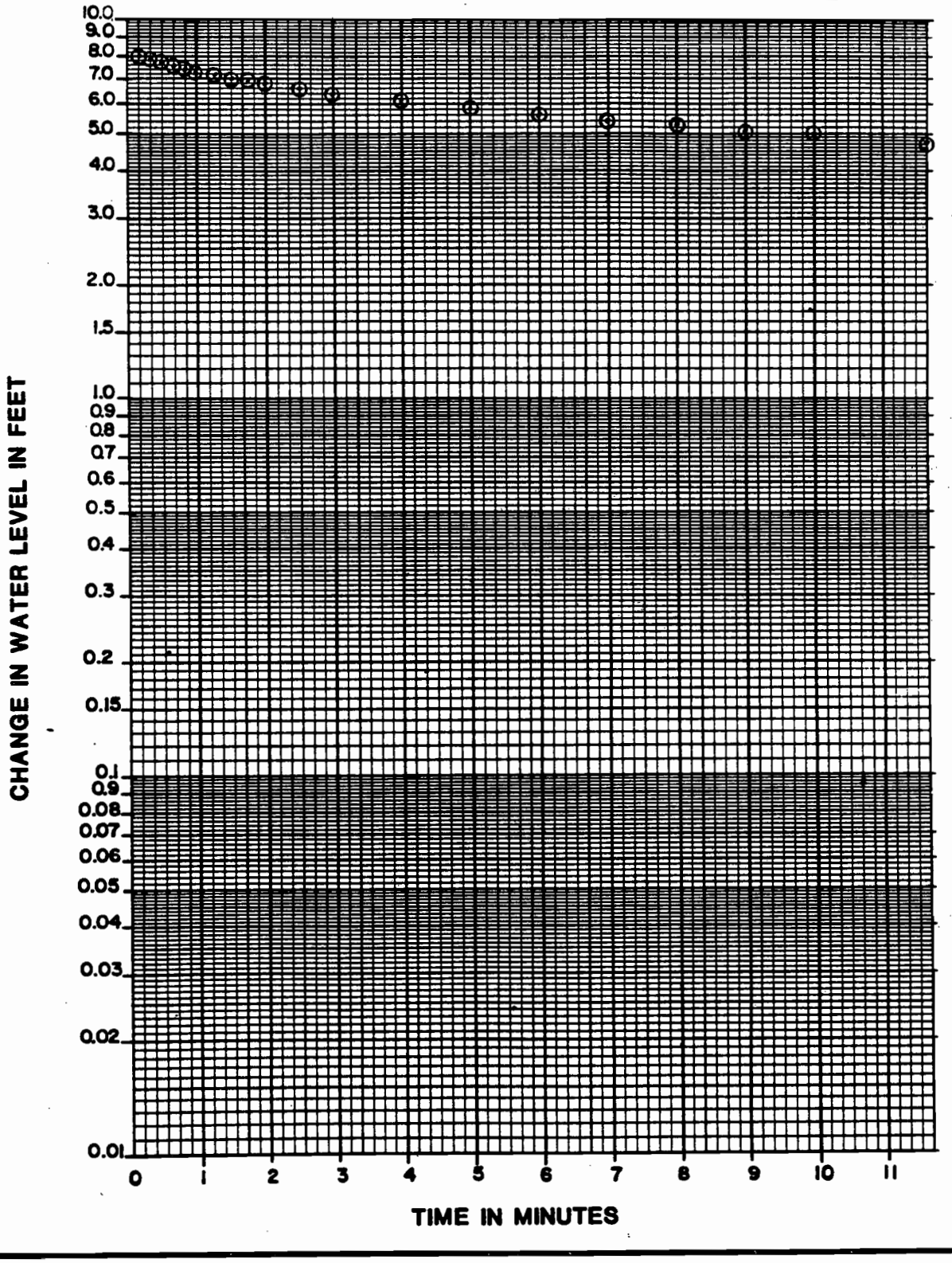
PERMEABILITY = 2.48E-07 FT/SEC = 7.55E-06 CM/SEC

TRANSMISSIVITY = 4.95E-06 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 964

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0964S01

WELL NO.: 0964

LOCATION: SWSA 5 @ 1.8' TO 2.0'

TYPE: Soil

SAMPLER: [signature] (SIGNATURE)

DATE: 7/28/87

TIME: 10:50 A.M.

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	7/31/87	1:30 PM	MCI	Nancy Owen	7/31/87	1:30 pm	

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0964S02

WELL NO.: 0964

LOCATION: SWSA 5 @ 20'

TYPE: SOIL

SAMPLER: [signature] (SIGNATURE)

DATE: 7/28/87

TIME: 11:30 A.M.

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	7/31/87	1:30 PM	MCI	[signature]	7/31/87	1:30 pm	

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0964 W01

WELL NO.: 0964

LOCATION: SW54 5 @40'

TYPE: DRILL WATER

SAMPLER: [signature] (SIGNATURE)

DATE: 7/30/87

TIME: 9:30 AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	7/31/87	1:30 PM	MCI	Nancy Owen	7/31/87	1:30 pm	

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 965 is located in WAG 5. It is in the northern part of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 18,398.526, E 30,072.061 (X-10 grid) or latitude 35° 55' 0.67006" and longitude 84° 18' 46.1057". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 965 was drilled by A.L. Clark Drilling Services, Inc. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of Richard Pickel. Drilling commenced on 8/13/87 and was finished on 8/17/87. Paragraph 2.4.1 includes a detailed discussion of

the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

8/13/87: The rig was moved to the well site and setup.

8/14/87: Split spoon samples were taken and drilling with 6" augers commenced.

8/17/87: The boring was drilled to a total depth of 28.5' and bailed. Two inch stainless steel screen, casing, sand and bentonite were installed.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist Bryn D. Howze. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination

* This information was typed directly from field notes and was edited only when necessary for clarification.

procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

One soil sample and one rock sample were collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 0965S01 was collected in the split spoon interval from 0.6 feet to 0.8 feet on 8/13/87 and rock sample 0965R01 was collected in the augered interval at 24.5'.

2.4 Installation and Development

2.4.1 Installation

This was a type A well. A two-inch diameter stainless steel silt trap was installed from 28.3 to 28.5 feet. Above the silt trap a two-inch diameter stainless steel screen was installed from 18.3 to 28.3 feet. A two-inch diameter stainless steel casing was installed above the screen from 18.3 feet to 2.25 feet above ground surface. A sandpack was then poured into the annular space from 16.2 to 28.5 feet, with a 3.2-foot bentonite pellet seal poured into the annular space above the sandpack from 13.0 to 16.2 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 965 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 224 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/11/90 at a depth of 25.6 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 965 was tested for the determination of hydraulic conductivity of the aquifer in the

vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.65×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 965

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	8/12/87	BH
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	8/12/87	BH
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	NA	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	8/12/87	BH
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	8/12/87	BH
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	8/12/87	BH
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.		

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Bryn Howze 8/12/87
Bryn D. Howze

ERC / EDGE Environmental and Energy Services Co.

WELL No. 965

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE Bryn Howze 8/13/87
Bryn D. Howze

ERC / EDGE Environmental and Energy Services Co.

WELL No. 965

ORNL MONITORING WELL LOG

LOCATION: WAG 5
DRILLER: Richard Pickel
HELPER: Leo Johnson
DRILL: Schramm Rotadrill

DATE: START: 8/13/87
FINISH: 8/17/87
LOGGED BY: Bryn D. Howze
HEALTH PHYSICIST: Jeff Whitesides

TYPE DRILLING: Auger
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: Two
TYPE: One soil and one rock
CONTAINMENT TYPE: Containment pan and plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 2.2'
DEPTH DRILLED IN ROCK: 26.3'
TOTAL DEPTH OF WELL: 28.5'

DRILLING FLUID SAMPLES:
TYPE: N/A
DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	2.5	0965S01	85	Silt, slightly sandy, light brown, mottled red,
		@ 0.6-0.8'		black and greenish-gray with roots, weathered
				shale fragments, hard
2.5	4.0		100	Shale, highly weathered, silty, yellow-brown,
				stiff
4.0	5.0		25	Shale, highly weathered, silty, yellow-brown,
				stiff
	@5.0			Split spoon refusal
5.0	15.0			Shale, highly weathered, silty, yellow-brown,
				stiff
15.0	28.5	0965R01		Limestone, bluish-gray, fine grained, slightly
		@ 24.5'		moist at 17.0', hard drilling at 18.0', wet at
				22.0', hard drilling at 25.0'
	28.5			Total Depth

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 965

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Bryn D. Howze
PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: Richard Pickel HELPER: N/A

EQUIPMENT ☒ 6 1/4 INCH AUGER 28.5 L.F.
☐ _____ INCH AUGER _____ L.F.

LOCATION WAG 5
ORNL GRID COORDINATES
N 18398.526
E 30072.061
ELEV. GROUND 812.20
ELEV. TOP STAINLESS STEEL CASING 814.45

DRILLING DATES:
STARTED: 8/13/87
FINISHED: 8/17/87

MATERIALS USED

EST. VOL.	USED VOL.	
	10.0	FEET OF 2 IN. S.S. SCREEN
	20.5	FEET OF 2 IN. S.S. CASING
3.0	3.0	SACKS OF SAND
50.0	50.0	POUNDS OF BENTONITE PELLETS
2.0	2.0	SACKS OF CEMENT
	NA	POUNDS OF POWDERED BENTONITE
	14.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

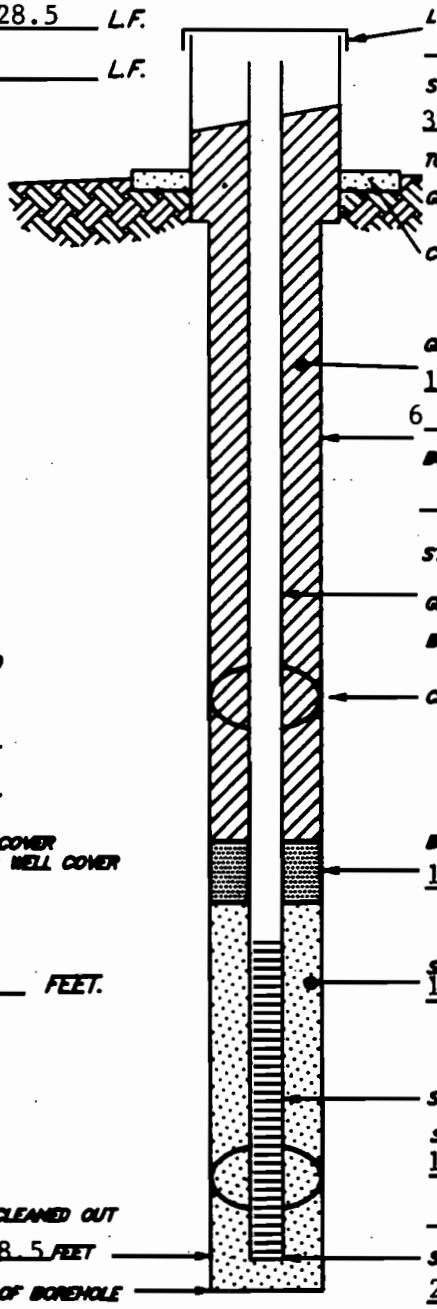
WELL COVER USED ☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 25.6 FEET.

CENTRALIZERS AT 5.0 FEET.
18.5 FEET.
28.3 FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER
8 INCH DIAMETER STEEL PROTECTIVE CASING
3.34 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO 13.0 FEET

6 1/4 INCH DIAMETER BOREHOLE

2 INCH DIAMETER STAINLESS STEEL CASING 2.25 FT. ABOVE GROUND SURFACE TO 18.3 FT. BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL
13.0 TO 16.2 FEET

SAND PACK
16.2 TO 28.5 FEET

2 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN
18.3 TO 28.3 FEET

2 INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP
28.3 TO 28.5 FEET

HOLE CLEANED OUT TO 28.5 FEET

BOTTOM OF BOREHOLE 28.5 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE Environmental and Energy Services Co.

WELL No. 965

DATE: 8/17/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		8/17/87	02
BENTONITE		8/17/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	8/17/87	05
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	8/17/87	04
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	8/17/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	8/17/87	05
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	1/11/90	03
GROUT		8/18/87	09
WELL COVERS			
SURFACE CASING		8/17/87	02

COMMENTS:

OBSERVER SIGNATURE/DATE Bryn Howze 8/18/87
Bryn D. Howze

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 965

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8/18/87	BH
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8/18/87	BH
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/10/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8/18/87	BH

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Bryn Howze 8/18/87
Bryn D. Howze

D. Charles Lytle 1/10/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 965

LOCATION: WAG5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and pumping

DEVELOPMENT BEGAN DATE: 1-2-90 TIME:

DEVELOPMENT ENDING DATE: 1-10-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 7.4 GALLONS

TOTAL GALLONS PUMPED: 224 TOTAL WELL VOLUMES PUMPED: 30.3

INITIAL pH: 6.1 FINAL pH: 7.0

INITIAL CONDUCTIVITY (uS): 605 FINAL CONDUCTIVITY (uS): 214

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0

WELL APPROVED BY: R.C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☐ GROUND SURFACE
- ☐ STORM SEWERS
- ■ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 12.2' water level from surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 1/10/90

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 965
LOCATION: WAG5
DATE: 1-2-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 7.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
1-2-90 1-4-90		83	Muddy		6.1	605	83	11.2	
1-5-90	1130	43	Cloudy		6.9	630	126	17.0	
1-8-90	1100	78	Cloudy		6.9	522	204	27.6	
1-10-90	1500	20	Clear	2.0	7.0	214	224	30.3	
RESULTS AT END OF DEVELOPMENT			Clear	2.0	7.0	214	224	30.3	

COMMENTS Water would not clear after 30 well volumes. Did not surge on 1-10-90; water cleared (had 2.0 NTU's). Passed, moved to next well.

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-10-90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 965 DATE OF TEST: 2/1/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 16.15 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .99 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

3.5798
3.6188

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	5.460	4.470
20.00	5.350	4.360
30.00	5.260	4.270
40.00	5.180	4.190
50.00	5.060	4.070
60.00	4.990	4.000
75.00	4.870	3.880
90.00	4.750	3.760
105.00	4.640	3.650
120.00	4.550	3.560
150.00	4.370	3.380
180.00	4.240	3.250
240.00	3.970	2.980
300.00	3.740	2.750
360.00	3.580	2.590
420.00	3.420	2.430
480.00	3.310	2.320
540.00	3.210	2.220
600.00	3.140	2.150
720.00	2.980	1.990
840.00	2.910	1.920
960.00	2.840	1.850
1080.00	2.750	1.760
1200.00	2.720	1.730
1320.00	2.700	1.710
1440.00	2.680	1.690
1560.00	2.650	1.660
1680.00	2.640	1.650
1800.00	2.600	1.610
1920.00	2.620	1.630
2040.00	2.570	1.580
2160.00	2.560	1.570

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

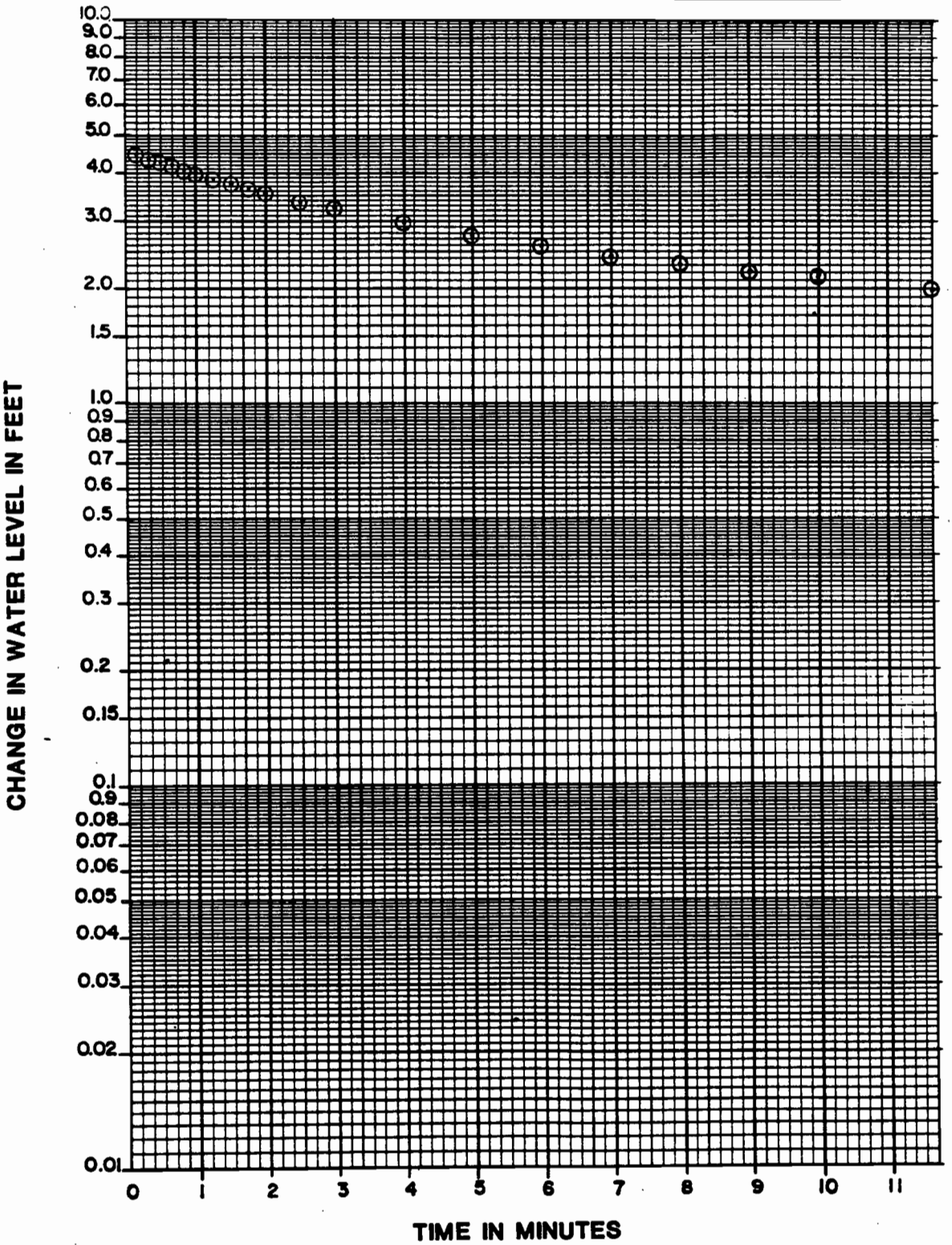
PERMEABILITY = 5.40E-07 FT/SEC = 1.65E-05 CM/SEC

TRANSMISSIVITY = 5.40E-06 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 965

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0965 501

WELL NO.: 965

LOCATION: SWSA 5

TYPE: Soil

SAMPLER: Bryn House (SIGNATURE)

DATE: 8/13/87

TIME: 8:30 AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn House	9/15/87	2:25	MCI	Nancy Owen	9/15/87	2:25	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0965 R01

WELL NO.: 965

LOCATION: SWSA 5

TYPE: Rock Cuttings

SAMPLER: Bryn Howze (SIGNATURE)

DATE: 8/14/87

TIME: 10:55 AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn Howze	9/15/87	2:25	MCI	Nancy Dean	9/15/87	2:25	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 966 is located in WAG 5. It is 50' east of the east boundary fence of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 18,332.790, E 30,202.039 (X-10 grid) or latitude 35° 55' 0.8447" and longitude 84° 18' 44.3481". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 966 was drilled by A.L. Clark Drilling Services, Inc. A Gus Pech auger rig was used to drill this boring for monitor well installation under the operation of A.L. Clark III. Drilling commenced on 8/17/87 and was finished on 8/20/87. Paragraph 2.4.1 includes a detailed discussion of

the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

8/17/87: The Gus Pech was steamed cleaned and mobilized to the location and setup. Split spoon samples were taken from 0.0' to 1.5' and the boring was augered from 0.0' to 18.0' with a 6" auger.

8/18/87: The boring was augered from 18.0' to 22.0'.

8/19/87: The boring was augered from 22.0' to 25.6' total depth and bailed.

8/20/87: The hole was bailed and stainless steel screen, casing, sandpack and bentonite were installed.

8/24/87: The annulus was grouted with one bag of cement.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist Michael L. Ebers. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

* This information was typed directly from field notes and was edited only when necessary for clarification.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out

approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

One soil sample was collected during drilling, placed in an I-CHEM specialty cleaned glass container, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. The chain of custody form for this sample is included with this data package. Soil sample 0966S01 was collected in the split spoon interval from 1.0 feet to 1.1 feet on 8/17/87.

2.4 Installation and Development

2.4.1 Installation

This was a type A well. A two-inch diameter stainless steel silt trap was installed from 24.1 to 24.4 feet. Above the silt trap a two-inch diameter stainless steel screen was installed from 9.1 to 24.1 feet. A two-inch diameter stainless steel casing was installed above the screen from 9.1 feet to 3.03 feet above ground surface. A

sandpack was then poured into the annular space from 7.7 to 24.4 feet, with a 1.9-foot bentonite pellet seal poured into the annular space above the sandpack from 7.7 to 5.8 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 966 was developed to remove drill cuttings, silt, and other fines from the monitoring well. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 349 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 5 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed

on 1/15/90 at a depth of 21.8 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 966 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 4.94×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 966

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	8/17/87	MLE
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	8/17/87	MLE
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	NA	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	8/20/87	MLE
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	8/17/87	MLE
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	8/17/87	MLE
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	8/17/87	MLE

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE: Michael L. Ebers 8/20/87

Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 966

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE Michael D. Ebers 8/17/87
Michael D. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 966

ORNL MONITORING WELL LOG

LOCATION: WAG 5
DRILLER: A.L. Clark III
HELPER: N/A
DRILL: Gus Pech

DATE: START: 8/17/87
FINISH: 8/20/87
LOGGED BY: Michael L. Ebers
HEALTH PHYSICIST: Jerry Gray

TYPE DRILLING: Auger
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: One
TYPE: Soil
CONTAINMENT TYPE: Auger pan and plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 1.5
DEPTH DRILLED IN ROCK: 24.1
TOTAL DEPTH OF WELL: 25.6

DRILLING FLUID SAMPLES:
TYPE: N/A
DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	0.2		100	Gravels
0.2	1.5	0966S01	100	Shale, weathered, light olive brown, silty,
		@ 1.0-1.1'		bedding 45° to vertical, dry crumbly, no
				bulk density - crumbly sample
	@1.5			Split spoon refusal
1.5	3.0			Shale, weathered, light olive brown, silty, dry
				crumbly
3.0	4.5			Siltstone, weathered, moderate olive brown,
				blocky, dry
4.5	8.5			Shale, light olive brown, weathered, soft, dry
8.5	13.0			Siltstone, medium gray, calcareous, with
				vertical calcite filled fractures, interbedded
				with shale, dry
13.0	17.0			Siltstone, medium gray, calcareous, with 50%
				shale, gray, dry
17.0	25.6			Siltstone, medium gray, calcareous, fairly hard
				very moist, shale at 22 to 23.5', soft
	25.6			Total Depth

ERC / EDGE Environmental and Energy Services Co.

WELL No. 966

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Michael L. Ebers
PROOFED BY: Bruce McMaster

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: A.L. Clark III
HELPER: NA

EQUIPMENT
■ 6 1/4 INCH AUGER 25.6 L.F.
□ _____ INCH AUGER _____ L.F.

LOCATION WAG 5
ORNL GRID COORDINATES
N 18,332.790
E 30,202.039
ELEV. GROUND 809.70
ELEV. TOP STAINLESS STEEL CASING 812.73

DRILLING DATES:
STARTED: 8/17/87
FINISHED: 8/24/87

MATERIALS USED

EST. VOL.	USED VOL.	
	15.0	FEET OF 2" IN. S.S. SCREEN
	12.1	FEET OF 2" IN. S.S. CASING
3.2	4.2	SACKS OF SAND
35.0	35.0	POUNDS OF BENTONITE PELLETS
1.0	1.0	SACKS OF CEMENT
	NA	POUNDS OF POWDERED BENTONITE
	6.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Spillage

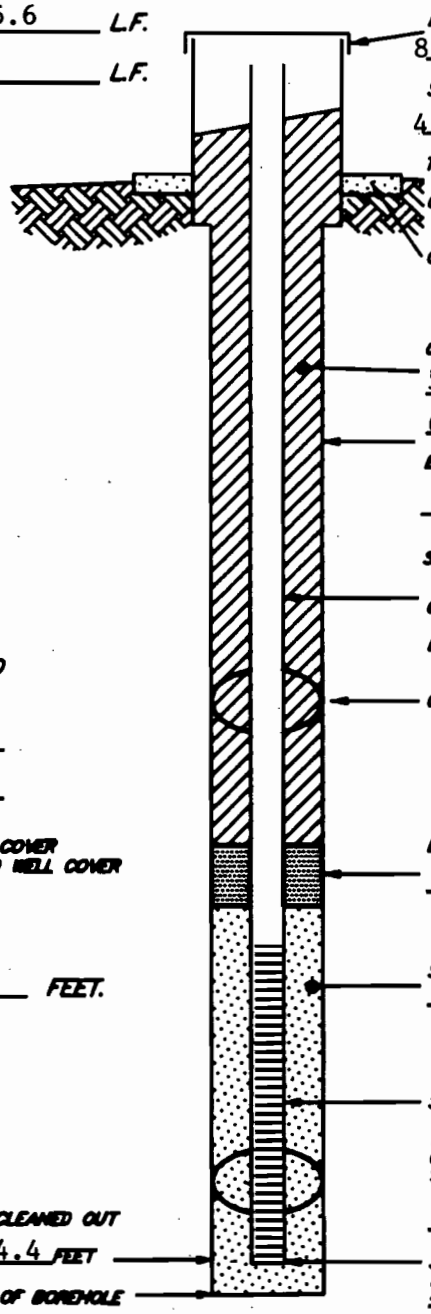
WELL COVER USED
■ LOCKING STEEL COVER
□ FLUSH MOUNTED WELL COVER
□ OTHER

SILT TRAP USED YES ■ NO □

MONITORING WELL PUMP BASE SET AT 21.8 FEET.

CENTRALIZERS AT 9.0 FEET.
24.0 FEET.
_____ FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER
8 5/8 INCH DIAMETER STEEL PROTECTIVE CASING 4.09 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO 5.8 FEET

6 1/4 INCH DIAMETER BOREHOLE

2 INCH DIAMETER STAINLESS STEEL CASING 3.03 FT. ABOVE GROUND SURFACE TO 9.1 FT. BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL 5.8 TO 7.7 FEET

SAND PACK 7.7 TO 24.4 FEET

2 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 9.1 TO 24.1 FEET

2 INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP 24.1 TO 24.4 FEET

HOLE CLEANED OUT TO 24.4 FEET

BOTTOM OF BOREHOLE 25.6 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 966

DATE: 8/20/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			8/20/87	02
BENTONITE			8/20/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED	■ YES ☐ NO)	8/20/87	05
STAINLESS STEEL CASING	(PREPACKAGED	■ YES ☐ NO)	8/20/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	■ YES ☐ NO)	8/20/87	05
STAINLESS STEEL CAPS	(PREPACKAGED	■ YES ☐ NO)	8/20/87	04
MONITORING WELL PUMP	(PREPACKAGED	■ YES ☐ NO)	1/15/90	03
GROUT			8/24/87	10
WELL COVERS			8/20/87	02
SURFACE CASING			8/87	02

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 8/24/87
Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 966

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8/20/87	MLE
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8/20/87	MLE
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/12/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8/20/87	MLE

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Michael L. Ebers 8/20/87
Michael L. Ebers

D. Charles Lytle 1/12/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 966

LOCATION: WAG5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and pumping

DEVELOPMENT BEGAN DATE: 1-2-90 TIME:

DEVELOPMENT ENDING DATE: 1-12-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 10.4 GALLONS

TOTAL GALLONS PUMPED: 349 TOTAL WELL VOLUMES PUMPED: 33.6

INITIAL pH: 6.9 FINAL pH: 7.0

INITIAL CONDUCTIVITY (uS): 545 FINAL CONDUCTIVITY (uS): 478

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 5.0 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ■ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 2.4' from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-11-90

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 966
LOCATION: WAG5
DATE: 1-2-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 10.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
1-2-90	1700	15	Cloudy						
1-3-90	1500	60	Cloudy		6.9	545	75		
1-4-90	1600	61	Cloudy		6.0	513	136	13.1	
1-5-90	1130	26	Cloudy		6.6	498	162	15.6	
1-8-90	1100	35	Cloudy		6.8	393	197		
1-10-90	1300	36	Cloudy		7.2	561	223	21.4	
1-11-90	1330	53	Cloudy		7.1	538	286		
1-11-90	1500	52	Cloudy		7.2	571	338	32.5	
1-12-90	0900	11	Clear	5.0	7.0	478	349	33.6	
RESULTS AT END OF DEVELOPMENT			Clear	5.0	7.0	478	349	33.6	

COMMENTS Water would not clear after 30 well volumes. Did not surge on 1-12-90. water cleared; passed and moved on.

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-12-90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 966 DATE OF TEST: 2/1/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 21.95 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 1.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 30

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR HO (FEET)
1.6899
1.6244

ERC / EDGE Environmental and Energy Services Co.

WELL No. 966

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	2.870	1.870
20.00	2.770	1.770
30.00	2.700	1.700
40.00	2.640	1.640
50.00	2.570	1.570
60.00	2.520	1.520
75.00	2.430	1.430
90.00	2.360	1.360
105.00	2.300	1.300
120.00	2.250	1.250
150.00	2.170	1.170
180.00	2.080	1.080
240.00	1.900	.900
300.00	1.790	.790
360.00	1.710	.710
420.00	1.630	.630
480.00	1.520	.520
540.00	1.460	.460
600.00	1.370	.370
720.00	1.300	.300
840.00	1.250	.250
960.00	1.180	.180
1080.00	1.160	.160
1200.00	1.120	.120
1320.00	1.120	.120
1440.00	1.090	.090
1560.00	1.060	.060
1680.00	1.040	.040
1800.00	1.040	.040
1920.00	1.010	.010

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

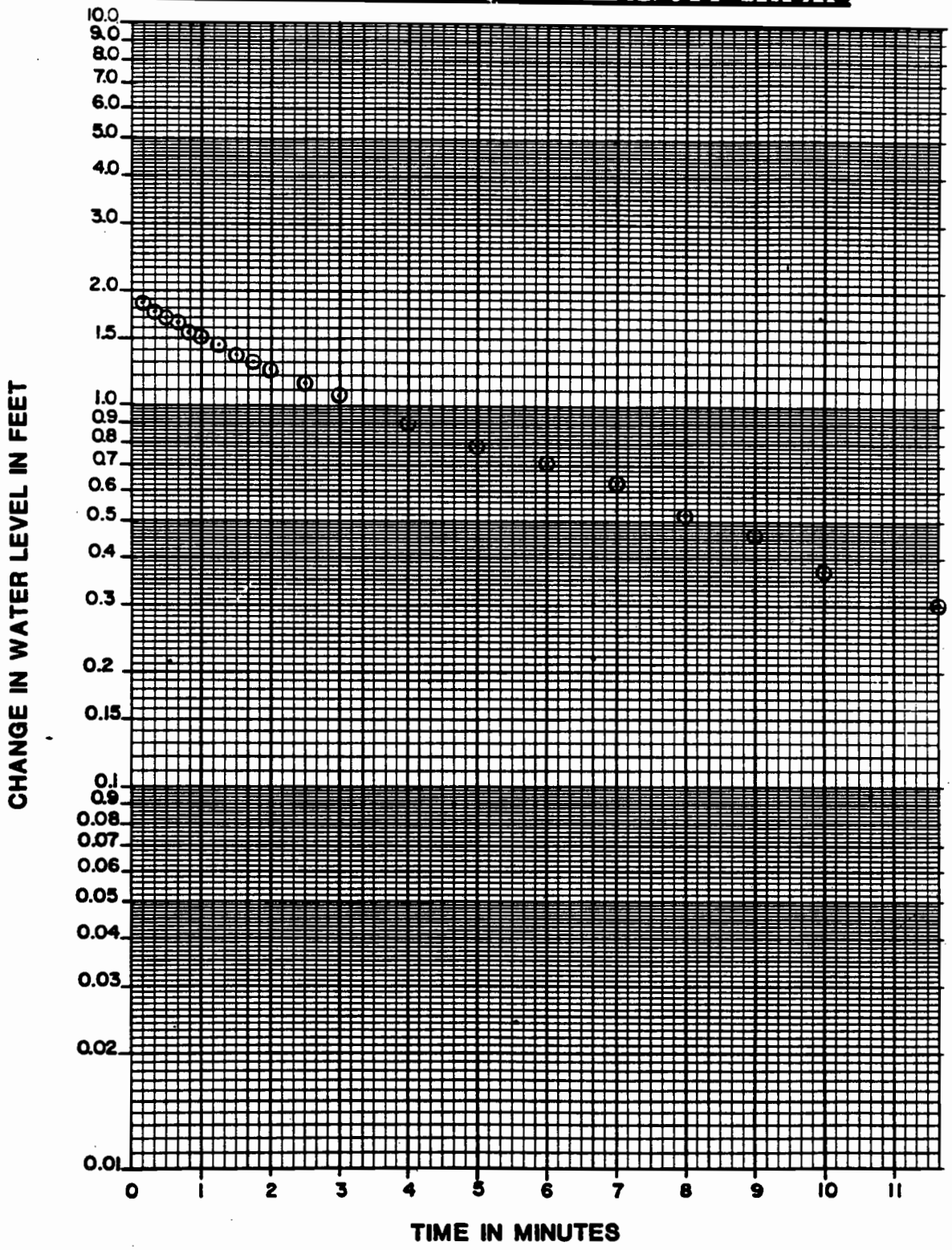
PERMEABILITY = 1.62E-06 FT/SEC = 4.94E-05 CM/SEC

TRANSMISSIVITY = 2.43E-05 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 966

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0966 S01

WELL NO.: 0966

LOCATION: SWSA 5 @ 1.0' TO 1.1'

TYPE: SOIL

SAMPLER: [signature] (SIGNATURE)

DATE: 8/17/87

TIME: 12:00 P.M.

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	9/1/87	12:00	MCI	Nancy Owen	9/1/87	12:00	ORNL CPA

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 967 is located in WAG 5. It is 50 feet outside the east boundary of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 18179.872, E 30447.163 (X-10 grid) or latitude 35° 55' 00.64" and longitude 84° 18' 41.08". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 967 was drilled by A.L. Clark Drilling Services, Inc. A Driltech air rotary rig was used to drill this boring for monitor well installation under the operation of Steve Clark with the assistance of Steve Kirk. Drilling commenced on

8/20/87 and was finished on 8/21/87. Paragraph 2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

8/20/87: The rig and tools were steam cleaned. The rig was mobilized to the staked location and set up. A 14" boring was augered from surface to 22.5'. Ten inch surface casing was placed in the boring and grouted in place.

8/21/87: The boring was advanced from 22.5' to 60.0' total depth with an 8 5/8" tricone roller bit. Four-inch stainless steel screen, casing, sand pack and bentonite were installed in the boring.

This well was logged by ERC Environmental and Energy Services Co. (ERC/EDGe) hydrogeologist John W. Anderson. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

* This information was typed directly from field notes and was edited only when necessary for clarification.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5.

Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

One soil sample and one drill water sample was collected during drilling, placed in an I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 0967S01 was collected in the split spoon interval from 2.9 feet to 3.1 feet on 8/20/87. Drill water sample 0969W01 was collected from the water pump on the drill rig on 8/21/87. Analytical results for the two samples described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type B well. A fourteen-inch diameter

boring was augered from ground surface to bedrock (22.5 feet). A ten-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill an eight-inch diameter boring to a total depth of 60.0 feet. A four-inch diameter stainless steel silt trap was installed from 59.7 to 60.0 feet. Above the silt trap, a four-inch diameter stainless steel screen was installed from 29.7 feet to 59.7 feet. A four-inch diameter stainless steel casing was installed from the top of the screen at 29.7 feet and extending 1.8 feet above ground surface. A sandpack was then poured into the annular space from 28.0 to 60.0 feet, with a 2.0-foot bentonite seal poured into the annular space above the sandpack from 26.0 to 28.0 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 967 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air

compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 309 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 1 NTU (nephelometric turbidity units). A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 12/21/89 at a depth of 57.5 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 967 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and

an Ommidata Datapod II data recorder. The hydraulic conductivity value of 5.94×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 967

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	8/20/87	
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	NA	
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	8/20/87	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	8/20/87	
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	8/20/87	
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	8/20/87	
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	8/20/87	

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE: John W. Anderson 8/20/87

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 967

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE John W. Anderson 8/20/87

ERC / EDGE Environmental and Energy Services Co.

WELL No. 967

ORNL MONITORING WELL LOG

LOCATION: WAG 5
DRILLER: Steve Clark
HELPER: Joe Clark
DRILL: Driltech

DATE: START: 8/20/87
FINISH: 8/21/87
LOGGED BY: John W. Anderson
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Split spoon, auger & air rotary
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: One
TYPE: Soil
CONTAINMENT TYPE: Auger pan, plastic and containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 22.5'
DEPTH DRILLED IN ROCK: 37.5'
TOTAL DEPTH OF WELL: 60.0'

DRILLING FLUID SAMPLES:
TYPE: water
DATE: 8/21/87
0967W01

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	2.6		90	Silty clay, orange, with chert fragments, damp
				fill
2.6	3.1	0967S01		Silty clay, tan, black stain on residual bedding
		@2.9-3.1'		some organic material (organic surface material)
				dry
@3.1				Shale, weathered, hard, tan with black stains,
				dry, split spoon refusal
3.1	22.5			Shale, weathered, hard tan with black stains
				dry
22.5	23.8			Shale, hard, tan, dry
23.8	33.2			Hard*
33.2	37.1			Soft
37.1	45.0			Hard
45.0	47.0			Soft
47.0	60.0			Medium Hard
	60.0			Total Depth
				* No detailed lithologic description available
				for the interval from 23.8' to 60.0' due to
				the use of a containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 967

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: John W. Anderson
PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: Steve Clark HELPER: Steve Kirk

DRILLING METHOD:
- ☒ 14 INCH AUGER 23.8 L.F.
- ☐ INCH AUGER L.F.
- ☒ 8 5/8 INCH ROTARY 36.2 L.F.
- ☐ INCH ROTARY L.F.

LOCATION WAG5
ORNL GRID COORDINATES
N 18179.872
E 30447.163
ELEV. GROUND 852.20
ELEV. TOP STAINLESS STEEL CASING 854.00
DRILLING DATES:
STARTED: 8/20/87
FINISHED: 8/21/87

MATERIALS USED

EST. VOL.	USED VOL.	
	NA	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	23.8	FT. OF 10.75 IN. SURFACE CASING
7.2	9.0	SACKS OF CEMENT (SURFACE CASING)
	18.0	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	54.0	GALLONS OF WATER (SURFACE CASING)
	31.5	FT. OF 4.0 IN. DIA. STAINLESS STEEL CASING
	30.0	FT. OF 4.0 IN. DIA. STAINLESS STEEL SCREEN
7.0	7.0	SACKS OF SAND
50.0	50.0	POUNDS OF BENTONITE PELLETS
9.6	10.0	SACKS OF CEMENT (WELL CASING)
	20.0	POUNDS OF POWERED BENTONITE (WELL CASING)
	60.0	GALLONS OF WATER (WELL CASING)
	2.59	FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Spillage & irregular auger boring diameter

SURFACE CASING TREMIE GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ☒ NO ☐

WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

SILT TRAP USED YES ☒ NO ☐

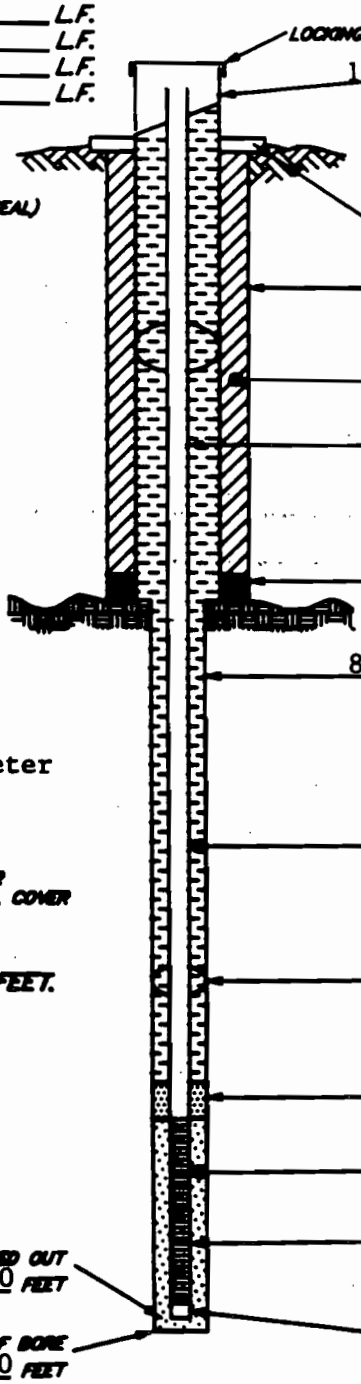
MONITORING WELL PUMP BASE SET AT 57.5 FEET.

CENTRALIZERS AT 5.0 FEET.
19.0 FEET.
40.0 FEET.
59.0 Feet

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT TO 60.0 FEET

BOTTOM OF BORE HOLE 60.0 FEET



TYPE B WELL

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 967

DATE: 8/21/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		8/21/87	02
BENTONITE		8/21/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	8/21/87	05
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	8/21/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	8/21/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	8/21/87	04
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	12/4/89	03
GROUT		8/24/87	10
WELL COVERS			
SURFACE CASING		8/20/87	01

COMMENTS:

OBSERVER SIGNATURE/DATE John W. Anderson 8/24/87

ERC / EDGE Environmental and Energy Services Co.

WELL No. 967

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8/21/87	
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8/21/87	
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	12/20/87	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8/21/87	

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS. PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE John W. Anderson 8/21/87

D. Charles Lytle 12/20/87
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 967

LOCATION: WAG5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging & Pumping

DEVELOPMENT BEGAN DATE: 12-4-89 TIME:

DEVELOPMENT ENDING DATE: 12-20-89

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 47.6 GALLONS

TOTAL GALLONS PUMPED: 309 TOTAL WELL VOLUMES PUMPED: 6.5

INITIAL pH: 6.5 FINAL pH: 6.5

INITIAL CONDUCTIVITY (uS): 363 FINAL CONDUCTIVITY (uS): 363

DESCRIPTION OF INITIAL TURBIDITY: Clear

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 1.0 NTU

WELL APPROVED BY: D. Charles Lytle

ODOR OF WATER: None

WATER DISCHARGED TO:
- ■ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 20.8' from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 12-21-89

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 967
LOCATION: WAG5
DATE: 12/4/89

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 47.6 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
12-4-89 12-19-89		300							
12-20-89	2:00	9	crystal clear	1.0	6.5	363	309	6.5	well developed
RESULTS AT END OF DEVELOPMENT			crystal clear	1.0	6.5	363	309	6.5	

COMMENTS

OBSERVER SIGNATURE/DATE D. Charles Lytle 12-21-89
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 0967 DATE OF TEST: 1/24/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: Michael L. Ebers

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 30.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 41.30 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 30.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .94 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 30

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR H0 (FEET)
.6216
.6350

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	1.950	1.010
20.00	1.890	.950
30.00	1.830	.890
40.00	1.790	.850
50.00	1.730	.790
60.00	1.690	.750
75.00	1.640	.700
90.00	1.590	.650
105.00	1.560	.620
120.00	1.510	.570
150.00	1.450	.510
180.00	1.400	.460
240.00	1.320	.380
300.00	1.290	.350
360.00	1.250	.310
420.00	1.200	.260
480.00	1.200	.260
540.00	1.190	.250
600.00	1.140	.200
720.00	1.110	.170
840.00	1.100	.160
960.00	1.130	.190
1080.00	1.110	.170
1200.00	1.100	.160
1320.00	1.060	.120
1440.00	1.060	.120
1560.00	1.080	.140
1680.00	1.080	.140
1800.00	1.080	.140
1920.00	1.060	.120

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

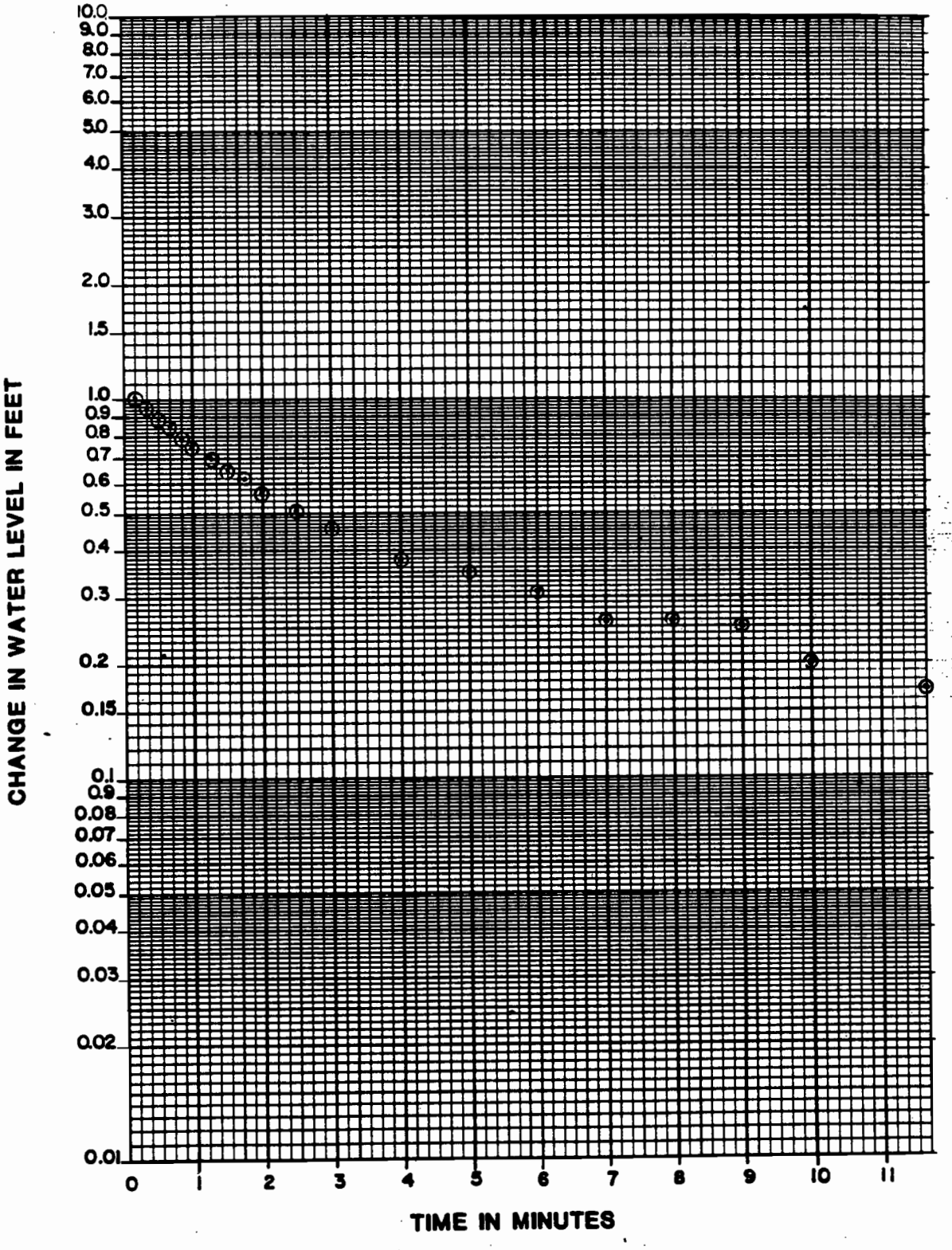
PERMEABILITY = 1.95E-06 FT/SEC = 5.94E-05 CM/SEC

TRANSMISSIVITY = 5.84E-05 FT**2/SEC

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 967

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0967 S01

WELL NO.: 0967

LOCATION: 2.9'-3.1'

TYPE: Soil

SAMPLER: John Anderson (SIGNATURE)

DATE: 8/20/87

TIME: 8:49

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
John Anderson	11/25/87	9:30	MCI	Michael S. Ebner	11/25/87	9:30	MCI
Michael S. Ebner	11/25/87	2:40PM	MCI	Nancy Owen	11-25-87	2:40	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: C967W01

WELL NO.: 0967

SAMPLER: John Anderson (SIGNATURE)

LOCATION: Dr. Hech Drilling Water

TYPE: Water

DATE: 8/21/87

TIME: 11:20

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
John Anderson	11/25/87	9:30	MCI	Michael P. Ebner	11/25/87	9:30	MCI
Michael P. Ebner	11/25/87	2:40PM	MCI	Nancy Owen	11/25/87	2:40	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 968 is located in WAG 5. It is on the new road along the eastern perimeter of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 17803.811, E 30573.520 (X-10 grid) or latitude 35° 54' 58.24" and longitude 84° 18' 37.26". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 968 was drilled by A.L. Clark Drilling Services, Inc. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of Richard Pickel. Drilling commenced on 8/18/87 and was finished on 8/24/87. Paragraph 2.4.1 includes a detailed discussion of

the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

8/18/87: The rig was moved to the well site and setup. Split spoons were taken to a depth of 0.8'.

8/19/87: The drill hole was drilled to 15.7' with 6" augers and bailing began.

8/20/87: Bailing continued until a decision by MMES to drill an additional five feet.

8/21/87: The boring was drilled to a total depth of 20.4' and bailed.

8/24/87: Additional bailing to remove drill cuttings and 2" stainless steel screen, casing, sand and bentonite were installed.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist Bryn D. Howze. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

* This information was typed directly from field notes and was edited only when necessary for clarification.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5.

Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

Two samples were collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 0968S01 was collected in the auger interval from 1.0 feet to 1.2 feet on 8/18/87, and rock sample 0968R01 was collected in the augered interval at 14.5' on 8/19/87.

2.4 Installation and Development

2.4.1 Installation

This was a type A well. A two-inch diameter stainless steel silt trap was installed from 20.2 to 20.4 feet. Above the silt trap a two-inch diameter stainless steel screen was installed from 10.2 to 20.2 feet. A two-

inch diameter stainless steel casing was installed above the screen from 10.2 feet to 2.30 feet above ground surface. A sandpack was then poured into the annular space from 8.4 to 20.4 feet, with a 2.3-foot bentonite pellet seal poured into the annular space above the sandpack from 6.1 to 8.4 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 968 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps and/or bailers were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 195 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/22/90 at a depth of 16.5 feet below ground surface. These

pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 968 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 2.58×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 968

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	8/18/87	BH
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	8/18/87	BH
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	NA	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	8/24/87	BH
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	8/18/87	BH
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	8/18/87	BH
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	8/18/87	BH

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Bryn Howze 8/18/87

Bryn D. Howze

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 968

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE Bryn Howze 8/18/87
Bryn B. Howze

ERC / EDGE Environmental and Energy Services Co.

WELL No. 968

ORNL MONITORING WELL LOG

LOCATION: WAG 5
DRILLER: Richard Pickel
HELPER: N/A
DRILL: Schramm Rotadrill

DATE: START: 8/18/87
FINISH: 8/24/87
LOGGED BY: Bryn D. Howze
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: Two
TYPE: One soil and one rock
CONTAINMENT TYPE: Auger pan and plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 8.0'
DEPTH DRILLED IN ROCK: 12.4'
TOTAL DEPTH OF WELL: 20.4'

DRILLING FLUID SAMPLES:
TYPE: N/A
DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	0.8		100	Clay, slightly silty, reddish-brown, with rock
				fragments, (chert fill for roadbed), firm
0.8	1.4	0968S01		Silt, slightly clayey, light brown, mottled,
		@ 1.0-1.2'		black, yellow with roots, rock fragments (shale
				and chert), very stiff
1.4	7.0			Limestone, shaley, highly weathered, light brown,
				with silt, some light gray chert fragments
7.0	20.4	0968R01		Limestone, light bluish-gray, fine grained,
		@ 14.5'		calcite filled veinlets, hard drilling at 8.0',
				moist at 9.5', wet at 14.0', soft at 16.5' -
				17.3', hard at 17.3'
	20.4			Total Depth

ERC / EDGE Environmental and Energy Services Co.

WELL No. 968

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Bryn D. Howze

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: Richard Pickel HELPER: N/A

EQUIPMENT ■ 6 INCH AUGER 20.4 L.F.

☐ _____ INCH AUGER _____ L.F.

LOCATION WAG 5

ORNL GRID COORDINATES

N 17803.811

E 30573.520

ELEV. GROUND 809.256

ELEV. TOP STAINLESS STEEL CASING 811.556

DRILLING DATES:

STARTED: 8/18/87

FINISHED: 8/24/87

MATERIALS USED

EST. VOL.	USED VOL.	
	10.0	FEET OF 2 IN. S.S. SCREEN
	12.5	FEET OF 2 IN. S.S. CASING
3.0	3.0	SACKS OF SAND
40.0	40.0	POUNDS OF BENTONITE PELLETS
1.0	1.0	SACKS OF CEMENT
	NA	POUNDS OF POWDERED BENTONITE
	6.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

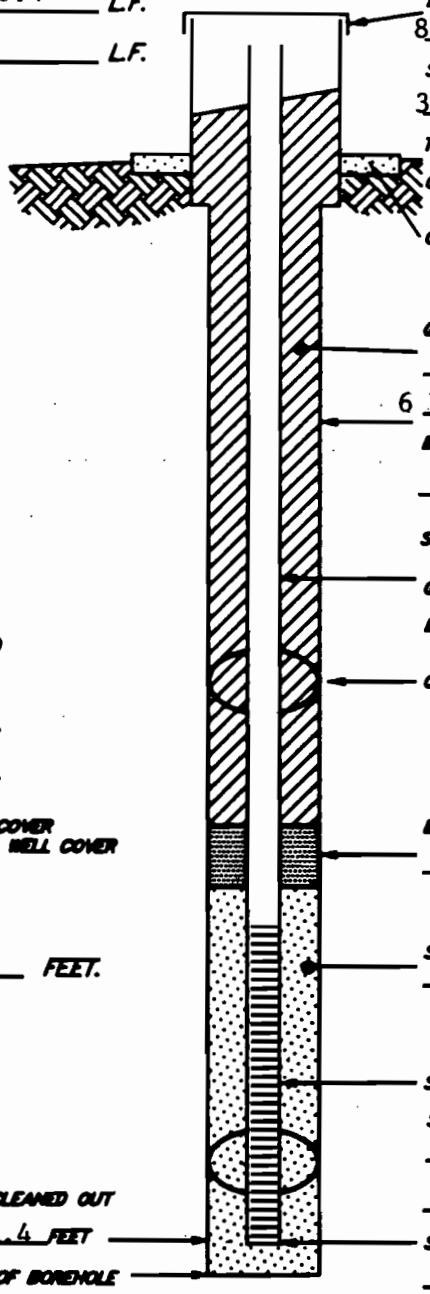
WELL COVER USED ■ LOCKING STEEL COVER ☐ FLUSH MOUNTED WELL COVER ☐ OTHER

SILT TRAP USED YES ■ NO ☐

MONITORING WELL PUMP BASE SET AT 16.5 FEET.

CENTRALIZERS AT 10.0 FEET. 20.0 FEET. _____ FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER 8 5/8 INCH DIAMETER STEEL PROTECTIVE CASING 3.49 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO 6.1 FEET

6 1/4 INCH DIAMETER BOREHOLE

2 INCH DIAMETER STAINLESS STEEL CASING 2.3 FT. ABOVE GROUND SURFACE TO 10.2 FT. BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL 6.1 TO 8.4 FEET

SAND PACK 8.4 TO 20.4 FEET

2 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 10.2 TO 20.2 FEET

2 INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP 20.2 TO 20.4 FEET

HOLE CLEANED OUT TO 20.4 FEET

BOTTOM OF BOREHOLE 20.4 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 968

DATE: 8/24/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		8/24/87	02
BENTONITE		8/24/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	8/24/87	05
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	8/24/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	8/24/87	03
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	8/24/87	03
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	1/22/90	03
GROUT		8/24/87	10
WELL COVERS			
SURFACE CASING		8/18/87	01

COMMENTS:

OBSERVER SIGNATURE/DATE Bryn D. Howze 8/24/87
Bryn D. Howze

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 968

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8/24/87	BH
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8/24/87	BH
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/19/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8/24/87	BH

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Bryn D. Howze 8/24/87
Bryn D. Howze

D. Charles Lytle 1/19/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 968

LOCATION: WAG 5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and pumping

DEVELOPMENT BEGAN DATE: 12-21-89 TIME:

DEVELOPMENT ENDING DATE: 1-19-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 7.3 GALLONS

TOTAL GALLONS PUMPED: 195 TOTAL WELL VOLUMES PUMPED: 26.7

INITIAL pH: 7.7 FINAL pH: 7.0

INITIAL CONDUCTIVITY (uS): 683 FINAL CONDUCTIVITY (uS): 625

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0

WELL APPROVED BY: R.C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ■ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 2.5' from surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 1/19/90

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 968
LOCATION: WAG 5
DATE: 12-21-89

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 7.3 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
12-21-89	1500	3	Muddy		7.7	683	3		
12-27-89	1500	14	Muddy		7.0	678	17	2.3	
1-2-90	1400	35	Muddy		7.0		52	7.1	
1-2-90	1500	10	Muddy		7.2	708	62	8.4	
1-2-90	1600	14	Cloudy		7.2	726	76	10.4	
1-3-90	1200	4	Cloudy				80	11.0	
1-8-90	0900	12	Cloudy		7.1	538	92	12.6	
1-12-90	1400	25	Cloudy		7.0	592	117	16.0	
1-15-90	1030	11	Clear	Pump Stuck	7.5	612	128	17.5	Pump Stuck
1-18-90	0900	35	Clear	5.0	7.2	592	163	22.3	
1-19-90	1400	32	Clear	2.0	7.0	625	195	26.7	
RESULTS AT END OF DEVELOPMENT			Clear	2.0	7.0	625	195	26.7	

COMMENTS Pump was unstuck on 1-17-90; water cleared; passed and moved on.

OBSERVER SIGNATURE/DATE D. Charles Lytle 1/19/90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 968 DATE OF TEST: 2/2/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 14.35 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .98 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

3.2720
3.2878

ERC / EDGE Environmental and Energy Services Co.

WELL No. 968

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.570	3.590
20.00	4.490	3.510
30.00	4.420	3.440
40.00	4.370	3.390
50.00	4.350	3.370
60.00	4.270	3.290
75.00	4.210	3.230
90.00	4.110	3.130
105.00	4.070	3.090
120.00	4.020	3.040
150.00	3.890	2.910
180.00	3.810	2.830
240.00	3.610	2.630
300.00	3.420	2.440
360.00	3.250	2.270
420.00	3.140	2.160
480.00	3.010	2.030
540.00	2.900	1.920
600.00	2.810	1.830
720.00	2.630	1.650
840.00	2.460	1.480
960.00	2.350	1.370
1080.00	2.200	1.220
1200.00	2.130	1.150
1320.00	2.050	1.070
1440.00	1.930	.950
1560.00	1.860	.880
1680.00	1.810	.830
1800.00	1.760	.780
1920.00	1.700	.720
2040.00	1.640	.660
2160.00	1.590	.610

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

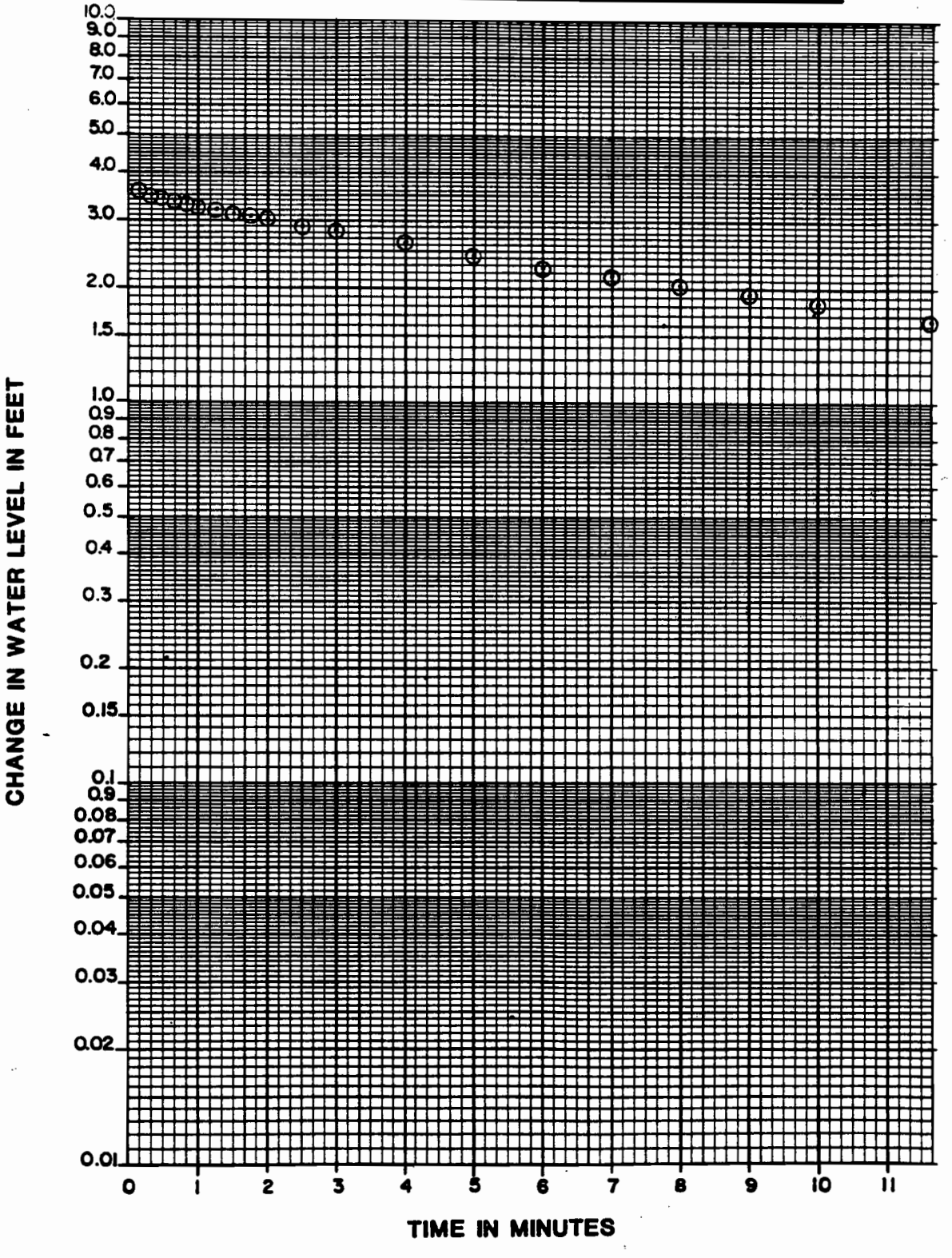
PERMEABILITY = 8.48E-07 FT/SEC = 2.58E-05 CM/SEC

TRANSMISSIVITY = 8.48E-06 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 968

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0968 S01

WELL NO.: 968

LOCATION: SWSA 5

TYPE: Soil

SAMPLER: Bryan Horge (SIGNATURE)

DATE: 8/18/87

TIME: 4:20 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryan Horge	9/15/87	2:25	MCI	Nancy Owen	9/15/87	2:25	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0968 R01

WELL NO.: 968

LOCATION: SWSA 5

TYPE: Rock Cuttings

SAMPLER: Bryan House (SIGNATURE)

DATE: 8/19/87

TIME: 12:30 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryan House	9/15/87	2:25	MCI	Nancy Owen	9/15/87	2:25	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 969 is located in WAG 5. It is 50 feet east of the east boundary of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 17,371.217, E 30,610.400 (X-10 grid) or latitude 35° 54' 54.89" and longitude 84° 18' 33.96". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 969 was drilled by A.L. Clark Drilling Services, Inc. A Gus Pech auger rig was used to drill this boring for monitor well installation under the operation of A.L. Clark III. Drilling commenced on 8/20/87 and was finished on 8/27/87. Paragraph 2.4.1 includes a detailed discussion of

the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

8/20/87: The drilling rig was steam cleaned and mobilized to the staked location and setup. The boring was augered from 0.0' to 8.0' with a 6" auger.

8/21/87: The boring was augered from 8.0' to 14.0'.

8/24/87: The boring was augered from 14.0' to 15.8' total depth.

8/25/87: The boring was reamed from 8.0' to 15.8' with a 6 1/4" tricone roller bit without compressed air or water.

8/26/87: The boring was bailed periodically during the day.

8/27/87: The boring was bailed and stainless steel screen, casing, sandpack and bentonite seal were installed.

8/28/87: The annular space was grouted.

This well was logged by ERC Environmental and Energy Services Co. (ERC/EDGe) hydrogeologist Michael L. Ebers. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

* This information was typed directly from field notes and was edited only when necessary for clarification.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out

approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

One soil sample was collected during drilling, placed in an I-CHEM specialty cleaned glass container, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. A chain of custody form for this sample is included with this data package. This soil sample, 0969S01, was collected in the split spoon interval from 3.6 feet to 3.8 feet on 8/20/87.

A bulk density soil sample was collected from the split spoon sample interval from 3.3 feet to 3.6 feet. The sample was measured and weighed, and a bulk density of 1.81 grams/cm^3 was calculated.

2.4 Installation and Development

2.4.1 Installation

This was a type A well. A two-inch diameter stainless steel silt trap was installed from 15.3 to 15.6 feet. Above the silt trap a two-inch

diameter stainless steel screen was installed from 5.3 to 15.3 feet. A two-inch diameter stainless steel casing was installed above the screen from 5.3 feet to 1.61 feet above ground surface. A sandpack was then poured into the annular space from 4.0 to 15.6 feet, with a 2.0-foot bentonite pellet seal poured into the annular space above the sandpack from 2.0 to 4.0 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 969 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 189 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/24/90 at a depth of 13.0 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 969 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 2.33×10^{-4} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 969

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	8/20/87	MLE
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	8/20/87	MLE
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	NA	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	8/27/87	MLE
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	8/20/87	MLE
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	8/20/87	MLE
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	8/20/87	MLE

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 8/27/87
Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 969

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE [signature] 8/20/87

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 969

ORNL MONITORING WELL LOG

LOCATION: WAG 5
DRILLER: A.L. Clark III
HELPER: N/A
DRILL: Gus Pech

DATE: START: 8/20/87
FINISH: 8/27/87
LOGGED BY: Michael L. Ebers
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Split spoon and auger
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: One
TYPE: Soil
CONTAINMENT TYPE: Auger pan and plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 8.0'
DEPTH DRILLED IN ROCK: 7.8'
TOTAL DEPTH OF WELL: 15.8'

DRILLING FLUID SAMPLES:
TYPE: N/A
DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	2.0		100%	Clay, reddish-brown and limestone gravel (road
				fill)
2.0	4.0	0969S01	100%	Clay, silty, grayish-orange, soft, somewhat
		3-6'-3.8'		crumbly, dry, few roots
				Bulk density @ 3.3-3.6' = 1.81 grams/cm^3
	@4.0			Split spoon refusal
4.0	8.0			Clay, moderate brown, slightly silty, slightly
				damp
8.0	15.8			Siltstone, calcareous, medium dark gray, with
				thin shale laminations, thin pink calcite
				filled fractures perpendicular to bedding,
				shaly and softer from 9.0 to 12.0' and 14.8'
				to 15.5', few thin limestone beds, olive gray,
				fine grained, styolitic
	15.8			Total Depth

ERC / EDGE Environmental and Energy Services Co.

WELL No. 969

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Michael L. Ebers
PROOFED BY: Bruce McMaster

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: A.L. Clark III HELPER: N/A

EQUIPMENT
- ■ 6 1/4 INCH AUGER 15.8 L.F.
- □ _____ INCH AUGER _____ L.F.

LOCATION WAG5
ORNL GRID COORDINATES
N 17371.217
E 30610.400
ELEV. GROUND 785.746
ELEV. TOP STAINLESS STEEL CASING 787.356

DRILLING DATES:
STARTED: 8/20/87
FINISHED: 8/28/87

MATERIALS USED

EST. VOL.	USED VOL.	
10.0		FEET OF 2 IN. S.S. SCREEN
6.9		FEET OF 2 IN. S.S. CASING
2.2	5.2	SACKS OF SAND
30.0	30.0	POUNDS OF BENTONITE PELLETS
1.0	1.0	SACKS OF CEMENT
	2.0	POUNDS OF POWDERED BENTONITE
	6.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Irregular auger boring diameter

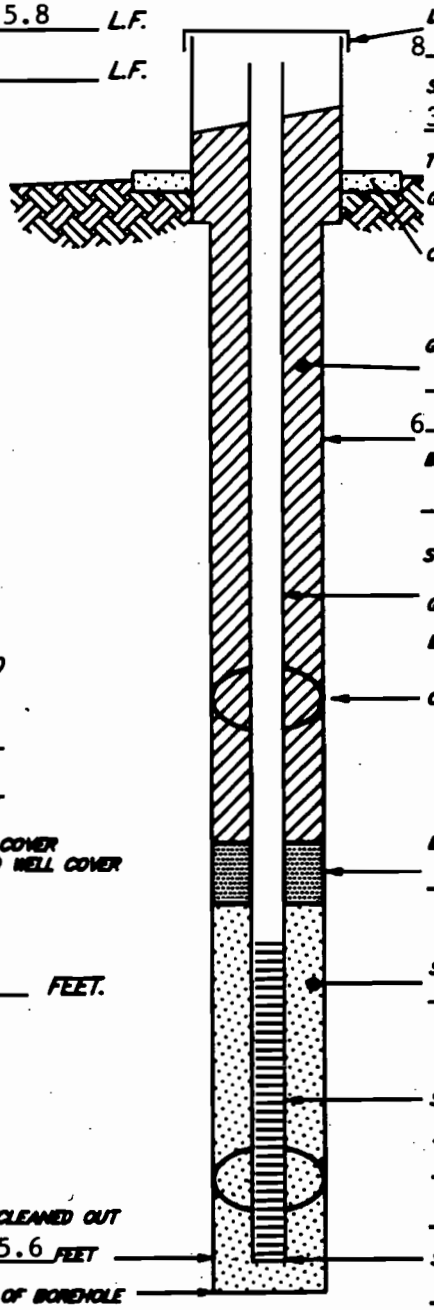
WELL COVER USED
- ■ LOCKING STEEL COVER
- □ FLUSH MOUNTED WELL COVER
- □ OTHER

SILT TRAP USED YES ■ NO □

MONITORING WELL PUMP BASE SET AT 13.0 FEET.

CENTRALIZERS AT 5.6 FEET.
15.6 FEET.
_____ FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER
8 5/8 INCH DIAMETER STEEL PROTECTIVE CASING
3.22 FT. ABOVE GROUND TO 2.1 FT. BELOW GROUND SURFACE
CONCRETE PAD

GROUT SEAL 0.0 TO 2.0 FEET
6 1/4 INCH DIAMETER BOREHOLE
2 INCH DIAMETER STAINLESS STEEL CASING 1.61 FT. ABOVE GROUND SURFACE TO 5.3 FT. BELOW GROUND SURFACE
CENTRALIZER (TYP.)

BENTONITE PELLET SEAL 2.0 TO 4.0 FEET
SAND PACK 4.0 TO 15.6 FEET
2 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 5.3 TO 15.3 FEET
2 INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP 15.3 TO 15.6 FEET

HOLE CLEANED OUT TO 15.6 FEET
BOTTOM OF BOREHOLE 15.8 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 969

DATE: 8/27/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		8/27/87	02
BENTONITE		8/27/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	8/27/87	05
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	8/27/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	8/27/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	8/27/87	04
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	1/24/90	03
GROUT		8/28/87	10
WELL COVERS			
SURFACE CASING		8/28/87	01

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 8/27/87
Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 969

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8/28/87	MLE
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8/28/87	MLE
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/23/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8/28/87	MLE

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Michael L. Ebers 8/28/87
Michael L. Ebers

D. Charles Lytle 1/23/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 969

LOCATION: WAG5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and pumping

DEVELOPMENT BEGAN DATE: 1-17-90 TIME:

DEVELOPMENT ENDING DATE: 1-23-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 6.7 GALLONS

TOTAL GALLONS PUMPED: 189 TOTAL WELL VOLUMES PUMPED: 28.2

INITIAL pH: 6.8 FINAL pH: 7.0

INITIAL CONDUCTIVITY (uS): 624 FINAL CONDUCTIVITY (uS): 626

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0

WELL APPROVED BY: R.C. Williams MMES

ODOR OF WATER:

WATER DISCHARGED TO:
- ☐ GROUND SURFACE
- ☐ STORM SEWERS
- ■ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 2.5' water level from surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-23-90

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 969
LOCATION: WAG5
DATE: 1-17-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 6.7 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
1-17-90	0900	5	Muddy		6.8	624	5		
1-17-90	1200	44	Muddy			742	49		
1-18-90	0900	52	Muddy		6.8	696	101	15.1	
1-19-90	1400	34	Cloudy		6.7	723	135	20.1	
1-23-90	1630	54	Clear	2.0	7.0	626	189	28.2	
RESULTS AT END OF DEVELOPMENT			Clear	2.0	7.0	626	189	28.2	

COMMENTS Water cleared even after surging; water had 2.0 NTU; passed and moved on.

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-23-90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 969 DATE OF TEST: 2/5/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 10.80 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .99 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 20

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR HO (FEET)

2.3060
2.5663
2.4040
2.5242

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.640	2.650
20.00	3.340	2.350
30.00	3.080	2.090
40.00	2.890	1.900
50.00	2.720	1.730
60.00	2.560	1.570
75.00	2.370	1.380
90.00	2.190	1.200
105.00	2.050	1.060
120.00	1.920	.930
150.00	1.700	.710
180.00	1.530	.540
240.00	1.280	.290
300.00	1.190	.200
360.00	1.110	.120
420.00	1.080	.090
480.00	1.060	.070
540.00	1.050	.060
600.00	1.000	.010
720.00	1.020	.030

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

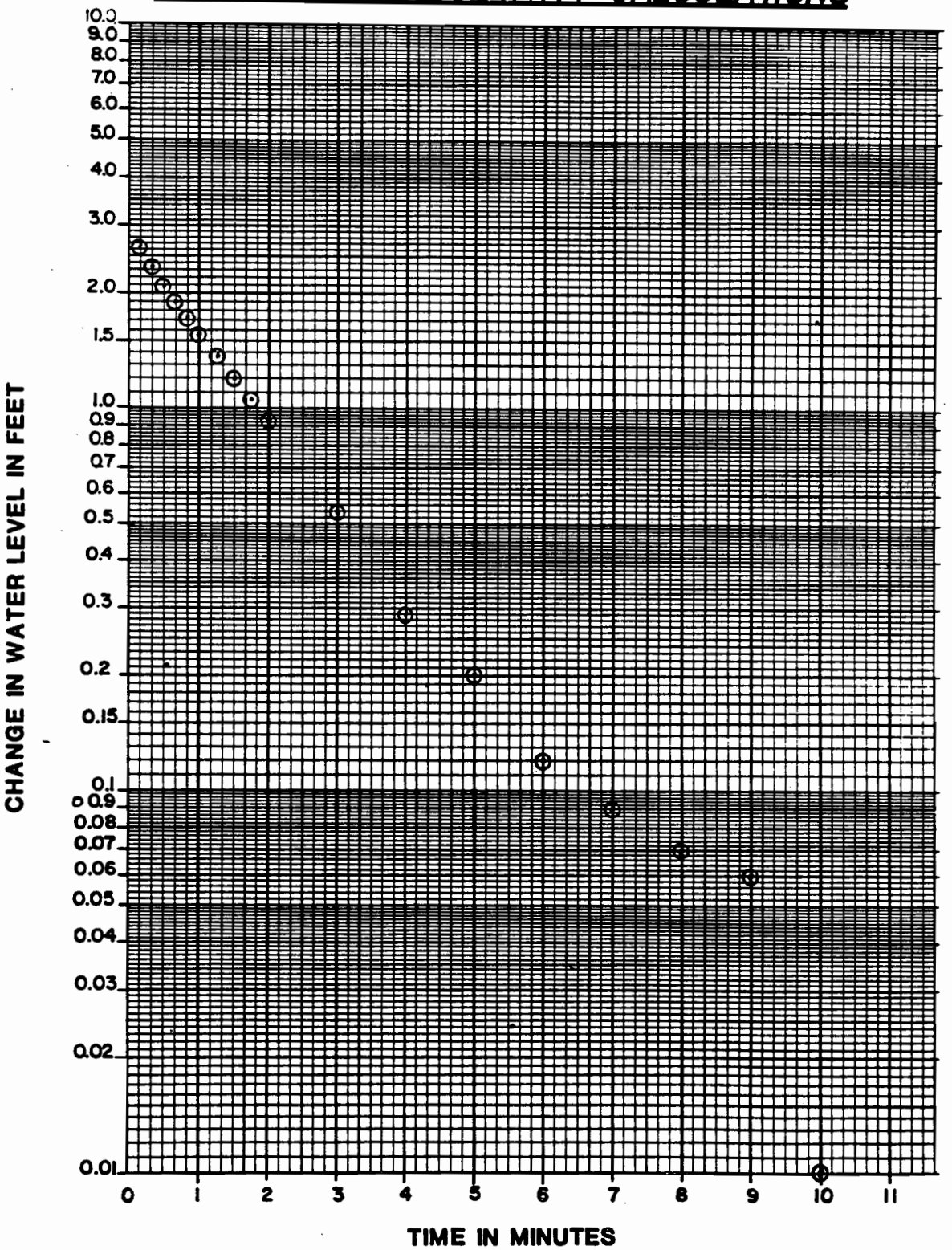
PERMEABILITY = 7.66E-06 FT/SEC = 2.33E-04 CM/SEC

TRANSMISSIVITY = 7.66E-05 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 969

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0969 S01

WELL NO.: 0969

LOCATION: SWSA 5 @ 3.6' TO 3.8'

TYPE: Soil

SAMPLER: [signature] (SIGNATURE)

DATE: 8/20/87

TIME: 4:30 P.M

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	9/1/87	12:00	MCI	Nancy Owen	9/1/87	12:00	ORNL CPA

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 970 is located in WAG 5. It is near the southeast corner of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 17350.888, E 30614.631 (X-10 grid) or latitude 35° 54' 54.75" and longitude 84° 18' 33.78". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 970 was drilled by A.L. Clark Drilling Services, Inc. A Driltech air rotary rig was used to drill this boring for monitor well installation under the operation of Steve Clark with the assistance of Steve Kirk. Drilling commenced on 8/24/87 and was finished on 8/25/87.

Paragraph 2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

8/24/87: The rig and tools were steam cleaned. The rig was mobilized to the staked location and set up. The boring was drilled with 14" augers from 0.0' to 11.5'. Ten inch surface casing was set and grouted.

8/25/87: The boring was advanced from 11.5' to total depth at 75.0' with an 8 5/8" tricone roller bit. Four inch stainless steel screen, casing, sandpack and bentonite seal were installed.

8/28/97: The annular space from 0.0' to 56.0' was grouted.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist John W. Anderson. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

* This information was typed directly from field notes and was edited only when necessary for clarification.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out

approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

No soil samples were collected during drilling. A drill water sample (0970W01) was collected from the water pump on the drill rig on 8/25/87. Analytical results for this sample can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type B well. A fourteen-inch diameter boring was augered from ground surface to bedrock (11.4 feet). A ten-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill an eight-inch diameter boring to a total depth of 75.0 feet. A four-inch diameter stainless steel silt

trap was installed from 74.7 to 75.0 feet. Above the silt trap, a four-inch diameter stainless steel screen was installed from 59.7 to 74.7 feet. A four-inch diameter stainless steel casing was installed from the top of the screen at 59.7 feet and extending 2.27 feet above ground surface. A sandpack was then poured into the annular space from 58.0 to 75.0 feet, with a 2.0-foot bentonite seal poured into the annular space above the sandpack from 56.0 to 58.0 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 970 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use
according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 148 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/3/90 at a depth of 72.3 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 970 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.05×10^{-4} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 970

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	8/24/87	
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	8/24/87	
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	NA	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	8/24/87	
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	8/24/87	
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	8/24/87	
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	8/24/87	

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE John W. Anderson 8/24/87

ERC / EDGE Environmental and Energy Services Co.

WELL No. 970

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE John W. Anderson 8/24/87

ERC / EDGE Environmental and Energy Services Co.

WELL No. 970

ORNL MONITORING WELL LOG

LOCATION: WAG 5
DRILLER: Steve Clark
HELPER: Steve Kirk
DRILL: Driltech

DATE: START: 8/24/87
FINISH: 8/25/87
LOGGED BY: John W. Anderson
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger, air rotary
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: None
TYPE: NA
CONTAINMENT TYPE: Auger pan, plastic and containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 11.5'
DEPTH DRILLED IN ROCK: 63.5'
TOTAL DEPTH OF WELL: 75.0'

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 8/25/87
0970W01

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	2.5			Silty clay, orange with light gray limestone
				gravel (fill), damp
2.5	4.8			Silty clay, light brown, with shale fragments,
				moist
4.8	11.5			Silty clay with abundant shale fragments, dark
				grayish-brown, moist, wet at 10.2'
	@11.5			Auger refusal
11.5	14.0			*Shale, silty, weathered, medium brown, wet
14.0	16.0			Very soft, possibly void
16.0	20.0			Limestone, hard
20.0	22.0			A little softer, drill jerking indicating thin
				beds or solution channels
22.0	29.0			Very hard
29.0	37.0			Medium hard
37.0	42.0			Hard
42.0	75.0			Medium hard
	75.0			Total Depth
				* No detailed lithologic description available
				for the interval from 11.5' to 75.0' due to
				the use of a containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 970

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: John W. Anderson

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: Steve Clark HELPER: Steve Kirk

DRILLING METHOD:
- ■ 14 INCH AUGER 11.5 L.F.
- □ ____ INCH AUGER ____ L.F.
- ■ 8 5/8 INCH ROTARY 63.5 L.F.
- □ ____ INCH ROTARY ____ L.F.

LOCATION WAG 5

ORNL GRID COORDINATES
N 17350.888
E 30614.631

ELEV. GROUND 784.596

ELEV. TOP STAINLESS STEEL CASING 786.866

DRILLING DATES:
STARTED: 8/24/87
FINISHED: 8/25/87

MATERIALS USED

EST. VOL.	USED VOL.	
	NA	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	11.5	FT. OF 10 IN. SURFACE CASING
3.7	4.0	SACKS OF CEMENT (SURFACE CASING)
	NA	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	24.0	GALLONS OF WATER (SURFACE CASING)
	62.0	FT. OF 4 IN. DIA. STAINLESS STEEL CASING
	15.0	FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
4.5	4.5	SACKS OF SAND
25.0	25.0	POUNDS OF BENTONITE PELLETS
10.5	10.5	SACKS OF CEMENT (WELL CASING)
	NA	POUNDS OF POWERED BENTONITE (WELL CASING)
	63.0	GALLONS OF WATER (WELL CASING)
	3.59	FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

SURFACE CASING TREMIE GROUTED YES ■ NO □

STAINLESS STEEL CASING TREMIE GROUTED YES ■ NO □

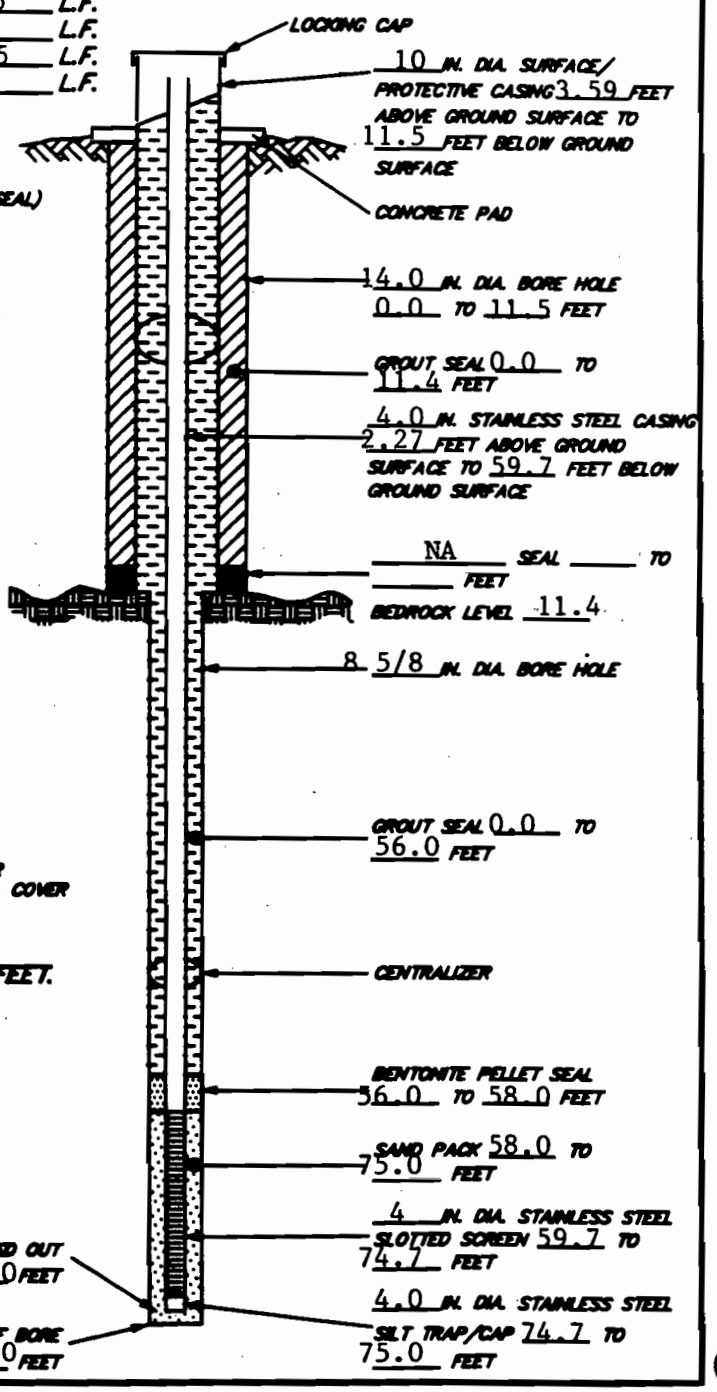
WELL COVER USED
- ■ LOCKING STEEL COVER
- □ FLUSH MOUNTED WELL COVER
- □ OTHER

SILT TRAP USED YES □ NO □

MONITORING WELL PUMP BASE SET AT 72.3 FEET.

CENTRALIZERS AT 15.0 FEET.
35.0 FEET.
55.0 FEET.
74.0 FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



TYPE B WELL

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 970

DATE: 8/26/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		8/26/87	02
BENTONITE		8/26/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	8/26/87	05
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	8/26/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	8/26/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	8/26/87	04
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	1/3/90	03
GROUT		8/27/87	10
WELL COVERS		8/26/87	05
SURFACE CASING		8/25/87	01

COMMENTS:

OBSERVER SIGNATURE/DATE John W. Anderson 8/27/87

ERC / EDGE Environmental and Energy Services Co.

WELL No. 970

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8/25/87	[illegible]
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8/25/87	[illegible]
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/2/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8/25/87	[illegible]

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE [signature] 8/25/87
John W. Anderson

[signature] 1/2/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 970

LOCATION: WAG5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and pumping

DEVELOPMENT BEGAN DATE: 12-27-89 TIME:

DEVELOPMENT ENDING DATE: 1-2-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 49.3 GALLONS

TOTAL GALLONS PUMPED: 148 TOTAL WELL VOLUMES PUMPED: 3.0

INITIAL pH: 7.5 FINAL pH: 7.1

INITIAL CONDUCTIVITY (uS): 714 FINAL CONDUCTIVITY (uS): 682

DESCRIPTION OF INITIAL TURBIDITY: Crystal Clear

DESCRIPTION OF FINAL TURBIDITY: Crystal Clear

FINAL MEASURED TURBIDITY: 2.0

WELL APPROVED BY: R.C. Williams MMES

ODOR OF WATER:

WATER DISCHARGED TO:

- ■ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 2.2 feet from ground surface

DEVELOPMENT OBSERVATIONS

Water stayed clear the whole time even after surging

OBSERVER SIGNATURE/DATE: D. Charles Lytle

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 970
LOCATION: WAG5
DATE: 12-27-89

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 49.3 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
12-27-89	2:00	15	Clear		7.5	714			
12-29-89	1:00	37	Clear	8.0	7.3	826			
12-29-89	2:00	15	Clear	8.5	7.3	754	67		
1-2-90	9:00	31	Clear	4.0	7.1	655			
1-2-90	2:00	14	Clear	1.0	7.2	667	112	23	
1-2-90	3:00	30	Clear	1.0	7.1	725	142		
1-2-90	4:00	6	Clear	2.0	7.1	682	148	3.0	
RESULTS AT END OF DEVELOPMENT			Crystal Clear	2.0	7.1	682	148	3.0	

COMMENTS Remained crystal clear even after surging. Passed.

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-2-90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 970

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 970 DATE OF TEST: 2/8/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 73.85 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .94 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR HO (FEET)

1.9258
1.9097

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	2.800	1.960
20.00	2.770	1.830
30.00	2.760	1.820
40.00	2.700	1.760
50.00	2.680	1.740
60.00	2.680	1.740
75.00	2.640	1.700
90.00	2.640	1.700
105.00	2.580	1.640
120.00	2.580	1.640
150.00	2.560	1.620
180.00	2.510	1.570
240.00	2.450	1.510
300.00	2.360	1.420
360.00	2.280	1.340
420.00	2.220	1.280
480.00	2.150	1.210
540.00	2.100	1.160
600.00	2.040	1.100
720.00	1.940	1.000
840.00	1.830	.890
960.00	1.760	.820
1080.00	1.660	.720
1200.00	1.580	.640
1320.00	1.510	.570
1440.00	1.430	.490
1560.00	1.370	.430
1680.00	1.300	.360
1800.00	1.250	.310
1920.00	1.190	.250
2040.00	1.150	.210
2160.00	1.120	.180

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

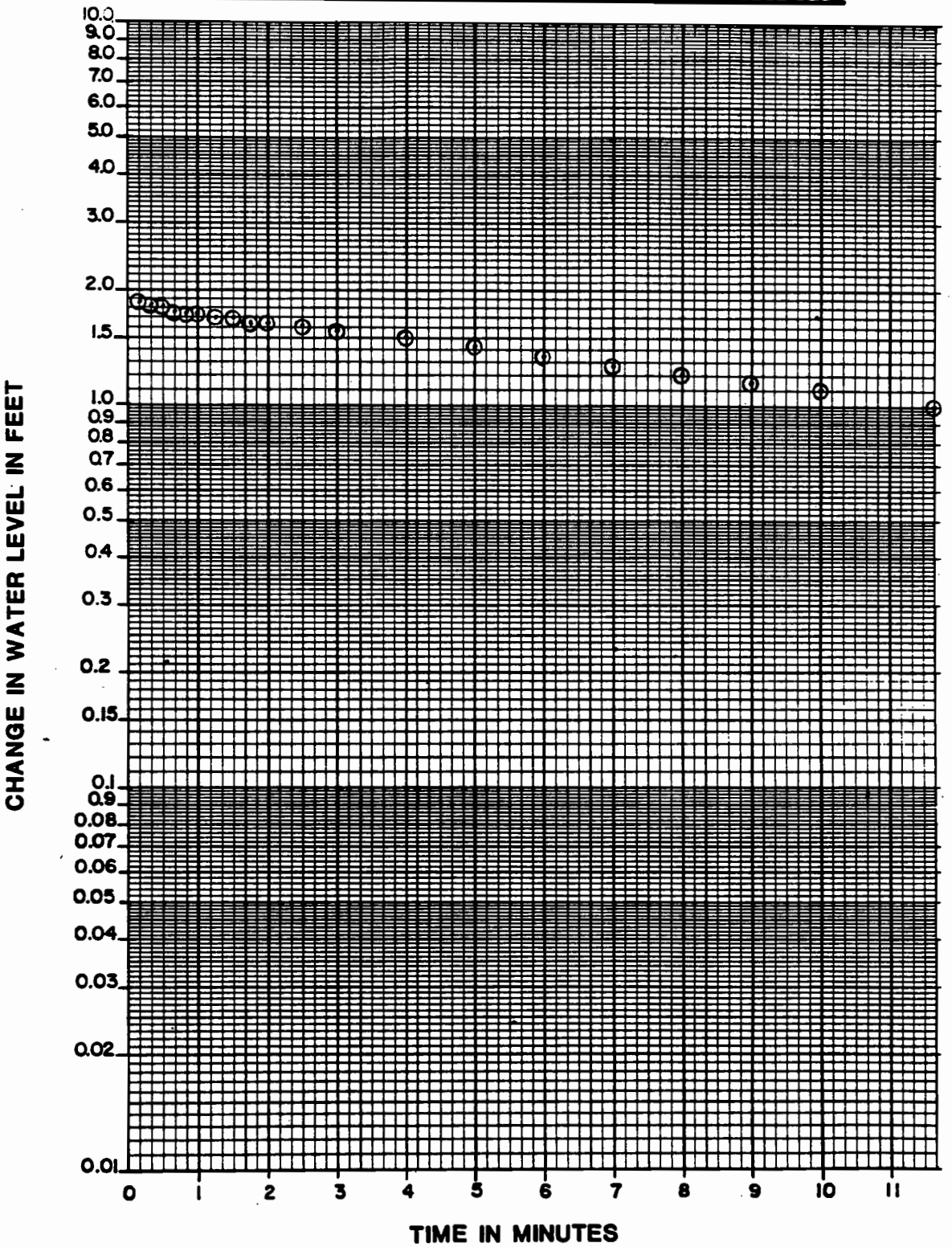
PERMEABILITY = 3.43E-06 FT/SEC = 1.05E-04 CM/SEC

TRANSMISSIVITY = 5.15E-05 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 970

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0970 W01

WELL NO.: 0970

LOCATION: Drilltech Drilling Water

TYPE: Water

SAMPLER: John Anderson (SIGNATURE)

DATE: 8/25/87

TIME: 9:10

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[illegible]	11/25/87	9:30	MCI	[illegible]	11/25/87	9:30	MCI
[illegible]	11/25/87	2:40PM	MCI	Nancy Owen	11/25/87	2:40	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 971 is located in WAG 5. It is on the new road along the southern perimeter of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 16,982.702, E 30,380.971 (X-10 grid) or latitude 35° 54' 50.43" and longitude 84° 18' 33.65". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 971 was drilled by A.L. Clark Drilling Services, Inc. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of Richard Pickel. Drilling commenced on 8/25/87 and was finished on 8/26/87. Paragraph 2.4.1 includes a detailed discussion of

the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

8/25/87: The rig was moved to the well site and setup. Augering through the roadbed fill (4.9' thick) began. Split spoon samples were taken from 4.9' to 8.1'.

8/26/87: The drill hole was drilled to a total depth of 14.9' and bailed. Two-inch stainless steel screen, casing, sand and bentonite were installed.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist Bryn D. Howze. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap

* This information was typed directly from field notes and was edited only when necessary for clarification.

underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

Two soil samples were collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 0971S01 was collected at 6.9 feet on 8/25/87 and rock sample 0971R01 was collected at 10.9' on 8/25/87. Analytical results for the two samples described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type A well. A two-inch diameter stainless steel silt trap was installed from 14.7 to 14.9 feet. Above the silt trap a two-inch diameter stainless steel screen was installed from 9.7 to 14.7 feet. A two-inch diameter stainless steel casing was installed above the screen from 9.7 feet to 2.57 feet above ground surface. A sandpack was then poured into the annular space from 8.6 to 14.9 feet, with a 2.9-foot bentonite pellet seal poured into the annular space above the sandpack from 5.7 to 8.6 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite

slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 971 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 229 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 29 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/8/90 at a depth of 11.9 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 971 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.11×10^{-4} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 971

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	8/25/87	BH
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	8/25/87	BH
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	NA	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	8/25/87	BH
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	8/25/87	BH
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	8/25/87	BH
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	8/25/87	BH

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Bryn Howze 8/26/87
Bryn D. Howze

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 971

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE Bryn Howze 8/25/87
Bryn D. Howze

ERC / EDGE Environmental and Energy Services Co.

WELL No. 971

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG 5

DRILLER: A. L. Clark II

HELPER: Richard Pickel

DRILL: Schramm Rotadrill

DATE: START: 8/25/87
FINISH: 8/26/87

LOGGED BY: Bryn D. Howze

HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger

LUBRICANT TYPE: Molykote 1000

No. SAMPLES TAKEN: Two

TYPE: One soil and one rock

CONTAINMENT TYPE: Auger pan and plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 7.7'

DEPTH DRILLED IN ROCK: 7.2'

TOTAL DEPTH OF WELL: 14.9'

DRILLING FLUID SAMPLES:

TYPE: NA DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	4.9		Augered	Clay, silty, orange-brown, mottled, black yellow
				with rock fragments (chert, oolitic limestone)
				(fill for roadbed)
4.9	6.9	0971S01	50%	Silt, slightly clayey, light brown, mottled
		@6.9'		yellow, black with roots
6.9	7.7		40%	Silt, slightly clayey, light brown.
7.7	8.1		55%	Shale, greenish-gray, very thinly bedded,
				calcite filled fractures
8.1	14.9	0971R01		Shale, greenish-gray, very thinly bedded,
		@ 10.9'		calcite filled fractures, wet at 10.0', hard
				drilling at 10.4'
	14.9			Total Depth

ERC / EDGE Environmental and Energy Services Co.

WELL No. 971

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Bryn D. Howze

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: A.L. Clark II HELPER: Richard Pickel

EQUIPMENT ■ 6 1/4 INCH AUGER 14.9 L.F.

□ _____ INCH AUGER _____ L.F.

LOCATION WAG5

ORNL GRID COORDINATES

N 16982.702

E 30380.971

ELEV. GROUND 775.886

ELEV. TOP STAINLESS STEEL CASING 778.456

DRILLING DATES:

STARTED: 8/25/87

FINISHED: 8/26/87

MATERIALS USED

EST. VOL.	USED VOL.	
5.0		FEET OF 2 IN. S.S. SCREEN
12.3		FEET OF 2 IN. S.S. CASING
2.0	2.0	SACKS OF SAND
40.0	40.0	POUNDS OF BENTONITE PELLETS
0.5	0.5	SACKS OF CEMENT
	NA	POUNDS OF POWDERED BENTONITE
	4.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

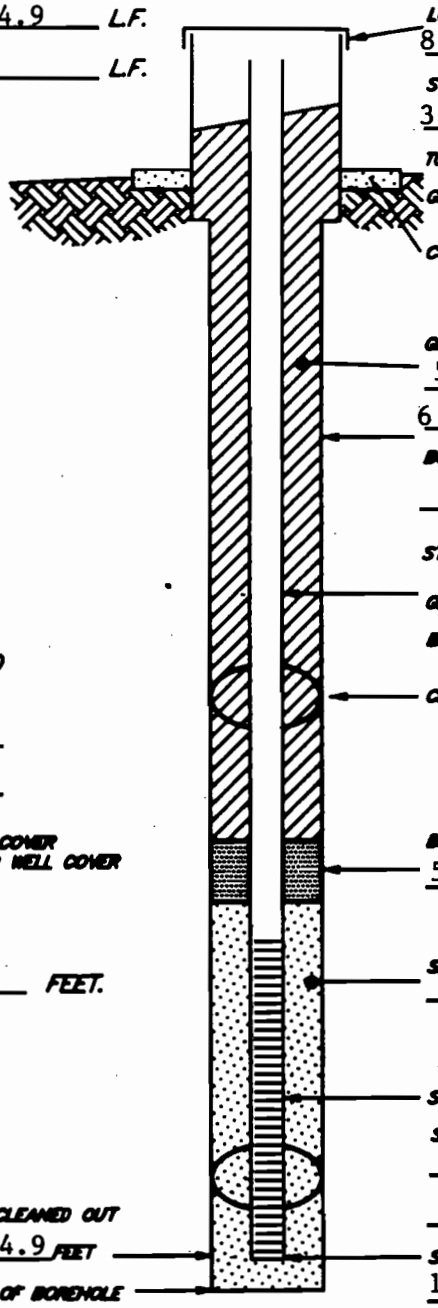
WELL COVER USED ■ LOCKING STEEL COVER □ FLUSH MOUNTED WELL COVER □ OTHER

SILT TRAP USED YES ■ NO □

MONITORING WELL PUMP BASE SET AT 11.9 FEET.

CENTRALIZERS AT 10.0 FEET.
14.7 FEET.
_____ FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



TYPE A WELL

NOT TO SCALE

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 971

DATE: 8/26/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		8/26/87	02
BENTONITE		8/26/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	8/26/87	05
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	8/26/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	8/26/87	03
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	8/26/87	03
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	1/8/90	03
GROUT		8/26/87	10
WELL COVERS			
SURFACE CASING		9/87	

COMMENTS:

OBSERVER SIGNATURE/DATE Bryn Howze 8/26/87
Bryn D. Howze

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 971

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8/26/87	BH
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8/26/87	BH
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/15/90	MLE
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8/26/87	BH

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Bryn Howze 8/26/87
Bryn D. Howze

Michael L. Ebers 1/5/90
Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 971

LOCATION: WAG5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Pumping

DEVELOPMENT BEGAN DATE: 12/27/89 TIME:

DEVELOPMENT ENDING DATE: 1/5/90

DEVELOPMENT OBSERVED BY: D. Charles Lytle and Michael L. Ebers

ONE WELL VOLUME: 4.1 GALLONS

TOTAL GALLONS PUMPED: 229 TOTAL WELL VOLUMES PUMPED: 56

INITIAL pH: 7.7 FINAL pH: 6.7

INITIAL CONDUCTIVITY (uS): 126 FINAL CONDUCTIVITY (uS): 835

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Very slightly cloudy

FINAL MEASURED TURBIDITY: 29 NTU's

WELL APPROVED BY: Michael L. Ebers

ODOR OF WATER: None

WATER DISCHARGED TO:
- ■ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 5.0' from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE: Michael L. Ebers 1/5/90

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 971
LOCATION: WAG5
DATE: 12-27-89

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 4.1 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
12-27-89	1500	7			7.7	126			
1-3-90	1500	94	Cloudy		6.3	875			
1-4-90	400	108	Cloudy		5.9	840	209		
1-5-90	1200	20	Very slightly cloudy	29	6.7	835	229	56	
RESULTS AT END OF DEVELOPMENT			Very slightly cloudy	29	6.7	835	229	56	

COMMENTS

OBSERVER SIGNATURE/DATE Michael L. Ebers 1/5/90
Michael L. Ebers

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 971 DATE OF TEST: 2/5/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 7.55 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 5.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .98 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 28

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR HO (FEET)
2.1510
2.2285

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.500	3.520
20.00	4.230	3.250
30.00	4.010	3.030
40.00	3.820	2.840
50.00	3.610	2.630
60.00	3.440	2.460
75.00	3.230	2.250
90.00	3.030	2.050
105.00	2.870	1.890
120.00	2.710	1.730
150.00	2.490	1.510
180.00	2.290	1.310
240.00	1.990	1.010
300.00	1.790	.810
360.00	1.650	.670
420.00	1.540	.560
480.00	1.450	.470
540.00	1.380	.400
600.00	1.330	.350
720.00	1.320	.340
840.00	1.300	.320
960.00	1.260	.280
1080.00	1.190	.210
1200.00	1.140	.160
1320.00	1.120	.140
1440.00	1.100	.120
1560.00	1.100	.120
1680.00	1.100	.120

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

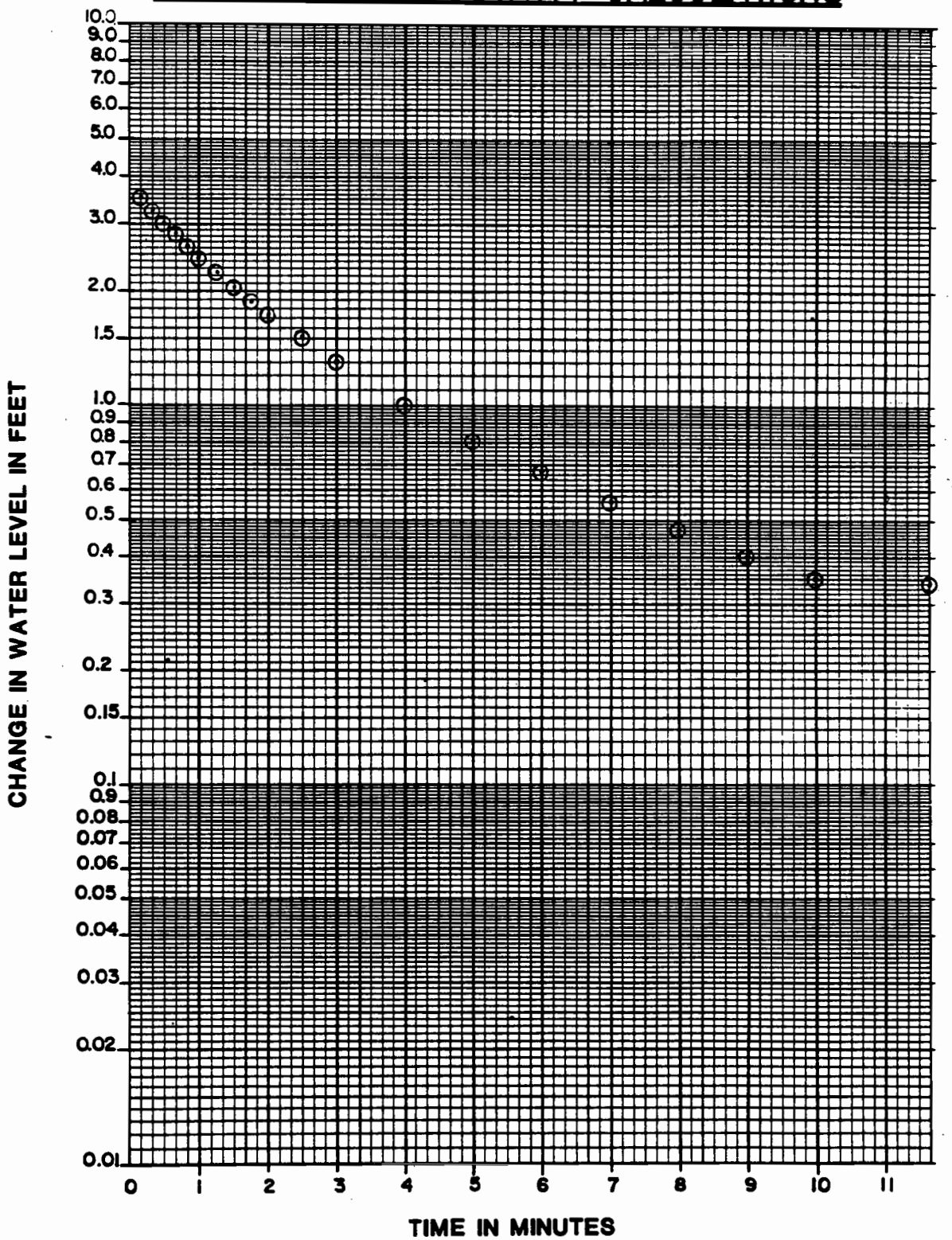
PERMEABILITY = 3.64E-06 FT/SEC = 1.11E-04 CM/SEC

TRANSMISSIVITY = 1.82E-05 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 971

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0971 S01

WELL NO.: 971

LOCATION: SWSA 5

TYPE: Soil

SAMPLER: Bryn Horne (SIGNATURE)

DATE: 8/25/87

TIME: 11:45 AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn Horne	9/15/87	2:25		Nancy Owen	9/15/87	2:25	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0971 R01

WELL NO.: 971

LOCATION: SWSA 5

TYPE: Rock Cuttings

SAMPLER: Bryan Howze (SIGNATURE)

DATE: 8/25/87

TIME: 12:12 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryan Howze	9/15/87	2:25	MCI	Nancy Owen	9/18/87	2:25	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 972 is located in WAG 5. It is 50' south of the southern boundary of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 16891.927, E 29852.631 (X-10 grid) or latitude 35° 54' 47.08" and longitude 84° 18' 38.14". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 972 was drilled by A.L. Clark Drilling Services, Inc. A Driltech air rotary rig was used to drill this boring for monitor well installation under the operation of Steve Clark with the assistance of Steve Kirk. Drilling commenced on

8/27/87 and was finished on 8/31/87. Paragraph 2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:

The rig and tools were steamcleaned and mobilized to the well location and set up. A 14" boring was drilled to a depth of 13.6'. Radioactivity levels of from 0.5 to 2.0 mR at 7' depth were detected by the site health physicist. Appropriate health and safety procedures were initiated at that time.

Ten-inch surface casing was set to a depth of 13.8' and grouted in. The boring was advanced with an 8 5/8" tricone air rotary to a total depth of 75.0'. Four-inch stainless steel casing, screen, sandpack and bentonite were installed.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist John W. Anderson. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

* This information was typed directly from field notes and was edited only when necessary for clarification.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5.

Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

No samples were collected during drilling. A drill water sample was collected from the water pump on the drill rig on 8/31/87. Analytical results for the sample described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type B well. A fourteen-inch diameter boring was augered from ground surface to bedrock (13.8 feet). A ten-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill an eight-

inch diameter boring to a total depth of 75.00 feet. A four-inch diameter stainless steel silt trap was installed from 74.7 to 75.0 feet. Above the silt trap, a four-inch diameter stainless steel screen was installed from 59.7 feet to 74.7 feet. A four-inch stainless steel casing was installed from the top of the screen at 59.7 feet and extending 2.63 feet above ground surface. A sandpack was then poured into the annular space from 59.0 to 75.0 feet, with a 2.0-foot bentonite seal poured into the annular space above the sandpack from 57.0 to 59.0 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 972 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 193 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The

final turbidity value measured at completion was 3.4 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/16/90 at a depth of 73.5 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 972 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 4.27×10^{-6} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 972

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	9/27/87	
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	8/27/87	
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	8/27/87	
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	8/27/87	
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	8/27/87	
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	8/27/87	

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE: 8/28/87
John W. Anderson

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 972

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE _____ 8/27/87
John W. Anderson

ERC / EDGE Environmental and Energy Services Co.

WELL No. 972

ORNL MONITORING WELL LOG

LOCATION: WAG 5
DRILLER: Steve Clark
HELPER: Steve Kirk
DRILL: Driltech

DATE: START: 8/27/87
FINISH: 8/31/87
LOGGED BY: John W. Anderson
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger and Air Rotary
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: None
TYPE: N/A
CONTAINMENT TYPE: Auger Pan, Plastic and Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 13.8
DEPTH DRILLED IN ROCK: 61.2
TOTAL DEPTH OF WELL: 75.0

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 8/31/87
0972W01

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	5.6			Silty clay with limestone fragments, orange
				with light gray, damp, (fill).
	@5.6			Original surface - organic material.
5.6	13.8			Silty clay with shale fragments, light brown,
				damp.
				*0.5 to 2.0 mR at 7.0'.
@	13.8			Shale, weathered, medium brown, wet, crumbly,
				auger refusal.
13.8	22.5			Shale, weathered, medium brown, wet, crumbly.
22.5	25.6			Hard - Limestone?
25.6	30.4			Soft, hole producing large quantity of water.
30.4	60.7			Fairly hard.
60.7	75.0			Closely spaced hard and soft layers.
	75.0			Total Depth
				Note: 0.5 to 2.0 mR at 7.0'.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 972

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: John W. Anderson

PROOFED BY:

DRILLING COMPANY: A..L. Clark Drilling Services

DRILLER: Steve Clark HELPER: Steve Kirk

DRILLING METHOD:
- ☒ 14 INCH AUGER 13.8 L.F.
- ☐ ____ INCH AUGER ____ L.F.
- ☒ 8 5/8 INCH ROTARY 61.2 L.F.
- ☐ ____ INCH ROTARY ____ L.F.

LOCATION WAG 5

ORNL GRID COORDINATES
N 16891.927
E 29852.631

ELEV. GROUND 774.546

ELEV. TOP STAINLESS STEEL CASING 777.176

DRILLING DATES:
STARTED: 8/27/87
FINISHED: 8/31/87

MATERIALS USED

EST. VOL.	USED VOL.	
	N/A	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	13.8	FT. OF 10 3/4 IN. SURFACE CASING
4.2	6.0	SACKS OF CEMENT (SURFACE CASING)
	12.0	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	36.0	GALLONS OF WATER (SURFACE CASING)
	62.3	FT. OF 4 IN. DIA. STAINLESS STEEL CASING
	15.0	FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
4.0	4.0	SACKS OF SAND
50.0	50.0	POUNDS OF BENTONITE PELLETS
17.0	16.0	SACKS OF CEMENT (WELL CASING)
	33.0	POUNDS OF POWERED BENTONITE (WELL CASING)
	96.0	GALLONS OF WATER (WELL CASING)
	3.36	FT. OF 10 3/4 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Spillage and irregular auger boring diameter.

SURFACE CASING TREMIE GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ☒ NO ☐

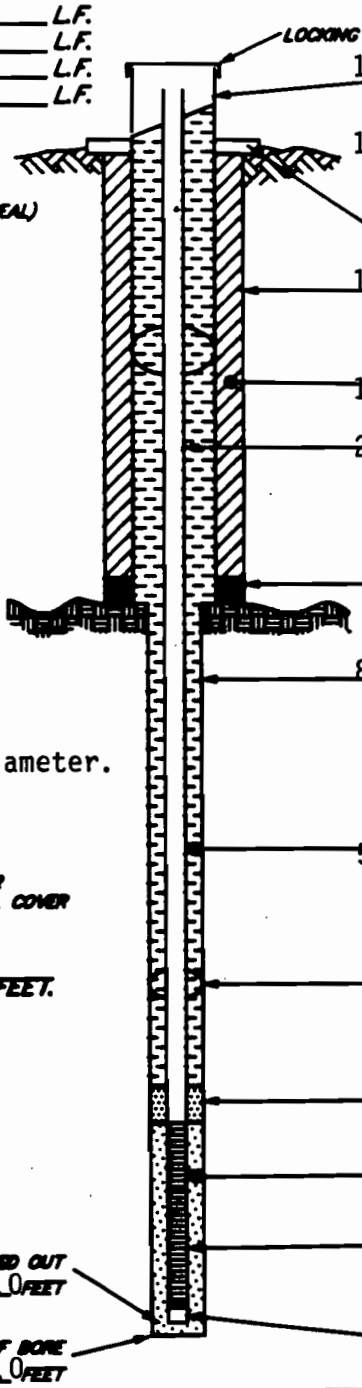
WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 73.5 FEET.

CENTRALIZERS AT 5.0 FEET.
15.0 FEET.
35.0 FEET.
55.0 FEET

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



TYPE B WELL

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 972

DATE: 8/31/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		8/31/87	02
BENTONITE		8/31/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	8/31/87	05
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	8/31/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	8/31/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	8/31/87	05
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	1/15/90	03
GROUT		9/01/87	10
WELL COVERS		9/87	01
SURFACE CASING		9/87	01

COMMENTS:

OBSERVER SIGNATURE/DATE: John W. Anderson 9/01/87

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 972

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8/31/87	
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8/31/87	
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	4/03/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8/31/87	

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE: 8/31/87
John W. Anderson

D. Charles Lytle 4/03/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 972

LOCATION: WAG 5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and pumping

DEVELOPMENT BEGAN DATE: 1-11-90 TIME:

DEVELOPMENT ENDING DATE: 1-15-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 57.5 GALLONS

TOTAL GALLONS PUMPED: 193 TOTAL WELL VOLUMES PUMPED: 3.4

INITIAL pH: 7.1 FINAL pH: 7.2

INITIAL CONDUCTIVITY (uS): 412 FINAL CONDUCTIVITY (uS): 430

DESCRIPTION OF INITIAL TURBIDITY: Slightly cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 3.0

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☐ GROUND SURFACE
- ☐ STORM SEWERS
- ■ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 3.4 water level from surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE: D. Charles Lytle 1-15-90

D. Charles Lytle

ERC / EDGE
Environmental and Energy Services Co.

WELL NO. 972
LOCATION: WAG 5
DATE: 1-11-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 57.5 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
1-11-90	1330	16	Slightly Cloudy	--	7.1	412			
1-11-90	1500	45	Cloudy	--	7.2	482	61		
1-12-90	1400	48	Clear	2.0	7.1	409	109	1.9	
1-12-90	1600		Clear	2.0	7.2	383	139	2.4	
1-15-90	1700	54	Clear	3.0	7.2	430	193	3.4	
RESULTS AT END OF DEVELOPMENT			Clear	3.0	7.2	430	193	3.4	

COMMENTS Water cleared even after surging. Tested well twice, still remained clear after surging. Passed and moved on.

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-15-90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 972 DATE OF TEST: 3/28/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 72.75 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .99 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR HO (FEET)
3.1109
3.1116

ERC / EDGE Environmental and Energy Services Co.

WELL No. 972

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.110	3.120
20.00	4.110	3.120
30.00	4.110	3.120
40.00	4.100	3.110
50.00	4.100	3.110
60.00	4.100	3.110
75.00	4.100	3.110
90.00	4.090	3.100
105.00	4.090	3.100
120.00	4.090	3.100
150.00	4.080	3.090
180.00	4.080	3.090
240.00	4.070	3.080
300.00	4.060	3.070
360.00	4.050	3.060
420.00	4.040	3.050
480.00	4.030	3.040
540.00	4.030	3.040
600.00	4.020	3.030
720.00	4.000	3.010
840.00	3.990	3.000
960.00	3.980	2.990
1080.00	3.960	2.970
1200.00	3.950	2.960
1320.00	3.940	2.950
1440.00	3.920	2.930
1560.00	3.910	2.920
1680.00	3.910	2.920
1800.00	3.890	2.900
1920.00	3.880	2.890
2040.00	3.860	2.870
2160.00	3.860	2.870

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

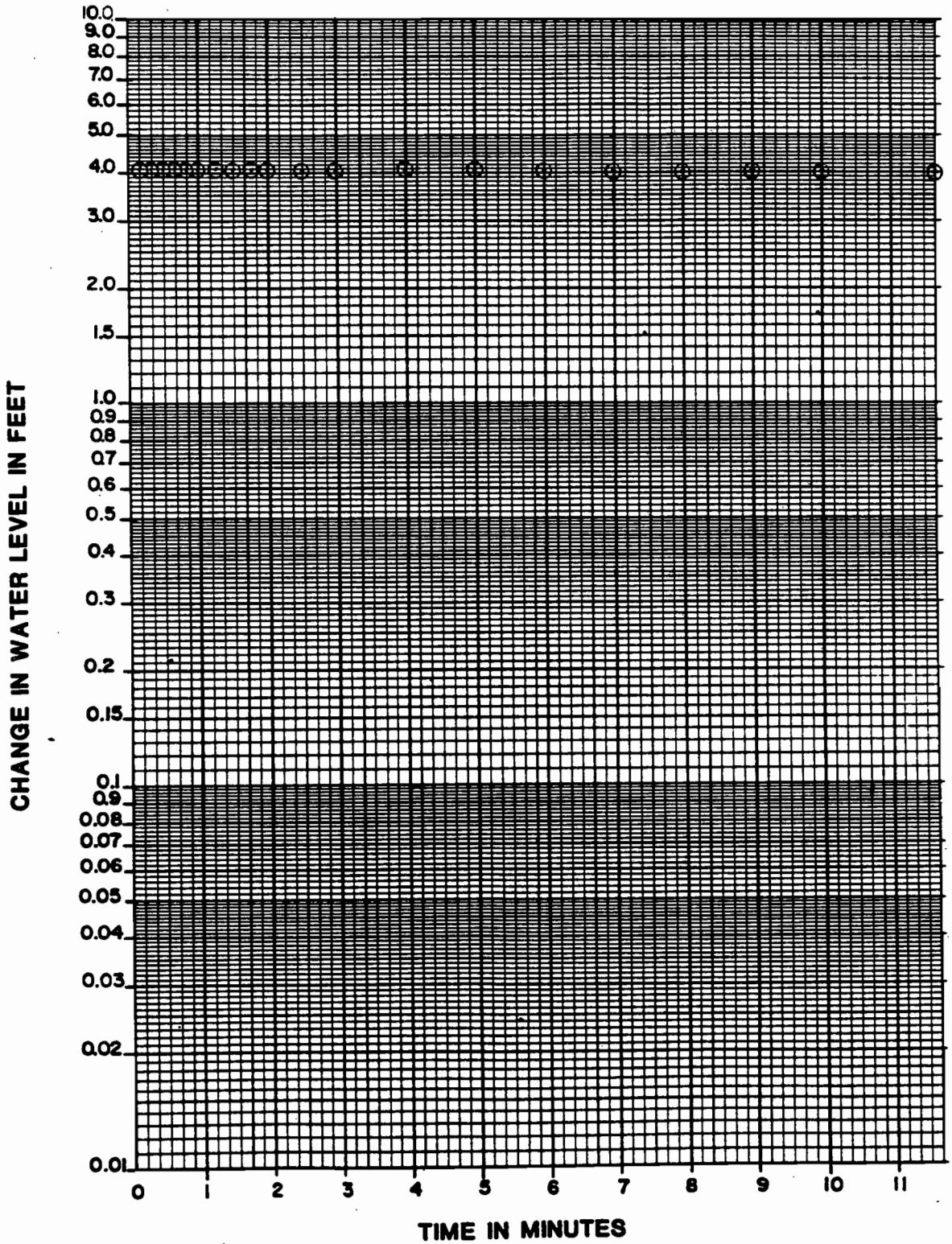
PERMEABILITY = 1.40E-07 FT/SEC = 4.27E-06 CM/SEC

TRANSMISSIVITY = 2.10E-06 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 972

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0972 W01

WELL NO.: 0972

LOCATION: Drilltech Rig Drilling Water

TYPE: Water

SAMPLER: John Anderson (SIGNATURE)

DATE: 8/31/87

TIME: 10:10

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
John Anderson	11/25/87	9:30	MCI	Michael S. Stone	11/25/87	9:30	MCI
Michael S. Stone	11/25/87	2:40PM	MCI	Nancy Owen	11-25-87	2:40	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 973 is located in WAG 5. It is on the new road along the southern perimeter of WAG 5 just north of Melton Branch. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 16897.749, E 29841.486 (X-10 grid) or latitude 35° 55' 46.77" and longitude 84° 18' 38.52". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 973 was drilled by A.L. Clark Drilling Services, Inc. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of Richard Pickel. Drilling commenced on 9/2/87 and was finished on 9/9/87.

Paragraph 2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

9/2/87: The rig was moved to the well site.

9/3/87: The rig was set up and drilling with 6" augers commenced.

9/4/87: The drill hole was drilled to a depth of 15.5'.

9/8/87: The drill hole was bailed to remove drill cuttings.

9/9/87: The drill hole was bailed one more time and 2" stainless steel screen, casing, sand and bentonite were installed.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist Bryn D. Howze. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing,

* This information was typed directly from field notes and was edited only when necessary for clarification.

centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

Two soil samples and one rock sample were collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 0973S01 was collected in the auger interval at 5.5 feet on 9/3/87, soil sample 0973S02 was collected in the augered interval at 11.4 feet on 9/3/87 and rock sample 0973R01 was collected in the augered interval at 14.4 feet on 9/4/87. Analytical results for the three samples described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type A well. A two-inch diameter stainless steel silt trap was installed from 15.3 to 15.5 feet. Above the silt trap a two-inch diameter stainless steel screen was installed from 10.3 to 15.3 feet. A two-inch diameter stainless steel casing was installed above the screen from 10.3 feet to 1.98 feet above ground surface. A sandpack was then poured into the annular space from 9.1 to 15.5 feet, with a 2.0-foot bentonite

pellet seal poured into the annular space above the sandpack from 7.1 to 9.1 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 973 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 160 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/19/90 at a depth of 12.6 feet below ground surface. These pumps are decontaminated at

American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 973 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.85×10^{-4} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 973

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	9/2/87	BH
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	9/2/87	BH
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	NA	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	9/9/87	BH
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	9/2/87	BH
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	9/2/87	BH
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	9/2/87	BH

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Bryn Howze 9/2/87
Bryn D. Howze

ERC / EDGE Environmental and Energy Services Co.

WELL No. 973

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE Bryn Howze 9/2/87

Bryn D. Howze

ERC / EDGE Environmental and Energy Services Co.

WELL No. 973

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG 5

DRILLER: Richard Pickel

HELPER: N/A

DRILL: Schramm Rotadrill

DATE: START: 9/2/87
FINISH: 9/9/87

LOGGED BY: Bryn D. Howze

HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger

LUBRICANT TYPE: Molykote 1000

No. SAMPLES TAKEN: Three

TYPE: Two soil and one rock

CONTAINMENT TYPE: Auger pan and plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 12.8'

DEPTH DRILLED IN ROCK: 2.7'

TOTAL DEPTH OF WELL: 15.5'

DRILLING FLUID SAMPLES:

TYPE: NA DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	5.5			Clay, slightly silty, orange-brown, with rock
				fragments, chert (fill for roadbed)
5.5	11.0	0973S01		Silt, light brown, with roots,
		@ 5.5'		* 0.2 mR at 5.5'
11.0	12.8	0973S02		Silt, clayey, light to medium gray, wet at 11.0'
		@ 11.4'		
12.8	13.2			Hard drilling (possible limestone)
13.2	14.3			Soft drilling (possible shale)
14.3	15.5	0973R01		Hard drilling (possible limestone)
		@ 14.4'		
	15.5			Total Depth
				Note: 0.2 mR at 5.5'
				No split spoon samples were taken due to
				contamination at the pre-fill ground surface

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 973

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Bryn D. Howze
PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: Richard Pickel HELPER: N/A

EQUIPMENT
■ 6 1/4 INCH AUGER 15.5 L.F.
□ _____ INCH AUGER _____ L.F.

LOCATION WAG 5
ORNL GRID COORDINATES
N 16897.749
E 29841.486
ELEV. GROUND 774.336
ELEV. TOP STAINLESS STEEL CASING 776.306

DRILLING DATES:
STARTED: 9/2/87
FINISHED: 9/9/87

MATERIALS USED

EST. VOL.	USED VOL.	
5.0		FEET OF 2 IN. S.S. SCREEN
12.3		FEET OF 2 IN. S.S. CASING
2.0	2.0	SACKS OF SAND
40.0	40.0	POUNDS OF BENTONITE PELLETS
1.5	1.5	SACKS OF CEMENT
NA		POUNDS OF POWDERED BENTONITE
10.0		GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

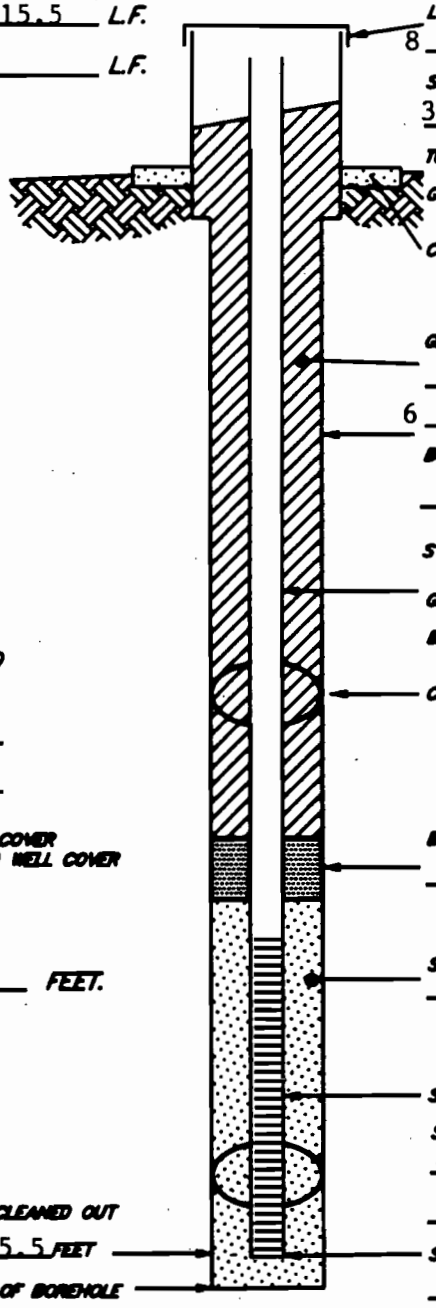
WELL COVER USED
■ LOCKING STEEL COVER
□ FLUSH MOUNTED WELL COVER
□ OTHER

SILT TRAP USED YES ■ NO □

MONITORING WELL PUMP BASE SET AT 12.6 FEET.

CENTRALIZERS AT 3.0 FEET.
15.0 FEET.
_____ FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER
8 5/8 INCH DIAMETER STEEL PROTECTIVE CASING 3.61 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO 7.1 FEET

6 1/4 INCH DIAMETER BOREHOLE

2 INCH DIAMETER STAINLESS STEEL CASING 1.98 FT. ABOVE GROUND SURFACE TO 10.3 FT. BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL 7.1 TO 9.1 FEET

SAND PACK 9.1 TO 15.5 FEET

2 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 10.3 TO 15.3 FEET

2 INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP 15.3 TO 15.5 FEET

HOLE CLEANED OUT TO 15.5 FEET

BOTTOM OF BOREHOLE 15.5 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE Environmental and Energy Services Co.

WELL No. 973

DATE: 9/9/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		9/9/87	02
BENTONITE		9/9/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	9/9/87	05
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	9/9/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	9/9/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	9/9/87	05
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	1/19/90	03
GROUT		9/10/87	10
WELL COVERS			
SURFACE CASING		9/87	01

COMMENTS:

OBSERVER SIGNATURE/DATE Bryn D. Howze 9/9/87

Bryn D. Howze

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 973

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	9/9/87	BH
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	9/9/87	BH
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/18/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	9/9/87	BH

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Bryn D. Howze 9/9/87
Bryn D. Howze

D. Charles Lytle 1/18/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 973

LOCATION: WAG5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and pumping

DEVELOPMENT BEGAN DATE: 1-11-90 TIME:

DEVELOPMENT ENDING DATE: 1-18-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 4.4 GALLONS

TOTAL GALLONS PUMPED: 160 TOTAL WELL VOLUMES PUMPED: 36.4

INITIAL pH: 6.8 FINAL pH: 7.1

INITIAL CONDUCTIVITY (uS): 998 FINAL CONDUCTIVITY (uS): 317

DESCRIPTION OF INITIAL TURBIDITY: Milky

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☐ GROUND SURFACE
- ☐ STORM SEWERS
- ■ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 3.8 feet from surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-18-90

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 973
LOCATION: WAG5
DATE: 1-11-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 4.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
1-11-90	1330	10	Milky		6.8	998			
1-11-90	1500	46	Cloudy		6.8	032	56		
1-12-90	1400	26	Milky		6.6	966	82	18.6	
1-12-90	1600	8	Milky		7.3	881	90	20.5	
1-15-90	1030	37	Milky		6.7	957	127	28.8	
1-15-90	1700	3	Milky		6.7	951	130	29.5	
1-18-90	0900	5	Cloudy		6.9	921	135	30.9	
1-18-90	1200	25	Clear	2.0	7.1	317	160	36.4	
RESULTS AT END OF DEVELOPMENT			Clear	2.0	7.1	317	160	36.4	

COMMENTS Water would not clear after 30.0 well volumes; did not surge on 1-18-90.
Water cleared; had 2.0 NTU's. Passed and moved on.

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-18-90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 973 DATE OF TEST: 2/5/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 5.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 10.75 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 5.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .98 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 25

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR HO (FEET)
2.6271
2.7856
2.9045

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.770	3.790
20.00	4.500	3.520
30.00	4.280	3.300
40.00	4.080	3.100
50.00	3.900	2.920
60.00	3.700	2.720
75.00	3.480	2.500
90.00	3.230	2.250
105.00	3.060	2.080
120.00	2.890	1.910
150.00	2.580	1.600
180.00	2.370	1.390
240.00	2.040	1.060
300.00	1.780	.800
360.00	1.600	.620
420.00	1.480	.500
480.00	1.380	.400
540.00	1.310	.330
600.00	1.250	.270
720.00	1.190	.210
840.00	1.150	.170
960.00	1.140	.160
1080.00	1.110	.130
1200.00	1.080	.100
1320.00	1.100	.120

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

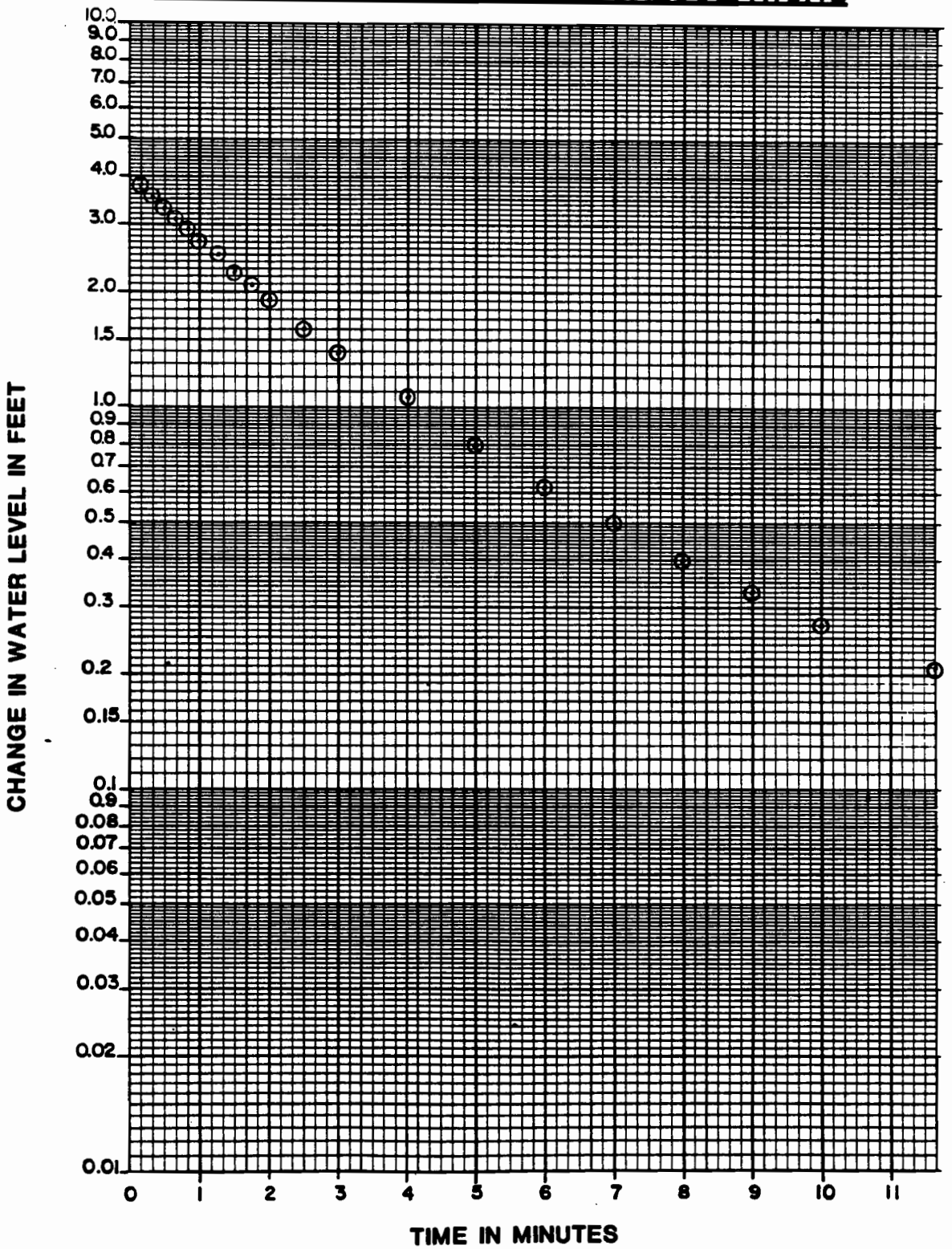
PERMEABILITY = 6.07E-06 FT/SEC = 1.85E-04 CM/SEC

TRANSMISSIVITY = 3.04E-05 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 973

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0973 S01

WELL NO.: 0973

LOCATION: SWSA 5

TYPE: Soil

SAMPLER: Bryn Howze Bryn Howze (SIGNATURE)

DATE: 9/3/87

TIME: 8:56 AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn D. Howze	9/11/87	8:30AM	MCI	Nancy Owen	9/11/87	8:30	ORNL

REMARKS: 0.2 mrem/hr at ½"

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0973 S02

WELL NO.: 0 973

LOCATION: SWSA 5

TYPE: Soil

SAMPLER: Bryn Howze (SIGNATURE) Bryn Howze

DATE: 9/3/87

TIME: 9:20AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn H. Howze	9/11/87	8:30AM	MCI	Nancy Owen	9/11/87	8:30	ORNL

REMARKS: 0.2 mrem/hr. at ½"

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0973 R01

WELL NO.: 0973

LOCATION: SWSA 5

TYPE: Rock cuttings

SAMPLER: Bryn Howze (SIGNATURE)

DATE: 9/4/87

TIME: 11:10 AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn D. Howze	9/11/87	8:30AM	MCI	Nancy Owen	9/11/87	8:30	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 974 is located in WAG 5. It is on the new road along the southern perimeter of WAG 5 just north of Melton Branch. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 16972.922, E 29425.677 (X-10 grid) or latitude 35° 54' 45.10" and longitude 84° 18' 43.23". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 974 was drilled by A.L. Clark Drilling Services, Inc. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of Richard Pickel. Drilling commenced on 8/28/87 and was finished on 9/1/87.

Paragraph 2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

8/28/87: The rig was moved to the well site and set up. The first 2.2' of fill was augered using 6 1/4" augers. Split spoon samples were taken from 2.2' to 6.7'.

8/31/87: The drill hole was drilled to 21.7' and bailing started.

9/1/87: The drill hole was drilled and cleaned out to a total depth of 22.3'. Two-inch stainless steel casing, screen, sand and bentonite were then installed.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist Bryn D. Howze. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

* This information was typed directly from field notes and was edited only when necessary for clarification.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5.

Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

Two samples were collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 0974S01 was collected in the split spoon interval from 3.9 feet to 4.1 feet on 8/28/87 and rock sample 0974R01 was collected in the augered interval at 15.2 feet on 8/28/87. Analytical results for these samples described above can be obtained from the Remedial Action Program data base at ORNL.

A bulk density soil sample was collected from the split spoon sample interval from 5.8 feet to 6.2 feet. The sample was measured and weighed, and a bulk density of 1.96 grams/cm^3 was calculated.

2.4 Installation and Development

2.4.1 Installation

This was a type A well. A two-inch diameter stainless steel silt trap was installed from 22.1 to 22.3 feet. Above the silt trap a two-inch diameter stainless steel screen was installed from 12.1 to 22.1 feet. A two-inch diameter stainless steel casing was installed above the screen from 12.1 feet to 3.26 feet above ground surface. A sandpack was then poured into the annular space from 10.1 to 22.3 feet, with a 2.8-foot bentonite pellet seal poured into the annular space above the sandpack from 7.3 to 10.1 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 974 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 189 gallons of water had been

evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 5 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/17/90 at a depth of 19.5 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 974 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 3.02×10^{-5} cm/second (shown

as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 974

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	8/28/87	BH
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	8/28/87	BH
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	NA	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	9/1/87	BH
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	8/28/87	BH
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	8/28/87	BH
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	8/28/87	BH

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Bryn Howze 9/1/87

Bryn B. Howze

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 974

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE Bryn Howze 8/28/87
Bryn D. Howze

ERC / EDGE Environmental and Energy Services Co.

WELL No. 974

ORNL MONITORING WELL LOG

LOCATION: WAG 5
DRILLER: Richard Pickel
HELPER: N/A
DRILL: Schramm Rotadrill

DATE: START: 8/28/87
FINISH: 9/1/87
LOGGED BY: Bryn D. Howze
HEALTH PHYSICIST: Sherry Cox

TYPE DRILLING: Auger
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: Two
TYPE: One soil and one rock
CONTAINMENT TYPE: Auger pan and plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 10.3'
DEPTH DRILLED IN ROCK: 12.0'
TOTAL DEPTH OF WELL: 22.3'

DRILLING FLUID SAMPLES:
TYPE: NA
DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	2.2		Augered	Clay, slightly silty, orange-brown with rock
				fragments (chert), firm (fill for roadbed)
2.2	4.2	0974S01	55	Silt, light brown, mottled orange and black,
		@ 3.9-4.1'		with roots and rock fragments (weathered shale)
				very stiff
4.2	6.2		50	Shale, highly weathered and silt, light brown
				to greenish-gray, mottled black and orange
				(Fe stains), with roots, very stiff
				Bulk density at 5.8-6.2' = 1.96 grams/cm^3
6.2	8.2		25	Shale, highly weathered, and silt, light brown
				to greenish-gray, mottled black and orange,
				very stiff
	@8.2			Split spoon refusal
8.2	10.3			Shale, weathered, light brown, fissile
10.3	11.0			Shale, medium gray, thinly bedded, calcareous,
				hard drilling at 10.3'
11.0	13.7			Shale, slightly silty, medium to dark gray,
				slightly calcareous, moist, soft drilling at
				11.0'
13.7	15.2			Limestone, light gray, fine grained, hard
				drilling at 13.7'

ERC / EDGE Environmental and Energy Services Co.

WELL No. 974

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	DEPTH (FEET) TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
15.2	18.7	0974R01		Soft drilling, possible shale
		@ 15.2'		
18.7	22.3			Limestone, light gray, hard drilling
	22.3			Total Depth

ERC / EDGE Environmental and Energy Services Co.

WELL No. 974

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Bryn D. Howze

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: Richard Pickel HELPER: N/A

EQUIPMENT ■ 6 1/4 INCH AUGER 22.3 L.F.

☐ _____ INCH AUGER _____ L.F.

LOCATION WAG 5

ORNL GRID COORDINATES

N 16972.922

E 29425.677

ELEV. GROUND 770.806

ELEV. TOP STAINLESS STEEL CASING 774.066

DRILLING DATES:

STARTED: 8/28/87

FINISHED: 9/1/87

MATERIALS USED

EST. VOL.	USED VOL.	
10.0		FEET OF 2 IN. S.S. SCREEN
15.4		FEET OF 2 IN. S.S. CASING
3.0	3.0	SACKS OF SAND
40.0	40.0	POUNDS OF BENTONITE PELLETS
1.0	1.0	SACKS OF CEMENT
	NA	POUNDS OF POWDERED BENTONITE
	7.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

_____

_____

WELL COVER USED ■ LOCKING STEEL COVER ☐ FLUSH MOUNTED WELL COVER ☐ OTHER

SILT TRAP USED YES ■ NO ☐

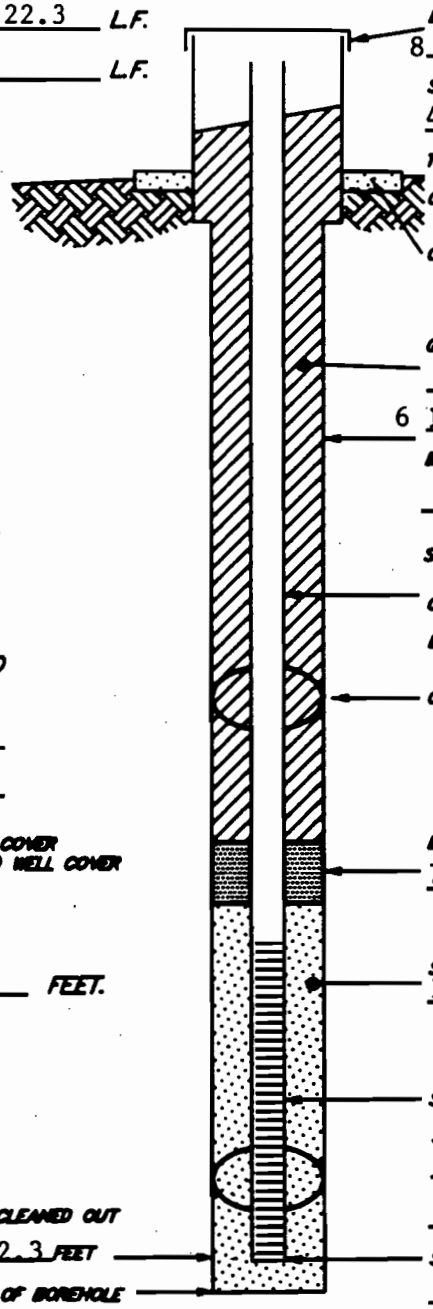
MONITORING WELL PUMP BASE SET AT 19.5 FEET.

CENTRALIZERS AT 12.0 FEET.

22.0 FEET.

_____ FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER

8 5/8 INCH DIAMETER STEEL PROTECTIVE CASING 4.11 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO 7.3 FEET

6 1/4 INCH DIAMETER BOREHOLE

2 INCH DIAMETER STAINLESS STEEL CASING 3.26 FT. ABOVE GROUND SURFACE TO 12.1 FT. BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL 7.3 TO 10.1 FEET

SAND PACK. 10.1 TO 22.3 FEET

2 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 12.1 TO 22.1 FEET

2 INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP 22.1 TO 22.3 FEET

HOLE CLEANED OUT TO 22.3 FEET

BOTTOM OF BOREHOLE 22.3 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 974

DATE: 9/1/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		9/1/87	02
BENTONITE		9/1/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES □ NO)	9/1/87	05
STAINLESS STEEL CASING	(PREPACKAGED ■ YES □ NO)	9/1/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES □ NO)	9/1/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES □ NO)	9/1/87	05
MONITORING WELL PUMP	(PREPACKAGED ■ YES □ NO)	1/17/90	03
GROUT		9/2/87	09
WELL COVERS			
SURFACE CASING		9/87	01

COMMENTS:

OBSERVER SIGNATURE/DATE Bryn D Howze 9/2/87
Bryn D Howze

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 974

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	9/1/87	BH
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	9/1/87	BH
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/16/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	9/1/87	BH

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Bryn Howze 9/1/87
Bryn D. Howze

D. Charles Lytle 1/16/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 974

LOCATION: WAG5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and pumping

DEVELOPMENT BEGAN DATE: 1-11-90 TIME:

DEVELOPMENT ENDING DATE: 1-16-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 7.3 GALLONS

TOTAL GALLONS PUMPED: 189 TOTAL WELL VOLUMES PUMPED: 26.0

INITIAL pH: 7.0 FINAL pH: 7.0

INITIAL CONDUCTIVITY (uS): 775 FINAL CONDUCTIVITY (uS): 740

DESCRIPTION OF INITIAL TURBIDITY: Very cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 5.0

WELL APPROVED BY: R.C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☐ GROUND SURFACE
- ☐ STORM SEWERS
- ■ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 6.7 feet from surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE: D. Charles Lytle 1-16-90

D. Charles Lytle

ERC / EDGE
Environmental and Energy Services Co.

WELL NO. 974
LOCATION: WAG5
DATE: 1-11-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 7.3 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
1-11-90	1500	54	very cloudy		7.0	775	54	7.4	
1-12-90	0900	10	slightly cloudy		6.9	721	64	8.8	
1-12-90	1400	20	slightly cloudy		6.9	721	84	11.5	
1-15-90	1030	44	slightly cloudy		7.0	726	128	17.5	
1-15-90	1700	5	slightly cloudy		7.0	748	133	18.2	
1-16-90	1100	42	slightly cloudy		7.0	739	175	24.0	
1-16-90	2400	14	Clear		7.0	740	189	26.0	
RESULTS AT END OF DEVELOPMENT			Clear	5.0	7.0	740	189	26.0	

COMMENTS Water cleared up after 25.0 volumes. Even after surging, water remained clear. Passed and moved on.

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-16-90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 974 DATE OF TEST: 2/8/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 13.35 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .98 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 30

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

1.8371
1.8700

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.690	2.710
20.00	3.510	2.530
30.00	3.360	2.380
40.00	3.210	2.230
50.00	3.080	2.100
60.00	2.990	2.010
75.00	2.820	1.840
90.00	2.710	1.730
105.00	2.600	1.620
120.00	2.570	1.590
150.00	2.500	1.520
180.00	2.430	1.450
240.00	2.270	1.290
300.00	2.180	1.200
360.00	2.090	1.110
420.00	1.990	1.010
480.00	1.910	.930
540.00	1.850	.870
600.00	1.790	.810
720.00	1.700	.720
840.00	1.630	.650
960.00	1.580	.600
1080.00	1.580	.600
1200.00	1.520	.540
1320.00	1.480	.500
1440.00	1.450	.470
1560.00	1.440	.460
1680.00	1.430	.450
1800.00	1.390	.410
1920.00	1.410	.430

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

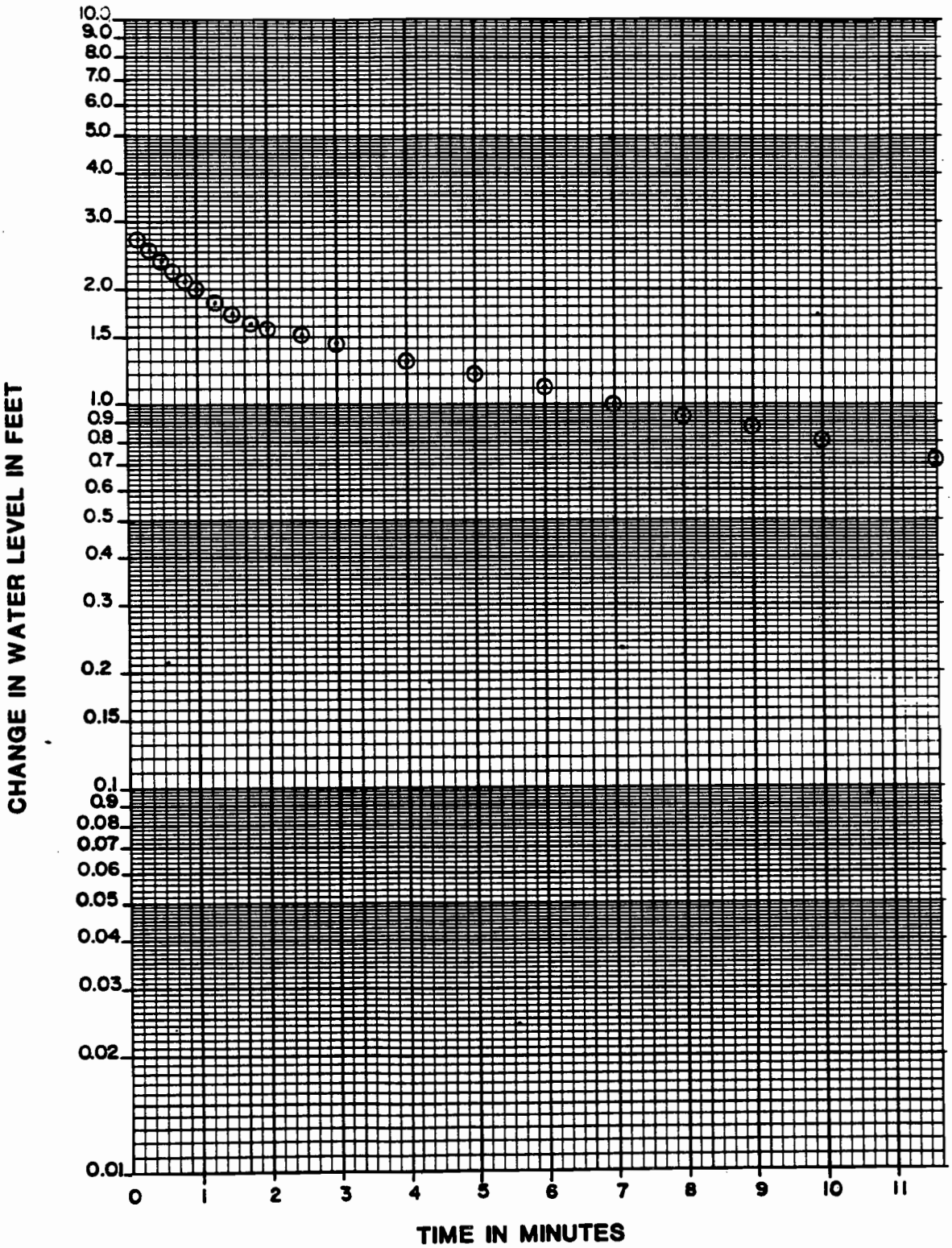
PERMEABILITY = 9.90E-07 FT/SEC = 3.02E-05 CM/SEC

TRANSMISSIVITY = 9.90E-06 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 974

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0974 501

WELL NO.: 974

LOCATION: SWSA 5

TYPE: Soil

SAMPLER: Bryn Hoyle (SIGNATURE)

DATE: 8/28/87

TIME: 10:25 AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn Hoyle	9/15/87	2:25	MCI	Nancy Owen	9/15/87	2:25	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0974 R01

WELL NO.: 974

LOCATION: SWSA 5

TYPE: Rock Cuttings

SAMPLER: Bryn Howze (SIGNATURE)

DATE: 8/28/87

TIME: 4:10 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn Howze	9/15/87	2:25	MCI	Nancy Owen	9/15/87	2:25	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 975 is located in WAG 5. It is along the south perimeter fence of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 16984.3892, E 29013.7017 (X-10 grid) or latitude 35° 54' 43.23" and longitude 84° 18' 47.24". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 975 was drilled by A.L. Clark Drilling Services, Inc. A Gus Pech auger rig was used to drill this boring for monitor well installation under the operation of A.L. Clark III with the assistance of Ray Clark. Drilling commenced on

9/1/87 and was finished on 9/10/87. Paragraph 2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/ completion form. A synopsis of the drilling activity follows:*

8/31/87: The Gus Pech was steam cleaned.

9/1/87: The rig was mobilized to the staked location and set up. The boring was augered from 0.0' to 10.0' with 6 1/4" augers and split spooned from 10.0' to 10.3'. Augered thru 0.5 to 1.0 mR at approximately 6'.

9/2/87: The boring was augered from 10.3' to 16.0'.

9/3/87: The boring was augered from 16.0' to 23.0'.

9/4/87: The boring was augered from 23.0' to 28.5' and bailed.

9/8/87: The boring was bailed.

9/9/87: The boring was bailed in the morning and stainless steel casing, screen, sandpack and bentonite were installed.

9/10/87: The annular space was grouted.

This well was logged by ERC Environmental and Energy Services Co. (ERC/EDGe) hydrogeologist

* This information was typed directly from field notes and was edited only when necessary for clarification.

Michael L. Ebers. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak

Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

Four soil samples were collected during drilling, placed in an I-CHEM specialty cleaned glass container, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody form for these samples are included with this data package. Soil sample 0975S01 was collected in the auger interval at 7.0 feet on 9/1/87, soil sample 0975S02 was collected in the augered interval at 10.0 feet on 9/1/87, soil sample 0975S03 was collected in the augered interval at 9.0 feet (fall in) on 9/1/87, soil sample 0975S04 was collected in the split

spoon interval from 10.2 feet to 10.3 feet on 9/1/87, and rock sample 0975R01 was collected in the augered interval at 28.0' on 9/4/87. Analytical results for the soil and rock samples described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type A well. A two-inch diameter stainless steel silt trap was installed from 28.0 to 28.3 feet. Above the silt trap a two-inch diameter stainless steel screen was installed from 18.0 to 28.0 feet. A two-inch diameter stainless steel casing was installed above the screen from 18.0 feet to 2.36 feet above ground surface. A sandpack was then poured into the annular space from 16.5 to 28.5 feet, with a 1.8-foot bentonite pellet seal poured into the annular space above the sandpack from 14.7 to 16.5 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 975 was developed to remove drill cuttings, silt, and other fines. The monitoring

well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 247 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/19/90 at a depth of 25.4 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 975 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity

of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Ommidata Datapod II data recorder. The hydraulic conductivity value of 6.60×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 975

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	9-01-87	MLE
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	9-01-87	MLE
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	9-09-87	MLE
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	9-01-87	MLE
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	9-01-87	MLE
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	9-01-87	MLE

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 9-09-87

Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 975

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE [signature] 9-01-87

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 975

ORNL MONITORING WELL LOG

LOCATION: WAG 5
DRILLER: A. L. Clark III
HELPER: Ray Clark
DRILL: Gus Pech

DATE: START: 9/01/87
FINISH: 9/09/87
LOGGED BY: Michael L. Ebers
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Split Spoon and Auger
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: Five
TYPE: 4 Soil and 1 Rock
CONTAINMENT TYPE: Auger Pan and Plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 10.3'
DEPTH DRILLED IN ROCK: 18.2'
TOTAL DEPTH OF WELL: 28.5'

DRILLING FLUID SAMPLES:
TYPE: None
DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	0.3			Gravel.
0.3	7.0	0975S01 @7.0'	Augered	Clay, reddish orange and chert cobbles - Fill
		0975S02 @10.0'		**0.5 to 1.0 mR at 6'.
7.0	10.0	0975S03 @9.0'	Augered	Silt, olive gray, dry crumbly.
10.0	10.3	0975S04	100%	
		@ 10.2-10.3'		
	10.3			Split spoon refusal.
10.3	12.0			Shale, silty, fairly hard.
12.0	15.0			Shale, soft, dark olive gray.
15.0	18.0			Limestone, olive gray, fine grained, inter-
				bedded with siltstone, thinly banded,
				calcareous.
18.0	20.0			Shale, dark olive gray, with few thin beds
				of siltstone.
20.0	21.0			Siltstone, medium gray, calcareous.
21.0	23.0			Shale, dark olive gray, interbedded with
				siltstone.
23.0	24.0			Limestone, olive gray, fine grained, hard.
24.0	28.5	0975R01		Shale, soft, with a few thin beds of siltstone,
		@28'		wet at 24.0'

ERC / EDGE Environmental and Energy Services Co.

WELL No. 975

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	DEPTH (FEET) TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
	28.5			Total Depth
				** NOTE: 0.5 to 1.0 mR at 6'.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 975

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Michael L. Ebers
PROOFED BY: Timothy A. Lee

DRILLING COMPANY: A. L. Clark Drilling Service

DRILLER: A. L. Clark III HELPER: Ray Clark

EQUIPMENT ☒ 6 1/4 INCH AUGER 28.5 L.F.
☐ _____ INCH AUGER _____ L.F.

LOCATION WAG 5
ORNL GRID COORDINATES
N 16,984.3892
E 29,013.7017
ELEV. GROUND 783.14
ELEV. TOP STAINLESS STEEL CASING 785.50

DRILLING DATES:
STARTED: 9/01/87
FINISHED: 9/09/87

MATERIALS USED

EST. VOL.	USED VOL.	
	10.0	FEET OF 2 IN. S.S. SCREEN
	20.4	FEET OF 2 IN. S.S. CASING
2.2	3.0	SACKS OF SAND
35.0	35.0	POUNDS OF BENTONITE PELLETS
1.9	1.9	SACKS OF CEMENT
	4.0	POUNDS OF POWDERED BENTONITE
	12.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

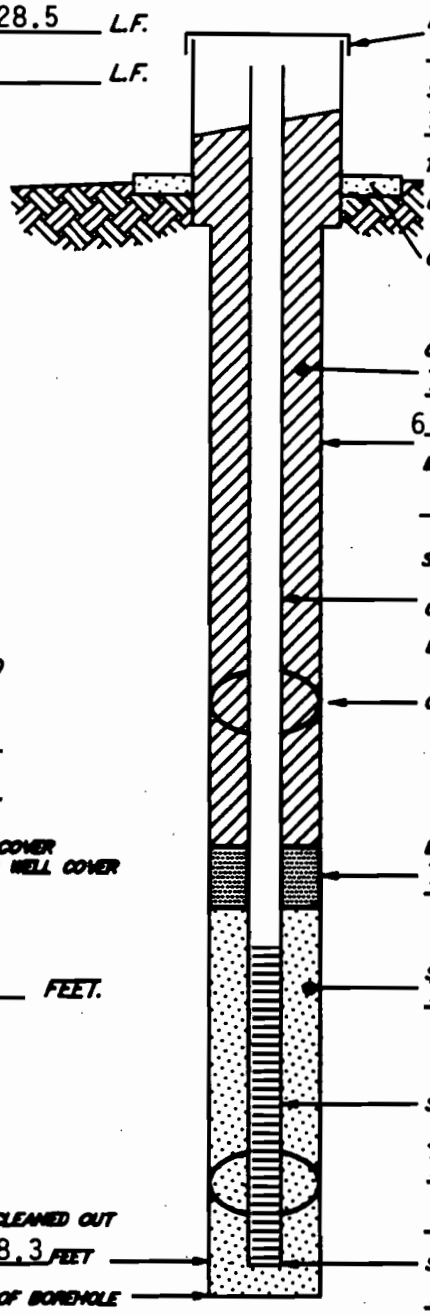
WELL COVER USED ☒ LOCKING STEEL COVER ☐ FLUSH MOUNTED WELL COVER ☐ OTHER

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 25.4 FEET.

CENTRALIZERS AT 3.0 FEET.
18.0 FEET.
28.0 FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER 8 INCH DIAMETER
STEEL PROTECTIVE CASING 3.57 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE
CONCRETE PAD
GROUT SEAL 0.0 TO 14.7 FEET
6 1/4 INCH DIAMETER BOREHOLE
2 INCH DIAMETER STAINLESS STEEL CASING 2.36 FT. ABOVE GROUND SURFACE TO 18.0 FT. BELOW GROUND SURFACE
CENTRALIZER (TYP.)
BENTONITE PELLET SEAL 14.7 TO 16.5 FEET
SAND PACK 16.5 TO 28.5 FEET
2 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 18.0 TO 28.0 FEET
2 INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP 28.0 TO 28.3 FEET
HOLE CLEANED OUT TO 28.3 FEET
BOTTOM OF BOREHOLE 28.5 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 975

DATE: 9/09/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		9/09/87	02
BENTONITE		9/09/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	9/09/87	05
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	9/09/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	9/09/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	9/09/87	05
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	1/18/90	03
GROUT		9/10/87	10
WELL COVERS			
SURFACE CASING		9/87	02

COMMENTS:

OBSERVER SIGNATURE/DATE 9/09/87

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 975

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	9/09/87	MLE
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	9/09/87	MLE
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/18/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	9/09/87	MLE

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE [signature] 9/09/87
Michael L. Ebers

D. Charles Lytle 1/18/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 975

LOCATION: WAG 5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 1-11-90 TIME:

DEVELOPMENT ENDING DATE: 1-18-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 7.4 GALLONS

TOTAL GALLONS PUMPED: 247 TOTAL WELL VOLUMES PUMPED: 33.4

INITIAL pH: 6.7 FINAL pH: 6.8

INITIAL CONDUCTIVITY (uS): 941 FINAL CONDUCTIVITY (uS): 853

DESCRIPTION OF INITIAL TURBIDITY: Milky

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER:

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 11.0 feet from surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE: D. Charles Lytle 1-18-90

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 975
LOCATION: WAG 5
DATE: 1-11-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 7.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
1-11-90	1330	35	Milky	--	6.7	941			
1-11-90	1500	22	Cloudy	--	6.7	970	57		
1-12-90	1600	55	Cloudy	--	7.1	854	112	25.1	
1-15-90	1030	27	Cloudy	--	6.8	894	139	18.8	
1-15-90	1700	14	Cloudy	--	6.7	942	153	20.7	
1-16-90	1100	16	Cloudy	--	6.6	899	169	23.0	
1-16-90	1200	34	Cloudy	--	6.6	930	203	27.4	
1-16-90	1500	20	Cloudy	--	6.6	898	223	30.1	
1-18-90	0900	54	Clear	2.0	6.8	853	247	33.4	
RESULTS AT END OF DEVELOPMENT			Clear	2.0	6.8	853	247	33.4	

COMMENTS Water would not clear after 30.0 well volumes. Did not surge on 1-18-90 and water cleared. Had 2.0 NTU's. Passed and moved on.

OBSERVER SIGNATURE/DATE D. Charles Lytle
D. Charles Lytle

MWFORM05.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 975 DATE OF TEST: 2/6/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 17.70 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 1.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 29

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR HO (FEET)
3.5926
3.6247

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	5.150	4.150
20.00	4.990	3.990
30.00	4.880	3.880
40.00	4.750	3.750
50.00	4.660	3.660
60.00	4.500	3.500
75.00	4.350	3.350
90.00	4.180	3.180
105.00	4.050	3.050
120.00	3.890	2.890
150.00	3.650	2.650
180.00	3.440	2.440
240.00	3.080	2.080
300.00	2.810	1.810
360.00	2.550	1.550
420.00	2.320	1.320
480.00	2.160	1.160
540.00	2.020	1.020
600.00	1.860	.860
720.00	1.670	.670
840.00	1.520	.520
960.00	1.450	.450
1080.00	1.380	.380
1200.00	1.320	.320
1320.00	1.260	.260
1440.00	1.200	.200
1560.00	1.170	.170
1680.00	1.140	.140
1800.00	1.110	.110

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

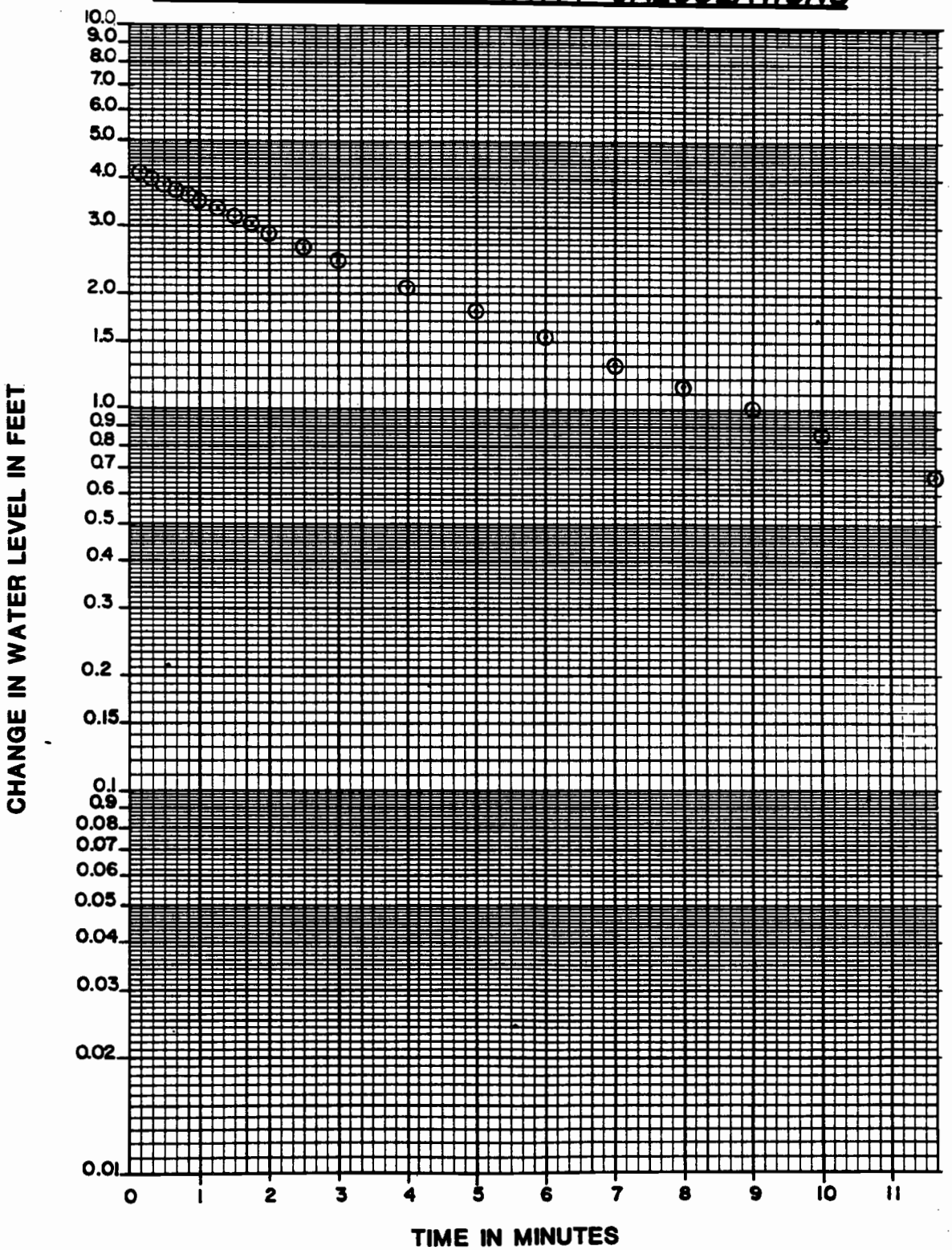
PERMEABILITY = 2.17E-06 FT/SEC = 6.60E-05 CM/SEC

TRANSMISSIVITY = 2.17E-05 FT**2/SEC

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 975

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0975 S01

WELL NO.: 0975

LOCATION: SWSA 5 @ ~7.0'

TYPE: SOIL

SAMPLER: [signature] (SIGNATURE)

DATE: 9/1/87

TIME: 8:00AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	9/1/87	12:00	MCI	Nancy Owen	9/1/87	12:00	ORNL CPA

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0975 S02

WELL NO.: 0975

LOCATION: SWSA 5 @ ~ 10.0'

TYPE: SOIL

SAMPLER: [signature] (SIGNATURE)

DATE: 9/1/87

TIME: 8:15 A.M.

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	9/1/87	12:00	MCI	Nancy Owen	9/1/87	12:00	ORNL CPA

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0975 S03

WELL NO.: 0975

LOCATION: SWSA 5 C 9.0'

TYPE: Soil - Fall in

SAMPLER: [signature] (SIGNATURE)

DATE: 9/1/87

TIME: 8:30AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	9/1/87	12:00	MCI	Nancy Owen	9/1/87	12:00	ORNL CPA

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0975 S04

WELL NO.: 0975

LOCATION: SWSA 5 @ 10.2 TO 10.3'

TYPE: WEATHERED SHALE

SAMPLER: [signature] (SIGNATURE)

DATE: 9/1/87

TIME: 9:15 A.M.

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	9/1/87	12:00	MCI	Nancy Owen	9/1/87	12:00	ORNL CPA

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0975 R01

WELL NO.: 0975

LOCATION: SWSA 5 @ 28.0'

TYPE: ROCK CUTTINGS

SAMPLER: [signature] (SIGNATURE)

DATE: 9/4/87

TIME: 12:00 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	9/11/87	8:30 AM	MCI	Nancy Owen	9/11/87	8:30 am	ORNL Chem. + Phys. Analy.

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 976 is located in WAG 5. It is 300' southeast of the old hydrofracture site. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 16978.4444, E 28994.2390 (X-10 grid) or latitude 35° 54' 43.07" and longitude 84° 18' 47.39". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 976 was drilled by A.L. Clark Drilling Services, Inc, and Geotek. A Gus Pech auger rig and an Ingersol Rand T-4 rig were used to drill this boring for monitor well installation under the operation of A.L. Clark III/Larry Ledbetter with the assistance of Ray Clark/Freddie Dixon.

Drilling commenced on 9/16/87 and was finished on 8/22/89. Paragraph 2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/ completion form. A synopsis of the drilling activity follows:*

9/16/87: The Gus Pech Auger rig and tools were decontaminated, mobilized to the staked location and set up. The boring was advanced from 0.0' to 12.0' with 14" augers. A 10" surface casing was set at 11.2' and tremie grouted. The rig was pulled off the boring and the top of the surface casing was covered with plastic.

8/21/89: The air rotary rig and drilling equipment were deconed.

8/22/89: The rig was mobilized to the site, the work area covered with plastic, the diverter head attached and the containment box was hooked up. (The surface casing was used for a diverter casing). An 8.0" borehole was advanced to a total depth of 84.50'. Photovac readings around the borehole were less than .1 ppm. During drilling the automatic feed control broke and the manual feet control had to be used. An air smaple was taken at 23.5' and a

* This information was typed directly from field notes and was edited only when necessary for clarification.

drill water sample at 48.0'. Also at 48.0' cutting began coming out the top of the diverter head when a timber broke that holds the pressure on the diverter attachment. Jerry Gray says that radiation meter readings are negligible. Cuttings coming out are O.K. Three containment boxes were used during drilling. After a 1 hour recharge the water level was measured at 30.30' below surface. The borehole was cleaned and the rods removed. The 4.0 inch stainless steel screen with bottom cap (15.28') was installed along with the 4.0 inch casing (70.0') to a total depth of 84.20'. Bryn Howze of ERC was on site to supervise the installation of the stainless steel centralizers were place at 80, 60, 40 and 20.0'. The sand was tremied in with water to a depth of 63.20'. Five bags of sand were used. One bucket of bentonite was poured into a level of 60.80'.

8/23/89: The annulus was tremie grouted with 12 sacks of cement and 60 lbs. of bentonite under the supervision of James Lamb of ERC.

* The air sample was checked under the ultraviolet light and no hydrocarbons were detected.

* Three containment boxes were sampled #1,3, 5. (There was no notation to document that these boxes were used at this well but they are believed to have been used here. R.C. Williams called for sampling). Two of the boxes had tritium contamination the other box had Beta. This is the cause for the controversy. In the future a form will be used to document the # on the box.

9/5/89: The well passed the "Go-NoGo gauge inspection". The casing was also cut and filed. R.C. Williams, Geotek, and ERC present.

This well was logged by ERC Environmental and Energy Services Co. (ERC/EDGe) hydrogeologists Michael L. Ebers and C. Allison Hodges. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap

underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

One soil sample was collected during drilling, placed in an I-CHEM specialty cleaned glass container, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody form for this sample is included with this data package. Soil sample 0976S01 was collected in the augered interval from 11.5 feet to 11.8 feet on 9/18/89 . A drill water sample was collected from the water pump on the drill rig on 8/22/89. Analytical results for the two samples described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type B well. A fourteen-inch diameter boring was augered from ground surface to bedrock (12.0 feet). A ten-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill an eight-inch diameter boring to a total depth of 84.5

feet. A four-inch diameter stainless steel silt trap was installed from 83.92 to 84.20 feet. Above the silt trap, a four-inch diameter stainless steel screen was installed from 68.92 feet to 83.92 feet. A four-inch diameter stainless steel casing was installed from the top of the screen at 68.92 feet and extending 1.99 feet above ground surface. A sandpack was then poured into the annular space from 63.20 to 84.20 feet, with a 2.4-foot bentonite seal poured into the annular space above the sandpack from 60.8 to 63.2 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 976 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 165 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was

2.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 2/6/90 at a depth of 81.8 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 976 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Ommidata Datapod II data recorder. The hydraulic conductivity value of 7.71×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 976

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	9/16/87	CAH
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	9/16/87 8/22/89	CAH
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	8/22/89 9/16/87	CAH
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	8/22/89 9/16/89	CAH
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	8/22/89 9/16/87	CAH
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	8/22/89	CAH

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE C. Allison Hodges 8/22/89

C. Allison Hodges

Michael L. Ebers 9/16/87

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 976

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

Michael L. Ebers 9/16/87
Michael L. Ebers

OBSERVER SIGNATURE/DATE C. Allison Hodges 8/21/89
C. Allison Hodges

ERC / EDGE Environmental and Energy Services Co.

WELL No. 976

ORNL MONITORING WELL LOG

LOCATION: WAG 5

DRILLER: A. L. Clark III/ Larry Ledbetter

HELPER: Ray Clark/Freddy Dixon/ Rick Herron

DRILL: Gus Pech/ Ingersol Rand T-4

DATE: START: 9/16/87

FINISH: 8/22/89

LOGGED BY: Michael L. Ebers/ C. Allison Hodges

HEALTH PHYSICIST: Carl Stooksbury/ Jerry Gray

TYPE DRILLING: Auger, Air Rotary

LUBRICANT TYPE: Molykote 1000/ Green Stuff

No. SAMPLES TAKEN: One

TYPE: Soil

CONTAINMENT TYPE: Auger Pan, Plastic, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 11.2

DEPTH DRILLED IN ROCK: 73.3

TOTAL DEPTH OF WELL: 84.5

DRILLING FLUID SAMPLES:

TYPE: Water DATE: 8/22/89

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	6.8			Clay, silty, with limestone gravel, moist,
				orange with light gray - fill.
6.8	7.1			Topsoil, dry, dark brown, original surface.
7.1	11.2			Clay, silty with shale fragments, moist light
				brown.
11.2	12.0	0976S01		Shale, highly weathered, moist, medium brown.
@	12.0	@11.5-11.8'		Auger refusal.
12.0	16.0			*Hard drilling - rock.
16.0	18.5			Smooth, fast drilling, soft spot - mud.
18.5	19.5			Hard, irregular drilling - rock.
19.5	23.5			Hard, regular drilling - rock.
23.5	26.0			Soft, easy, fast drilling - mud.
26.0	27.0			Hard, regular drilling - rock.
27.0	29.0			Smooth, easy drilling - rock.
29.0	34.0			Hard, rough, irregular drilling - rock.
34.0	37.0			Hard, regular drilling - rock.
37.0	39.5			Hard, rough, slow drilling - rock. Bit locked
				up at 38.0'.
39.5	41.0			Soft, easy, fast drilling - mud.
41.0	42.0			Hard, rough drilling - rock.
42.0	44.0			Soft, easy, fast drilling - mud.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 976

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
44.0	48.0			Hard, rough, slow dirlling. Bit locked up at
				45.0'.
48.0	53.0			Very hard, rough, irregular drilling.
53.0	56.5			Soft, easy, fast drilling.
56.5	84.5			Hard, irregular, slow drilling. Bit locked
				up at 58.5'.
	84.5			Total Depth
				*Lithologic description of rock drilled from
				12.0' to 84.5' not available due to the use
				of a containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 976

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Michael L. Ebers/ C. Allison Hodges

PROOFED BY: C. Allison Hodges/ Michael L. Ebers

DRILLING COMPANY: 0-12.0' - A. L. Clark/ 12.0-84.5' Geotek

DRILLER: A. L. Clark III/ Larry Ledbetter

HELPER: Ray Clark/Freddie Dixon/ Rick Herron

LOCATION: WAG 5

ORNL GRID COORDINATES
N 16,978.4444
E 28,994.2390

ELEV. GROUND 783.96

ELEV. TOP STAINLESS STEEL CASING 785.95

DRILLING DATES:
STARTED: 9/16/87
FINISHED: 8/22/89

DRILLING METHOD:
- [x] 14 INCH AUGER 12.0 L.F.
- [ ] ____ INCH AUGER ____ L.F.
- [x] 8 INCH ROTARY 72.5 L.F.
- [ ] ____ INCH ROTARY ____ L.F.

MATERIALS USED

EST. VOL.	USED VOL.	
	N/A	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	11.2	FT. OF 10 IN. SURFACE CASING
3.4	8.0	SACKS OF CEMENT (SURFACE CASING)
	N/A	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	40.0	GALLONS OF WATER (SURFACE CASING)
	71.4	FT. OF 4 IN. DIA. STAINLESS STEEL CASING
	15.0	FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
5.2	5.0	SACKS OF SAND
48	50.0	POUNDS OF BENTONITE PELLETS
9.1	12.0	SACKS OF CEMENT (WELL CASING)
	60.0	POUNDS OF POWERED BENTONITE (WELL CASING)
	72.0	GALLONS OF WATER (WELL CASING)
	3.0	FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES: Wash out zones.

SURFACE CASING TREMIE GROUTED: YES [x] NO [ ]

STAINLESS STEEL CASING TREMIE GROUTED: YES [x] NO [ ]

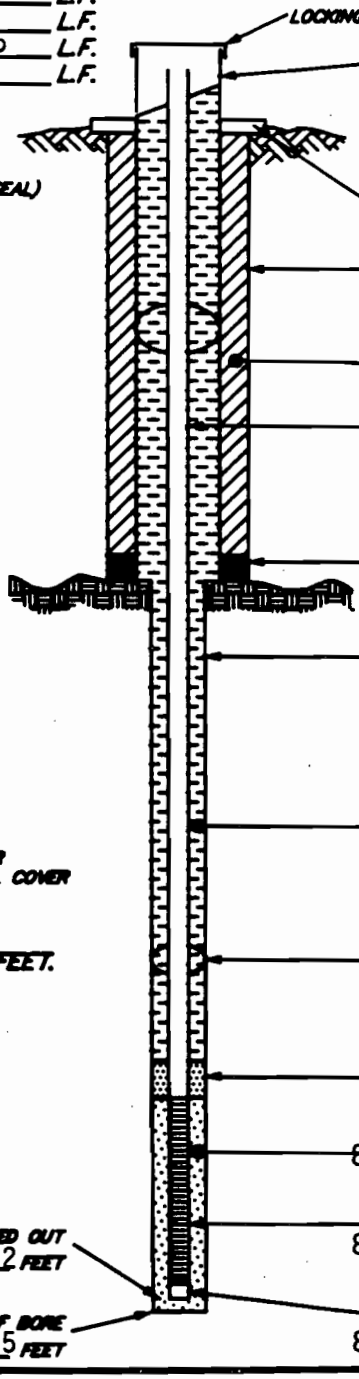
WELL COVER USED:
- [x] LOCKING STEEL COVER
- [ ] FLUSH MOUNTED WELL COVER
- [ ] OTHER

SILT TRAP USED: YES [x] NO [ ]

MONITORING WELL PUMP BASE SET AT 81.8 FEET.

CENTRALIZERS AT 20.0 FEET.
40.0 FEET.
60.0 FEET.
80.0 FEET

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



TYPE B WELL

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 976

DATE: 8-22-89

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		8-22-89	1
BENTONITE		8-22-89	Stores
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	8-22-89	Stores
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	8-22-89	Stores
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	8-22-89	Stores
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	8-22-89	Stores
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	2-06-90	3
GROUT		8-23-89	1
WELL COVERS			
SURFACE CASING			

COMMENTS:

OBSERVER SIGNATURE/DATE C. Allison Hodges 8-23-89
C. Allison Hodges

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 976

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8-22-89	CAH
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8-22-89	CAH
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	2-06-90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8-22-89	CAH

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE C. Allison Hodges 8-22-89
C. Allison Hodges

D. Charles Lytle 2-06-90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 976

LOCATION: WAG 5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 2-06-90 TIME:

DEVELOPMENT ENDING DATE: 2-06-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 55.6 GALLONS

TOTAL GALLONS PUMPED: 165 TOTAL WELL VOLUMES PUMPED: 3.0

INITIAL pH: 7.2 FINAL pH: 7.2

INITIAL CONDUCTIVITY (uS): 658 FINAL CONDUCTIVITY (uS): 658

DESCRIPTION OF INITIAL TURBIDITY: Clear

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 14.0 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 2-06-90

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 976
LOCATION: WAG 5
DATE: 2-06-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 55.6 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
2-06-90	1400	165	Clear	2.0	7.2	658	165	3.0	
RESULTS AT END OF DEVELOPMENT		165	Clear	2.0	7.2	658	165	3.0	

COMMENTS Surged, pumped, and developed in 4 hours time on 2-06-90, very fast recovering, well passed with 3 well volumes and moved off hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 2-06-90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 976 DATE OF TEST: 2/7/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 67.10 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 1.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

1.5610
1.5865

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 976

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.060	2.060
20.00	2.990	1.990
30.00	2.940	1.940
40.00	2.900	1.900
50.00	2.830	1.830
60.00	2.780	1.780
75.00	2.730	1.730
90.00	2.650	1.650
105.00	2.600	1.600
120.00	2.530	1.530
150.00	2.450	1.450
180.00	2.370	1.370
240.00	2.230	1.230
300.00	2.120	1.120
360.00	2.040	1.040
420.00	1.940	.940
480.00	1.870	.870
540.00	1.830	.830
600.00	1.790	.790
720.00	1.710	.710
840.00	1.650	.650
960.00	1.610	.610
1080.00	1.590	.590
1200.00	1.560	.560
1320.00	1.530	.530
1440.00	1.530	.530
1560.00	1.520	.520
1680.00	1.510	.510
1800.00	1.510	.510
1920.00	1.500	.500
2040.00	1.500	.500
2160.00	1.500	.500

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

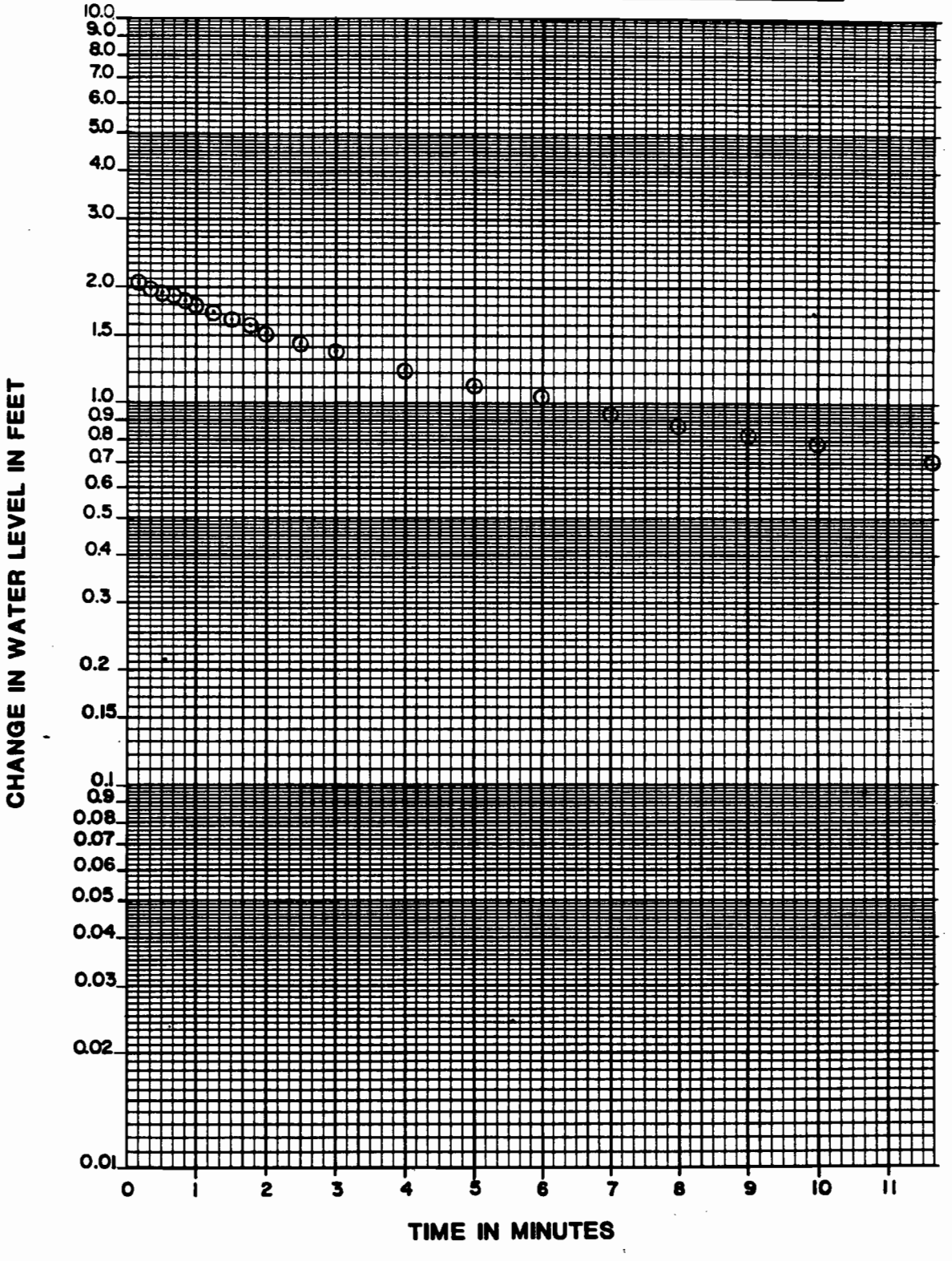
PERMEABILITY = 2.53E-06 FT/SEC = 7.71E-05 CM/SEC

TRANSMISSIVITY = 3.79E-05 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 976

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0976 S01

WELL NO.: 0976

LOCATION: 11.5 – 11.8'

TYPE: Soil

SAMPLER: [signature] (SIGNATURE)

DATE: 9/18/87

TIME: 9:20

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	11/25/87	9:30	MCI	[signature]	11/25/87	9:30	MCI
[signature]	11/25/87	2:40PM	MCI	[signature]	11-25-87	2:40	ORNL

REMARKS:

EDGe Engineering, Design & Geosciences Group, Inc.
725 Pellissippi Parkway
P.O. Box 23010 Knoxville, Tn 37933-1010

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 976W01

WELL NO.	LOCATION:	TYPE:
976	WAG-5	WATER

SAMPLER:	SAMPLE INTERVAL:	DATE:	TIME:
C. Allison Hodge (SIGNATURE)	N/A	8-22-89	1201

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
C. Allison Hodge	9-1-89	9:40	EDGE	M. Ferguson	9-1-89	9:40	

TYPE OF SAMPLE: ☐ SPLIT SPOON CORES–SOIL ☐ AUGER CUTTINGS–SOIL ☐ AUGER CUTTINGS–ROCK
☐ AIR ROTARY CUTTINGS–ROCK ■ DRILL WATER (NO AIR IN SAMPLE) ☐ OTHER _____

ALL SAMPLES ARE IMMEDIATELY PLACED IN I-CHEM SPECIALTY CLEANED CONTAINERS AND SEALED.

REMARKS: _____

1.0 General Information

1.1 Well Location

Monitoring well number 977 is located in WAG 5. It is in the southwest corner of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 17084.3543, E 28444.0990 (X-10 grid) or latitude 35° 54' 40.61" and longitude 84° 18' 53.90". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 977 was drilled by A.L. Clark Drilling Services, Inc. A Gus Pech auger rig was used to drill this boring for monitor well installation under the operation of A.L. Clark III with the assistance of Ray Clark. Drilling commenced on

7/14/87 and was finished on 7/14/87. Paragraph 2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

7/14/87: The Gus Pech augering rig was steam cleaned and mobilized to the well location and set up. The boring was drilled from 0.0' to 20.0' total depth with 6 1/4" augers. The boring was completed with a 2" stainless steel screen, casing, sand pack and bentonite.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist John W. Anderson. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap

* This information was typed directly from field notes and was edited only when necessary for clarification.

underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

No samples were collected during drilling.

2.4 Installation and Development

2.4.1 Installation

This was a type A well. A two-inch diameter stainless steel silt trap was installed from 19.5 to 19.8 feet. Above the silt trap a two-inch diameter stainless steel screen was installed from 4.5 to 19.5 feet. A two-inch diameter stainless steel casing was installed above the screen from 4.5 feet to 2.03 feet above ground surface. A sandpack was then poured into the annular space from 3.0 to 20.0 feet, with a 1.5-foot bentonite pellet seal poured into the annular space above the sandpack from 1.5 to 3.0 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 977 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to

use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 158 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 4 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/18/90 at a depth of 17.1 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 977 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and

measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 3.76×10^{-4} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 977

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	7/14/87	
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	7/14/87	
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	7/14/87	
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	7/14/87	
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	7/14/87	
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	7/14/87	

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE: 7/14/87

John W. Anderson

ERC / EDGE Environmental and Energy Services Co.

WELL No. 977

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE [signature] 7/14/87
John W. Anderson

ERC / EDGE Environmental and Energy Services Co.

WELL No. 977

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG 5

DRILLER: A. L. Clark III

HELPER: Ray Clark

DRILL: Gus Pech

DATE: START: 7/14/87

FINISH: 7/14/87

LOGGED BY: John W. Anderson

HEALTH PHYSICIST: Sherrie Chadwick

TYPE DRILLING: Auger

LUBRICANT TYPE: Silicone

No. SAMPLES TAKEN: None

TYPE: N/A

CONTAINMENT TYPE: Auger Pan and Plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 9.0'

DEPTH DRILLED IN ROCK: 11.0'

TOTAL DEPTH OF WELL: 20.0'

DRILLING FLUID SAMPLES:

TYPE: N/A DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	0.5			Topsoil, dark brown with organic material.
0.5	1.5			Limestone gravel, light gray, angular.
1.5	9.0			Limestone gravel with orange brown clay, moist.
9.0	14.5			Shale, highly weathered, light brown, damp.
14.5	17.3			Shale, highly weathered, crumbly, with greenish
				brown clay, damp.
17.3	17.5			Shale, highly weathered, crumbly, with greenish
				brown clay, wet.
17.5	19.0			Limestone, light gray, hard.
19.0	20.0			Shale, weathered, very soft, wet.
	20.0			Total Depth

ERC / EDGE Environmental and Energy Services Co.

WELL No. 977

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: John W. Anderson

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A. L. Clark Drilling Services

DRILLER: A. L. Clark III HELPER: Ray Clark

EQUIPMENT ■ 6.25 INCH AUGER 20.0 L.F.

□ _____ INCH AUGER _____ L.F.

LOCATION WAG 5

ORNL GRID COORDINATES

N 17084.3543

E 28444.0990

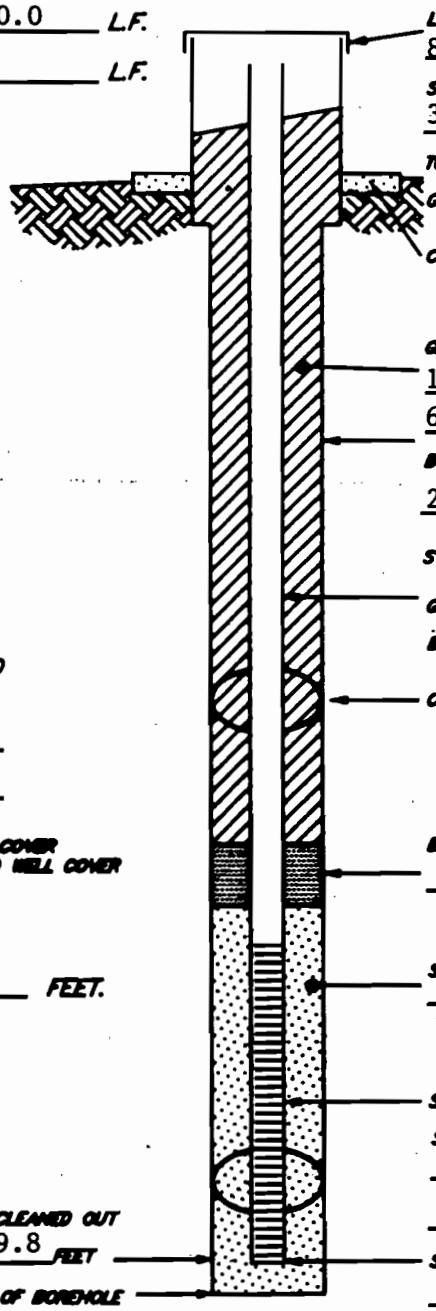
ELEV. GROUND 764.73

ELEV. TOP STAINLESS STEEL CASING 766.76

DRILLING DATES:

STARTED: 7/14/87

FINISHED: 7/14/87



LOCKING STEEL COVER 8 5/8 INCH DIAMETER

STEEL PROTECTIVE CASING 3.11 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO 1.5 FEET

6.25 INCH DIAMETER BOREHOLE

2 INCH DIAMETER STAINLESS STEEL CASING 2.03 FT. ABOVE GROUND SURFACE TO 4.5 FT. BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL 1.5 TO 3.0 FEET

SAND PACK 3.0 TO 20.0 FEET

2 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 4.5 TO 19.5 FEET

2 INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP 19.5 TO 19.8 FEET

HOLE CLEANED OUT TO 19.8 FEET

BOTTOM OF BOREHOLE 20.0 FEET

MATERIALS USED

EST. VOL.	USED VOL.	
15.0		FEET OF 2 IN. S.S. SCREEN
6.5		FEET OF 2 IN. S.S. CASING
4.0	4.0	SACKS OF SAND
30.0	30.0	POUNDS OF BENTONITE PELLETS
0.5	0.5	SACKS OF CEMENT
1.0		POUNDS OF POWDERED BENTONITE
3.0		GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

_____

_____

WELL COVER USED ■ LOCKING STEEL COVER □ FLUSH MOUNTED WELL COVER □ OTHER

SILT TRAP USED YES ■ NO □

MONITORING WELL PUMP BASE SET AT 17.1 FEET.

CENTRALIZERS AT 6.0 FEET. 19.0 FEET. _____ FEET.

NOTE: ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

TYPE A WELL

NOT TO SCALE

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 977

DATE: 7/14/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		7/14/87	02
BENTONITE		7/14/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	7/14/87	04
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	7/14/87	04
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	7/14/87	04
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	7/14/87	04
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	1/18/90	03
GROUT		7/14/87	09
WELL COVERS			
SURFACE CASING		7/87	02

COMMENTS:

OBSERVER SIGNATURE/DATE: John W. Anderson 7/14/87

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WELL No. 977

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	7/14/87	
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	7/14/87	
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/17/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	7/14/87	

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE _____ 7/14/87
John W. Anderson

D. Charles Lytle 1/17/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 977

LOCATION: WAG 5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 1-15-90 TIME:

DEVELOPMENT ENDING DATE: 1-17-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 9.5 GALLONS

TOTAL GALLONS PUMPED: 158 TOTAL WELL VOLUMES PUMPED: 16.3

INITIAL pH: 6.5 FINAL pH: 6.3

INITIAL CONDUCTIVITY (uS): 402 FINAL CONDUCTIVITY (uS): 296

DESCRIPTION OF INITIAL TURBIDITY: Rusty

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 4.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☐ GROUND SURFACE
- ☐ STORM SEWERS
- ■ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 5.4 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle

D. Charles Lytle 1/17/90

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 977
LOCATION: WAG 5
DATE: 1-15-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 9.5 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
1-15-90	1030	16	Rusty	--	6.5	402	16		
1-15-90	1500	33	Cloudy	--	6.3	375	49	5.2	
1-16-90	1100	17	Cloudy	--	6.2	372	66	6.9	
1-16-90	1200	20	Cloudy	--	6.3	396	86	9.1	
1-16-90	1500	30	Slightly Cloudy	--	6.3	345	116	12.2	
1-17-90	0900	24	Slightly Cloudy	--	6.2	276	140	14.7	
1-17-90	1100	18	Clear	4.0	6.3	296	158	16.3	
RESULTS AT END OF DEVELOPMENT			Clear	4.0	6.3	296	158	16.3	

COMMENTS Water cleared, surged well, waited several cycles, took sample, water remained clear, passed and moved on.

D. Charles Lytle

OBSERVER SIGNATURE/DATE D. Charles Lytle 1/17/90

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 977 DATE OF TEST: 2/13/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 15.10 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .98 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 20

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

1.1465
1.2490
1.3227

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.640	2.660
20.00	3.140	2.160
30.00	2.730	1.750
40.00	2.440	1.460
50.00	2.180	1.200
60.00	1.980	1.000
75.00	1.780	.800
90.00	1.590	.610
105.00	1.490	.510
120.00	1.410	.430
150.00	1.300	.320
180.00	1.250	.270
240.00	1.210	.230
300.00	1.190	.210
360.00	1.170	.190
420.00	1.140	.160
480.00	1.110	.130
540.00	1.110	.130
600.00	1.100	.120
720.00	1.100	.120

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

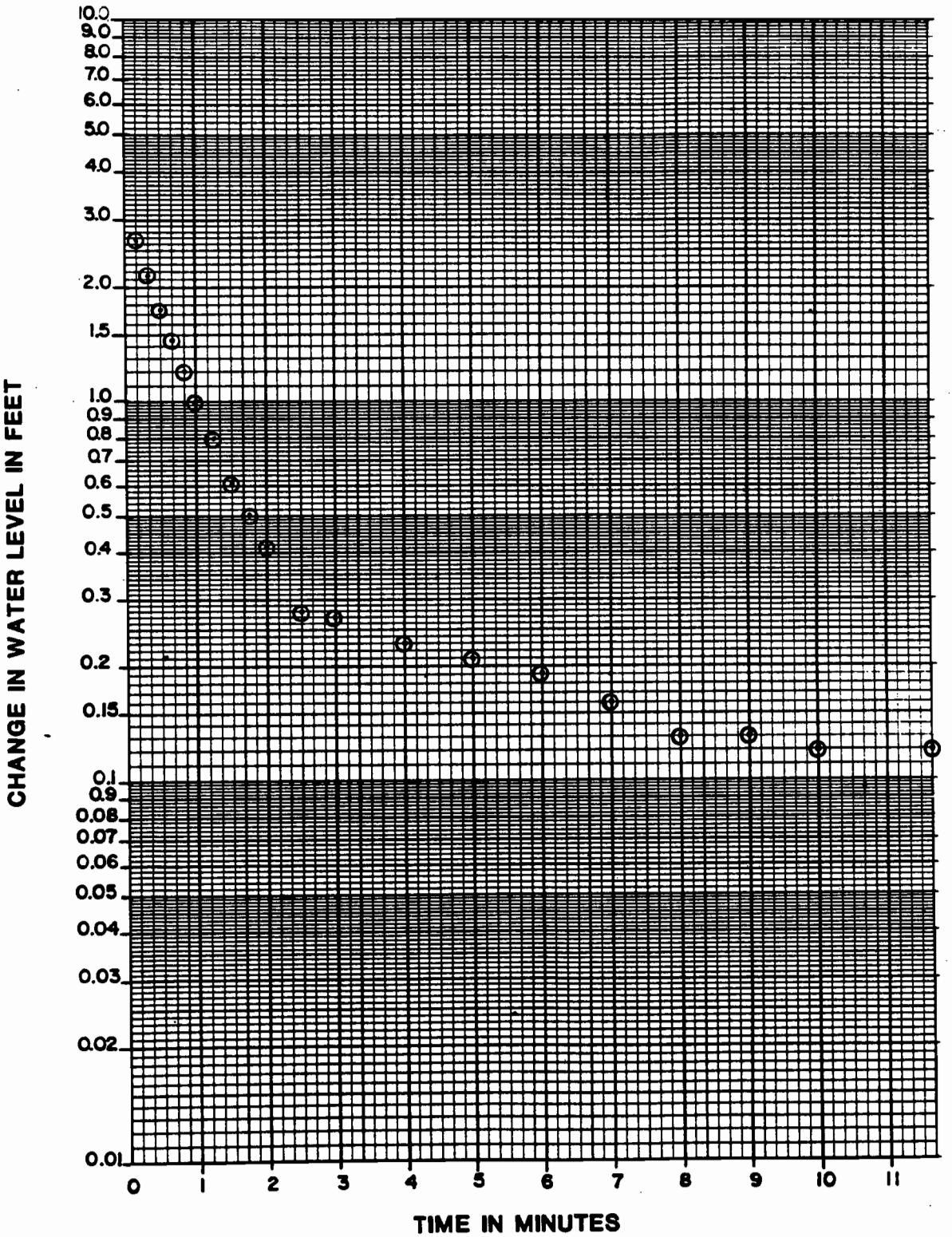
PERMEABILITY = 1.23E-05 FT/SEC = 3.76E-04 CM/SEC

TRANSMISSIVITY = 1.85E-04 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 977

HYDRAULIC CONDUCTIVITY CALCULATIONS



1.0 General Information

1.1 Well Location

Monitoring well number 978 is located in WAG 5. It is along the western perimeter of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 17729.8052, E 28749.9259 (X-10 grid) or latitude 35° 54' 47.60" and longitude 84° 18' 55.18". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 978 was drilled by A.L. Clark Drilling Services, Inc. A Gus Pech auger rig was used to drill this boring for monitor well installation under the operation of A.L. Clark, III with the

assistance of A.L. Clark, Jr. Drilling commenced on 7/16/87 and was finished on 7/23/87. Paragraph 2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:

The Gus Pech auger rig was steam cleaned, mobilized to the staked location and set up. The interval from 0.0' to 3.9' was split spooned. The 6 1/4" boring was augered from 0.0' to 20.0' total depth. Stainless steel casing, screen, sandpack and bentonite were installed and the annular space was grouted.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist John W. Anderson. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap

underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

One soil sample was collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. A chain of custody form for this sample is included with this data package. This soil sample, 0978S01, was collected in the split spoon interval from 0.8' to 1.2 feet on 9/16/87. Analytical results for this sample can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type A well. A two-inch diameter stainless steel silt trap was installed from 19.7 to 20.0 feet. Above the silt trap a two-inch diameter stainless steel screen was installed from 9.7 to 19.7 feet. A two-inch diameter stainless steel casing was installed above the screen from 9.7 feet to 2.47 feet above ground surface. A sandpack was then poured into the annular space from 9.0 to 20.0 feet, with a 2.0-foot bentonite pellet seal poured into the annular space above the sandpack from 7.0 to 9.0 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite

slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 978 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 244 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured was 25 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 12/29/89 at a depth of 16.9 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 978 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.25×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 978

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	7/16/87	
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	7/16/87	
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	7/16/87	
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	7/16/87	
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	7/16/87	
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	7/16/87	

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE: 7/16/87

John W. Anderson

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 978

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE John M McLoughlin 7/16/87
John M. McLoughlin

ERC / EDGE Environmental and Energy Services Co.

WELL No. 978

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG 5

DRILLER: A. L. Clark III

HELPER: A. L. Clark, Jr.

DRILL: Gus Pech

DATE: START: 7/16/87
FINISH: 7/28/87

LOGGED BY: John W. Anderson

HEALTH PHYSICIST: Sherrie Chadwick

TYPE DRILLING: Split Spoon and Auger

LUBRICANT TYPE: Silicone

No. SAMPLES TAKEN: One

TYPE: Soil

CONTAINMENT TYPE: Auger Pan and Plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 3.5'

DEPTH DRILLED IN ROCK: 16.5'

TOTAL DEPTH OF WELL: 20.0'

DRILLING FLUID SAMPLES:

TYPE: N/A DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	3.5	0978S01		Clay with highly weathered shale, orange
		@ 0.8-1.2		brown with light green, damp.
3.5	3.9			Shale, slightly weathered, crumbly, damp.
@	3.9			Split spoon refusal.
3.9	7.0			Shale, slightly weathered, crumbly, damp.
7.0	9.7			Limestone, hard, wet.
9.7	12.4			Shale, medium brown, soft, wet.
12.4	13.5			Limestone, hard, wet.
13.5	17.8			Shale, soft, wet.
17.8	19.0			Limestone, hard, wet.
19.0	20.0			Shale, soft, wet.
	20.0			Total Depth

ERC / EDGE Environmental and Energy Services Co.

WELL No. 978

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: John W. Anderson

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A. L. Clark Drilling Service

DRILLER: A. L. Clark III

HELPER: Richard Pickel

LOCATION WAG 5

ORNL GRID COORDINATES
N 17729.8052
E 28749.9259

ELEV. GROUND 764.84

ELEV. TOP STAINLESS STEEL CASING 767.31

DRILLING DATES:
STARTED: 7/16/87
FINISHED: 7/23/87

EQUIPMENT

☒ 6.25 INCH AUGER _____ L.F.

☐ _____ INCH AUGER _____ L.F.

MATERIALS USED

EST. VOL.	USED VOL.	
	10.0	FEET OF 2.0 IN. S.S. SCREEN
	12.2	FEET OF 2.0 IN. S.S. CASING
3.0	3.5	SACKS OF SAND
35.0	35.0	POUNDS OF BENTONITE PELLETS
1.0	1.0	SACKS OF CEMENT
	2.0	POUNDS OF POWDERED BENTONITE
	6.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

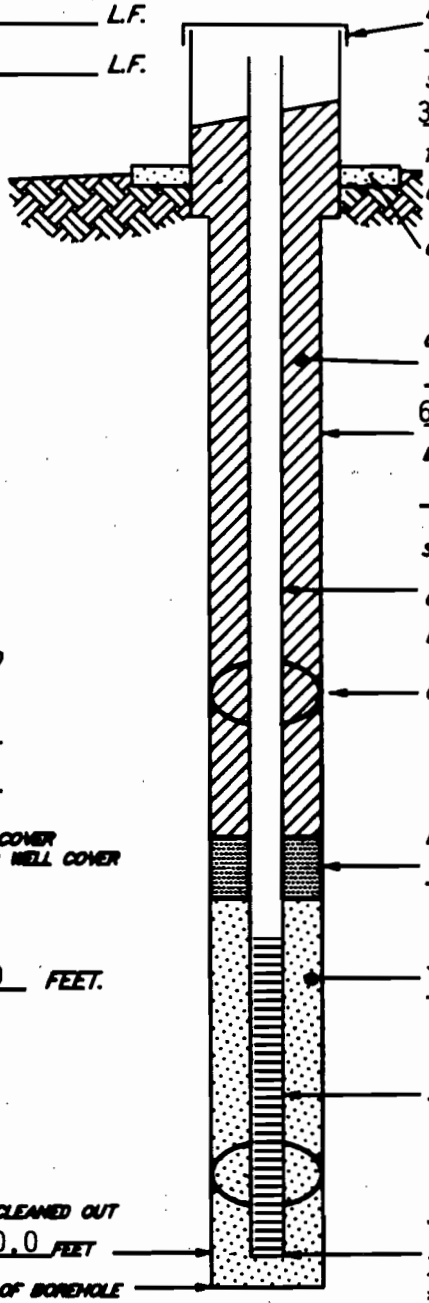
WELL COVER USED
☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 16.9 FEET.

CENTRALIZERS AT 4.0 FEET.
19.0 FEET.
_____ FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER
8 INCH DIAMETER
STEEL PROTECTIVE CASING
3.67 FT. ABOVE GROUND
TO 2.0 FT. BELOW
GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO
7.0 FEET

6.25 INCH DIAMETER
BOREHOLE

2 INCH DIAMETER STAINLESS
STEEL CASING 2.47 FT. ABOVE
GROUND SURFACE TO 9.7 FT.
BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL
7.0 TO 9.0 FEET

SAND PACK
9.0 TO 20.0 FEET

2 INCH DIAMETER
STAINLESS STEEL 0.010
SLOTTED SCREEN
9.7 TO 19.7 FEET

2 INCH DIAMETER STAINLESS
STEEL SILT TRAP/CAP
19.7 TO 20.0 FEET

HOLE CLEANED OUT
TO 20.0 FEET

BOTTOM OF BOREHOLE
20.0 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE Environmental and Energy Services Co.

WELL No. 978

DATE: 7/23/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		7/23/87	02
BENTONITE		7/23/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	7/23/87	04
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	7/23/87	04
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	7/23/87	04
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	7/23/87	04
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	12/28/89	03
GROUT		7/24/87	09
WELL COVERS			
SURFACE CASING		7/87	02

COMMENTS:

OBSERVER SIGNATURE/DATE: John W. Anderson 7/24/87

ERC / EDGE Environmental and Energy Services Co.

WELL No. 978

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	7/23/87	
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	7/23/87	
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	12/28/89	
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	7/23/87	

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE _____ 7/23/87
John W. Anderson

D. Charles Lytle 12/28/89
D. Charles Lytle

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 978

LOCATION: WAG 5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 12-19-89 TIME:

DEVELOPMENT ENDING DATE: 12-28-89

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 6.7 GALLONS

TOTAL GALLONS PUMPED: 244 TOTAL WELL VOLUMES PUMPED: 36.4

INITIAL pH: 9.6 FINAL pH: 6.9

INITIAL CONDUCTIVITY (uS): 989 FINAL CONDUCTIVITY (uS): 154

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Slightly Cloudy

FINAL MEASURED TURBIDITY: 25 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- [x] GROUND SURFACE
- [ ] STORM SEWERS
- [ ] DRUMS
- [ ] TANK TRUCK
- [ ] STORAGE TANKS
- [ ] OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 5.2 feet from ground surface.

DEVELOPMENT OBSERVATIONS

Water slightly cloudy after 36.4 well volumes (25 NTU's). Well approved by MMES.

OBSERVER SIGNATURE/DATE D. Charles Lytle 12/28/89

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 978
LOCATION: WAG 5
DATE: 12-19-89

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 6.7 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
12-19-89	9:30	12	Cloudy	--	9.6	989	12		
12-19-89	1:20	24	Cloudy	--	7.1	907	36	5	
12-20-89	9:45	4	Cloudy	--	6.6		40		
12-20-89	11:00	28	Muddy	--	6.6		68		
12-21-89	9:00	29	Cloudy	--	6.8		97		
12-21-89	11:00	19	Cloudy	--	5.7	100	116		
12-21-89	1:30	20	Cloudy	--	6.8	48	136		
12-27-89	9:00	8	Cloudy	--	7.2	55	144		
12-27-89	10:00	10	Slightly Cloudy	2.5	7.1	63	154		
12-27-89	11:00	22	Cloudy	--	6.2	66	176	26	
12-27-89	3:00	32	Cloudy	--	6.6	132	208		
12-28-89	12:00	36	Slightly Cloudy	25	6.9	154	244	36.4	
RESULTS AT END OF DEVELOPMENT			Slightly Cloudy	25	6.9	154	244	36.4	

COMMENTS Water slightly cloudy after 36.4 well volumes (25 NTU's).
Well approved by MMES.

OBSERVER SIGNATURE/DATE D. Charles Lytle 12-28-89
D. Charles Lytle

MWFORM08.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 978 DATE OF TEST: 2/22/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 15.85 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .99 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

2.9199
2.9452

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.520	3.530
20.00	4.420	3.430
30.00	4.350	3.360
40.00	4.280	3.290
50.00	4.210	3.220
60.00	4.140	3.150
75.00	4.060	3.070
90.00	3.990	3.000
105.00	3.910	2.920
120.00	3.850	2.860
150.00	3.750	2.760
180.00	3.660	2.670
240.00	3.500	2.510
300.00	3.370	2.380
360.00	3.280	2.290
420.00	3.180	2.190
480.00	3.110	2.120
540.00	3.060	2.070
600.00	2.970	1.980
720.00	2.910	1.920
840.00	2.820	1.830
960.00	2.770	1.780
1080.00	2.730	1.740
1200.00	2.690	1.700
1320.00	2.640	1.650
1440.00	2.610	1.620
1560.00	2.600	1.610
1680.00	2.570	1.580
1800.00	2.570	1.580
1920.00	2.570	1.580
2040.00	2.570	1.580
2160.00	2.560	1.570

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

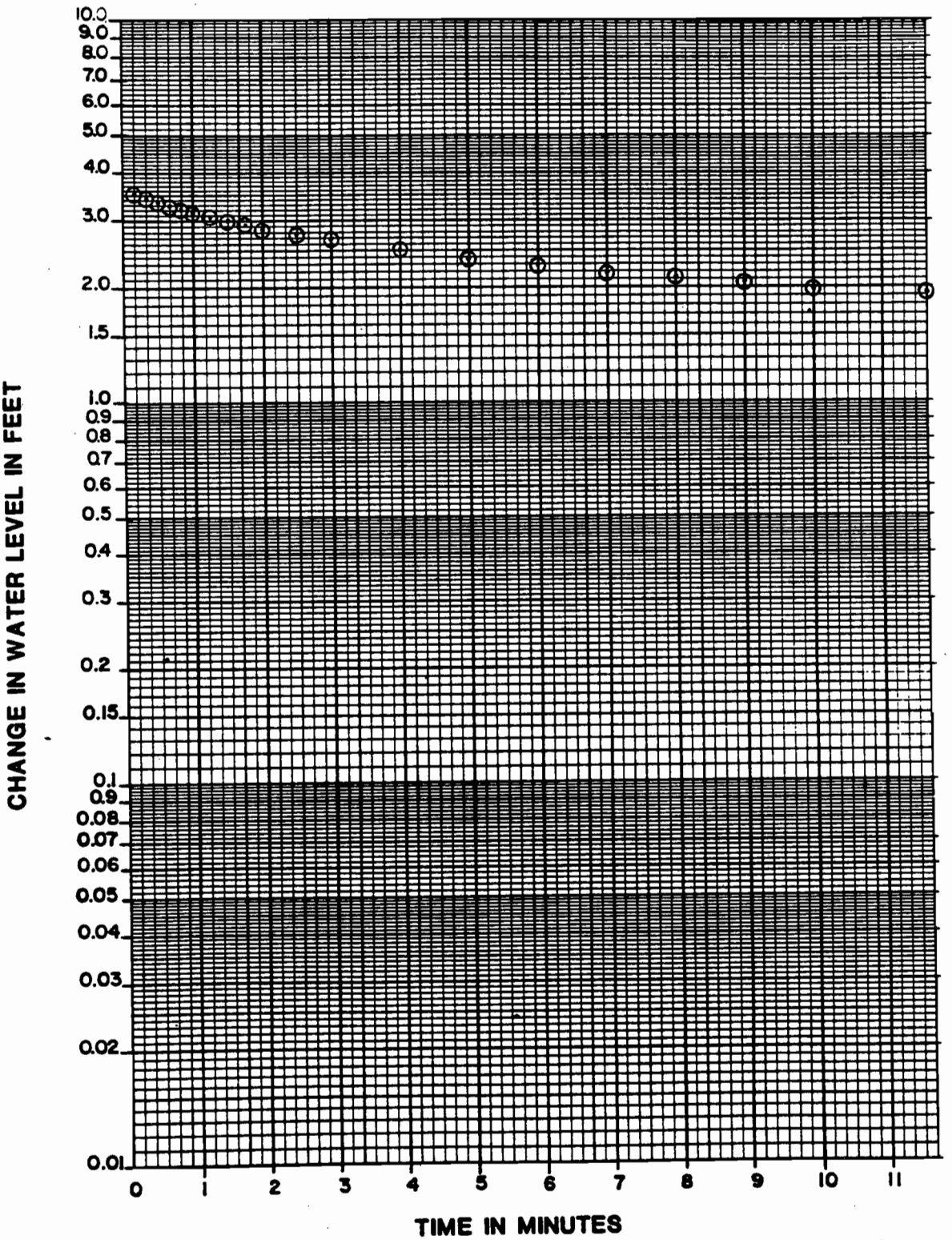
PERMEABILITY = 4.11E-07 FT/SEC = 1.25E-05 CM/SEC

TRANSMISSIVITY = 4.11E-06 FT**2/SEC

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 978

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0978 S01

WELL NO.: 0978

LOCATION: 0.8-1.2'

TYPE: Soil

SAMPLER: John Anderson (SIGNATURE)

DATE: 9/16/87 TIME: 2:05

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
John Anderson	11/25/87	9:30	MCI	Christopher J. Eshen	11/25/87	9:30	MCI
Christopher J. Eshen	11/25/87	2:40 PM	MCI	Nancy Owen	11-25-87	2:40	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 979 is located in WAG 5. It is along the west boundary fence of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 17740.8120, E 28746.5079 (X-10 grid) or latitude 35° 54' 47.67" and longitude 84° 18' 55.29". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 979 was drilled by A.L. Clark Drilling Services, Inc. A Driltech air rotary rig was used to drill this boring for monitor well installation under the operation of Steve Clark with the assistance of Steve Kirk. Drilling commenced on 8/11/87 and was finished on 8/13/87. Paragraph

2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

8/10/87: The rig and tools were steam cleaned.

8/11/87: The drilling rig was mobilized to the staked well location and set up. A 14" auger was used to drill the boring from 0.0' to 9.0' and 10 3/4" casing was set and grouted.

8/12/87: The boring was drilled from 9.0' to 50.0' with an 8" tricone roller bit using a containment box. Stainless steel screen, casing, sandpack and bentonite were installed.

8/13/87: The annular space was grouted.

This well was logged by ERC Environmental and Energy Services Co. (ERC/EDGe) hydrogeologist Michael L. Ebers. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

* This information was typed directly from field notes and was edited only when necessary for clarification.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5.

Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

No soil samples were collected during drilling. A drill water sample was collected from the water pump on the drill rig on 8/12/87. Analytical results for the sample described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type B well. A fourteen-inch diameter boring was augered from ground surface to bedrock (9.0 feet). A ten-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill an eight-inch diameter boring to a total depth of 49.6

feet. A four-inch diameter stainless steel silt trap was installed from 49.3 to 49.6 feet. Above the silt trap, a four-inch diameter stainless steel screen was installed from 34.3 feet to 49.3 feet. A four-inch diameter stainless steel casing was installed from the top of the screen at 34.3 feet and extending 2.78 feet above ground surface. A sandpack was then poured into the annular space from 32.5 to 49.6 feet, with a 2.5-foot bentonite seal poured into the annular space above the sandpack from 30.0 to 32.5 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 979 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 168 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was

2 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 12/22/89 at a depth of 45.2 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 979 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Ommidata Datapod II data recorder. The hydraulic conductivity value of 7.95×10^{-6} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 979

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	8/11/87	MME
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	8/11/87	MME
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	8/12/87	MME
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	8/11/87	MME
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	8/11/87	MME
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	8/11/87	MME

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 8/12/87

Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 979

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE [signature] 8/11/87

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 979

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG 5
DRILLER: Steve Clark
HELPER: Steve Kirk
DRILL: Driltech

DATE: START: 8/10/87
FINISH: 8/13/87
LOGGED BY: Michael L. Ebers
HEALTH PHYSICIST: Sherrie Cox

TYPE DRILLING: Auger and Air Rotary
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: None
TYPE: N/A
CONTAINMENT TYPE: Auger Pan, Plastic and Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 9.0'
DEPTH DRILLED IN ROCK: 40.6'
TOTAL DEPTH OF WELL: 49.6'

DRILLING FLUID SAMPLES:
TYPE: Drill Water DATE: 8/12/87
0979W01

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	4.0			Clay, medium light brown, silty, few gravels,
				dry, loose.
4.0	6.0			Clay, midium brown, slightly silty, dry,
				medium dense.
6.0	7.0			Clay, medium brown, slightly silty, dry,
				medium dense, with flat limestone pebbles
				and cobbles, (weathered surfaces), olive gray,
				fine grained with 1/16" calcite filled
				fractures perpendicular to bedding.
7.0	9.0			Limestone, thin bedded, fine grained, olive
				gray, weathered along bedding planes.
	@9.0			Auger refusal.
9.0	49.6	0979W01		Shale, fairly soft with thin beds of limestone
		@49.6'		up to 6" thick.
	49.6			Total Depth

ERC / EDGE Environmental and Energy Services Co.

WELL No. 979

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Michael L. Ebers

PROOFED BY:

DRILLING COMPANY: A. L. Clark Drilling Services

DRILLER: Steve Clark HELPER: Steve Kirk

DRILLING METHOD:
- ☒ 14.0 INCH AUGER 9.0 L.F.
- ☐ ____ INCH AUGER ____ L.F.
- ☒ 8 5/8 INCH ROTARY 40.6 L.F.
- ☐ ____ INCH ROTARY ____ L.F.

LOCATION WAG 5

ORNL GRID COORDINATES
N 17,740.8120
E 28,746.5079

ELEV. GROUND 764.88

ELEV. TOP STAINLESS STEEL CASING 767.66

DRILLING DATES:
STARTED: 8/10/87
FINISHED: 8/13/87

MATERIALS USED

EST. VOL.	USED VOL.	
	25.0	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	9.0	FT. OF 10 3/4 IN. SURFACE CASING
2.7	3.0	SACKS OF CEMENT (SURFACE CASING)
	6.0	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	21.0	GALLONS OF WATER (SURFACE CASING)
	37.1	FT. OF 4 IN. DIA. STAINLESS STEEL CASING
	15.0	FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
3.8	4.5	SACKS OF SAND
30.0	30.0	POUNDS OF BENTONITE PELLETS
6.7	10.0	SACKS OF CEMENT (WELL CASING)
	N/A	POUNDS OF POWERED BENTONITE (WELL CASING)
	70.0	GALLONS OF WATER (WELL CASING)
	3.64	FT. OF 10 3/4 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Voids and Spillage.

SURFACE CASING TREMIE GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ☒ NO ☐

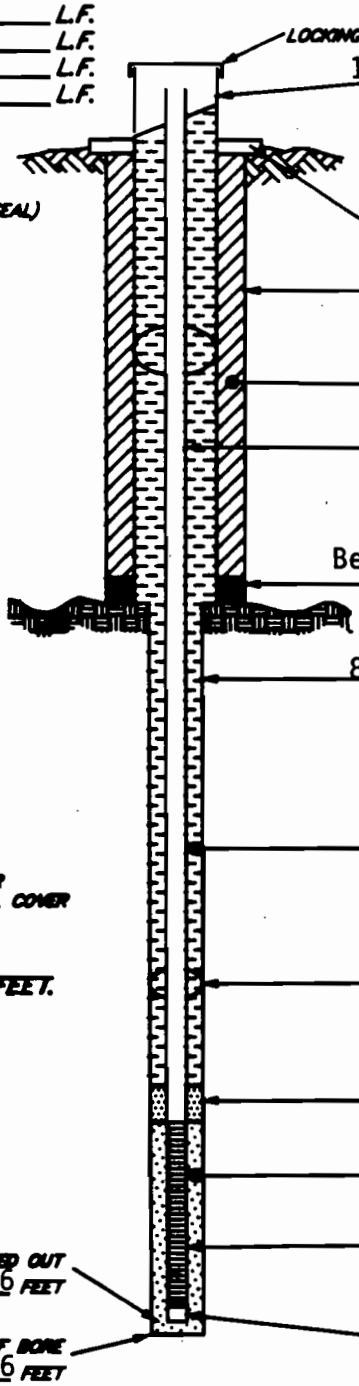
WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 45.2 FEET.

CENTRALIZERS AT 3.0 FEET.
9.0 FEET.
29.0 FEET.
49.0 FEET

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



TYPE B WELL

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 979

DATE: 8/11/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		8/12/87	02
BENTONITE		8/11/87	02
		8/12/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	8/12/87	05
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	8/12/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	8/12/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	8/12/87	04
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	12/21/89	03
GROUT		8/11/87	09
		8/13/87	09
WELL COVERS			
SURFACE CASING		8/11/87	01

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 8/12/87

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 979

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8/12/87	MLE
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8/12/87	MLE
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	12/21/89	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8/12/87	MLE

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE [signature] 8/12/87
Michael L. Ebers

D. Charles Lytle 12/21/89
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 979

LOCATION: WAG 5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 12/19/89 TIME:

DEVELOPMENT ENDING DATE: 12/21/89

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 40.0 GALLONS

TOTAL GALLONS PUMPED: 168 TOTAL WELL VOLUMES PUMPED: 4.2

INITIAL pH: 10.7 FINAL pH: 5.3

INITIAL CONDUCTIVITY (uS): 478 FINAL CONDUCTIVITY (uS): 874

DESCRIPTION OF INITIAL TURBIDITY: Clear

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0 NTU's

WELL APPROVED BY: D. Charles Lytle

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 6.2' from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE: D. Charles Lytle 12/21/89

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 979
LOCATION: WAG 5
DATE: 12/19/89

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 40.0 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
12-19-89	9:50	25	Clear	4.0	10.7	478	25		
12-19-89	1:25	11	Clear	3.0	10.2	703	36		
12-20-89	9:40	21	Clear	10.0	6.8		57		
12-20-89	10:50	11	Clear	2.0	6.9		68		
12-20-89	1:30	20	Clear	28	68	781	88		
12-21-89	9:00	24	Clear	9.0	6.9	706	112		
12-21-89	11:00	25	Clear	2.0	4.0	886	137		
12-21-89	1:30	26	Clear	2.0	6.8	895	163		
* 12-21-89	2:10	5	Clear	2.0	5.3	874	168	4.2	Well Developed
RESULTS AT END OF DEVELOPMENT		--	Clear	2.0	5.3	874	168	4.2	

COMMENTS *Final sample taken at 10 pump cycles after surging well.

OBSERVER SIGNATURE/DATE D. Charles Lytle 12/21/89
D. Charles Lytle

MWFORM06.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 979 DATE OF TEST: 2/7/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 46.55 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .91 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

.9639
.9952

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	2.340	1.430
20.00	2.320	1.410
30.00	2.300	1.390
40.00	2.270	1.360
50.00	2.270	1.360
60.00	2.270	1.360
75.00	2.270	1.360
90.00	2.260	1.350
105.00	2.270	1.360
120.00	2.250	1.340
150.00	2.190	1.280
180.00	2.200	1.290
240.00	2.120	1.210
300.00	2.070	1.160
360.00	2.030	1.120
420.00	2.000	1.090
480.00	1.940	1.030
540.00	1.930	1.020
600.00	1.860	.950
720.00	1.790	.880
840.00	1.750	.840
960.00	1.670	.760
1080.00	1.620	.710
1200.00	1.580	.670
1320.00	1.480	.570
1440.00	1.450	.540
1560.00	1.410	.500
16080.00	1.350	.440
1800.00	1.310	.400
1920.00	1.270	.360
2040.00	1.210	.300
2160.00	1.160	.250

(**********

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

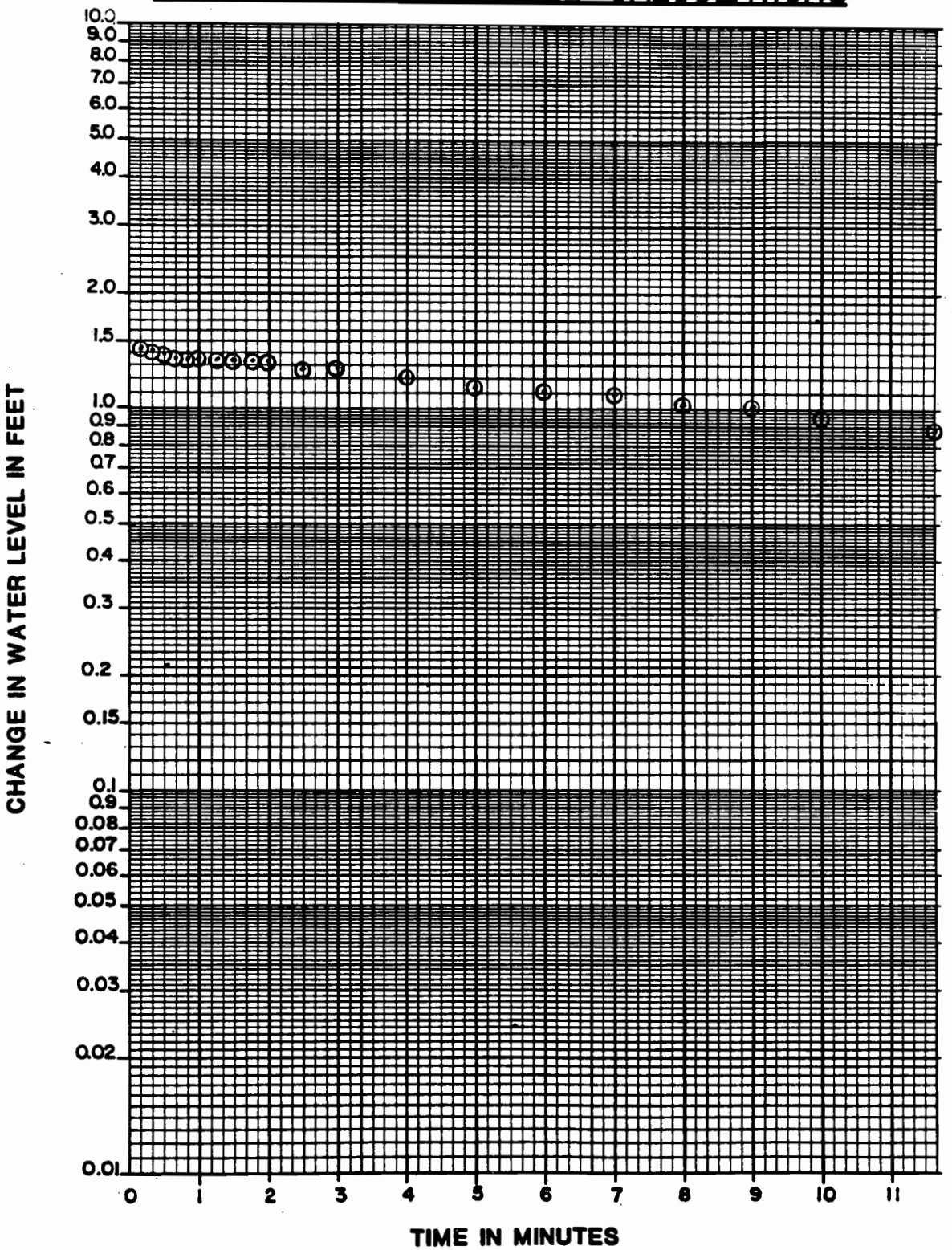
PERMEABILITY = 2.61E-07 FT/SEC = 7.95E-06 CM/SEC

TRANSMISSIVITY = 3.91E-06 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 979

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0979 W01

WELL NO.: 0979

LOCATION: SWSA 5

DRILL WATER @50'

TYPE: DRILL WATER

SAMPLER: [signature] (SIGNATURE)

DATE: 8/12/87

TIME: 9:00 A.M.

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	9/1/87	12:00	MCI	Nancy Owen	9/1/87	12:00	ORNL CPA

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 980 is located in WAG 5. It is located along the west perimeter fence of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 18204.9650, E 28970.8160 (X-10 grid) or latitude 35° 54' 52.72" and longitude 84° 18' 56.16". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 980 was drilled by A.L. Clark Drilling Services, Inc. A Drilltech air rotary rig was used to drill this boring for monitor well installation under the operation of Steve Clark with the assistance of Steve Kirk. Drilling commenced on 8/13/87 and was finished on 8/17/87.

Paragraph 2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

8/12/87: The Driltech air rotary rig and tools were steam cleaned.

8/13/87: The rig was mobilized to the well location and set up. Drilled from 0.0' to 8.2' with 14" augers, set and grouted 10 3/4" surface casing.

8/14/87: The boring was deepened with an 8 5/8" tricone roller bit from 8.2' to 50.0'. Four inch stainless steel screen, casing, sand pack and bentonite were installed.

8/17/87: The annular space was grouted.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist Michael L. Ebers. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

* This information was typed directly from field notes and was edited only when necessary for clarification.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5.

Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

No soil samples were collected during drilling.

A drill water sample (0980W01) was collected from the water pump on the drill rig on 8/14/87. Analytical results for this sample can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type B well. A fourteen-inch diameter boring was augered from ground surface to bedrock (8.2 feet). A ten-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between

the regolith and bedrock water bearing zones. The air rotary method was then used to drill an eight-inch diameter boring to a total depth of 50.0 feet. A four-inch diameter stainless steel silt trap was installed from 49.7 to 50.0 feet. Above the silt trap, a four-inch diameter stainless steel screen was installed from 34.7 feet to 49.7 feet. A four-inch diameter stainless steel casing was installed from the top of the screen at 34.7 feet and extending 1.88 feet above ground surface. A sandpack was then poured into the annular space from 33.6 to 50.0 feet, with a 1.6-foot bentonite seal poured into the annular space above the sandpack from 32.0 to 33.6 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 980 was developed to remove drill cuttings, silt, and other fines from the monitoring well. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 415 gallons of water had been evacuated and the clarity of the discharge water

was approved by the company representative. The final turbidity value measured at completion was 5 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/4/90 at a depth of 47.3 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 980 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 7.72×10^{-6} cm/second (shown as permeability on the hydraulic conductivity

calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 980

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	8/13/87	MLE
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	8/13/87	MLE
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	N/A
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	8/14/87	MLE
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	8/13/87	MLE
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	8/13/87	MLE
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	8/13/87	MLE

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 8/13/87

Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 980

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE John M McLoughlin 8/10/87
John M. McLoughlin

ERC / EDGE Environmental and Energy Services Co.

WELL No. 980

ORNL MONITORING WELL LOG

LOCATION: WAG 5
DRILLER: Steve Clark
HELPER: Steve Kirk
DRILL: Driltech

DATE: START: 8/13/87
FINISH: 8/17/87
LOGGED BY: Michael L. Ebers
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger and Air Rotary
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: None
TYPE: N/A
CONTAINMENT TYPE: Auger Pan, Plastic and Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 8.2'
DEPTH DRILLED IN ROCK: 41.8'
TOTAL DEPTH OF WELL: 50.0'

DRILLING FLUID SAMPLES:
TYPE: Drill Water DATE: 8/14/87
0980 W01

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	4.0			Silt, dark yellowish orange, dry, crumbly.
4.0	7.5			Clay, dark yellowish brown, slightly silty,
				damp, medium dense with weathered sandstone
				cobbles.
7.5	8.2			Siltstone, medium gray and olive gray,
				calcareous, hard.
	@8.2			14" auger refusal.
8.2	50.0			Shale.
	50.0			Total Depth
				*No detailed lithologic description available
				from 8.2' to 50.0' due to the use of a
				containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 980

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Michael L. Ebers
PROOFED BY: Bruce McMaster

DRILLING COMPANY: A. L. Clark Drilling Services

DRILLER: Steve Clark
HELPER: Steve Kirk

DRILLING METHOD:
- ■ 14.0 INCH AUGER 8.2 L.F.
- □ ____ INCH AUGER ____ L.F.
- ■ 8.25 INCH ROTARY 41.8 L.F.
- □ ____ INCH ROTARY ____ L.F.

LOCATION WAG 5
ORNL GRID COORDINATES
N 18204.9650
E 28970.8160
ELEV. GROUND 762.19
ELEV. TOP STAINLESS STEEL CASING 764.07

DRILLING DATES:
STARTED: 8/12/87
FINISHED: 8/17/87

MATERIALS USED

EST. VOL.	USED VOL.	
	30.0	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	8.2	FT. OF 10 3/4 IN. SURFACE CASING
2.5	3.0	SACKS OF CEMENT (SURFACE CASING)
	N/A	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	21.0	GALLONS OF WATER (SURFACE CASING)
	36.6	FT. OF 4 IN. DIA. STAINLESS STEEL CASING
	15.0	FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
4.0	4.5	SACKS OF SAND
25.0	25.0	POUNDS OF BENTONITE PELLETS
7.5	9.0	SACKS OF CEMENT (WELL CASING)
	N/A	POUNDS OF POWERED BENTONITE (WELL CASING)
	54.0	GALLONS OF WATER (WELL CASING)
	2.96	FT. OF 10 3/4 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES: Spillage

SURFACE CASING TREMIE GROUTED YES ■ NO □

STAINLESS STEEL CASING TREMIE GROUTED YES ■ NO □

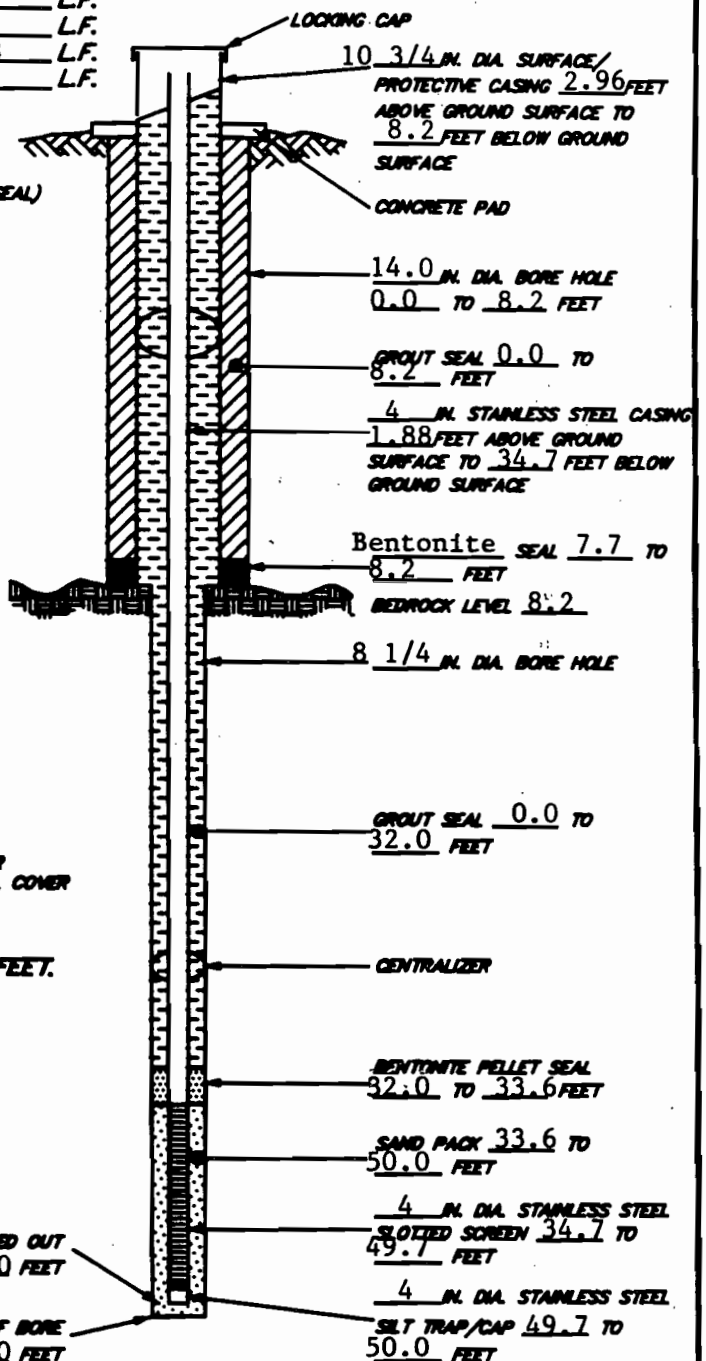
WELL COVER USED
- ■ LOCKING STEEL COVER
- □ FLUSH MOUNTED WELL COVER
- □ OTHER

SILT TRAP USED YES ■ NO □

MONITORING WELL PUMP BASE SET AT 47.3 FEET.

CENTRALIZERS AT 2.0 FEET.
10.0 FEET.
30.0 FEET.
50.0

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



TYPE B WELL

ERC / EDGE Environmental and Energy Services Co.

WELL No. 980

DATE: 8/13/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		8/14/87	02
BENTONITE		8/13/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES, □ NO)	8/14/87	05
STAINLESS STEEL CASING	(PREPACKAGED ■ YES, □ NO)	8/14/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES, □ NO)	8/14/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES, □ NO)	8/14/87	04
MONITORING WELL PUMP	(PREPACKAGED ■ YES, □ NO)	1/04/90	03
GROUT		8/13/87	09
		8/17/87	09
WELL COVERS			
SURFACE CASING		8/13/87	01

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 8/14/87

Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 980

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8/14/87	MLE
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8/14/87	MLE
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/03/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8/14/87	MLE

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Michael L. Ebers 8/14/87
Michael L. Ebers

D. Charles Lytle 1/03/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 980

LOCATION: WAG 5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 12-19-89 TIME:

DEVELOPMENT ENDING DATE: 01-03-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 49.2 GALLONS

TOTAL GALLONS PUMPED: 425 TOTAL WELL VOLUMES PUMPED: 8.6

INITIAL pH: 12.2 FINAL pH: 8.2

INITIAL CONDUCTIVITY (uS): 590 FINAL CONDUCTIVITY (uS): 690

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 5 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER:

WATER DISCHARGED TO:

- ■ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 2.3 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle

D. Charles Lytle 1/03/90

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 980
LOCATION: WAG 5
DATE: 12-19-89

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 49.2 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
12-19-89	10:20	45	Cloudy	--	12.2	590			
12-19-89	1:00		Cloudy	--	11.1	589			
12-20-89	9:30	18	Cloudy	--	3.3				
12-20-89	10:40	5	Cloudy	--	8.3		73		
12-20-89	1:30	42	Cloudy	--	8.1	625	115		
12-21-89	8:30	20	Cloudy	--	7.8	403	135		
12-21-89	11:00	26	Cloudy	--	6.5	743	161		
12-21-89	3:00	14	Cloudy	--	5.6	674	165		
12-27-89	9:00	6	Clear	41	7.2	780	171		
12-27-89	10:00	18	Cloudy	--	7.0	730	189		
12-27-89	11:00	14	Cloudy	--	5.4	756	208	4.2	
12-28-89	3:00	14	Cloudy	--	8.0	900			
12-29-89	12:00	18	Clear	18	8.5	785	240	4.9	
12-29-89	1:00	37	Cloudy	--	7.4	836	277	5.8	
12-29-89	2:00	10	Cloudy	--	7.8	783	287		
01-02-90	9:00	6	Clear	9.0	7.2	795	293	6.0	
01-02-90	2:00	36	Cloudy	--	7.5	646	329	6.7	
RESULTS AT END OF DEVELOPMENT									

COMMENTS Water stayed clean even after surging.

OBSERVER SIGNATURE/DATE D. Charles Lytle
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 980
LOCATION: WAG 5
DATE: 1-02-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 49.2 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
01-02-90	3:00	32	Cloudy	--	8.1	671	361		
01-02-90	4:00	14	Cloudy	--	8.2	759	375		
01-03-90	2:00	40	Cloudy	--	8.1	655	415	8.4	
01-04-90	8:00	10	Clear	5.0	8.2	690	425	8.6	
RESULTS AT END OF DEVELOPMENT			Clear	5.0	8.2	690	425	8.6	

COMMENTS Water stayed clear even after surging.

OBSERVER SIGNATURE/DATE D. Charles Lytle
D. Charles Lytle 1/04/90

INFORMOL.DWG

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 980

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 980 DATE OF TEST: 2/8/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 49.25 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .98 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

1.5486
1.5494

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	2.540	1.560
20.00	2.560	1.580
30.00	2.530	1.550
40.00	2.560	1.580
50.00	2.540	1.560
60.00	2.520	1.540
75.00	2.530	1.550
90.00	2.540	1.560
105.00	2.520	1.540
120.00	2.510	1.530
150.00	2.500	1.520
180.00	2.500	1.520
240.00	2.500	1.520
300.00	2.460	1.480
360.00	2.470	1.490
420.00	2.460	1.480
480.00	2.460	1.480
540.00	2.450	1.470
600.00	2.450	1.470
720.00	2.430	1.450
840.00	2.430	1.450
960.00	2.410	1.430
1080.00	2.390	1.410
1200.00	2.390	1.410
1320.00	2.380	1.400
1440.00	2.390	1.410
1560.00	2.340	1.360
1680.00	2.360	1.380
1800.00	2.330	1.350
1920.00	2.320	1.340
2040.00	2.310	1.330
2160.00	2.310	1.330

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

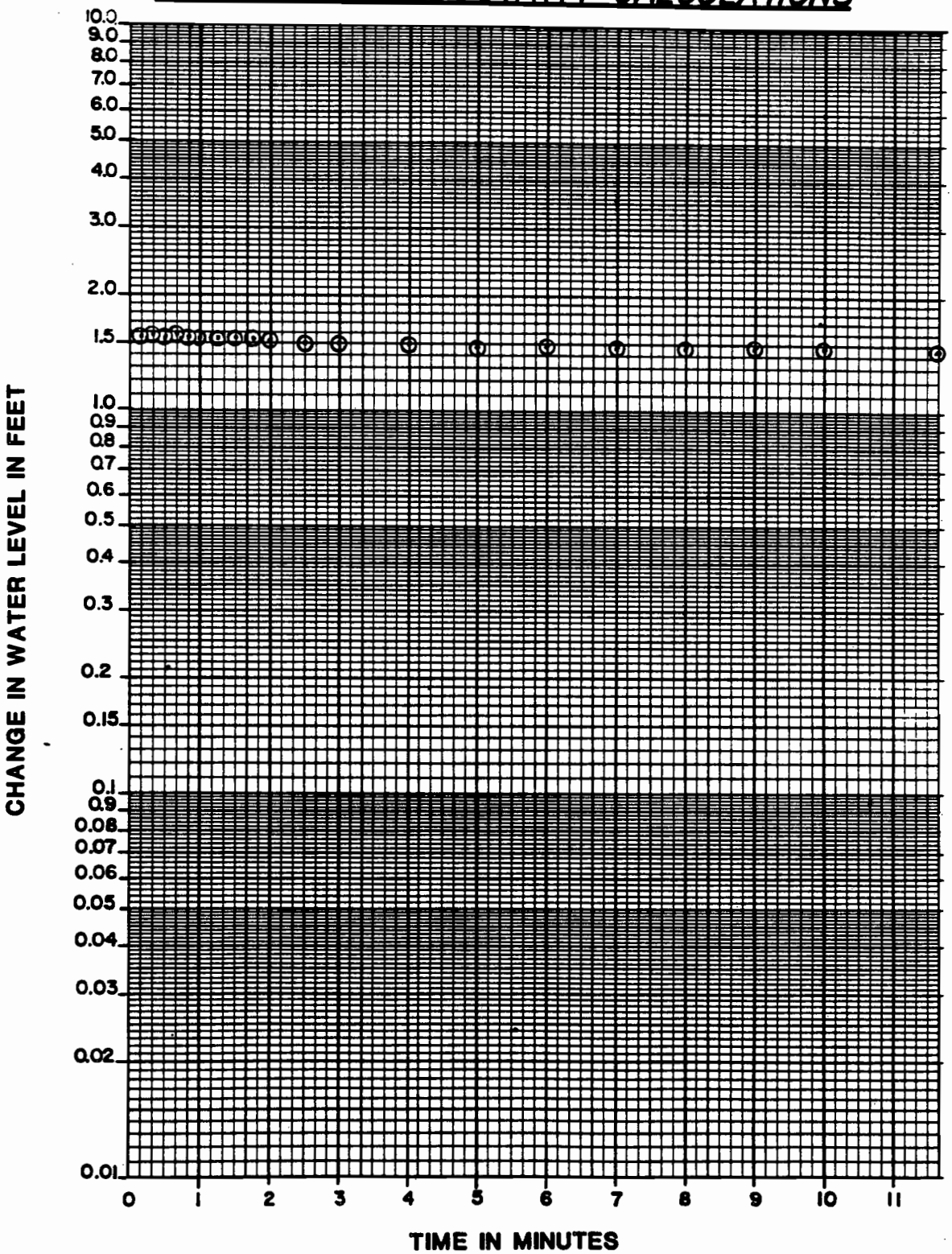
PERMEABILITY = 2.53E-07 FT/SEC = 7.72E-06 CM/SEC

TRANSMISSIVITY = 3.80E-06 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 980

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0980 W01

WELL NO.: 0980

LOCATION: SWSA5 @ 50.0'

TYPE: DRILL WATER

SAMPLER: [signature] (SIGNATURE)

DATE: 8/14/87

TIME: 9:00AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	9/1/87	12:00	MCI	Nancy Owen	9/1/87	12:00	ORNL CPA

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 981 is located in WAG 5. It is along the western perimeter of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 18225.4958, E 28978.9727 (X-10 grid) or latitude 35° 54' 52.93" and longitude 84° 18' 56.22". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 981 was drilled by A.L. Clark Drilling Services, Inc. A Gus Pech auger rig was used to drill this boring for monitor well installation under the operation of A.L. Clark III with the assistance of Richard Pickel. Drilling commenced

on 7/24/87 and was finished on 7/25/87. Paragraph 2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

The Gus Pech rig and tools were steam cleaned and mobilized to the staked location and set up. The boring was split spooned from 0.0' to 6.8', then drilled with 6" augers from surface to 20.0' total depth. Two inch stainless steel casing, screen, sand pack and bentonite were installed and the annular space grouted.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist John W. Anderson. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap

* This information was typed directly from field notes and was edited only when necessary for clarification.

underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

Two soil samples were collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 0981S01 was collected in the split spoon interval from 6.4 feet to 6.6 feet on 7/24/87, and soil sample 0981S02 was collected in the split spoon interval from 0.5 feet to 0.7 feet on 7/24/87. Analytical results for the two soil samples described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type A well. A two-inch diameter stainless steel silt trap was installed from 19.7 to 20.0 feet. Above the silt trap a two-inch diameter stainless steel screen was installed from 9.7 to 19.7 feet. A two-inch diameter stainless steel casing was installed above the screen from 9.7 feet to 2.06 feet above ground surface. A sandpack was then poured into the annular space from 8.0 to 20.0 feet, with a 2.0-foot bentonite pellet seal poured into the annular space above the sandpack from 6.0 to 8.0 feet. The annular space

from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 981 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 346 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 65 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 12/29/89 at a depth of 17.1 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 981 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.33×10^{-4} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 981

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	7/24/87	
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	7/24/87	
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	7/24/87	
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	7/24/87	
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	7/24/87	
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	7/24/87	

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE 7/24/87

John W. Anderson

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 981

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE John W. Anderson 7/24/87

ERC / EDGE Environmental and Energy Services Co.

WELL No. 981

ORNL MONITORING WELL LOG

LOCATION: WAG 5
DRILLER: A. L. Clark III
HELPER: Richard Pickel
DRILL: Gus Pech

DATE: START: 7/24/87
FINISH: 7/24/87
LOGGED BY: John W. Anderson
HEALTH PHYSICIST: N/A

TYPE DRILLING: Split spoons and auger
LUBRICANT TYPE: Silicone
No. SAMPLES TAKEN: Two
TYPE: Soil
CONTAINMENT TYPE: Auger pan and plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 6.8'
DEPTH DRILLED IN ROCK: 13.2'
TOTAL DEPTH OF WELL: 20.0'

DRILLING FLUID SAMPLES:
TYPE: N/A
DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	0.7	0981S02		Topsoil, medium brown with organic material.
		0.5'-0.7'		
0.7	4.0			Clay, silty, light brown, minor shale fragments,
				dry.
4.0	6.0			Clay, silty, light brown, abundant shale
				fragments.
6.0	6.8	0981S01		Clay, silty, light brown, abundant shale
		6.4'-6.7'		fragments, moist.
	6.8			Split spoon refusal.
6.8	20.0			Shale, dark brown, highly weathered.
	20.0			Total Depth

ERC / EDGE Environmental and Energy Services Co.

WELL No. 981

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: John W. Anderson
PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A. L. Clark Drilling Service

DRILLER: A. L. Clark, Jr. HELPER: A. L. Clark III

EQUIPMENT ■ 6.25 INCH AUGER 20.0 L.F.
☐ _____ INCH AUGER _____ L.F.

LOCATION WAG 5
ORNL GRID COORDINATES
N 18225.4958
E 28978.9727
ELEV. GROUND 761.53
ELEV. TOP STAINLESS STEEL CASING 763.59

DRILLING DATES:
STARTED: 7/24/87
FINISHED: 7/25/87

MATERIALS USED

EST. VOL.	USED VOL.	
10.0		FEET OF 2.0 IN. S.S. SCREEN
11.8		FEET OF 2.0 IN. S.S. CASING
2.5	3.5	SACKS OF SAND
35.0	35.0	POUNDS OF BENTONITE PELLETS
1.0	1.0	SACKS OF CEMENT
	N/A	POUNDS OF POWDERED BENTONITE
	6.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Spillage

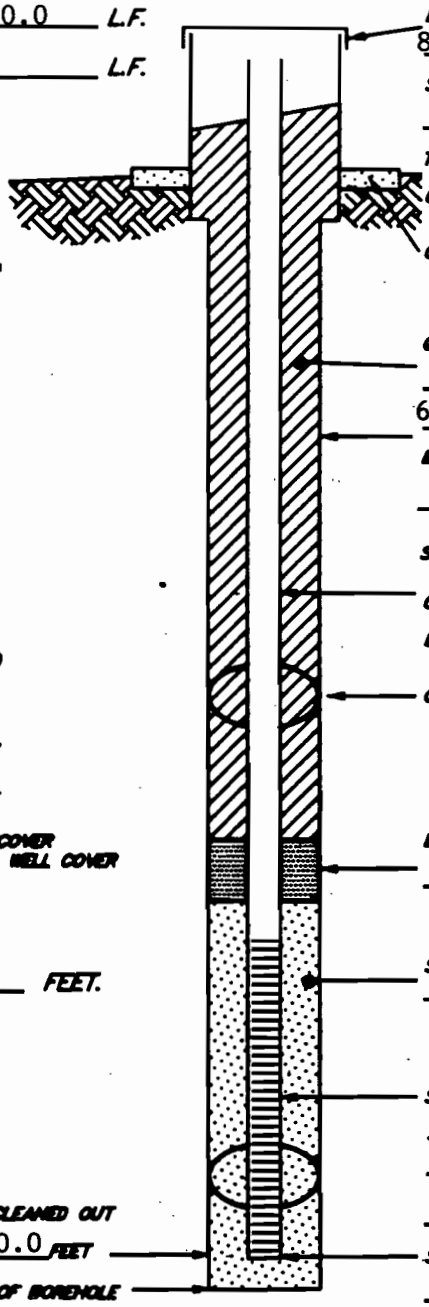
WELL COVER USED ■ LOCKING STEEL COVER ☐ FLUSH MOUNTED WELL COVER ☐ OTHER

SILT TRAP USED YES ■ NO ☐

MONITORING WELL PUMP BASE SET AT 17.1 FEET.

CENTRALIZERS AT 9.0 FEET.
19.0 FEET.
_____ FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER
8 5/8 INCH DIAMETER STEEL PROTECTIVE CASING 3.36 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO 6.0 FEET

6 1/4 INCH DIAMETER BOREHOLE

2 INCH DIAMETER STAINLESS STEEL CASING 2.06 FT. ABOVE GROUND SURFACE TO 9.7 FT. BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL 6.0 TO 8.0 FEET

SAND PACK 8.0 TO 20.0 FEET

2 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 9.7 TO 19.7 FEET

2 INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP 19.7 TO 20.0 FEET

HOLE CLEANED OUT TO 20.0 FEET

BOTTOM OF BOREHOLE 20.0 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 981

DATE: 7/25/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		7/25/87	02
BENTONITE		7/25/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	7/25/87	05
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	7/25/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	7/25/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	7/25/87	04
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	12/29/89	03
GROUT		7/26/87	09
WELL COVERS			
SURFACE CASING		7/87	01

COMMENTS:

OBSERVER SIGNATURE/DATE: John W. Anderson 7/26/87

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 981

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	7/25/87	
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	7/25/87	
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	12/28/89	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	7/25/87	

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE John W. Anderson 7/25/87

D. Charles Lytle 12/28/89
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 981

LOCATION: WAG 5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 12-19-89 TIME:

DEVELOPMENT ENDING DATE: 12-28-89

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 9.4 GALLONS

TOTAL GALLONS PUMPED: 346 TOTAL WELL VOLUMES PUMPED: 36.8

INITIAL pH: 10.6 FINAL pH: 7.1

INITIAL CONDUCTIVITY (uS): 507 FINAL CONDUCTIVITY (uS): 729

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Cloudy

FINAL MEASURED TURBIDITY: 65 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 32 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle

D. Charles Lytle 12/28/89

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 981
LOCATION: WAG 5
DATE: 12-19-89

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 9.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
12-19-89	10:30		Muddy	--	10.6	507			
12-19-89	11:00	40		--	9.6	555			
12-20-89	9:30	38	Cloudy	--	9.9				
12-20-89	10:45	5	Muddy	--	7.1		83		
12-21-89	8:30	46	Clear	10.0	7.0	540	129		
12-21-89	11:00	44	Muddy	--	6.9	690	173		
12-21-89	3:00	26	Cloudy	--	5.9	730	199		
12-27-89	9:00	10	Cloudy	--	7.3	698	209		
12-27-89	10:00	30	Cloudy	--	7.1	654	239		
12-27-89	11:00	16	Cloudy	--	8.3		255	27	
12-27-89	3:00	36	Cloudy	--	7.1	785	291	31.0	
12-28-89	2:30	55	Cloudy	65	7.1	729	346	36.8	
RESULTS AT END OF DEVELOPMENT			Cloudy	65	7.1	729	346	36.8	

COMMENTS

OBSERVER SIGNATURE/DATE D. Charles Lytle 12/28/89
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 981

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 981 DATE OF TEST: 2/7/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 16.55 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 1.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 23

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR HO (FEET)

1.8497
1.8520

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.110	2.110
20.00	2.930	1.930
30.00	2.760	1.760
40.00	2.640	1.640
50.00	2.540	1.540
60.00	2.420	1.420
75.00	2.310	1.310
90.00	2.180	1.180
105.00	2.100	1.100
120.00	2.040	1.040
150.00	1.890	.890
180.00	1.770	.770
240.00	1.600	.600
300.00	1.550	.550
360.00	1.400	.400
420.00	1.360	.360
480.00	1.310	.310
540.00	1.200	.200
600.00	1.120	.120
720.00	1.060	.060
840.00	1.060	.060
960.00	1.040	.040
1080.00	1.020	.020

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

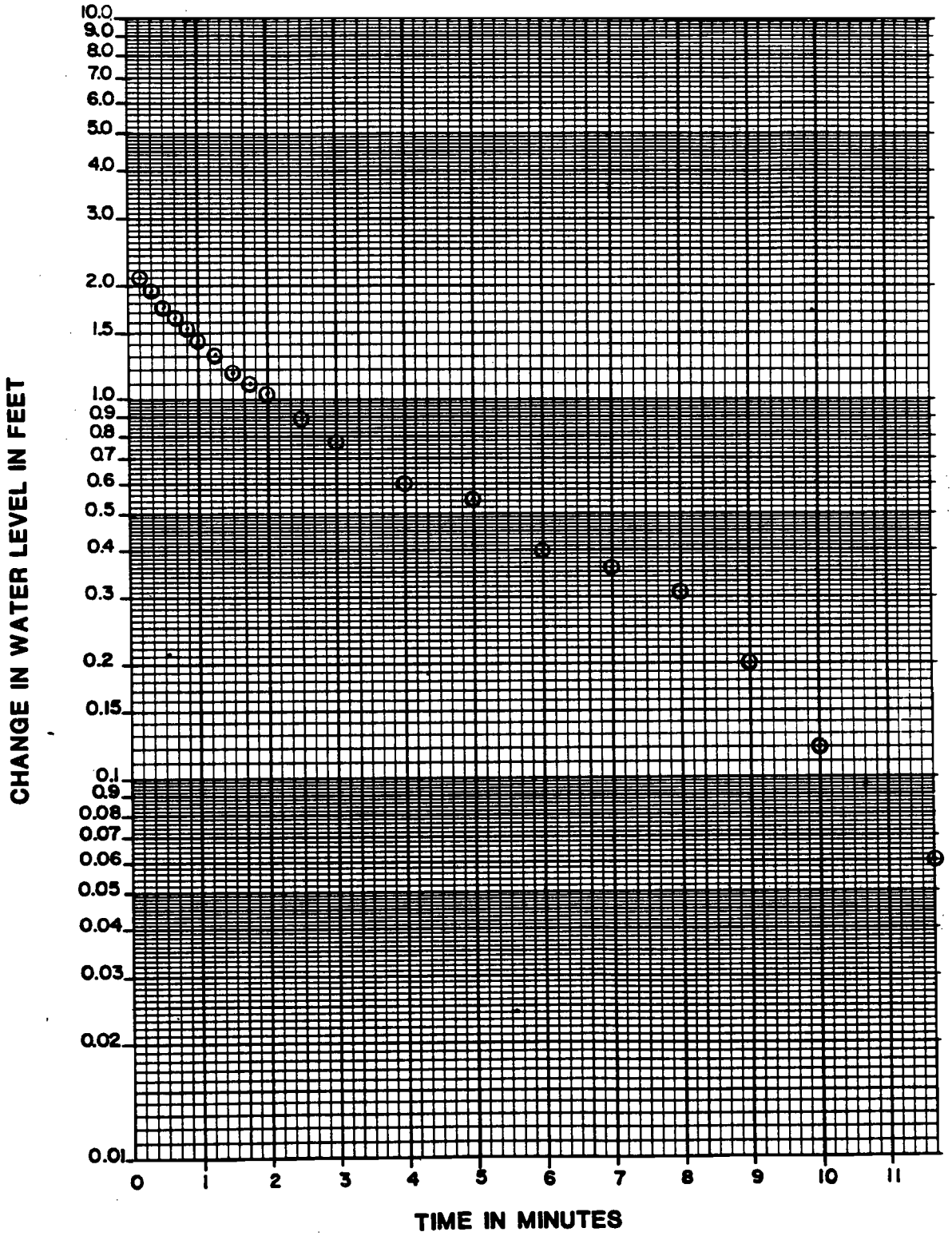
PERMEABILITY = 4.37E-06 FT/SEC = 1.33E-04 CM/SEC

TRANSMISSIVITY = 4.37E-05 FT**2/SEC

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 981

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0981 S01

WELL NO.: 0981

LOCATION: 6.4-6.6

TYPE: Soil

SAMPLER: (SIGNATURE)

DATE: 7/24/87

TIME: 10:25

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
	11/25/87	9:30	MCI		11/25/87	9:30	MCI
	11/25/87	2:40PM	MCI	Nancy Owen	11-25-87	2:40	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0981 S02

WELL NO.: 0981

LOCATION: 0.5-0.7

TYPE: Soil

SAMPLER: (SIGNATURE)

DATE: 7/24/87

TIME: 10:20

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
	11/25/87	9:30	MCI		11/25/87	9:30	MCI
	11/25/87	2:40PM	MCI	Nancy Owen	11-25-87	2:40	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 982 is located in WAG 5. It is along the western perimeter of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 18513.5507, E 29195.3421 (X-10 grid) or latitude 35° 54' 56.49" and longitude 84° 18' 55.98". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 981 was drilled by A.L. Clark Drilling Services, Inc. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of Richard Pickel. Drilling

commenced on 7/31/87 and was finished on 8/11/87. Paragraph 2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows:*

7/31/87: The rig was moved to the well site and set up. Split spoon samples were taken from 0.0' to 2.0'. Drilling with six-inch augers began.

8/10/87: The boring was drilled to 16.7'.

8/11/87: The boring was bailed and 2" stainless steel screen, casing, sand and bentonite were installed.

This well was logged by Engineering, Design and Geosciences Group, Inc. (EDGe) hydrogeologist Bryn D. Howze. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing,

* This information was typed directly from field notes and was edited only when necessary for clarification.

centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

Two samples were collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 0982S01 was collected in the split spoon interval from 1.8 feet to 2.0 feet on 7/31/87, and rock sample 0982R01 was collected in the augered interval at 11.7 feet on 7/31/87. Analytical results for these samples described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type A well. A two-inch diameter stainless steel silt trap was installed from 16.2 to 16.4 feet. Above the silt trap a two-inch diameter stainless steel screen was installed from 6.2 to 16.2 feet. A two-inch diameter stainless steel casing was installed above the screen from 6.2 feet to 1.99 feet above ground surface. A sandpack was then poured into the annular space from 5.0 to 16.4 feet, with a 2.0-foot bentonite pellet seal poured into the annular space above the sandpack from 3.0 to 5.0 feet. The annular

space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 982 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 118 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 2/1/90 at a depth of 14.1 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 982 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 4.48×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 982

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	7/31/87	MLE
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	7/31/87	MLE
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	NA	NA
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	7/31/87	MLE
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	7/31/87	MLE
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	7/31/87	MLE
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	7/31/87	MLE

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 7/31/87

Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 982

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE [signature] 7/31/87

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 982

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG5

DRILLER: A.L. Clark III

HELPER: Richard Pickel

DRILL: Schramm Rotadrill

DATE: START: 7/31/87
FINISH: 8/11/87

LOGGED BY: Bryn D. Howze

HEALTH PHYSICIST: Sherrie Cox

TYPE DRILLING: Split spoons and augers

LUBRICANT TYPE: Molykote 1000

No. SAMPLES TAKEN: two

TYPE: one soil and one rock

CONTAINMENT TYPE: Auger pan and plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 2.0'

DEPTH DRILLED IN ROCK: 14.7'

TOTAL DEPTH OF WELL: 16.7'

DRILLING FLUID SAMPLES:

TYPE: N/A DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	1.7		100	Silt, slightly clayey, orange-brown, mottled, yellow and black with roots, rock fragments (shale, sandstone)
1.7	2.0	0982S01 @1.8-2.0'		Silt, slightly clayey, light brown, mottled, greenish-gray, black, yellow, with weathered shale, relict bedding
2.0	12.0	0982R01 @ 11.7'		Shale, weathered, olive gray, mottled orange (Fe stains?), black, with silt, slightly clayey medium brown, slightly moist at 10', moist at 11'
12.0	16.7			Limestone, light gray, fine grained, interbedded with shale
	16.7			Total Depth

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 982

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Bryn D. Howze
PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: Richard Pickel
HELPER: N/A

LOCATION WAG5
ORNL GRID COORDINATES
N 18513.5507
E 29195.3421
ELEV. GROUND 774.81
ELEV. TOP STAINLESS STEEL CASING 776.80

DRILLING DATES:
STARTED: 7/31/87
FINISHED: 8/11/87

EQUIPMENT
■ 6 1/4 INCH AUGER 16.7 L.F.
□ _____ INCH AUGER _____ L.F.

MATERIALS USED

EST. VOL.	USED VOL.	
10.0		FEET OF 2 IN. S.S. SCREEN
8.2		FEET OF 2 IN. S.S. CASING
3.0	3.0	SACKS OF SAND
40.0	40.0	POUNDS OF BENTONITE PELLETS
0.5	0.5	SACKS OF CEMENT
	NA	POUNDS OF POWDERED BENTONITE
	3.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

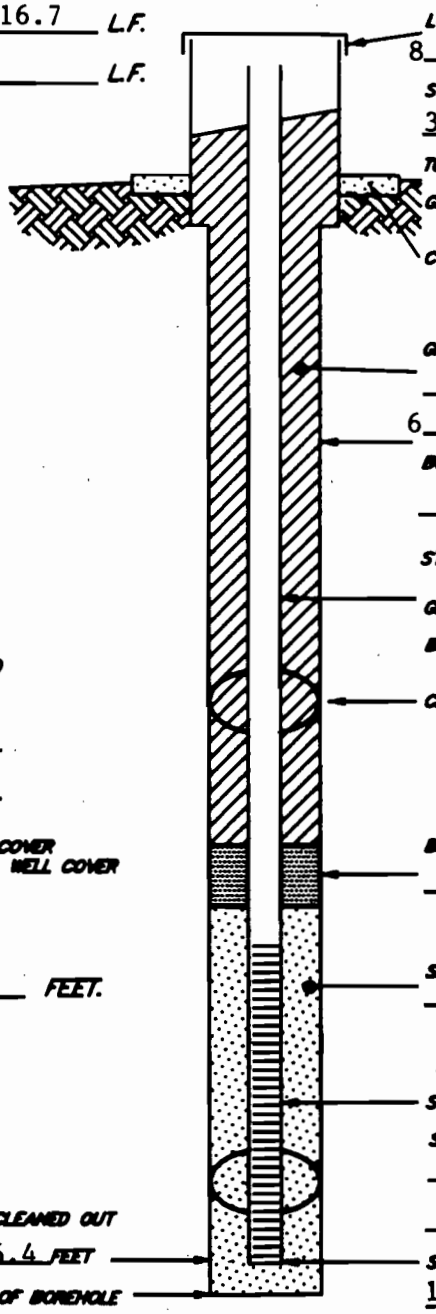
WELL COVER USED
■ LOCKING STEEL COVER
□ FLUSH MOUNTED WELL COVER
□ OTHER

SILT TRAP USED YES ■ NO □

MONITORING WELL PUMP BASE SET AT 14.1 FEET.

CENTRALIZERS AT 3.0 FEET.
16.2 FEET.
_____ FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER
8 5/8 INCH DIAMETER STEEL PROTECTIVE CASING
3.76 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO 3.0 FEET

6 1/4 INCH DIAMETER BOREHOLE

2 INCH DIAMETER STAINLESS STEEL CASING 1.99 FT. ABOVE GROUND SURFACE TO 6.2 FT. BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL 3.0 TO 5.0 FEET

SAND PACK 5.0 TO 16.4 FEET

2 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 6.2 TO 16.2 FEET

2 INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP 16.2 TO 16.4 FEET

HOLE CLEANED OUT TO 16.4 FEET

BOTTOM OF BOREHOLE 16.7 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 982

DATE: 8/11/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		8/11/87	02
BENTONITE		8/11/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	8/11/87	05
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	8/11/87	04
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	8/11/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	8/11/87	04
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	2/1/90	03
GROUT		8/12/87	09
WELL COVERS			
SURFACE CASING		8/87	01

COMMENTS:

OBSERVER SIGNATURE/DATE Bryn Howze 8/12/87
Bryn D. Howze

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 982

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8/11/87	BH
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8/11/87	BH
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/31/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8/11/87	BH

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Bryn D. Howze 8/11/87
Bryn D. Howze

D. Charles Lytle 1/31/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 982

LOCATION: WAG5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and pumping

DEVELOPMENT BEGAN DATE: 12-29-89 TIME:

DEVELOPMENT ENDING DATE: 01-31-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 6.8 GALLONS

TOTAL GALLONS PUMPED: 118 TOTAL WELL VOLUMES PUMPED: 17.4

INITIAL pH: 7.5 FINAL pH: 7.3

INITIAL CONDUCTIVITY (uS): 719 FINAL CONDUCTIVITY (uS): 625

DESCRIPTION OF INITIAL TURBIDITY: muddy

DESCRIPTION OF FINAL TURBIDITY: clear

FINAL MEASURED TURBIDITY: 2.0

WELL APPROVED BY: R.C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ■ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 2.4 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-31-90

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 982
LOCATION: WAG5
DATE: 12-29-89

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 6.8 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
12-29-89	1300	18	Muddy		7.5	719			
12-29-89	1400	20	Cloudy		7.2	733	38		
01-02-90	1000	8	Muddy		7.1	617	46	6.8	
01-03-90	1300	28	Clear	7.0	7.6	657	74	10.9	
01-31-90	1100	44	Clear	2.0	7.3	625	118	17.4	
RESULTS AT END OF DEVELOPMENT			Clear	2.0	7.3	625	118	17.4	

COMMENTS Reason for time lapse: pump broke and was sent back. Water cleared on 1-30-90 (7.0 NTU's) and was passed on 1-31-90 with 2.0 NTU's. Moved off of well.

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-31-90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

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(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 982 DATE OF TEST: 2/8/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 13.25 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .98 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

2.1602
2.1906

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.160	3.180
20.00	3.910	2.930
30.00	3.760	2.780
40.00	3.620	2.640
50.00	3.480	2.500
60.00	3.370	2.390
75.00	3.220	2.240
90.00	3.060	2.080
105.00	2.950	1.970
120.00	2.840	1.860
150.00	2.680	1.700
180.00	2.520	1.540
240.00	2.320	1.340
300.00	2.150	1.170
360.00	2.020	1.040
420.00	1.900	.920
480.00	1.810	.830
540.00	1.730	.750
600.00	1.660	.680
720.00	1.540	.560
840.00	1.470	.490
960.00	1.410	.430
1080.00	1.360	.380
1200.00	1.320	.340
1320.00	1.270	.290
1440.00	1.240	.260
1560.00	1.200	.220
1680.00	1.180	.200
1800.00	1.170	.190
1920.00	1.130	.150
2040.00	1.130	.150
2160.00	1.110	.130

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METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

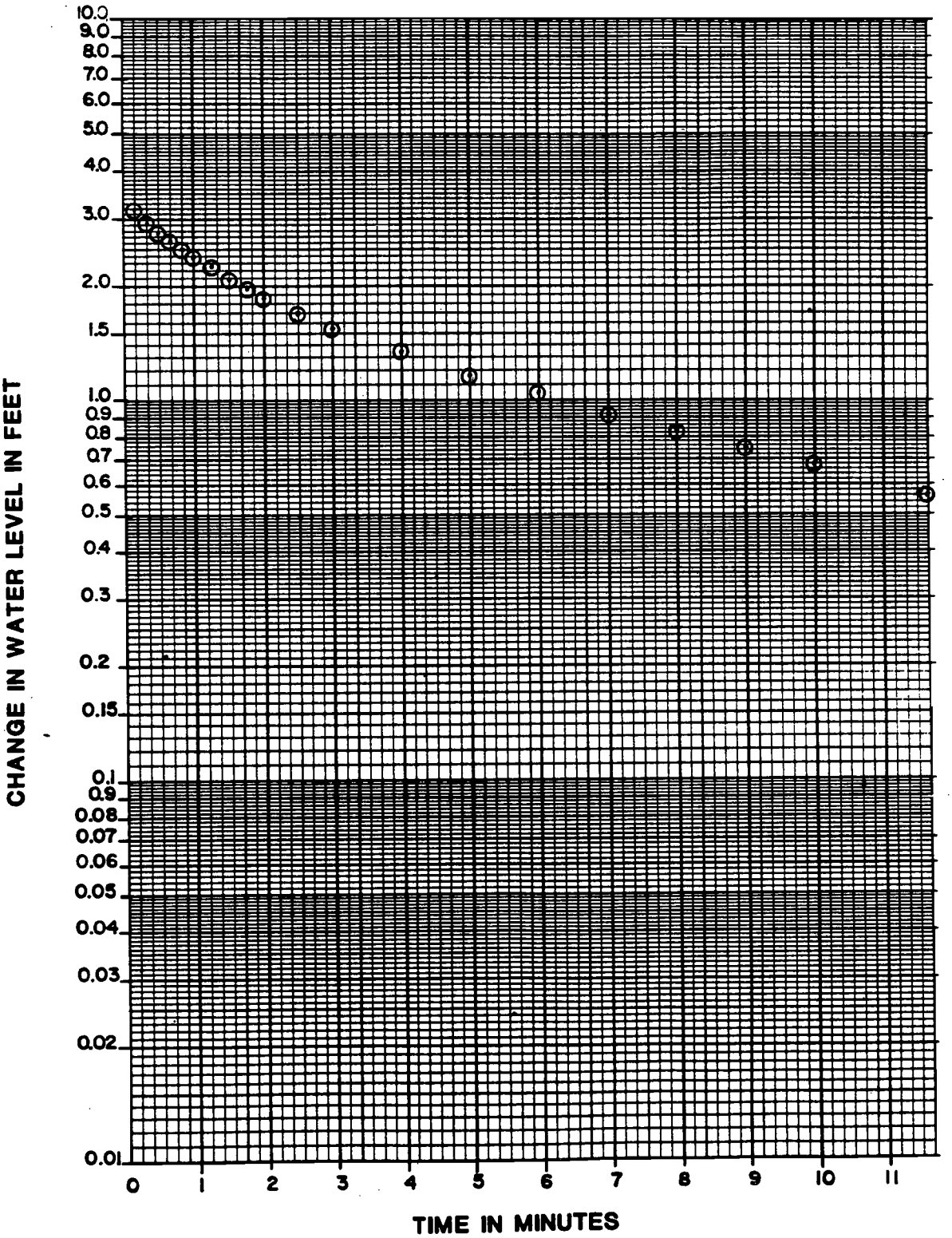
PERMEABILITY = 1.47E-06 FT/SEC = 4.48E-05 CM/SEC

TRANSMISSIVITY = 1.47E-05 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 982

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0982 S01

WELL NO.: 0982

LOCATION: SWSA 5

TYPE: Soil

SAMPLER: [signature] (SIGNATURE)

DATE: 7/31/87

TIME: 10:10 AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	9/15/87	2:25	MCI	Nancy Owen	9/15/87	2:25	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615)966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0982 R01

WELL NO.: 982

LOCATION: SWSA 5

TYPE: Rock Cuttings

SAMPLER: Bryn Hoyle (SIGNATURE)

DATE: 7/31/87

TIME: 2:05 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn Hoyle	9/15/87	2:25	MCI	Nancy Owen	9/15/87	2:25	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 983 is located in WAG 5. It is located along the western perimeter fence of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 18803.881, E 29402.271 (X-10 grid) or latitude 35° 55' 00.02" and longitude 84° 18' 55.85". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 983 was drilled by A.L. Clark Drilling Services, Inc. A Gus Pech auger rig was used to drill this boring for monitor well installation under the operation of A.L. Clark III with the assistance of Ray Clark. Drilling commenced on 8/10/87 and was finished on 8/14/87. Paragraph

2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/ completion form. A synopsis of the drilling activity follows:*

The Gus Pech auger rig was steam cleaned and mobilized to the staked location. The boring was split spooned from 0.0' to 8.0' and drilled to 25' total depth with 6 1/4" augers. The boring was bailed for 1 1/2 days, the recharge being slow, estimated at 4 gallons/hour.

The boring was set with 2" stainless steel screen, casing, sandpack and bentonite.

This well was logged by ERC Environmental and Energy Services Co. (ERC/EDGe) hydrogeologist John W. Anderson. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing,

* This information was typed directly from field notes and was edited only when necessary for clarification.

stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and

contain many folds and faults resulting in varying strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

No soil samples were collected during drilling.

2.4 Installation and Development

2.4.1 Installation

This was a type A well. A two-inch diameter stainless steel silt trap was installed from 24.7 to 25.0 feet. Above the silt trap a two-inch diameter stainless steel screen was installed from 9.7 to 24.7 feet. A two-inch diameter stainless steel casing was installed above the screen from 9.7 feet to 2.24 feet above ground surface. A sandpack was then poured into the annular space from 8.0 to 25.0 feet, with a 2-foot bentonite pellet seal poured into the annular space above the sandpack from 6.0 to 8.0 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 983 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 284 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 10 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/12/90 at a depth of 22.3 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 983 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity

of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Ommidata Datapod II data recorder. The hydraulic conductivity value of 6.01×10^{-6} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 983

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	8/10/87	
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	8/10/87	
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	N/A
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	8/10/87	
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	8/10/87	
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	8/10/87	
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	8/10/87	

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE 8/10/87

John W. Anderson

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 983

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE _____ 8/10/87
John W. Anderson

ERC / EDGE Environmental and Energy Services Co.

WELL No. 983

ORNL MONITORING WELL LOG

LOCATION: WAG 5
DRILLER: A. L. Clark III
HELPER: Ray Clark
DRILL: Gus Pech

DATE: START: 8/10/87
FINISH: 8/14/87
LOGGED BY: Michael L. Ebers
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Split Spoon and Auger
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: None
TYPE: N/A
CONTAINMENT TYPE:

THICKNESS OF SOIL (REFUSAL DEPTH): 8.0'
DEPTH DRILLED IN ROCK: 17.0'
TOTAL DEPTH OF WELL: 25.0'

DRILLING FLUID SAMPLES:
TYPE: N/A
DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	6.0		100	Silty clay with shale fragments, orange brown
				and light green, crumbly, dry.
6.0	8.0			Silty clay with shale fragments, light brown
				mottled with light green.
	8.0			Split spoon refusal.
8.0	13.0			Shale, highly weathered, light greenish brown,
				dry.
13.0	13.5			Limestone, light gray, hard.
13.5	16.1			Siltstone, light brown, soft, very soft and
				wet at 15.2'.
16.1	18.7			Limestone, light gray, wet.
18.7	20.0			Very soft, water coming out of boring.
20.0	25.0			Limestone, weathered, light gray, hard, wet.
	25.0			Total Depth
				Notes:
				Bailed borehole for 1.5 days, recharge very
				slow, in 4 gallons/hr. S. Laman advised to
				go ahead and set well.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 983

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: John W. Anderson
PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A. L. Clark Drilling Services

DRILLER: A. L. Clark III
HELPER: Ray Clark

EQUIPMENT
☒ 6.25 INCH AUGER 25.0 L.F.
☐ _____ INCH AUGER _____ L.F.

LOCATION WAG 5
ORNL GRID COORDINATES
N 18,803.881
E 29,401.271
ELEV. GROUND 788.44
ELEV. TOP STAINLESS STEEL CASING 790.68

DRILLING DATES:
STARTED: 8/10/87
FINISHED: 8/14/87

MATERIALS USED

EST. VOL.	USED VOL.	
	15.0	FEET OF 2 IN. S.S. SCREEN
	12.0	FEET OF 2 IN. S.S. CASING
4.5	4.5	SACKS OF SAND
50.0	50.0	POUNDS OF BENTONITE PELLETS
1.0	1.0	SACKS OF CEMENT
	N/A	POUNDS OF POWDERED BENTONITE
	6.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

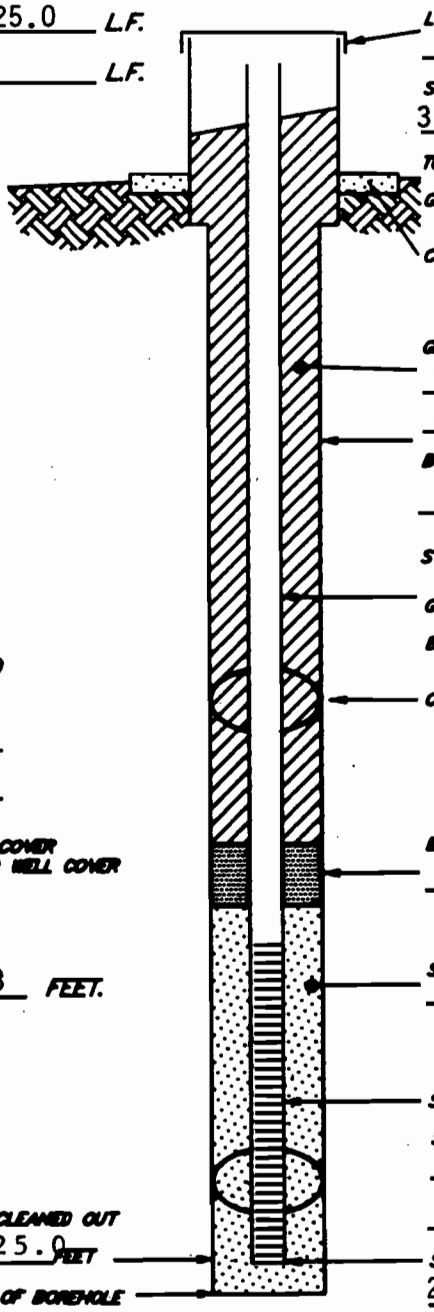
WELL COVER USED
☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 22.3 FEET.

CENTRALIZERS AT 4.0 FEET.
24.0 FEET.
_____ FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER
8 INCH DIAMETER
STEEL PROTECTIVE CASING
3.53 FT. ABOVE GROUND
TO 2.0 FT. BELOW
GROUND SURFACE
CONCRETE PAD

GROUT SEAL 0.0 TO
6.0 FEET
6.25 INCH DIAMETER
BOREHOLE
2 INCH DIAMETER STAINLESS
STEEL CASING 2.24 FT. ABOVE
GROUND SURFACE TO 9.7 FT.
BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL
6.0 TO 8.0 FEET

SAND PACK
8.0 TO 25.0 FEET

2 INCH DIAMETER
STAINLESS STEEL 0.010
SLOTTED SCREEN
9.7 TO 24.7 FEET

2 INCH DIAMETER STAINLESS
STEEL SILT TRAP/CAP
24.7 TO 25.0 FEET

HOLE CLEANED OUT
TO 25.0 FEET

BOTTOM OF BOREHOLE
25.0 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE Environmental and Energy Services Co.

WELL No. 983

DATE: 8/14/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		8/14/87	02
BENTONITE		8/14/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	8/14/87	05
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	8/14/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	8/14/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	8/14/87	04
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	1/11/90	03
GROUT		8/15/87	09
WELL COVERS		8/89	01
SURFACE CASING			

COMMENTS:

OBSERVER SIGNATURE/DATE: 8/15/87

John W. Anderson

ERC / EDGE Environmental and Energy Services Co.

WELL No. 983

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8/14/87	[illegible]
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8/14/87	[illegible]
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/11/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8/14/87	[illegible]

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE [signature] 8/14/87
John W. Anderson

D. Charles Lytle 1/11/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 983

LOCATION: WAG 5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 12-20-89 TIME:

DEVELOPMENT ENDING DATE: 1-11-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 9.4 GALLONS

TOTAL GALLONS PUMPED: 284 TOTAL WELL VOLUMES PUMPED: 30.2

INITIAL p

INITIAL C CTIVITY (uS): 491

DESCRIP.

DESCRIP.

FINAL MA

MES

8.5

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: water level from surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-11-90

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 983
LOCATION: WAG 5
DATE: 12-20-89

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 9.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
12-20-89	1:30	2	Crystal Clear	4.0	6.8	537	2		
12-21-89	9:00	24	Muddy	--	6.8	459	26		
12-27-89	9:00	8	Cloudy	--	7.4	749	34		
12-27-89	10:00	4	Cloudy	--	7.1	609	38		
12-28-89	12:00	12	Cloudy	--	7.1	631	50	5.3	
1-02-90	9:00	10	Cloudy	--	7.1	936	60		
1-02-90	2:00	32	Cloudy	--	7.0	919	92	9.8	
1-02-90	3:00	38	Muddy	--	7.2	939	130		
1-02-90	4:00	24	Very Cloudy	--	6.7	935	154		
1-03-90	1400	44	Cloudy	--	6.9	566	198	21.1	
1-04-90	1600	36	Cloudy	--	5.9	558	234	24.9	
1-05-90	1100	5	Cloudy	--			239	25.4	
1-08-90	1045	25	Cloudy	--	7.1	418	264	28.1	
1-11-90	0930	20	Clear	10	6.9	491	284	30.2	
RESULTS AT END OF DEVELOPMENT			Clear	10	6.9	491	284	30.2	

COMMENTS Water would not clear after 30 well volumes, did not surge well on 1-11-90. Water clear; passed and moved to next well.

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-11-90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 983 DATE OF TEST: 2/7/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 19.25 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 1.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 30

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

3.1225
3.1318

ERC / EDGE Environmental and Energy Services Co.

WELL No. 983

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.400	3.400
20.00	4.330	3.330
30.00	4.300	3.300
40.00	4.240	3.240
50.00	4.220	3.220
60.00	4.210	3.210
75.00	4.140	3.140
90.00	4.110	3.110
105.00	4.060	3.060
120.00	4.040	3.040
150.00	4.000	3.000
180.00	3.950	2.950
240.00	3.850	2.850
300.00	3.770	2.770
360.00	3.690	2.690
420.00	3.600	2.600
480.00	3.610	2.610
540.00	3.550	2.550
600.00	3.490	2.490
720.00	3.420	2.420
840.00	3.390	2.390
960.00	3.360	2.360
1080.00	3.280	2.280
1200.00	3.260	2.260
1320.00	3.240	2.240
1440.00	3.180	2.180
1560.00	3.150	2.150
1680.00	3.110	2.110
1800.00	3.050	2.050
1920.00	3.020	2.020

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

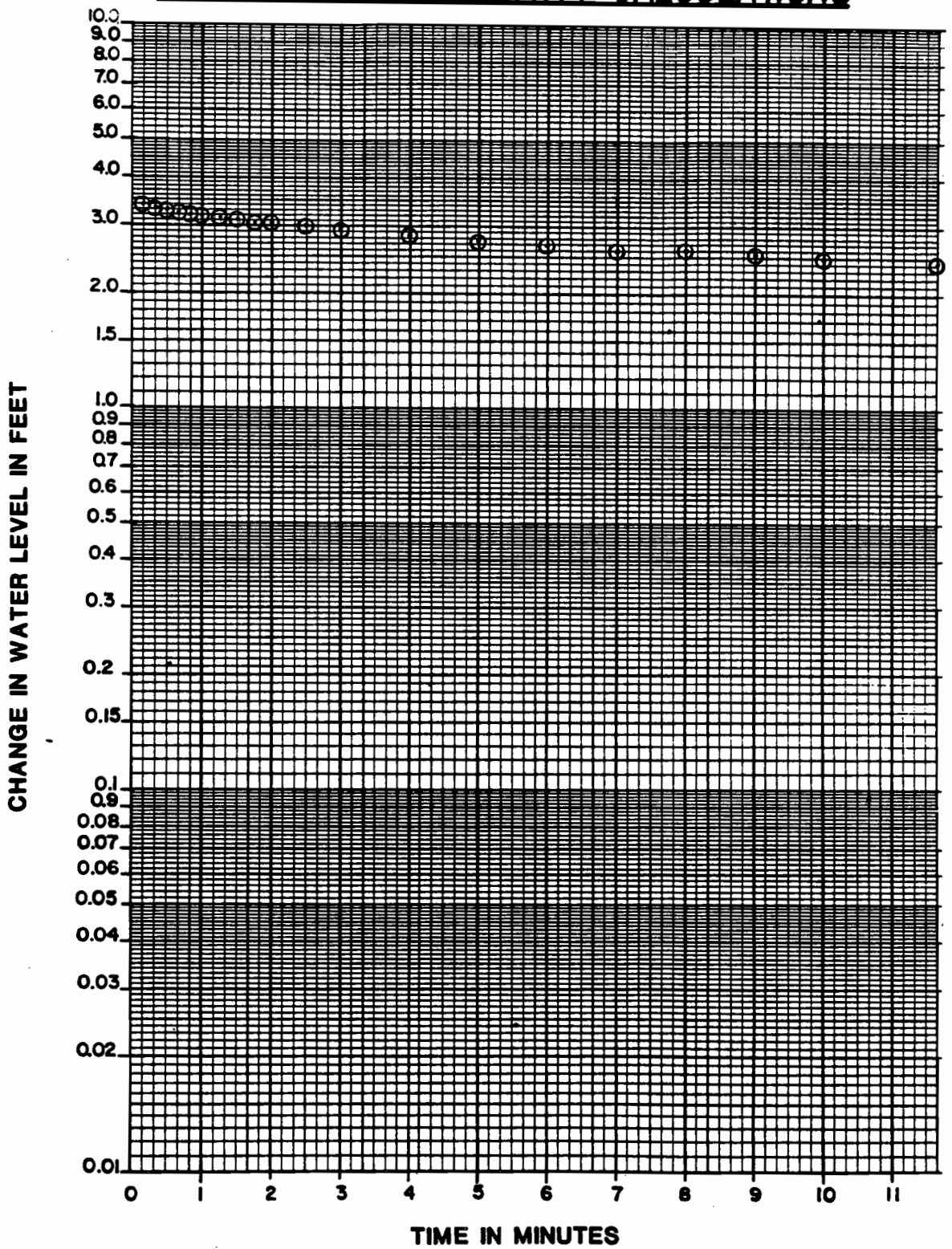
PERMEABILITY = 1.97E-07 FT/SEC = 6.01E-06 CM/SEC

TRANSMISSIVITY = 2.96E-06 FT**2/SEC

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 983

HYDRAULIC CONDUCTIVITY CALCULATIONS



1.0 General Information

1.1 Well Location

Monitoring well number 984 is located in WAG 5. It is located along the western perimeter of WAG 5. The location is shown on ORNL drawing number C3E 20004 A080. Survey coordinates for this well are N 18819.933, E 29411.994 (X-10 grid) or latitude 35° 55' 00.20" and longitude 84° 18' 55.86". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 984 was drilled by A.L. Clark Drilling Services, Inc. A Driltech air rotary rig was used to drill this boring for monitor well installation under the operation of Steve Clark with the assistance of Steve Kirk. Drilling commenced on

8/18/87 and was finished on 8/19/87. Paragraph 2.4.1 includes a detailed discussion of the well installation, and a well schematic is included on the well installation/ completion form. A synopsis of the drilling activity follows:*

The Driltech air rotary drilling rig was steam cleaned and mobilized to the staked location and set up. The boring was drilled with 14" augers from the surface to 13.0 feet. Ten-inch surface casing was set and grouted. The boring was advanced with six-inch tricone air rotary from 13.0 feet to 80.0 feet total depth. Four inch stainless steel screen, casing, sandpack and bentonite were installed and the annular space grouted to the surface.

This well was logged by ERC Environmental and Energy Services Co. (ERC/EDGe) hydrogeologist John W. Anderson. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing,

* This information was typed directly from field notes and was edited only when necessary for clarification.

stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning and decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions For Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O., K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 5 is located in Melton Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 5 is underlain by shale, siltstone and limestone of the Middle to Upper Cambrian Conasauga Group. The Conasauga Group in the Oak Ridge area consists of six formations. They are, in ascending order, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, Nolichucky Shale and the Maynardville Limestone. All of the formations but the Maynardville Limestone underlie WAG 5. Structurally, WAG 5 is located on the upper sheet of the Copper Creek thrust fault which crops out approximately 1,100 feet north of WAG 5. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying

strike and dips. The average strike and dip appear to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

No samples were collected during drilling. A drill water sample was collected from the water pump on the drill rig on 8/19/87. Analytical results for the sample described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a type B well. A fourteen-inch diameter boring was augered from ground surface to bedrock (13.0 feet). A ten-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill an eight-inch diameter boring to a total depth of 80.0 feet. A four-inch diameter stainless steel silt trap was installed from 79.7 to 80.0 feet. Above the silt trap, a four-inch diameter stainless

steel screen was installed from 59.7 feet to 79.7 feet. A four-inch diameter stainless steel casing was installed from the top of the screen at 59.7 feet and extending 1.99 feet above ground surface. A sandpack was then poured into the annular space from 58.0 to 80.0 feet, with a 2.0 foot bentonite seal poured into the annular space above the sandpack from 56.0 to 58.0 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 984 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 540 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 3 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 1/15/90 at a depth of 77.6 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 984 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Ommidata Datapod II data recorder. The hydraulic conductivity value of 8.28×10^{-6} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 984

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	9/18/87	
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	9/18/87	
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	N/A
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	9/18/87	
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	9/18/87	
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	9/18/87	
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	9/18/87	

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE 9/18/87

John W. Anderson

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 984

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE [signature] 8/18/87
John W. Anderson

ERC / EDGE Environmental and Energy Services Co.

WELL No. 984

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG 5

DRILLER: Steve Clark

HELPER: Steve Kirk

DRILL: Driltech

DATE: START: 8/18/87

FINISH: 8/19/87

LOGGED BY: John W. Anderson

HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger and Air Rotary

LUBRICANT TYPE: Molykote 1000

No. SAMPLES TAKEN: None

TYPE: N/A

CONTAINMENT TYPE: Auger Pan, Plastic and Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 13.0'

DEPTH DRILLED IN ROCK: 67.0'

TOTAL DEPTH OF WELL: 80.0'

DRILLING FLUID SAMPLES:

TYPE: Water DATE: 8/19/87

0984W01

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	8.0			Silty clay with shale fragments, orange brown and light green, crumbly, dry.
8.0	13.0			Shale, highly weathered, light greenish brown, dry.
13.0	13.5			Limestone, light gray, hard.*
13.5	16.1			Siltstone, light brown, soft.
16.1	18.7			Limestone, light gray, wet.
18.7	20.0			Very soft.
20.0	51.0			Medium hard to hard.
51.0	72.0			Very soft.
72.0	80.0			Medium hard.
	80.0			Total Depth
				*No detailed lithologic description available for the interval from 13.0' to 80.0' total depth due to the use of a containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 984

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: John W. Anderson

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A. L. Clark Drilling Services

DRILLER: Steve Clark HELPER: Steve Kirk

DRILLING METHOD:
- [x] 14.0 INCH AUGER 13.0 L.F.
- [ ] ____ INCH AUGER ____ L.F.
- [x] 8 INCH ROTARY 67.0 L.F.
- [ ] ____ INCH ROTARY ____ L.F.

LOCATION WAG 5

ORNL GRID COORDINATES
N 18,819.933
E 29,411.994

ELEV. GROUND 788.77

ELEV. TOP STAINLESS STEEL CASING 790.76

DRILLING DATES:
STARTED: 8/18/87
FINISHED: 8/19/87

MATERIALS USED

EST. VOL.	USED VOL.	
	N/A	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	13.0	FT. OF 10 IN. SURFACE CASING
3.4	5.0	SACKS OF CEMENT (SURFACE CASING)
	N/A	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	30.0	GALLONS OF WATER (SURFACE CASING)
	82.0	FT. OF 4 IN. DIA. STAINLESS STEEL CASING
	20.0	FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
6.0	6.0	SACKS OF SAND
50.0	50.0	POUNDS OF BENTONITE PELLETS
12.0	12.0	SACKS OF CEMENT (WELL CASING)
	N/A	POUNDS OF POWERED BENTONITE (WELL CASING)
	72.0	GALLONS OF WATER (WELL CASING)
	2.86	FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Spillage.

SURFACE CASING TREMIE GROUTED YES [x] NO [ ]

STAINLESS STEEL CASING TREMIE GROUTED YES [x] NO [ ]

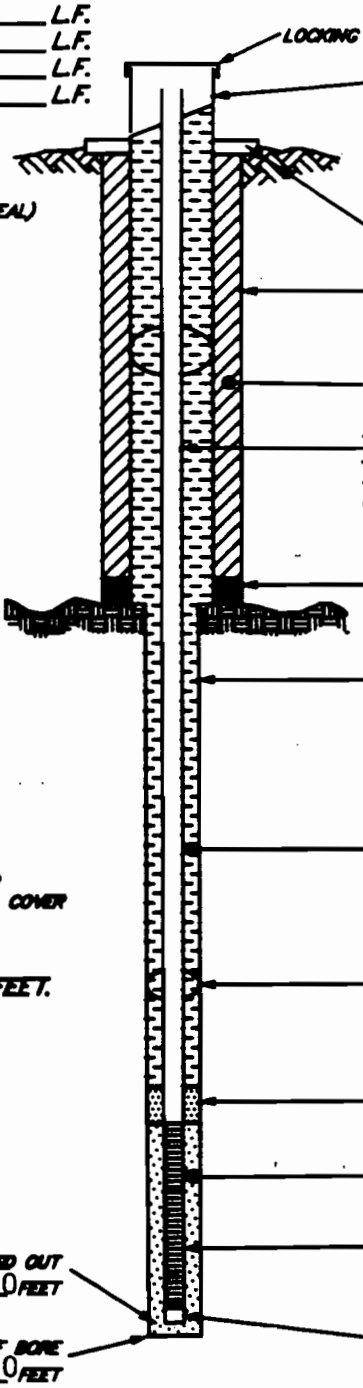
WELL COVER USED
- [x] LOCKING STEEL COVER
- [ ] FLUSH MOUNTED WELL COVER
- [ ] OTHER

SILT TRAP USED YES [x] NO [ ]

MONITORING WELL PUMP BASE SET AT 77.6 FEET.

CENTRALIZERS AT 12.0 FEET.
35.0 FEET.
59.0 FEET.
79.0 FEET

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



TYPE B WELL

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 984

DATE: 8/20/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		8/19/87	02
BENTONITE		8/19/87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	8/19/87	05
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	8/19/87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	8/19/87	05
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	8/19/87	04
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	1/12/90	03
GROUT		8/20/87	09
WELL COVERS			
SURFACE CASING		8/18/87	01

COMMENTS:

OBSERVER SIGNATURE/DATE: John W. Anderson 8/20/87

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 984

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	8/19/87	
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	8/19/87	
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	1/12/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	8/19/87	

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE _____ 8/19/87
John W. Anderson

D. Charles Lytle 1/12/90
D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL No. 984

LOCATION: WAG 5

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 12-19-89 TIME:

DEVELOPMENT ENDING DATE: 1-12-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 63.4 GALLONS

TOTAL GALLONS PUMPED: 540 TOTAL WELL VOLUMES PUMPED: 8.5

INITIAL pH: 10.7 FINAL pH: 7.0

INITIAL CONDUCTIVITY (uS): 712 FINAL CONDUCTIVITY (uS): 897

DESCRIPTION OF INITIAL TURBIDITY: Milky

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 5.9' water level from surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE: D. Charles Lytle 1-12-90

D. Charles Lytle

ERC / EDGE Environmental and Energy Services Co.

WELL NO. 984
LOCATION: WAG 5
DATE: 12-16-89

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 63.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
12-19-89	10:45	30	Milky	--	10.7	712	30		
12-20-89	11:15	8	Cloudy	--	6.8		38		
12-21-89	11:00	38	Slightly Cloudy	--	6.6	88	76		
12-21-89	2:00	14	Cloudy	--	6.7	84	90		
12-27-89	10:00	8	Cloudy	--	7.1	31	98		
12-28-89	12:00	24	Cloudy	--	6.9	62	122		
12-29-89	2:00	17	Cloudy	--	7.2	109	139	1.6	
1-02-90	1700	104		--			243		
1-03-90	1500	69	Cloudy	--	7.0	939	312	4.9	
1-04-90/ 1-05-90	1100	103	Cloudy	--			415	6.5	
1-08-90	1130	61	Cloudy	--	6.9	738	476		
1-10-90	1500	34	Cloudy	--	7.0	876	510	8.0	
1-12-90	1400	10	Clear	3.0	7.0	897	540	8.5	
RESULTS AT END OF DEVELOPMENT			Clear	3.0	7.0	897	540	8.5	

COMMENTS Water cleared on 1-11-90 even after surging. Waited until 1-12-90, took another sample. Clear even after surging. Passed and moved on.

OBSERVER SIGNATURE/DATE D. Charles Lytle 1-12-90
D. Charles Lytle

MWFORM08.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 984 DATE OF TEST: 2/7/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG 5

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 73.25 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .97 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

1.6254
1.6251

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	2.630	1.660
20.00	2.630	1.660
30.00	2.600	1.630
40.00	2.600	1.630
50.00	2.590	1.620
60.00	2.590	1.620
75.00	2.590	1.620
90.00	2.580	1.610
105.00	2.590	1.620
120.00	2.590	1.620
150.00	2.580	1.610
180.00	2.550	1.580
240.00	2.540	1.570
300.00	2.540	1.570
360.00	2.550	1.580
420.00	2.510	1.540
480.00	2.480	1.510
540.00	2.480	1.510
600.00	2.470	1.500
720.00	2.460	1.490
840.00	2.450	1.480
960.00	2.440	1.470
1080.00	2.420	1.450
1200.00	2.400	1.430
1320.00	2.390	1.420
1440.00	2.380	1.410
1560.00	2.340	1.370
1680.00	2.370	1.400
1800.00	2.340	1.370
1920.00	2.320	1.350
2040.00	2.300	1.330
2160.00	2.270	1.300

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

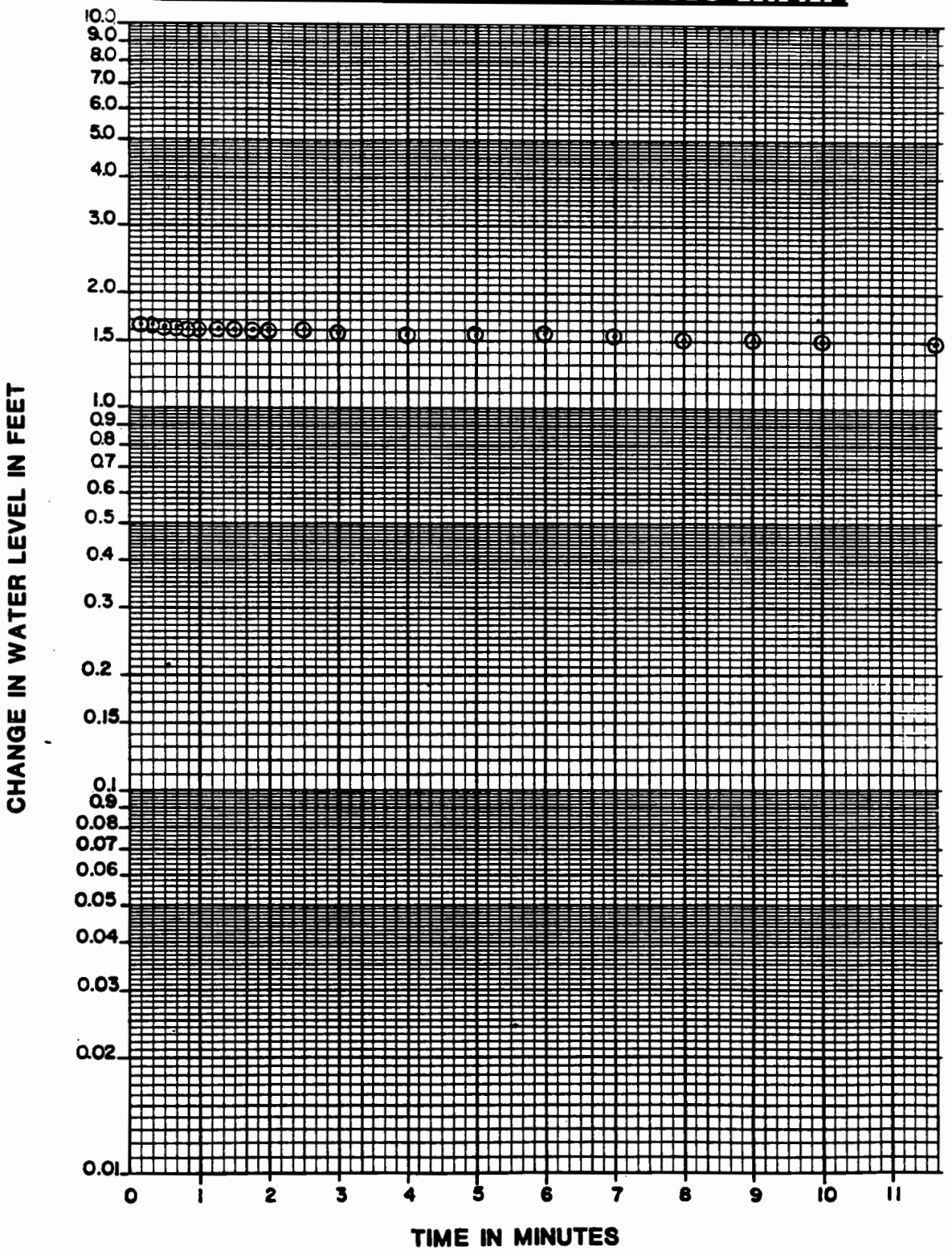
PERMEABILITY = 2.72E-07 FT/SEC = 8.28E-06 CM/SEC

TRANSMISSIVITY = 5.43E-06 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 984

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0984 W01

WELL NO.: 0984

SAMPLER: [signature] (SIGNATURE)

LOCATION: Drilling Water

TYPE: Water

DATE: 8/19/87

TIME: 9:45

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	11/25/87	9:30	MCI	[signature]	11/25/87	9:30	MCI
[signature]	11/25/87	2:40 PM	MCI	Nancy Owen	11-25-87	2:40	ORNL

REMARKS:

Appendix B

Operating Instructions for Handling Water and Cuttings from Well Drilling and Development of Groundwater Quality Monitoring Wells

OPERATING INSTRUCTIONS FOR HANDLING CUTTINGS AND WATER FROM FROM WELL DRILLING AND DEVELOPMENT OF THE GROUNDWATER QUALITY MONITORING WELLS

Prepared by
J. A. Greene

PROCEDURE REVIEW AND APPROVAL Form

Environmental and Health Protection Division

Procedure Title: Operating Instructions for Handling Cuttings and Water from Well Drilling and Development of the Groundwater Quality Monitoring Wells

Procedure No. _____ Rev. No. 0 Date _____

Author _____

REVIEW AND APPROVAL At a minimum, procedures are approved by the manager of the implementing unit and the next higher level manager. SOPs must be reviewed by QA staff to assure that QA requirements are met and to verify that applicable standards are specified. Signatures of the approvers MUST appear on the first page of each approved procedure. The required approvers and the QA reviewer must sign below.

Approved by: _____ Date _____
Manager, Implementing Unit

_____ Date _____
Higher Level Manager

Reviewed by: Gene F. Bowles Date 1/16/90
Quality Assurance

In the spaces below indicate additional reviews (R) or approvals (A). All reviewers and approvers must sign and date this form before the procedure can be finally approved. If more than one procedure is being reviewed, attach list.

R/A		Name	Date
R	~~Facility Manager~~ MK Engineering	J.R. Lawson	11/4/89
	Environmental Protection Officer		
R	Safety Officer		
	Office of Operational Safety		
A	Health Physics	J.L. Gray	08-31-89
R	Industrial Hygiene	B.R. Lankford	9/15/89
	Division Director		
	Associate Division Director		
	Section Head		
A	Other Project Manager	J.A. GREENE	11/19/89
A	Other Environmental Compliance	C.E. Nix	10/5/89
R	Other Waste Management	C.B. Scott	11/1/89

Is revision of the SAR/OSR required? _ YES X NO
If yes, by whom: _____

Signature Mark E Baldwin Date 8-30-89
Procedure Review Officer

Next review dates: 2 yrs. _____ _____

Forward a completed copy of this form to the division QA Office, 4500N, MS-6186.

OPERATING INSTRUCTIONS FOR HANDLING CUTTINGS AND WATER FROM FROM WELL DRILLING AND DEVELOPMENT OF THE GROUNDWATER QUALITY MONITORING WELLS

1.0 PURPOSE

The purpose of this document is to cite the steps that are followed to handle water and soil produced during the installation and development of wells.

2.0 SCOPE

This document applies to well drilling and development associated with the Groundwater Quality Monitoring Wells Installation Program at Oak Ridge National Laboratory.

3.0 REFERENCE

Health, Safety, and Environmental Protection Procedures for Excavating Operations, ORNL/M-116/R1, Oak Ridge National Laboratory, March 3, 1988.

4.0 DEFINITIONS

Well Ratings. Ratings assigned during the excavation permit cycle by Radiation Protection (RP) and Industrial Hygiene (IH) to indicate the probability of encountering radioactive and chemical contamination, respectively. These ratings are based on historical information or from previous drilling or excavation activity. The ratings are marked on the excavation permits. (RP ratings on permits may sometimes be called ''HP'' for ''Health Physics.'' The two designations are interchangeable.) Protective measures required for the three categories are stated in Table 1, ''Excavation-classification categories,'' in ORNL/M-116/R1. The categories for soil handling are stated in Appendix B, ''Radiological Soil Handling Criteria,'' in ORNL/M-116/R1.

RP Category 1. A rating assigned by RP which indicates that the probability of encountering radioactive contamination is low and that intermittent monitoring is required by RP.

IH Category 1. A rating assigned by IH which indicates that the probability of encountering chemical contamination (i.e., organics) is low and that monitoring is not required by IH. An IH and/or Environmental Monitoring and Compliance (EM&C) representative will be called in any time chemical or hazardous contamination is suspected.

RP Category 2. A rating assigned by RP which indicates that the probability of encountering radioactive contamination is moderate and that continuous monitoring is required. The RP representative will determine the necessary level of protective clothing to be worn.

IH Category 2. A rating assigned by IH which indicates that the probability of encountering chemical contamination is moderate and that respirators must be on-site and ready for use by the workers when

indicated by the IH or RP representative on-site. Location will be checked periodically with an IH field instrument, such as a Photovac or Organic Vapor Organizer (OVA).

RP Category 3. A rating assigned by RP which indicates that there is a high probability of encountering radioactive contamination. Therefore, continuous monitoring by an RP representative is required, and protective clothing must be worn. In addition to the training listed above, workers must have successfully completed the Category 3 Driller Training course that is administered by Environmental and Health Protection Division (E&HP) personnel.

IH Category 3. A rating assigned by IH which requires the workers to wear respirators as a minimum. Additional protection deemed appropriate by IH will be designated for each location. Continuous monitoring by IH personnel is required.

Training Requirements. Training requirements for workers include the Basic Radiation Training administered by E&HP personnel and the 40 h of training required by the Superfund Amendment Reauthorization Act (SARA) through a company-approved course. There is an additional training course required for Category 3 drilling.

Air rotary containment box. A box specially designed to contain the cuttings and water that are blown from the borehole during air rotary drilling. The box is equipped with a high-efficiency particulate air (HEPA) filter to prevent particles that possibly contain contaminants from being dispersed into the air. Air rotary drilling is generally used only for drilling into bedrock.

Auger pan. A metal catch pan with a hole cut in the middle. The pan surrounds the borehole and contains soil cuttings as they are augered up.

Proper On-Site Disposal. Disposal of noncontaminated soil and water produced from work on a well at a location near the well that is not openly visible to the public and has no risk of causing erosion or direct discharge into a stream. The construction engineer (CE) will indicate to the drillers which areas are acceptable for on-site disposal. The pH will have been checked and adjusted to the 5-to-9 range before releasing. This precise definition is intended wherever this term is used in this procedure.

Proper Contaminated Waste Disposal. Generally, radioactively contaminated soil will be packaged in drums and tagged by the RP representative for disposal by ORNL Waste Operations. However, Category-2-level soil may be used on site as backfill in remote areas when covered by 1 ft of noncontaminated soil as stipulated in ORNL/M-116/R1. The CE will specify to the drillers when a well location has been approved by EM&C for on-site disposal of contaminated soil. This definition is intended wherever this term is used in this procedure.

Temporary Drilling Equipment Cleaning Facility. An outdoor area located in Melton Valley for steam cleaning of drill rigs and associated equipment, referred to as the steam cleaning area.

Containment Box Holding Pit. A lined pit at the Temporary Drilling Equipment Cleaning Facility. The contents of the pit will be sampled and tested for gross alpha, gross beta, pH, and tritium*, before being released through a silt fence. Contents that have a potential for containing hazardous materials (i.e., IH Category 2 and 3 locations) will have been checked with an IH field instrument before being released into the pit.)

Steam Cleaning Pits. Two lined pits at the Temporary Drilling Equipment Cleaning Facility that collect runoff from the steam cleaning operations. The contents of the pits will be sampled and tested for gross alpha, gross beta, pH, and tritium*, before being released through a silt fence. Contents that have a potential for containing hazardous materials (i.e., IH Category 2 and 3 locations) will have been checked with an IH field instrument before being released into the pit.)

5.0 RESPONSIBILITIES

5.1 Radiation Protection Personnel monitor and determine the presence of detectable radioactive contamination in drill cuttings during well-drilling activities. They provide guidance to ensure that exposures to the workers, public, and environment are kept as low as reasonably achievable. They also provide radiation monitoring during the precursory cleaning by the drillers.

5.2 Well-Drilling Personnel perform well drilling and completion activities. They package soil and water in appropriate containers and transport it, if necessary; perform precursory cleaning of low-level contaminated equipment; and perform cleaning of equipment between the drilling of each well.

5.3 EDGe Hydrogeologists observe all crucial well installation activities and record data for all boreholes drilled. They do a visual inspection of the cuttings produced during augering and note any unusual occurrences and obvious deleterious material encountered during the drilling process. They check the cuttings and water with a Photovac or OVA or similar instrument and check pH of water when necessary.

5.4 Construction Engineer serves as the field contact and provides guidance to the drillers during field activities.

6.0 PROCEDURE

6.1 EXPLANATION OF THE WELL RATING SYSTEM

Each well is assigned a rating by RP and IH before drilling begins. Because additional information is gained during drilling,

well ratings may be changed by RP and IH as the work progresses. A lower RP Category rating will be changed to a Category 3 rating upon encountering radioactive contamination within the Category 3 range defined in ORNL/M-116/R1. Likewise, an IH Category 3 may result if chemical contamination is detected in a well with a lower rating. The RP and/or IH representative on site will notify the on-site personnel when conditions warrant a rating change. Any additional actions or modifications in protective clothing required by the rating change will be executed at that time. The change will be documented immediately by the on-site hydrogeologist in the well data package and as soon as possible by the RP and/or IH representative by a signed written statement stating the well number, the old and new ratings, and the rationale supporting the change. The statement will be sent by the RP and/or IH representative to the Construction Engineer (CE) for filing with the original excavation permit. A copy will be sent to the RAP Well Installation Manager by the CE.

A well category also may be changed from a higher rating to a lower rating. For example, if no contamination is encountered while drilling a Category 2 or 3 well, it may be changed to a lower rating after drilling to a certain depth or for development purposes, depending on the history of the area. The documentation procedure stated above for an increase in rating must also be followed for a decrease in rating.

6.2 CATEGORY 1 WELLS (RP OR IH)

6.2.1 Category 1 Drilling

6.2.1.1 Category 1 Auger Cuttings

a. Auger cuttings will be collected in a catch pan.

b. An RP representative will scan the cuttings intermittently to check for radioactive contamination. Cuttings will be inspected for any unusual discoloration or odor by the hydrogeologist.

c. If there is no contamination detected, proper on-site disposal or disposal at the steam cleaning area will be done.

6.2.1.2 Category 1 Air Rotary Drilling

a. Cuttings will be collected in a containment box.

b. When the containment box is full, one of the following will be done to empty cuttings and/or decant water from the containment box:

(1) proper on-site disposal.

(2) disposal at the containment box holding pit.

6.2.2 Category 1 Well Development

6.2.2.1 Water removed from the well will be contained in drums.

6.2.2.2 The pH of the water will be measured and will be adjusted to be between 5 and 9 by the CE if it is above or below that range.

6.2.2.3 Drums of water will be discarded by proper on-site disposal or disposal at the steam cleaning area will be done.

6.3 CATEGORY 2 WELLS (RP AND IH)

6.3.1 Category 2 Drilling

6.3.1.1 Category 2 Auger Cuttings

a. Auger cuttings will be collected in a catch pan.

b. An RP representative will scan the cuttings continuously to check for radioactive contamination. Cuttings will be inspected for any unusual discoloration or odor and tested with a Photovac or OVA by the hydrogeologist for presence of RCRA materials.

c. If there is no contamination detected, proper on-site disposal or disposal at the steam cleaning area will be done.

d. Cuttings will be contained in drums if contamination is detected. Proper disposal will be arranged by Martin Marietta Energy Systems through Waste Operations.

6.3.1.2 Category 2 Air Rotary Drilling

a. Rock cuttings and drill water will be collected in a containment box.

b. When the containment box becomes full, the RP representative will perform a wet towel smear to detect the presence of radioactive contamination. An inspection for unusual discoloration or odor and tests with an OVA will be conducted for the presence of RCRA materials by the ~~hydro~~geologist.

c. If no contamination is detected, one of the following will be done to empty cuttings and/or decant water from the containment box:

(1) proper on-site disposal.

(2) disposal at the containment box holding pit.

d. If contamination is detected by the tests, arrangements will be made by Martin Marietta Energy Systems through Waste Operations to properly dispose of the water. Further laboratory testing of the box contents may be done.

6.3.2 Category 2 Development

6.3.2.1 Water removed from the well will be contained in drums.

6.3.2.2 When the drums are ready to be emptied, the RP representative will perform a wet towel smear to detect the presence of radioactive contamination. An inspection for unusual discoloration or odor and tests with an OVA will be conducted for presence of RCRA materials by the hydrogeologist. The pH will be adjusted if necessary.

6.3.2.3 If no contamination is detected, the water will be discarded by proper on-site disposal or disposal at the steam cleaning area will be done.

6.3.2.4 If contamination is detected by the tests, arrangements will be made by Martin Marietta Energy Systems to properly dispose of the water. Further laboratory testing may be done.

6.4 CATEGORY 3 WELLS (RP AND IH)

6.4.1 Category 3 Drilling

6.4.1.1 Category 3 Augering

a. When a well is classified as an RP Category 3 or an IH Category 3, continuous monitoring will be required by RP and IH. Wearing of respirators will be required. Cuttings will be inspected for any unusual discoloration or odor. Tests for chemical contamination (i.e., organics) will be performed with IH field instruments by an IH representative for IH Category 3 wells. Specially trained personnel will be required to do the drilling.

b. If no contamination is detected by RP or IH while augering through soil to bedrock, a rating may be changed by RP or IH to a Category 2 depending on the depth, the type of contamination expected, and the history of the area.

c. If contamination is detected during augering, cuttings will be drummed. Proper disposal of all cuttings and water will be arranged by Martin Marietta Energy Systems.

6.4.1.2 Category 3 Air Rotary Drilling

a. Rock cuttings and drill water will be collected in a containment box.

b. When the containment box becomes filled with water and/or cuttings, a sample will be collected by EM&C and will be tested by the Analytical Chemistry Division for gross alpha, gross beta, tritium*, for an RP Category 3. If it is an IH Category 3, the IH representative on-site will determine which (if any) laboratory testing is necessary for chemical contaminants.

c. Proper disposition of the containment box contents will be decided by consensus of E&HP, the IH or RP representative, EM&C, and the CE, based on the results from Analytical Chemistry Division of the above tests.

6.4.2 Category 3 Development

6.4.2.1 Water pumped from Category 3 wells will be contained in drums. Samples will be collected by EM&C and will be tested by Analytical Chemistry Division for gross alpha, gross beta, tritium*, and pH. It will be tested with IH field instruments by IH representatives for the presence of RCRA materials.

6.4.2.2 A decision based on the test results will be made between E&HP and Engineering whether to continue development.

6.5 BOREHOLE CLEANING

When sludge and water have accumulated in the bottoms of boreholes drilled in soil, the boreholes must be cleaned out prior to setting casings. A decision based on the location of the borehole and its rating will be made between the RP and/or IH representatives whether the sludge and water from the borehole must be contained in a drum. Water and sludge from a Category 2 well will be drummed, and a wet towel smear will be done by RP to

determine proper disposal of the drum contents. Laboratory testing of the drum contents for gross alpha, gross beta, tritium*, and pH will be done if recommended by the RP or IH representative. Water and sludge removed from an RP Category 3 well will be drummed, and laboratory testing will be done for gross alpha, gross beta, tritium*, and pH. EM&C will be consulted to determine proper disposal based on the test results. Further laboratory testing to determine actual contaminants will be done if recommended by EM&C.

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*Testing for tritium will be done for wells located in areas where tritium contamination is suspected. This decision will be made between RP and EM&C.

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