Environmental Restoration Division
ORNL Environmental Restoration Program

**Groundwater Quality Monitoring Well Installation for
Waste Area Grouping 4 at Oak Ridge National
Laboratory, Oak Ridge, Tennessee**

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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.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

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EXECUTIVE SUMMARY

This report documents the drilling and installation of 15 groundwater quality monitoring (GQM) wells on the perimeter of Waste Area Grouping (WAG) 4. WAG 4 is comprised of about 27 acres located in Melton Valley approximately 2700 ft southwest of the Oak Ridge National Laboratory main plant. It contains three inactive solid waste management units: (1) the abandoned intermediate level liquid waste transfer line located along the WAG's northwestern boundary, (2) the experimental pilot pit area, and (3) SWSA 4, the largest unit in the WAG. The wells at WAG 4 were drilled and developed between September 1987 and October 1990. These wells were installed to characterize and assess the WAG in accordance with applicable Department of Energy (DOE), 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 4 were drilled with auger or air rotary rigs. Depending on the hydrogeologic conditions present at each proposed well location, one of four 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. 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 4. 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) 4. 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. The first four wells in WAG 4 were drilled by A. L. Clark Drilling Services during the period from September 1987 to November 1987. Eleven additional wells were drilled by Geotek Engineering Co. from September 1989 to April 1990. These 15 wells were developed from May 1990 to October 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 4

WAG 4 consists of about 27 acres located in Melton Valley approximately 2700 ft southwest of the ORNL main plant area [Fig. 1, map pocket (MMES maps #C3D20004A119, Rev. 0 and C3D20004A120, Rev. 0)]. It contains three inactive SWMUs: (1) the abandoned intermediate level liquid waste (ILLW) transfer line located along the WAG's northwestern boundary, (2) the experimental pilot pit area, and (3) SWSA 4, the largest unit in the WAG.

The ILLW transfer lines were used to transport fission waste products from the main plant area to the pits and trenches (WAG 1) for disposal. The lines were constructed of 2-in.-diam cast-iron pipe and were buried about 3 ft deep. The lines were decommissioned over a 2-year period beginning in 1981.

The experimental pilot pit area contains two pits that were to be used in studying means of fixing radioactive waste. Contaminated materials were removed from the site.

SWSA 4 is an elongated, irregular-shaped tract that trends northeast to southwest. It is bounded by White Oak Creek (WOC) to the east, Lagoon Road to the northwest, a reservation access road to the west, and an unnamed tributary to WOC to the southeast. The site was opened to waste disposal in 1951 and received a variety of low-level radioactive solid wastes and some hazardous chemical waste. The waste was disposed of in both auger holes

and trenches excavated in the soil and weathered shale underlying the site. SWSA 4 was closed to radioactive and chemical waste in 1959 but continued to receive uncontaminated construction debris as a surface cap until 1973. Fifteen wells were installed along the perimeter of WAG 4 (Fig. 1, map pocket).

2. INSTALLATION METHODS

Two separate drilling contractors drilled and installed the GQM wells in WAG 4. A.L. Clark drilled 4 wells in 1987, and Geotek drilled 11 wells in 1989 and 1990. The drilling and installation methods used by A.L. Clark varied slightly from those methods used by Geotek.

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 4. These types are described in Sects. 2.1 and 2.2. 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 *Construction Specifications for Monitoring Wells Installation Construction Project*, K-4491G-G1.¹ The proposed well design criteria for the WAG 4 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 Actual completion data for WAG 4 are listed in Table 1.

2.1 A. L. CLARK DRILLING SERVICES DRILLING AND INSTALLATION METHODS

A.L. Clark drilled monitor wells 950 through 953 in 1987. Three types of GQM wells were installed in WAG 4 during this period. The three well types and the procedures that A. L. Clark Drilling Services employed to drill and install each type are discussed in detail in Sects. 2.1.1 through 2.1.3.

2.1.1 Type A Well

The type A well boring is drilled to total depth with 7-in. solid-stem augers. On completion, the boring is bailed with a steel bailer to remove drill cuttings. The well is completed with 2-in. stainless steel screen, casing, and a silt trap. Stainless steel centralizers are positioned at the base and 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 through a tremie pipe to the surface.

2.1.2 Type B Well

The first step in drilling the type B well is to auger a 14-in-diam boring from the surface to approximately 1 ft into solid rock. A 10-in.-diam string of steel casing is installed in the boring, and the annulus is grouted to the surface. The boring is then deepened with an 8-in. tricone air rotary bit to total depth. The well is then completed with 4-in. stainless steel screen and casing. A sandpack, a bentonite seal, and grout are installed in the annular space by the same procedures as 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.

2.1.3 Type D Well

The first step in drilling a type D well is to auger a 12-in. boring from the surface to approximately 1 ft into solid rock. An 8-in.-diam string of steel casing is installed in the boring and grouted to the surface. The boring is then deepened with a six-in. tricone air rotary bit to total depth. The well is then completed with 2-in. stainless steel screen and casing. A sandpack, bentonite seal, and grout are installed in the annular space using the same procedures as in the type A well.

2.2 GEOTEK ENGINEERING DRILLING AND INSTALLATION METHODS

Geotek drilled wells 948, 949, and 954 through 962 during 1989 and 1990. Three types of GQM wells were installed in WAG 4 during this period. The three well types and the procedures Geotek employed to drill and install each type are discussed in Sects. 2.2.1 through 2.2.3.

2.2.1 Type A Well

The type A well boring is drilled to total depth with 7-in.-diam 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 silt trap. Stainless steel centralizers are positioned at the base and top of the screen and every 20 ft along the casing. A sandpack is tremied 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 through a tremie pipe to the surface.

2.2.2 Type B Well

The first step in drilling a type B well is to auger a 22-in.-diam boring from the surface to 10 feet deep or auger refusal. A 15.25-in.-diam steel diverter casing is installed, and the annulus is grouted to the surface. The boring is then deepened with a 14.5-in.-diam tricone air rotary bit to a minimum of 2 ft into bedrock. Next, a 10.75-in.-diam steel surface casing is installed and grouted into place. The air rotary method is used to drill an 8-in.-diam boring to total depth. The boring is completed with 4-in.-diam stainless steel screen and casing. A sandpack, bentonite seal, and grout are installed in the annular space using the same procedures as those for the type A well.

2.2.3 Type D Well

A type D well is a converted type A well. If the 7-in.-diam auger encounters refusal before total depth on a type A well, the boring is reamed with a 22-in.-diam auger to refusal and a 15.25-in.-diam steel diverter is installed. The annulus is then grouted to the surface. The boring is deepened with a 6-in.-diam tricone air rotary bit to total depth, and the well is completed with 2-in.-diam stainless steel screen and casing. Sandpack, bentonite seal, and grout are installed in the annular space using the same procedures as those for the type A well.

Table 1. Actual completion data for WAG 4

Well	Depth clean to (ft) ^a	SST casing diam (in.)	Well type	Screened interval (ft)	Water level (ft) ^b
948	82.37	4	B	62.1–82.1	-13.9
949	33.38	2	D	17.20–33.14	-7.8
950	49.0	2	A	28.7–48.7	-1.2
951	70.3	4	B	49.1–69.9	+1.2
952	30.5	2	A	5.3–30.3	+3.1
953	69.9	4	B	49.6–69.6	+2.7
954	61.9	4	B	41.7–61.7	-2.3
955	22.4	2	D	12.2–22.2	-6.4
956	22.5	2	D	12.3–22.3	-3.8
957	82.2	4	B	52.0–82.0	-1.0
958	27.3	2	D	12.1–27.1	-4.5
959	72.1	4	B	51.9–71.9	-4.5
960	32.5	2	D	17.2–32.2	-8.1
961	80.3	4	B	60.0–80.0	-17.8
962	37.18	2	A	26.6–36.94	-8.5

^aTotal drilled depth may vary from clean-out depth. See data packages (Appendix A)

^bPredevelopment 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 4 was conducted in accordance with procedures outlined in *Health, Safety, and Environmental Protection Procedures for Excavating Operations*, ORNL/M-116/R1³. Among the procedures set forth by this document is a system for rating proposed well locations according to the degree of possibility that contamination will be encountered. Ratings obtained by this system were used to determine 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 fundamentals of radioactivity and other types of contamination as well as the other hazards that could be encountered at ORNL. The workers were 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 included in Appendix B.

4. FIELD SUPPORT

The GQM wells in WAG 4 were installed by the construction contractors A.L. Clark Drilling Services and Geotek Engineering Company during the period from September 1987 to April 1990.

ORNL Engineering administered the drilling contract through Energy Systems Procurement. The management organization chart for the project can be found in the report *Task Management Plan for Groundwater Quality Monitoring Well Installation*, ORNL/RAP/LTR-88/28.⁴

The hydrogeologic support and installation record keeping were supplied through a contract with ERC Environmental and Energy Services Company (ERCE). 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 maps (Fig. 1).

5. DRILLING RECORDS

A complete data package has been compiled for each of the 15 GQM wells drilled in WAG 4. 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.

Three additional forms used in the field by the site hydrogeologist but not included in the published data packages are the monitoring well progress form, the hydraulic conductivity test field sheet, and the containment box checklist. 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 wells. 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 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 15 wells in WAG 4, 14 had turbidities less than or equal to 5 NTUs. The number of well volumes removed ranged from 8.6 to 88.8, with an average of 22.6. The procedure for measuring turbidity described in ORNL/RAP/LTR-88/28⁴ was replaced with a more accurate method. While the previously used method depended on 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 turbidity of the sample.

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 analyses. 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 during air rotary drilling. All samples were transferred using chain-of-custody forms, which are included in the data packages. The sampling procedures are explained in the report 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 ⁴⁰K were routinely performed on the soil and water samples. The results from these analyses are contained in the ER Division Records Control Data Base.

8. SPECIAL NOTES ON INSTALLATION AND DEVELOPMENT

During the drilling of the GQM wells in WAG 4, several events occurred in which contamination was detected.

- A rotten organic odor was detected during the installation of the casing in well 948.
- Radioactivity contamination of 2 mR/h was detected in the auger cuttings at 0.5 in. during the augering of well 954 from 0.0 ft to 13.5 ft. During the grouting of well 954, volatile organic readings of from 20 to 65 ppm were recorded. Volatile organic readings of from 100 to 1000 ppm were recorded in the head space in the barrels containing well development water.
- Readings of 10,000 cpm (radioactivity) were taken in the auger cuttings at 0.5 in. during augering from 0.0 ft to 9.5 ft in well 955. Volatile organic readings over 1000 ppm were taken in the head space in the barrels containing well development water from well 955. A predevelopment water sample showed 8000 Bq/L of tritium.
- Organic volatile readings of from 30 to 45 ppm were recorded in the well bore from 0.0 ft to 13.5 ft in well 956. During the cleaning out of the boring at 22.5 ft, a hole blew out of the ground 20 ft from the well. A strong sewer-gas odor was noticed, and volatile organic readings over 100 ppm were recorded. Volatile organic readings over 100 ppm were taken in the head space in the barrels containing well development water from well 956.
- Volatile organic readings of from 100 to 1000 ppm were detected in the head space in the barrels containing well development water in well 957. A predevelopment water sample indicated 88,000 Bq/L of tritium.
- A predevelopment water sample indicated 99,000 Bq/L tritium in well 958.

REFERENCES

1. Engineering Division, *Construction Specifications for Monitoring Wells Installation Construction Project*, K-4491G-G1 (Rev. 2), Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., August 1988.
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 948 is located in WAG 4. It is located on the west side of WAG 4 approximately 150' south of the intersection of Chemical Waste Area Road and Lagoon Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 18,959.2548, E 27,001.4340 (X-10 grid) or latitude 35°, 54', 48.39" and longitude 84°, 19', 20.92". 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 948 was drilled by Geotek Engineering Company. A Mobile B-50 and an Ingersoll Rand T-4 rig were used to drill this boring for monitor well installation under the operation of Rick Herron and Larry Ledbetter with the assistance of James Shelton and Fred Dixon. Drilling commenced on 9/26/89 and was finished on 10/12/89. 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. This information was typed directly from field notes and was edited only when necessary for clarification.

- 9/26/89: The Mobile B-50 auger rig was decontaminated and mobilized to the site and set up. The boring was split spooned and augered to 19.0' with 8" hollow stem augers. The boring was reamed from 0.0' to 7.0' with 22" augers and a diverter casing set and grouted in.
- 10/4/89: The Ingersoll Rand T-4 was steam cleaned and mobilized to the well location.
- 10/5/89: The boring was deepened from 7.0' to 15.0' with 14" augers and drilled to 21.0' with a tricone air rotary bit. A 20.6' joint of 10 3/4" surface casing was placed in the boring.
- 10/6/89: The surface casing was grouted in.
- 10/11/89: The Ingersoll Rand T-4 was steam cleaned.
- 10/12/89: The rig was mobilized to the well location and setup. An 8" tricone was used to deepen the boring from 21.0' to 83.0'. Boring produced 8' of water at 60' in 10 minutes and 25' water at 83' in 10 minutes. Completed well at 83' with 4" stainless steel screen casing, sand and bentonite. Drillers noticed a rotten organic odor from boring while installing casing. Photovac readings of containment box were 1000+ ppm. Containment box was allowed to aerate then checked and ok'ed by MMES Industrial Hygiene.
- 10/13/89: Annular space in well was grouted.
- 10/17/89: The well was tested with the "Go-No GO" gauge and passed by R.C. Williams.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4.

Strike in and near WAG 4 ranges from N 85° E to N 15° E and dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

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. Soil sample 948S01 was collected in the augered interval from 16.0 feet to 19.0 feet on 9/26/89. A drill water sample was collected from the water pump on the drill rig on 10/12/89. Analytical results for the two 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 4.4 to 4.7 feet. The sample was measured and weighed, and a bulk density of 2.0 grams/cm³ was calculated.

The Ingersoll-Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on October 12, 1989. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter exhibited a dull fluorescence.

2.4 Installation and Development

2.4.1 Installation

This was a Type B well. A 22.0-inch diameter boring was augered from ground surface to 7.0 feet. A 15 1/4-inch diverter casing was installed from surface to 7.0 feet below ground surface and grouted in place. A 14.0-inch diameter boring was augered from 7.0 feet to 15.0 feet (auger refusal). The boring was then extended past the refusal depth with a 14.0-inch air rotary tricone roller bit from 15.0 feet to 21.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 21.0 feet, sealed with a 3.4-foot bentonite pellet layer from 17.6 feet to 21.0 feet, and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. After the surface casing was installed, the air rotary method was used to drill an 8-inch diameter boring to a total depth of 83.0 feet. A 4-inch diameter stainless steel silt trap was installed from 82.10 feet to 82.37 feet. Above the silt trap, a 4-inch diameter stainless steel screen was installed from 62.1 feet to 82.1 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 62.1 feet and extended 2.3 feet above ground surface. A sandpack was then tremied into the annular space from 59.4 to 82.37 feet, with a 2.6-foot bentonite pellet seal poured into the annular space above the sandpack from 56.8 to 59.4 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 948 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 1155 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 4.0 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 June 13, 1990, at a depth of 80.6 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 948 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.14×10^{-5}

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MONITORING WELL PROGRAM
WELL DATA NARRATIVE
WELL No. 948

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.

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS

DATE _____

INITIALS

1. EXCAVATION PERMIT OBTAINED

9 / 26 / 89

$$C_4H_8$$

2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.

9 / 26 / 89

CAH

3a. SCREEN AND CASING 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

С.А.Н.

36. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.

10/12/89

ME

4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.

9 / 26 / 89

CAH

5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.

9/26/89

САН

6. POLYETHYLENE COVER IN PLACE OVER HOLE.

9 / 26 / 89

CAH

7. AIR ROTARY COMPRESSED AIR SAMPLED.

RESULTS:

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE

Allison Hodges

9 / 26 / 89

Michael L. Ebers

PAGE 8 OF 23

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WELL No. 948

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 C. Allison Hodges 9/26/89
C. Allison Hodges

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and Energy
Services Co.

WELL No. 948

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG4

DRILLER: Rick Herron/Larry Ledbetter

HELPER: James Shelton/Fred Dixon

DRILL: Mobile B-50/Ingersoll Rand T-4

DATE: START: 9-26-89

FINISH: 10-12-89

LOGGED BY: C. Allison Hodges
Michael L. Ebers

HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Split spoon, augering, Air Rotary **LUBRICANT TYPE:** Green stuff

No. SAMPLES TAKEN: One (948S01) **TYPE:** Soil

CONTAINMENT TYPE: Auger pan, plastic, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 19.0

DEPTH DRILLED IN ROCK: 64.0

TOTAL DEPTH OF WELL: 83.0

DRILLING FLUID SAMPLES:

TYPE: Drill Water **DATE:** 10/12/89
(948W01)

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	2.5			Gravel fill material (RAD)
2.5	2.8		90%	Gravel, roots, fill material (RAD), clay, mottled, dark yellowish orange, light brown, silty, micaceous, slightly damp, firm (Fill material)
3.2	4.5		80%	Clay, shaley, mottled (in layers), dark yellowish orange, light brown with pale olive and grayish green lenses that are silty, whole sample micaceous; scattered brittle shale fragments, dusky brown, moist. Bulk density @ 4.4' to 4.7' = 2.0 grams/cm ³
4.5	5.5		40%	Shale, clayey, thinly laminated, light olive brown, dusky yellow, silty; with hard shale fragments (layers), dusky brown, crumbly, dry but will hold form
5.5	6.75		100%	Shale, clayey, thinly laminated, light olive brown and dusky yellow, very silty, damp
6.75	7.5			Augered, shale, clayey, light olive brown, damp
7.5	8.2		50%	Shale, slightly clayey, breaks at 45°, light olive gray, with pale greenish to yellowish

WELL No. 948

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 11 OF 23

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WELL No. 948

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: C. Allison Hodges
PROOFED BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Rick Herron
Larry Ledbetter
HELPER: James Shelton, Fred Dixon

DRILLING METHOD: ☒ 22.0 INCH AUGER 7.0 L.F.
☒ 14.0 INCH AUGER 8.0 L.F.
☒ 14.0 INCH ROTARY 6.0 L.F.
☒ 8.0 INCH ROTARY 62.0 L.F.

MATERIALS USED

EST. VOL. USED VOL.
50.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
20.6 FT. OF 3/4 IN. SURFACE CASING
5.3 6.0 SACKS OF CEMENT (SURFACE CASING)
30.0 POUNDS OF POWERED BENTONITE (SURFACE CASING)
36.0 GALLONS OF WATER (SURFACE CASING)
64.4 FT. OF 4 IN. DIA. STAINLESS STEEL CASING
20.0 FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
5.7 5.3 SACKS OF SAND
52.0 50.0 POUNDS OF BENTONITE PELLETS
11.2 16.0 SACKS OF CEMENT (WELL CASING)
80 POUNDS OF POWERED BENTONITE (WELL CASING)
96 GALLONS OF WATER (WELL CASING)
3.1 FT. OF 3/4 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Irregular 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 80.6 FEET.

CENTRALIZERS AT 21.0 FEET.
41.0 FEET.
61.0 FEET.
81.0 FEET

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

LOCATION WAG4

ORNL GRID COORDINATES
N 18,959.2548

E 27,001.4340

ELEV. GROUND 828.69

ELEV. TOP STAINLESS

STEEL CASING 830.71

DRILLING DATES:

STARTED: 9/26/89

FINISHED: 10/12/89

TYPE B WELL

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WELL No. 948

DATE: 10/12/89

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL	DATE USED	BATCH NUMBER
SAND	10/12/89	1
BENTONITE	10/6/89	1
	10/12/89	1
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	10/12/89	MMES Stores
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	10/12/89	MMES Stores
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	10/12/89	MMES Stores
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	10/12/89	MMES Stores
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	6/13/90	6
GROUT	10/6/89	1
	10/13/89	2
WELL COVERS	10/12/89	MMES Stores
SURFACE CASING	10/6/89	1

COMMENTS:

OBSERVER SIGNATURE/DATE

Michael L. Ebers

10/12/89

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WELL No. 948

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

COMPLIANCE
DATE INITIALS

1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>10/12/89</u>	<u>MLE</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>10/12/89</u>	<u>MLE</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>6/13/90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>10/13/89</u>	<u>MLE</u>

* 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 10/13/89

Michael L. Ebers

6/13/90
C. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 948
Upper
LOCATION: WAG4

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 5-24-90

TIME: _____

DEVELOPMENT
ENDING DATE: 6/13/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 60.5 GALLONS

TOTAL GALLONS PUMPED: 1155 TOTAL WELL VOLUMES PUMPED: 19.1

INITIAL pH: 7.5 FINAL pH: 8.2

INITIAL CONDUCTIVITY ($\mu S/cm$): 635 FINAL CONDUCTIVITY ($\mu S/cm$): 679

DESCRIPTION OF INITIAL TURBIDITY: Slightly cloudy

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: 13.9 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle 6/13/90
D. Charles Lytle

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WELL NO. 948
LOCATION: Upper WAG4
DATE: 5/24/90

MONITORING WELL DEVELOPMENT PROGRESS

Page 1 of 2

ONE WELL VOLUME = 60.5 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (μ S/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
5/24/90	1300	78	Cloudy	---	7.5	635	78	1.3	
5/24/90	1430	40	Cloudy	---	7.7	640	118	2.0	
5/25/90	1000	37	Cloudy	---	7.6	567	155	2.6	
5/25/90	1400	35	Cloudy	---	8.0	620	190	3.1	
5/29/90	0900	38	Cloudy	---	8.1	643	228	3.7	
5/29/90	1100	6	Cloudy	---	7.9	636	234	3.8	
5/30/90	1030	101	Cloudy	---	7.9	647	335	5.5	
5/30/90	1300	48	Cloudy	---	7.9	671	383	6.3	
5/31/90	1430	147	Cloudy	---	8.6	723	530	9.0	
6/4/90	1100	71	Cloudy	---	7.8	636	601	10.0	
6/4/90	1300	23	Slightly Cloudy	---	8.0	638	624	10.3	
6/5/90	1100	60	Slightly Cloudy	---	8.2	662	684	11.3	
6/5/90	1430	42	Slightly Cloudy	---	8.1	694	726	12.0	
6/6/90	1000	43	Slightly Cloudy	---	7.9	715	769	12.7	
6/6/90	1300	27	Slightly Cloudy	---	8.0	694	696	13.2	
6/7/90	1430	59	Slightly Cloudy	---	8.0	630	855	14.1	
6/8/90	1100	51	Clear	8.0	7.9	695	906	15.0	
RESULTS AT END OF DEVELOPMENT									

COMMENTS

OBSERVER SIGNATURE/DATE

ERCE
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and Energy
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WELL NO. 948
LOCATION: Upper WAG4
DATE: 5/24/90

MONITORING WELL DEVELOPMENT PROGRESS

Page 2 of 2

ONE WELL VOLUME = 60.5 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (μ S/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
6/8/90	1405	14	Slightly Cloudy	---	8.0	692	920	15.2	
6/11/90	1100	55	Slightly Cloudy	---	8.1	701	975	16.1	
6/11/90	1410	58	Slightly Cloudy	---	8.0	674	1033	17.1	
6/12/90	1105	40	Clear	9.0	8.0	690	1073	17.7	
6/12/90	1500	25	Clear	6.0	7.8	720	1098	18.1	
6/13/90	0930	40	Clear	6.0	8.5	677	1138	18.9	
6/13/90	1100	17	Clear	4.0	8.2	679	1155	19.1	
RESULTS AT END OF DEVELOPMENT			Clear	4.0	8.2	679	1155	19.1	

COMMENTS

COMMENTS A good producer. This well took a long time to clear up made plenty of water but pumped slow. Passed with 4.0 NTU's and moved to another hole

OBSERVER SIGNATURE/DATE

D. Charles Lytle 6/13/90
D. Charles Lytle

M\FORM-05.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.: 948

DATE OF TEST: 10-30-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

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 = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 64.90 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 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

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

2.6837
2.6854

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.740	2.740
20.00	3.730	2.730
30.00	3.690	2.690
40.00	3.690	2.690
50.00	3.670	2.670
60.00	3.670	2.670
75.00	3.660	2.660
90.00	3.640	2.640
105.00	3.640	2.640
120.00	3.640	2.640
150.00	3.620	2.620
180.00	3.600	2.600
240.00	3.600	2.600
300.00	3.580	2.580
360.00	3.540	2.540
420.00	3.530	2.530
480.00	3.500	2.500
540.00	3.500	2.500
600.00	3.430	2.430
720.00	3.400	2.400
840.00	3.360	2.360
960.00	3.320	2.320
1080.00	3.290	2.290
1200.00	3.260	2.260
1320.00	3.210	2.210
1440.00	3.200	2.200
1560.00	3.170	2.170
1680.00	3.130	2.130
1800.00	3.100	2.100
1920.00	3.080	2.080
2040.00	3.040	2.040
2160.00	3.020	2.020

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $3.75\text{E-}07$ FT/SEC = $1.14\text{E-}05$ CM/SEC

TRANSMISSIVITY = $7.50\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $4.33\text{E-}07$ FT/SEC = $1.32\text{E-}05$ CM/SEC

TRANSMISSIVITY = $8.66\text{E-}06$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

Engineering, Design & Geosciences Group, Inc.
726 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

948501

WELL NO.

48

LOCATION:

WAG-4

TYPE:

Soil/Rock

SAMPLER:

[Signature]

(SIGNATURE)

SAMPLE INTERVAL:

14.0 - 19.0

DATE:

9-26-89

TIME:

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

[Signature]

10-3-89

EDGE

[Signature]

10-3-89 1530

TYPE OF SAMPLE: ☐ SPLIT SPOON CORES-SOIL

☐ AUGER CUTTINGS-SOIL

☐ AUGER CUTTINGS-ROCK

☐ AIR ROTARY CUTTINGS-ROCK

☐ DRILL WATER (NO AIR IN SAMPLE)

☒ OTHER Soil/Rock

Auger

ALL SAMPLES ARE IMMEDIATELY PLACED IN I-CHEM SPECIALTY CLEANED CONTAINERS AND SEALED.

REMARKS:

Engineering, Design & Geosciences Group, Inc.
726 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

948W01

WELL NO.

948

LOCATION:

WAG 4

TYPE:

DRILL WATER

SAMPLER:

[Signature]
(SIGNATURE)

SAMPLE INTERVAL:

N/A

DATE:

10/12/89

TIME:

1130

RELINQUISHED BY:
(SIGNATURE)

DATE:

10/16/89

TIME:

1045

WITH:

EDGE

RECEIVED BY:
(SIGNATURE)

DATE:

10/16/89

TIME:

1025

WITH:

ORNL

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: WATER SAMPLE TAKEN FROM PUMP AT SIDE OF RIG

1.0 General Information

1.1 Well Location

Monitoring well number 949 is located in WAG 4. It is located on the west side of WAG 4 approximately 150 feet south of the intersection of Chemical Waste Area Road and Lagoon Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 18,977.1629, E 27,004.2363 (X-10 grid) or latitude 35°-54'-48.55" and longitude 84°-19'-21.01". 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 949 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4 and a Mobile B-50 auger rig were used to drill this boring for monitor well installation under operation of Rick Herron and Larry Ledbetter with the assistance of James Shelton and Fred Dixon. Drilling commenced on September 28, 1989, and was finished on October 13, 1989. 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. This information was typed directly from field notes and was edited only when necessary for clarification.

- 9-26-89 The auger rig, augers and tools were decontaminated.
- 9-28-89 Drilling equipment was loaded and moved to the well site along with the auger rig. The rig was set up and a 14.0 inch boring was augered to 6.5 feet. A 10.0 inch diverter casing was installed.
- 10-13-89 The air rotary rig and tools were decontaminated, mobilized to the site and set up. The diverter head and containment box were rigged up and an 8.0-inch tricone was used to drill from 6.5 feet to a total depth of 33.5 feet. After 20 minutes, the water level increased by 1.5 feet. Based on the water level in Well 948 (17.0 feet below land surface) the well was set as per M. McLaughlin. A 15.94 foot section of 2.0-inch screen and 19.50 foot section of 2.0-inch casing was installed and grouted.
- 10-16-89 The well was tested with the "Go - No Go" gauge. The gauge became lodged at 20.0 feet. The well was retested by using a submersible pump. The pump reached the total depth and was passed by R. C. Williams.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist C. Allison Hodges and 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and

dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

2.3 Sample Collection

A drill water sample was collected from the water pump on the drill rig on October 13, 1989. Analytical results for Sample 949W01 can be obtained from the Remedial Action Program data base at ORNL.

The Ingersoll Rand T-4 compressed air was not sampled.

2.4 Installation and Development

2.4.1 Installation

This was a Type D well. A 14.0-inch diameter boring was augered from ground surface to 6.5 feet and a 10.0-inch diameter diverter casing was installed from 0.0 feet to 6.5 feet and grouted. The air rotary method was required to complete the boring to the specified total well depth. An 8-inch diameter boring was drilled with an air rotary tricone roller bit from 6.5 to 33.4 feet. A 2-inch diameter stainless steel silt trap was installed from 33.14 feet to 33.38 feet. A 2-inch diameter stainless steel screen was installed above the silt trap from 33.14 feet to 17.20 feet. Above the screen a 2-inch diameter stainless steel casing was installed from 17.20 feet to 2.3 feet above ground surface. A sandpack was then tremied into the

annular space from 14.50 to 33.38 feet, with a 2.3-foot bentonite pellet seal poured into the annular space above the sandpack from 12.20 to 14.50 feet. The annular space from the top of the bentonite seal to the surface was tremie-grouted with a cement/bentonite slurry. A detail of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 949 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 350 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 3.0 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 May 30, 1990, at a depth of 31.5 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 949 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.34×10^{-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
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WELL No. 949

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>9-28-89</u>	<u>CAH</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>10-13-89</u>	<u>NLE</u>
3a. SCREEN AND CASING HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	<u>N/A</u>	<u>N/A</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>10-13-89</u>	<u>NLE</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>10-13-89</u>	<u>NLE</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>9-28-89</u>	<u>CAH</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>9-26-89</u>	<u>CAH</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u> </u>	<u> </u>

RESULTS: _____

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

C. Allison Hodges 9-26-89
Michael L. Ebers 10/13/89

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and Energy
Services Co.

WELL No. 949

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE C. Allison Hodges 9-26-89

C. Allison Hodges

WELL No. 949

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG4

DRILLER: Rick Herron/Larry Ledbetter

HELPER: James Shelton/Fred Dixon

DRILL: Mobile B-50/Ingersoll Rand T-4

DATE: START: 9/28/89

FINISH: 10/13/89

LOGGED BY: C. Allison Hodges
Michael L. Ebers

HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Augering, air rotary

LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: None

TYPE: N/A

CONTAINMENT TYPE: Auger pan, plastic and containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 21.5'

DEPTH DRILLED IN ROCK: 11.9' .

TOTAL DEPTH OF WELL: 33.4'

DRILLING FLUID SAMPLES:

TYPE: Drill Water DATE: 10/13/89

(949WO1)

* No detailed lithologic logs could be provided from 6.5' to 33.4' due to the use of a containment box

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WELL No. 949

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED C. Allison Hodges PROOFED
BY: Michael L. Ebers BY: C. Allison Hodges

DRILLING COMPANY: Geotek

DRILLER: Rick Herron/
Larry Ledbetter HELPER: James Shelton/Fred Dixon

EQUIPMENT ☒ 14.0 INCH AUGER 6.5 L.F.
☒ 8.0 INCH AUGER 26.9 L.F.
☐ INCH ROTARY L.F.

MATERIALS USED

EST. USED
VOL. VOL.

15.94 FEET OF 2.0 IN. S.S. SCREEN
19.3 FEET OF 2.0 IN. S.S. CASING
4.5 6.0 SACKS OF SAND
58.0 58.0 POUNDS OF BENTONITE PELLETS
2.0 3.0 SACKS OF CEMENT
15.0 POUNDS OF POWDERED BENTONITE
18.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED
VOLUMES AND USED VOLUMES

Irregular boring diameter

WELL COVER USED

☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED

YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 31.5 FEET.

CENTRALIZERS AT 10.0 FEET.

31.0 FEET.

 FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT
TO 33.38 FEET

BOTTOM OF BOREHOLE
33.4 FEET

LOCATION WAG4

ORNL GRID COORDINATES

N 18,977.1629

E 27,004.2363

ELEV. GROUND 827.40

ELEV. TOP STAINLESS

STEEL CASING 829.44

DRILLING DATES:

STARTED: 9-28-89

FINISHED: 10-13-89

TYPE D WELL

NOT TO SCALE

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WELL No. 949

DATE: 10-13-89

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	10/13/89	1
BENTONITE	10/13/89	MMES Stores
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	10/13/89	MMES Stores
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	10/13/89	MMES Stores
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	10/13/89	MMES Stores
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	10/13/89	MMES Stores
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	5/30/90	8
GROUT	10/13/89	1
WELL COVERS	10/89	1
SURFACE CASING	10/89	1

COMMENTS:

OBSERVER SIGNATURE/DATE

Michael D. Ebers
Michael D. Ebers

10/13/89

ERC / EDGE
Environmental
and Energy
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WELL No. 949

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

COMPLIANCE
DATE INITIALS

1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>10/13/89</u>	<u>NLE</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>10/13/89</u>	<u>NLE</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>5/30/90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>10/13/89</u>	<u>NLE</u>

* 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

10/13/89

D. Charles Lytle

5/30/90

ERCE
Environmental
and Energy
Services Co.

WELL No. 949

LOCATION: WAG4

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 5/24/90

TIME: _____

DEVELOPMENT
ENDING DATE: 5/30/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 11.6 GALLONS

TOTAL GALLONS PUMPED: 350 TOTAL WELL VOLUMES PUMPED: 30.2

INITIAL pH: 7.9 FINAL pH: 8.2

INITIAL CONDUCTIVITY ($\mu S/cm$): 687 FINAL CONDUCTIVITY ($\mu S/cm$): 692

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 3.0 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: 7.8 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/30/90

D. Charles Lytle

WATERDEVELOP

WELL NO. 949

LOCATION: WAG4

DATE: 5/24/90

ONE WELL VOLUME = 11.6 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
5/24/90	1300	34	Cloudy	---	7.9	687	34	3.0	
5/24/90	1430	59	Cloudy	---	8.4	671	93	8.0	
5/25/90	1000	28	Slightly Cloudy	----	8.1	638	121	10.4	
5/25/90	1400	69	Slightly Cloudy	---	7.9	689	190	16.4	
5/29/90	0900	63	Slightly Cloudy	---	7.8	673	253	22.0	
5/29/90	1100	14	Slightly Cloudy	---	8.0	685	267	23.0	
5/30/90	1030	83	Clear	3.0	8.2	692	350	30.2	
RESULTS AT END OF DEVELOPMENT			Clear	3.0	8.2	692	350	30.2	

COMMENTS

Good producer. Water remained clean even after surging. Passed with
TU's and 30.2 well volumes.

OBSERVER SIGNATURE/DATE

D. Charles Lytle 5/30/90

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.: 949

DATE OF TEST: 11-1-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.94 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 20.60 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.94 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

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

4.2962
4.3153

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	5.620	4.620
20.00	5.560	4.560
30.00	5.470	4.470
40.00	5.430	4.430
50.00	5.360	4.360
60.00	5.310	4.310
75.00	5.230	4.230
90.00	5.170	4.170
105.00	5.110	4.110
120.00	5.020	4.020
150.00	4.900	3.900
180.00	4.790	3.790
240.00	4.580	3.580
300.00	4.420	3.420
360.00	4.290	3.290
420.00	4.130	3.130
480.00	4.010	3.010
540.00	3.890	2.890
600.00	3.750	2.750
720.00	3.530	2.530
840.00	3.340	2.340
960.00	3.190	2.190
1080.00	3.030	2.030
1200.00	2.900	1.900
1320.00	2.760	1.760
1440.00	2.670	1.670
1560.00	2.570	1.570
1680.00	2.470	1.470
1800.00	2.390	1.390
1920.00	2.310	1.310
2040.00	2.260	1.260
2160.00	2.190	1.190

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $4.41\text{E-}07$ FT/SEC = $1.34\text{E-}05$ CM/SEC

TRANSMISSIVITY = $7.03\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $6.06\text{E-}07$ FT/SEC = $1.85\text{E-}05$ CM/SEC

TRANSMISSIVITY = $9.66\text{E-}06$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

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 949w601
WELL NO. 949	LOCATION: WAG 4	TYPE: DRILL WATER		
SAMPLER: <i>Michael J. Shaw</i>	SAMPLE INTERVAL: N/A	DATE: 10/13/89	TIME: 1300	
RELINQUISHED BY: (SIGNATURE) <i>Michael J. Shaw</i>	DATE: 10/16/89	TIME: 1045	WITH: EDGE	RECEIVED BY: (SIGNATURE) <i>JCP Allen</i>
	DATE: 10/16/89	TIME: 1045	WITH: ORNL	
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: <u>WATER SAMPLE TAKEN FROM PUMP AT SIDE OF RIG</u>

1.0 General Information

1.1 Well Location

Monitoring well number 950 is located in WAG 4. It is located north of WAG 4 approximately 130 feet north of Lagoon Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 19,594.6062, E 28,013.5128 (X-10 grid) or latitude 35°-54'-59.18" and longitude 84°-19'-14.99". 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 950 was drilled by A.L. Clark Drilling Services. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of Rick Pickel with the assistance of Leo Johnson. Drilling commenced on September 22, 1987, and was finished on September 23, 1987. 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. This information was typed directly from field notes and was edited only when necessary for clarification.

9-22-87 The drill rig and tools were steam cleaned. The rig was mobilized to the staked location and set up. Split spoon samples were taken from 0.0 to 1.4 feet. The boring was augered from the surface to 49.5 feet, and bailed.

9-23-90 Bailed hole and set well with 2-inch stainless steel screen, casing, sand pack and bentonite.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

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 0950S01 was collected in the split spoon interval from 1.0 to 1.2 feet on September 22, 1987 and soil sample 0950S01 was collected in the augered interval at 45 feet on September 22, 1987.

2.4 Installation and Development

2.4.1 Installation

This was a Type A well. A 6-inch diameter boring was split spooned and augered from ground surface to a total depth of 49.5 feet. A 2-inch diameter stainless steel screen with welded bottom cap was installed from 28.7 feet to 49.0 feet. A 2-inch diameter stainless steel casing was installed above the screen from 28.7 feet to 2.28 feet above ground surface. A sandpack was then poured into the annular space from 24.0 to 49.0 feet, with a 2.0-foot bentonite pellet seal poured into the annular space above the sandpack from 22.0 to 24.0 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 950 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 405 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 5/23/90 at a depth of 47.1 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 950 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 2.32×10^{-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.

WELL No. 950

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

COMPLIANCE

DATE _____

INITIALS

1. EXCAVATION PERMIT OBTAINED

9/22/87

MLE

2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.

9/22/87

ALL

3a. SCREEN AND CASING 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, CASING AND CENTRALIZERS WERE USED.

9/23/87

MILE

4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.

9/22/87

MLE

5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.

9/22/87

MLE

6. POLYETHYLENE COVER IN PLACE OVER HOLE.

9/22/87

MLE

7. AIR ROTARY COMPRESSED AIR SAMPLED.

RESULTS:

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE

Michael L. Ebers

9/23/87

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 950

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 L. Ebers

9/22/87

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 950

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: SWSA 4
DRILLER: Rick Pickel
HELPER: Leo Johnson
DRILL: Schramm

DATE: START: 9/22/87
FINISH: 9/23/87
LOGGED BY: Michael L. Ebers
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Split spoon and 7" auger LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: Two TYPE: Soil
CONTAINMENT TYPE: Auger pan and plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 49.5'
DEPTH DRILLED IN ROCK: ---
TOTAL DEPTH OF WELL: 49.5'

DRILLING FLUID SAMPLES:

TYPE: None DATE:

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	0.7		100%	Clay, moderate brown, slightly silty with weathered shale fragments locally mottled reddish brown and yellowish brown, fairly loose and slightly damp
0.7	1.4	0950S01 @ 1.0'-1.2'	100%	Shale, weathered, moderate brown with light greenish gray and yellowish brown silty streaks crumbly, dry
	1.4			Split spoon refusal
1.4	15.0			Shale, weathered, reddish brown, interbedded with shaly siltstone, yellowish brown and greenish gray
15.0	29.0			Shale, weathered, reddish brown, locally silty
29.0	49.5	0950S02 @ 45'		Shale as above with silty streaks
				36-40' damp - medium soft
				40-46' moist - very soft
				46-48.8' wet - very soft
	49.5			Total Depth

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WELL No 950

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED

BY: Michael L. Ebers

PROOFED

BY: James Caruthers

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: Richard Pickel

HELPER: Leo Johnson

EQUIPMENT

☒ 6 INCH AUGER 49.5 L.F.

☐ _____ INCH AUGER _____ L.F.

MATERIALS USED

EST. USED
VOL. VOL.

20.0 FEET OF 2 IN. S.S. SCREEN

31.0 FEET OF 2 IN. S.S. CASING

4.5 5.5 SACKS OF SAND

28.0 35.0 POUNDS OF BENTONITE PELLETS

2.9 7.0 SACKS OF CEMENT

14.0 POUNDS OF POWDERED BENTONITE

42.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED
VOLUMES AND USED VOLUMES

Irregular boring diameter

WELL COVER USED

☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED

YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 47.1 FEET.

CENTRALIZERS AT 7.0 FEET.

27.0 FEET.

47.0 FEET.

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

HOLE CLEANED OUT
TO 49.0 FEET

BOTTOM OF BOREHOLE
49.5 FEET

LOCATION WAG4

ORNL GRID COORDINATES

N 19,594.6062

E 28,013.5128

ELEV. GROUND 836.99

ELEV. TOP STAINLESS

STEEL CASING 839.27

DRILLING DATES:

STARTED: 9/22/87

FINISHED: 9/23/87

LOCKING STEEL COVER

8 INCH DIAMETER

STEEL PROTECTIVE CASING

3.48 FT. ABOVE GROUND

TO 2.0 FT. BELOW

GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO

22.0 FEET

6 INCH DIAMETER

BOREHOLE

2 INCH DIAMETER STAINLESS

STEEL CASING 2.28 FT. ABOVE

GROUND SURFACE TO 28.7 FT.

BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL

22.0 TO 24.0 FEET

SAND PACK

24.0 TO 49.0 FEET

2 INCH DIAMETER

STAINLESS STEEL 0.010

SLOTTED SCREEN

28.7 TO 48.7 FEET

2 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP

48.7 TO 49.0 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 950

DATE: 9/22/87

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL	DATE USED	BATCH NUMBER
SAND	9/23/87	2
BENTONITE	9/23/87	2
	9/24/87	3
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	9/23/87	5
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	9/23/87	5
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	9/23/87	5
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	9/23/87	5
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	5/23/90	6
GROUT	9/24/87	11
WELL COVERS		
SURFACE CASING	9/87	2

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 9/24/87

Michael L. Ebers

ERC / EDGE
Environmental
and Energy
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WELL No. 950

POST-WELL COMPLETION
CHECKLIST

	COMPLIANCE	
	DATE	INITIALS
<u>POST-WELL COMPLETION TASKS</u>		
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>9/23/87</u>	<u>MLE</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>9/23/87</u>	<u>MLE</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>5/23/90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>9/23/87</u>	<u>MLE</u>

- * 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 9/23/87
Michael L. Ebers

D. Charles Lytle 5/23/90
D. Charles Lytle

ERCE
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and Energy
Services Co.

WELL No. 950

LOCATION: WAG4

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 5/17/90 TIME: _____

DEVELOPMENT
ENDING DATE: 5/23/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 16.8 GALLONS

TOTAL GALLONS PUMPED: 405 TOTAL WELL VOLUMES PUMPED: 24.1

INITIAL pH: 7.3 FINAL pH: 7.4

INITIAL CONDUCTIVITY ($\mu S/cm$): 390 FINAL CONDUCTIVITY ($\mu S/cm$): 211

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

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: 1.2 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle 5/23/90
D. Charles Lytle

ONE WELL VOLUME = 16.8 GALLONS

COMMENTS Good producer. Water remained clean after surging. Passed with 2.0 NTU's and moved to another hole.

PAGE 13 OF 19

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WELL No. 950

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.: 950

DATE OF TEST: 9-25-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 38.30 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 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

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

3.3989
3.4678

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	6.240	5.240
20.00	6.010	5.010
30.00	5.750	4.750
40.00	5.550	4.550
50.00	5.350	4.350
60.00	5.160	4.160
75.00	4.930	3.930
90.00	4.700	3.700
105.00	4.480	3.480
120.00	4.290	3.290
150.00	3.990	2.990
180.00	3.740	2.740
240.00	3.310	2.310
300.00	3.000	2.000
360.00	2.760	1.760
420.00	2.580	1.580
480.00	2.390	1.390
540.00	2.260	1.260
600.00	2.130	1.130
720.00	1.950	.950
840.00	1.810	.810
960.00	1.710	.710
1080.00	1.650	.650
1200.00	1.790	.790
1320.00	1.730	.730
1440.00	1.690	.690
1560.00	1.610	.610
1680.00	1.630	.630
1800.00	1.560	.560
1920.00	1.540	.540
2040.00	1.500	.500
2160.00	1.490	.490

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 950

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $7.62\text{E-}07$ FT/SEC = $2.32\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.52\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $9.52\text{E-}07$ FT/SEC = $2.90\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.90\text{E-}05$ FT**2/SEC

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:

0950 Soil

WELL NO.:

0950

LOCATION:

SWSA 4

TYPE:

Soil

SAMPLER:

Churchard J. Shum
(SIGNATURE)

@ 1.0' TO 1.2'

DATE:

9/22/87

TIME:

10:45AM

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECIEVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Churchard J. Shum

10/20/87

9:45AM

MCI

Nancy Owen

10/20/87

9:45

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:

0950 So2

WELL NO.:

0950

LOCATION:

SWSA 4

TYPE:

Soil

SAMPLER:

[Signature]
(SIGNATURE)

@ ~ 45'

DATE:

9/22/87

TIME:

1.45 PM

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECIEVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

[Signature]

10/20/87

9.45AM

MCI

Nancy Owen

10/20/87

9:45

ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 951 is located in WAG 4. It is located north of WAG 4 approximately 130 feet north of Lagoon Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 19,594.2885, E 28,028.6975 (X-10 grid) or latitude 35°-54'-59.26" and longitude 84°-19'-14.83". 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 951 was drilled by A.L. Clark Drilling Services. A Gus Pech rig was used to drill this boring for monitor well installation under the operation of A.L. Clark III. Drilling commenced on 11/23/87, and was finished on 12/1/87. 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. This information was typed directly from field notes and was edited only when necessary for clarification.

11/23/87: The drill rig and tools were steam cleaned and mobilized to the staked location and set up. The boring was augered from surface to 20.6 feet with 14 inch augers. Ten inch surface casing was installed from the surface to 20.6 feet and grouted in place.

11/30/87: The boring was advanced from 20.6 feet to 70.3 feet with an 8 5/8 inch tricone air rotary and the boring cleaned out. Four inch stainless steel casing, screen, sand and bentonite were set.

12/1/87: The annular space was grouted to the surface.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

2.3 Sample Collection

No samples were collected during drilling.

2.4 Installation and Development

2.4.1 Installation

This was a Type B well. A 14-inch diameter boring was augered from surface to 20.6 feet (auger refusal). A 10-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 20.6 feet, sealed with a 1.6 foot bentonite pellet layer from 19.0 feet to 20.6 feet, and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. After the surface casing was

installed, the air rotary method was used to drill an 8-inch diameter boring to a total depth of 70.3 feet. A 4-inch diameter stainless steel screen with bottom cap was installed from 70.3 feet to 49.1 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 49.1 feet and extended 2.17 feet above ground surface. A sandpack was then poured into the annular space from 70.3 up to 47.5 feet, with a 2.2-foot bentonite pellet seal poured into the annular space above the sandpack from 45.3 to 47.5 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 951 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 700 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 4.0 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 5/30/90 at a depth of 60.4 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 951 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 7.64×10^{-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. 951

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE
DATE **INITIALS**

1.	EXCAVATION PERMIT OBTAINED.	<u>11/23/87</u>	<u>BDH</u>
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>11/23/87</u>	<u>BDH</u>
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.	<u>N/A</u>	<u>N/A</u>
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	<u>11/30/87</u>	<u>BDH</u>
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>11/23/87</u>	<u>BDH</u>
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	<u>11/23/87</u>	<u>BDH</u>
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>11/23/87</u>	<u>BDH</u>

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Bryn D. Howze
Bryn D. Howze

11/23/87

Bryn D. Howze

11/23/87

OBSERVER SIGNATURE/DATE *Bryn D. Howze*

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

DECONTAMINATION CHECKLIST DRILLING EQUIPMENT

ERC / EDGE
Environmental
and Energy
Services Co.

1221-1000

WELL No. 951

WELL No. 951

PAGE 1 OF 1

DATE: START: 11/23/87
FINISH: 12/11/87
LOGGED BY: Bryn D. Howze
HEALTH PHYSICIST: Paul Eldridge

CONTAINMENT TYPE: Auger pan, plastic and containment box

TOTAL DEPTH OF WELL: 70.3'

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ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 951

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: Avery L. Clark III HELPER: Leo Johnson

DRILLING METHOD: ☒ 14 INCH AUGER 20.6 L.F.
☐ INCH AUGER L.F.
☒ 8 5/8 INCH ROTARY 49.7 L.F.
☐ INCH ROTARY L.F.

MATERIALS USED

EST. VOL.	USED VOL.	
<u>50.0</u>	<u>50.0</u>	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
<u>20.6</u>	<u>20.6</u>	FT. OF <u>10</u> IN. SURFACE CASING
<u>6</u>	<u>8</u>	SACKS OF CEMENT (SURFACE CASING)
<u>48</u>	<u>48</u>	POUNDS OF POWERED BENTONITE (SURFACE CASING)
<u>16</u>	<u>16</u>	GALLONS OF WATER (SURFACE CASING)
<u>53.0</u>	<u>53.0</u>	FT. OF <u>4</u> IN. DIA. STAINLESS STEEL CASING
<u>20.8</u>	<u>20.8</u>	FT. OF <u>4</u> IN. DIA. STAINLESS STEEL SCREEN
<u>7.5</u>	<u>7.5</u>	SACKS OF SAND
<u>50</u>	<u>50</u>	POUNDS OF BENTONITE PELLETS
<u>13</u>	<u>18</u>	SACKS OF CEMENT (WELL CASING)
<u>34</u>	<u>34</u>	POUNDS OF POWERED BENTONITE (WELL CASING)
<u>108</u>	<u>108</u>	GALLONS OF WATER (WELL CASING)
<u>3.31</u>	<u>3.31</u>	FT. OF <u>10</u> IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Catties, spillage and irregular auger boring diameter

SURFACE CASING TREME GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREME 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 60.4 FEET.

CENTRALIZERS AT 4.0 FEET.

30.0 FEET.

50.0 FEET.

70.0 FEET

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

TYPE B WELL

LOCATION SWSA4
ORNL GRID COORDINATES
N 19,594.2885
E 28,028.6975
ELEV. GROUND 836.00
ELEV. TOP STAINLESS
STEEL CASING 838.17
DRILLING DATES:
STARTED 11/23/87
FINISHED 12/1/87

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 951

DATE: 12/1/87

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	11/23/87	3
	11/30/87	3
BENTONITE	11/23/87	3
	11/30/87	3
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	11/30/87	5
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	11/30/87	5
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	11/30/87	5
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	11/30/87	5
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	5/30/90	6
GROUT	11/23/87	15
	12/1/87	15
WELL COVERS		
SURFACE CASING	11/23/87	2

COMMENTS:

OBSERVER SIGNATURE/DATE Bryn D. Howze 11/30/87
Bryn D. Howze

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WELL No. 951

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>12/1/87</u>	<u>BDH</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>12/1/87</u>	<u>BDH</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>5/30/90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>12/1/87</u>	<u>BDH</u>

* 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

12/1/87

Bryn D. Howze

D. Charles Lytle

5/30/90

D. Charles Lytle

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WELL No. 951

LOCATION: WAG4

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 5/17/90

TIME: _____

DEVELOPMENT
ENDING DATE: 5/30/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 62.5 GALLONS

TOTAL GALLONS PUMPED: 700 TOTAL WELL VOLUMES PUMPED: 11.2

INITIAL pH: 7.0 FINAL pH: 7.9

INITIAL CONDUCTIVITY ($\mu S/cm$): 252 FINAL CONDUCTIVITY ($\mu S/cm$): 417

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 4.0 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR
OF WATER: None

WATER	☒ GROUND SURFACE	☐ TANK TRUCK
DISCHARGED	☐ STORM SEWERS	☐ STORAGE TANKS
TO:	☐ DRUMS	☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: +1.2 feet above ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle / 30/90
D. Charles Lytle

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WELL NO. 951

LOCATION: WAG4

DATE: 5/17/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 62.5 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
5/17/90	1100	169	Cloudy	---	7.0	252	169	2.7	
5/17/90	1400	12	Cloudy	---	7.5	449	181	3.0	
5/18/90	0900	34	Cloudy	---	7.8	356	215	3.4	
5/18/90	1330	31	Cloudy	---	7.7	478	246	4.0	
5/18/90	1430	16	Cloudy	---	7.5	413	262	4.2	
5/21/90	1430	30	Slightly Cloudy	---	7.6	421	292	4.7	
5/23/90	1000	127	Slightly Cloudy	---	7.5	344	419	6.7	
5/24/90	1300	46	Slightly Cloudy	---	7.9	433	465	7.4	
5/24/90	1430	27	Slightly Cloudy	---	8.0	438	492	8.0	
5/25/90	1000	34	Slightly Cloudy	---	8.3	401	526	8.4	
5/29/90	0900	49	Slightly Cloudy	---	7.9	395	575	9.2	
5/29/90	1100	38	Slightly Cloudy	---	7.9	417	613	9.8	
5/30/90	1030	57	Slightly Cloudy	---	8.0	440	670	10.7	
5/30/90	1300	30	Clear	4.0	7.9	417	700	11.2	
RESULTS AT END OF DEVELOPMENT			Clear	4.0	7.9	417	700	11.2	

COMMENTS Good producer. Water remained clear even after surging.

Passed with 4.0 NTU's and moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/30/90
D. Charles Lytle

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WELL No. 951

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.: 951

DATE OF TEST: 9-25-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

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 = 20.80 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 60.50 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.80 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

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

SUCCESSIVE COMPUTED
VALUES FOR H₀
(FEET)

2.9792
2.9804

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.000	3.000
20.00	4.010	3.010
30.00	3.990	2.990
40.00	4.000	3.000
50.00	3.990	2.990
60.00	3.980	2.980
75.00	3.980	2.980
90.00	3.960	2.960
105.00	3.950	2.950
120.00	3.950	2.950
150.00	3.940	2.940
180.00	3.930	2.930
240.00	3.890	2.890
300.00	3.890	2.890
360.00	3.880	2.880
420.00	3.850	2.850
480.00	3.830	2.830
540.00	3.810	2.810
600.00	3.780	2.780
720.00	3.740	2.740
840.00	3.700	2.700
960.00	3.660	2.660
1080.00	3.630	2.630
1200.00	3.610	2.610
1320.00	3.580	2.580
1440.00	3.590	2.590
1560.00	3.550	2.550
1680.00	3.540	2.540
1800.00	3.510	2.510
1920.00	3.490	2.490
2040.00	3.490	2.490
2160.00	3.430	2.430

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WELL No. 951

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $2.51\text{E-}07$ FT/SEC = $7.64\text{E-}06$ CM/SEC

TRANSMISSIVITY = $5.21\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $2.95\text{E-}07$ FT/SEC = $8.98\text{E-}06$ CM/SEC

TRANSMISSIVITY = $6.13\text{E-}06$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 952 is located in WAG 4. It is located north of WAG 4 approximately 75 feet north of Lagoon Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 19,597.7866, E 28,670.7630 (X-10 grid) or latitude 35°-55'-02.82" and longitude 84°-19'-08.37". 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 952 was drilled by A.L. Clark Drilling Services. A Gus Pech 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 9/23/87, and was finished on 9/24/87. 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. This information was typed directly from field notes and was edited only when necessary for clarification.

9/23/87: The Gus Peck drill rig and tools were steam cleaned and the rig was mobilized to the staked location and set up. The boring was split spooned from the surface to 1.4 feet. The boring was augered from the surface to 30.5 feet with 6 1/4 inch augers. Two inch stainless steel screen, casing, sandpack and bentonite seal were installed.

9/24/87: The annulus was grouted from 1.5 feet up to the surface.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

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 0952S1 was collected in the split spoon interval from 0.0 to 0.3 feet on 9/23/87 and rock sample 0952R1 was collected at 30 feet.

2.4 Installation and Development

2.4.1 Installation

This was a Type A well. A 6-inch diameter boring was split spooned and augered from ground surface to a total depth of

30.5 feet. A 2-inch diameter stainless steel screen with bottom cap was installed from 5.3 feet to 30.5 feet. A 2-inch diameter stainless steel casing was installed above the screen from 5.3 feet to 2.88 feet above ground surface. A sandpack was then poured into the annular space from 30.5 to 3.5 feet, with a 2.0 foot bentonite pellet seal poured into the annular space above the sandpack from 1.5 to 3.5 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 952 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 523 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 5/23/90 at a depth of 28.8 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 952 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.47×10^{-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.

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WELL No. 952

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

DATE **INITIALS**

1.	EXCAVATION PERMIT OBTAINED.	<u>9/23/87</u>	<u>BDH</u>
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>9/23/87</u>	<u>BDH</u>
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.	<u>N/A</u>	<u>N/A</u>
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	<u>9/24/87</u>	<u>BDH</u>
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>9/23/87</u>	<u>BDH</u>
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	<u>9/23/87</u>	<u>BDH</u>
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	<u> </u>	<u>BDH</u>

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE Bryn D. Howze 9/24/87
Bryn D. Howze

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and Energy
Services Co.

WELL No. 952

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Bryn D. Howze
Bryn D. Howze

9/23/87

WELL No. 952

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: SWSA 4

DATE: START: 9/23/87

DRILLER: Butch Clark

FINISH: 9/24/87

HELPER: Ray Clark

LOGGED BY: Bryn Howze

DRILL: Gus Pech

HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger LUBRICANT TYPE: Molykote 1000

LUBRICANT TYPE: Molykote 1000

No. SAMPLES TAKEN: Two TYPE: 1 Soil, 1 Rock (Saturated)

TYPE: 1 Soil, 1 Rock (Saturated)

CONTAINMENT TYPE: Auger pan, plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 1.4'

DRILLING FLUID SAMPLES:

DEPTH DRILLED IN ROCK: 29.1'

TYPE: N/A DATE: _____

TOTAL DEPTH OF WELL: 30.5'

[illegible]

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WELL No. 952

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED

PROOFED

BY: Bryn D. Howze

BY: Michael L. Ebers

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: A.L. Clark III HELPER: Ray Clark

EQUIPMENT ☒ 6 1/4 INCH AUGER 30.5 L.F.

☐ INCH AUGER L.F.

MATERIALS USED

EST. USED
VOL. VOL.

25.0 FEET OF 2 IN. S.S. SCREEN

8.2 FEET OF 2 IN. S.S. CASING

5.1 5.8 SACKS OF SAND

40 40 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 28.8 FEET.

CENTRALIZERS AT 5.0 FEET.

10.0 FEET.

30.5 FEET.

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

HOLE CLEANED OUT
TO 30.5 FEET

BOTTOM OF BOREHOLE
30.5 FEET

LOCATION: WAG4
ORNL GRID COORDINATES
N 19,597.7866
E 28,670.7630
ELEV. GROUND 817.55
ELEV. TOP STAINLESS
STEEL CASING 820.43
DRILLING DATES:
STARTED: 9/23/87
FINISHED: 9/24/87

LOCKING STEEL COVER
10 INCH DIAMETER
STEEL PROTECTIVE CASING
3.70 FT. ABOVE GROUND
TO 2.0 FT. BELOW
GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO
1.5 FEET

6 1/4 INCH DIAMETER

BOREHOLE

2 INCH DIAMETER STAINLESS

STEEL CASING 2.88 FT. ABOVE

GROUND SURFACE TO 5.3 FT.
BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL
1.5 TO 3.5 FEET

SAND PACK
3.5 TO 30.5 FEET

2 INCH DIAMETER
STAINLESS STEEL 0.010

SLOTTED SCREEN
5.3 TO 30.3 FEET

2 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP
30.3 TO 30.5 FEET

TYPE A WELL

NOT TO SCALE

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WELL No. 952

DATE: 9/24/87

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	9/24/87	2
BENTONITE	9/24/87	2
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	9/24/87	5
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	9/24/87	5
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	9/24/87	5
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	9/24/87	5
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	5/23/90	6
GROUT	9/24/87	11
WELL COVERS		
SURFACE CASING	9/87	1

COMMENTS:

OBSERVER SIGNATURE/DATE Bryn D. Howze 9/24/87
Bryn D. Howze

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 952

POST-WELL COMPLETION
CHECKLIST

		COMPLIANCE DATE	INITIALS
<u>POST-WELL COMPLETION TASKS</u>			
1.	MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>9/24/87</u>	<u>BDH</u>
2.	ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>9/24/87</u>	<u>BDH</u>
3.	WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>5/23/90</u>	<u>DCC</u>
4.	DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>9/24/87</u>	<u>BDH</u>

* 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 9/24/87
Bryn D. Howze

D. Charles Lytle 5/23/90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 952
LOCATION: WAG4

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 5/11/90 TIME: _____

DEVELOPMENT
ENDING DATE: 5/23/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 16.1 GALLONS

TOTAL GALLONS PUMPED: 523 TOTAL WELL VOLUMES PUMPED: 32.5

INITIAL pH: 8.1 FINAL pH: 7.6

INITIAL CONDUCTIVITY ($\mu S/cm$): 248 FINAL CONDUCTIVITY ($\mu S/cm$): 228

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 ☐ TANK TRUCK
☐ STORM SEWERS ☐ STORAGE TANKS
☐ DRUMS ☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: +3.1 feet above ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/23/90
D. Charles Lytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL NO. 952
LOCATION: WAG4
DATE: 5/11/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 16.1 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
5/11/90	1300	10	Milky	---	8.1	248	10		
5/15/90	0900	102	Milky	---	7.8	276	112	7.0	
5/15/90	1100	18	Milky	---	7.6	313	130	8.1	
5/16/90	1400	16	Milky	---	7.6	263	146	9.1	
5/17/90	0900	83	Milky	---	7.6	327	229	14.2	
5/17/90	1400	14	Milky	---	7.5	247	243	15.1	
5/18/90	0900	42	Cloudy	---	7.9	218	285	17.1	
5/18/90	1330	46	Slightly Cloudy	---	7.2	316	331	20.5	
5/18/90	1430	18	Slightly Cloudy	---	7.5	235	349	22.0	
5/21/90	1430	72	Slightly Cloudy	---	7.5	260	421	26.1	
5/23/90	1000	102	Clear	2.0	7.6	228	523	32.5	
RESULTS AT END OF DEVELOPMENT			Clear	2.0	7.6	228	523	32.5	

COMMENTS Good producer. Water remained clean after surging. Passed and moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/23/90
D. Charles Lytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 952

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.: 952

DATE OF TEST: 10-09-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 25.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 25.03 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 25.00 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

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

4.5163

4.6162

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	7.660	6.660
20.00	7.250	6.250
30.00	6.940	5.940
40.00	6.690	5.690
50.00	6.460	5.460
60.00	6.260	5.260
75.00	5.990	4.990
90.00	5.740	4.740
105.00	5.530	4.530
120.00	5.340	4.340
150.00	4.890	3.890
180.00	4.640	3.640
240.00	4.240	3.240
300.00	3.760	2.760
360.00	3.560	2.560
420.00	3.360	2.360
480.00	3.210	2.210
540.00	3.090	2.090
600.00	2.930	1.930
720.00	2.640	1.640
840.00	2.530	1.530
960.00	2.390	1.390
1080.00	2.330	1.330
1200.00	2.240	1.240
1320.00	2.160	1.160
1440.00	2.090	1.090
1560.00	2.040	1.040
1680.00	1.950	.950
1800.00	1.910	.910
1920.00	1.890	.890
2040.00	2.000	1.000
2160.00	2.000	1.000

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $4.81\text{E-}07$ FT/SEC = $1.47\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.20\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $6.15\text{E-}07$ FT/SEC = $1.87\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.54\text{E-}05$ FT**2/SEC

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:

0952 51

WELL NO.:

952

LOCATION:

SWSA 4

TYPE:

Soil

SAMPLER:

Bryn Hodge

(SIGNATURE)

0.0' - 0.3'

DATE:

9/23/87

TIME:

10:15 AM

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECIEVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Bryn Hodge

12/14/87

9:17 AM

MCI

Nancy Owen

12-14-87

9:17

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:

0952 R1

WELL NO.:

952

LOCATION:

SW SA 4
at 30.0'

TYPE:

Rock (Saturated)

SAMPLER:

Bryan Hoge

(SIGNATURE)

DATE:

9/23/87

TIME:

4:10 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<i>Bryan Hoge</i>	12/14/87	9:17AM	MCT	<i>Nancy Owen</i>	12-14-87	9:17	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 953 is located in WAG 4. It is located north of WAG 4 approximately 75 feet north of Lagoon Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 19,594.1315, E 28,686.0885 (X-10 grid) or latitude 35°-55'-02.87" and longitude 84°-19'-08.19". 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 953 was drilled by A.L. Clark Drilling Services. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of A.L. Clark II with the assistance of Rick Pickel. Drilling commenced on 11/17/87, and was finished on 11/20/87. 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. This information was typed directly from field notes and was edited only when necessary for clarification.

11/12-87 The Schramm Rotadrill air rotary drill rig and to tools were steam cleaned.

11-13-87:

11/17/87: The rig was mobilized to the staked location and set up on plastic. Augered from surface to 20.5 feet with 14 inch augers.

11/18/87: Steam cleaned 26.9 feet of 10 3/4 inch surface casing. Ran casing in boring and grouted annulus to the surface.

11/19/87: Rigging up to drill with containment.

11/20/87: Advanced boring from 26.5 feet to 70.0 feet with an 8 5/8 inch tricone bit. Cleaned hole and ran in stainless steel screen, casing, sandpack and bentonite seal. Grouted annulus from 41.0 feet to the surface.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

2.3 Sample Collection

A drill water sample was collected from the water pump on the drill rig on 11/20/87. Analytical results for the drill water 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 14-inch diameter boring was augered from the surface to 26.5 feet (auger refusal). A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 26.5 feet, sealed with a 1.5-foot bentonite pellet layer from 25.0 feet to 26.5 feet, and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. After the surface casing was installed, the air rotary method was used to drill an 8-inch diameter boring to a total depth of 70.5 feet. A 4-inch diameter stainless steel screen with bottom cap was installed from 49.6 feet to 69.9 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 49.6 feet and extended 2.3 feet above ground surface. A sandpack was then poured into the annular space from 69.9 feet up to 47.0 feet, with a 6.0-foot bentonite seal from 41.0 to 47.0 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 953 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 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 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 5/16/90 at a depth of 67.2 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 953 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 3.41×10^{-6} cm/second (shown as permeability on the hydraulic

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MONITORING WELL PROGRAM
WELL DATA NARRATIVE
WELL No. 953

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.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE
DATE **INITIALS**

1.	EXCAVATION PERMIT OBTAINED.	<u>11/17/87</u>	<u>MLE</u>
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>11/17/87</u>	<u>MLE</u>
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.	<u>N/A</u>	<u>N/A</u>
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	<u>11/17/87</u>	<u>MLE</u>
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>11/17/87</u>	<u>MLE</u>
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	<u>11/17/87</u>	<u>MLE</u>
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>11/17/87</u>	<u>MLE</u>

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Michael L. Ebers
Michael L. Ebers

11/17/87

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 953

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE Michael L. Ebers 11/17/87

Michael L. Ebers

ORNL MONITORING WELL LOG

PAGE 1 OF 1

DATE: START: 11/17/87

FINISH: 11/20/87

LOGGED BY: Michael L. Ebers

HEALTH PHYSICIST: Paul Eldridge

LUBRICANT TYPE: Molykote 1000

CONTAINMENT TYPE: Auger pan, plastic, containment box

DRILLING FLUID SAMPLES:

TYPE: Drill Water DATE: 11/20/87

(0953W01)

PAGE 9 OF 20

ERC / EDGE
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and Energy
Services Co.

WELL No. 953

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Michael L. Ebers PROOFED BY: James Caruthers

DRILLING COMPANY: A.L. Clark Drilling Services

DRILLER: A.L. Clark III HELPER: Rick Pickel

DRILLING METHOD: ☒ 14 INCH AUGER 26.5 L.F.
☐ INCH AUGER L.F.
☒ 8 INCH ROTARY 44.0 L.F.
☐ INCH ROTARY L.F.

MATERIALS USED

EST. USED VOL. VOL.
50.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
26.9 FT. OF 3/4 IN. SURFACE CASING
8.0 10.0 SACKS OF CEMENT (SURFACE CASING)
20.0 POUNDS OF POWDERED BENTONITE (SURFACE CASING)
60.0 GALLONS OF WATER (SURFACE CASING)
53.0 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
12.0 50.0 POUNDS OF BENTONITE PELLETS
9.1 12.0 SACKS OF CEMENT (WELL CASING)
24.0 POUNDS OF POWDERED BENTONITE (WELL CASING)
72.0 GALLONS OF WATER (WELL CASING)
3.48 FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

*Bentonite pellets partially bridged @ 41'?

SURFACE CASING TREME GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREME 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 67.2 FEET.

CENTRALIZERS AT 9.0 FEET.
29.0 FEET.
49.0 FEET.
69.0 FEET

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

LOCATION WAG4
ORNL GRID COORDINATES
N 19,594.1315
E 28,686.0885
ELEV. GROUND 816.89
ELEV. TOP STAINLESS
STEEL CASING 819.19
DRILLING DATES:
STARTED 11/17/87
FINISHED 11/20/87

TYPE B WELL

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 953

DATE: 11/18/87

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL	DATE USED	BATCH NUMBER
SAND	11/20/87	3
BENTONITE	11/18/87	3
	11/20/87	3
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	11/20/87	5
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	11/20/87	5
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	11/20/87	5
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	11/20/87	5
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	5/16/90	6
GROUT	11/18/87	14
	11/20/87	14
WELL COVERS		
SURFACE CASING	11/18/87	2

COMMENTS:

OBSERVER SIGNATURE/DATE

Michael L. Ebers

11/20/87

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 953

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

COMPLIANCE
DATE INITIALS

1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>11/23/87</u>	<u>MLE</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>11/23/87</u>	<u>MLE</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>5/16/90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>11/23/87</u>	<u>MLE</u>

* 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 11/23/87
Michael L. Ebers

D. Charles Lytle 5/16/90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 953

LOCATION: WAG4

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 5/11/90

TIME: _____

DEVELOPMENT
ENDING DATE: 5/16/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 63.2 GALLONS

TOTAL GALLONS PUMPED: 349 TOTAL WELL VOLUMES PUMPED: 5.5

INITIAL pH: 7.7 FINAL pH: 7.9

INITIAL CONDUCTIVITY ($\mu S/cm$): 576 FINAL CONDUCTIVITY ($\mu S/cm$): 550

DESCRIPTION OF INITIAL TURBIDITY: Slightly Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR
OF WATER: None

WATER	☒ GROUND SURFACE	☐ TANK TRUCK
DISCHARGED	☐ STORM SEWERS	☐ STORAGE TANKS
TO:	☐ DRUMS	☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: +2.7 feet above ground surface

DEVELOPMENT OBSERVATIONS

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

D. Charles Lytle

WELL NO. 953

LOCATION: WAG4

DATE: 5/11/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 63.2 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (µS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
5/11/90	1300	189	Slightly Cloudy	---	7.7	576	189	3.0	
5/15/90	0900	130	Slightly Cloudy	---	7.8	545	319	5.0	
5/15/90	1100	12	Slightly Cloudy	---	7.7	575	331	5.2	
5/16/90	1400	18	Clear	2.0	7.9	550	349	5.5	
RESULTS AT END OF DEVELOPMENT			Clear	2.0	7.9	550	349	5.5	

COMMENTS Good producer. Water remains clean even after surging. Passed with 2.0 NTU's and moved to another hole.

OBSERVER SIGNATURE/DATE

D. Charles Lytle 5/16/90

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.: 953

DATE OF TEST: 10-09-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

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 = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 66.80 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 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

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

2.7399
2.7405

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.750	2.750
20.00	3.730	2.730
30.00	3.750	2.750
40.00	3.730	2.730
50.00	3.730	2.730
60.00	3.750	2.750
75.00	3.750	2.750
90.00	3.730	2.730
105.00	3.720	2.720
120.00	3.730	2.730
150.00	3.730	2.730
180.00	3.720	2.720
240.00	3.720	2.720
300.00	3.710	2.710
360.00	3.710	2.710
420.00	3.690	2.690
480.00	3.690	2.690
540.00	3.690	2.690
600.00	3.650	2.650
720.00	3.630	2.630
840.00	3.610	2.610
960.00	3.630	2.630
1080.00	3.600	2.600
1200.00	3.590	2.590
1320.00	3.610	2.610
1440.00	3.610	2.610
1560.00	3.580	2.580
1680.00	3.540	2.540
1800.00	3.530	2.530
1920.00	3.540	2.540
2040.00	3.540	2.540
2160.00	3.520	2.520

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.12\text{E-}07$ FT/SEC = $3.41\text{E-}06$ CM/SEC

TRANSMISSIVITY = $2.24\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.29\text{E-}07$ FT/SEC = $3.94\text{E-}06$ CM/SEC

TRANSMISSIVITY = $2.58\text{E-}06$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

Engineering, Design & Geosciences Group, Inc.
725 Pellissippi Parkway
P.O. Box 23010 Knoxville, Tn 37933-1010 (615)966-9788

WELL No. 953

AREA: SWSA4

NONCONFORMANCE REPORT

ISSUE DATE: 11/28/87

DATE OF NONCONFORMANCE: 11/20/87

DESCRIPTION OF NONCONFORMANCE:

Annular space above bentonite seal was grout 1 1/2 hours after bentonite seal was installed. Refer to Release Specific Technical Directions for Regulatory Compliance Monitoring Wells, Phase I, O.R.N.L., W.O. K-4147, April, 1987, page 8, last paragraph. This reference states that initial grouting shall be done no sooner than 12 hours after the bentonite seal is installed.

POSSIBLE DETRIMENTAL EFFECTS TO WELL QUALITY:

Minimal. Bentonite seal had, most likely, setup in 1 1/2 hours.

COMMENTS:

OBSERVER OF NONCONFORMANCE:

Michael L. Ebers

DATE:

11/20/87

REPORTED BY:

Michael L. Ebers

DATE:

11/23/87

DISTRIBUTION PROJECT MANAGER:

Jill Mortimore

DATE SUBMITTED:

11/24/87

CONSTRUCTION ENGINEER:

Steve Laman

DATE SUBMITTED:

11/24/87

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:

0953 WOI

WELL NO.:

0953

LOCATION: SWSA 4

DRILL WATER FROM WATER PUMP
ON SIDE OF RIG

TYPE:

DRILL WATER

SAMPLER:

Clifford J. Shus
(SIGNATURE)

DATE:

11/20/87

TIME:

8:30 A.M.

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECIEVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Clifford J. Shus

11/25/87

2:40 PM

MCI

Nancy Owen

11/25/87

2:40 pm

OPNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 954 is located in WAG 4. It is located approximately 650 feet south of the intersection of Melton Valley Drive and Lagoon Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 19,252.0613, E 29,252.9303 (X-10 grid) or latitude 35° -55' -03.18" and longitude 84° -19' -00.15". 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 954 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4 rig was used to drill this boring for monitor well installation under the operation of Larry Ledbetter with the assistance of Fred Dixon, Tom Doonan and Tracy Mitchell. Drilling commenced on 4/10/90, and was finished on 4/17/90. 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. This information was typed directly from field notes and was edited only when necessary for clarification.

- 4/10/90: This location was determined to be Class III. The rig was mobilized to location and set up on 2 sheets of plastic. Split spoon samples were taken from surface to 13.5 feet (RAD = 2MR/hr. OVA <0.05 ppm). The boring was reamed to 10.0 feet using a 22-inch auger (RAD = 2MR/hr. OVA <0.05 ppm). Set 10.0 feet of decontaminated steel diverter casing and grouted it to surface with 9.0 sacks cement.
- 4/11/90: Drill from 10.0 to 29.5 feet using an 8.0 inch air rotary tricone bit into containment box (RAD = Background, OVA = 4 ppm). Looked as though the water in hole had an oily sheen on it. OVA was picking up a reading. Set 26.3 feet of 10.0-inch decontaminated steel surface casing with bentonite pellet seal.
- 4/12/90: Grout surface casing annular with 19.0 sacks cement.
- 4/16/90: Drill from 26.3 to 62.5 feet using an 8.0 inch air rotary tricone bit into containment box (RAD ≤ Background, OVA = <0.05 ppm). Hole was bridged at 30.0 feet and needed to be cleaned out.
- 4/17/90: Clean bridge out and set 4.0 inch stainless steel screen and casing with sandpack and bentonite seal.
- 4/18/90: Tremie grout annulus with 9.0 sacks cement. During grouting, OVA read 30 to 65 ppm.

Therefore, an Industrial Hygienist was called out to location. The grouting was continued with readings of 20 to 30 ppm.

This well was logged by ERC Environmental and Energy Services Co. (ERC) hydrogeologist Timothy A. Lee. 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

2.3 Sample Collection

No samples were collected.

2.4 Installation and Development

2.4.1 Installation

This was a Type B well. A 22.0-inch diameter boring was augered from ground surface to 10.0 feet. A 15 1/4-inch diverter casing was installed from surface to 10.0 feet below ground surface and grouted in place. The boring was then extended past the diverter casing depth with a 14.0-inch air rotary tricone roller bit from 10.0 feet to 26.3 feet. A 10.0-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 26.3 feet, sealed with a 2.0-foot bentonite pellet layer from 24.3 feet, and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. After the surface casing was installed, the air rotary method was used to drill an 8-inch diameter boring to a total depth of 62.5 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 41.7 feet to 61.9 feet. A 4-inch diameter stainless steel casing was

installed from the top of the screen at 41.7 feet and extended 3.3 feet above ground surface. A sandpack was then tremied into the annular space from 61.9 feet up to 39.4 feet, with a 1.7-foot bentonite pellet seal poured into the annular space above the sandpack from 37.7 to 39.4 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 954 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 825 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 4.0 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 9/17/90 at a depth of 60.6 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 954 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.14×10^{-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.

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and Energy
Services Co.

WELL No. 954

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>4/10/90</u>	<u>Tbz</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>4/10/90</u>	<u>Tbz</u>
3a. SCREEN AND CASING HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	<u>N/A</u>	<u>N/A</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>4/17/90</u>	<u>Tbz</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>4/10/90</u>	<u>Tbz</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>4/10/90</u>	<u>Tbz</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>4/10/90</u>	<u>Tbz</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>4/16/90</u>	<u>Tbz</u>

RESULTS: No detectable hydrocarbons under ultraviolet light

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 4/17/90
Timothy A. Lee

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and Energy
Services Co.

WELL No. 954

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

Timothy A. Lee
Timothy A. Lee

4/17/90

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WELL No. 954

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG4
DRILLER: Larry Ledbetter
HELPER: Fred Dixon, Tom Doonan, Tracy Mitchell
DRILL: Ingersoll Rand T-4

DATE: START: 4/10/90
FINISH: 4/17/90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: C.E. Stooksbury

TYPE DRILLING: Split spoon, auger, air rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: None TYPE: N/A
CONTAINMENT TYPE: Plastic, pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 13.5'
DEPTH DRILLED IN ROCK: 49.0'
TOTAL DEPTH OF WELL: 62.5'

DRILLING FLUID SAMPLES:
TYPE: N/A DATE: N/A

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	5.0		Augered	Gravel fill
5.0	6.0		Augered	RAD = 1 MR/hr
6.0	8.0		5%	Clay, mottled dark yellowish brown and grayish brown, slightly silty, moist RAD = .5 MR/hr
8.0	10.0		50%	RAD = 2 MR/hr; clay, mottled dark yellowish orange and pale olive, iron stains, scarlet specs; dripping wet; scattered leaves and vegetation
10.0	12.0		50%	Clay, silty, mottled dark yellowish orange to light olive gray, dripping wet, black specs and reddish brown specs, iron stains. RAD = Background
12.0	13.0		50%	Shale, iron stains, light olive gray, dripping wet
13.0	13.5		50%	Shale, medium bluish gray, crumbly
	13.5			Split spoon refusal
	13.5			Auger refusal
13.5	14.0		Air Rotary	*Shale, softer
14.0	15.5			*Limestone, hard
15.5	16.0			*Shale, softer

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 10 OF 20.

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WELL No. 954

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Timothy A. Lee PROOFED BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter HELPER: Fred Dixon, Tom Doonan, Tracy Mitchell

DRILLING METHOD: ☒ 6 INCH AUGER 13.5 L.F.
☐ 14.0 INCH AUGER 16.0 L.F.
☒ 8.0 INCH ROTARY 33.0 L.F.

MATERIALS USED

EST. VOL. USED
50.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
26.3 FT. OF 10.0 IN. SURFACE CASING
7.2 19.0 SACKS OF CEMENT (SURFACE CASING)
95.0 POUNDS OF POWERED BENTONITE (SURFACE CASING)
152.0 GALLONS OF WATER (SURFACE CASING)
45.0 FT. OF 4.0 IN. DIA. STAINLESS STEEL CASING
20.0 FT. OF 4.0 IN. DIA. STAINLESS STEEL SCREEN
5.6 5.6 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
9.0 9.0 SACKS OF CEMENT (WELL CASING)
45.0 POUNDS OF POWERED BENTONITE (WELL CASING)
72.0 GALLONS OF WATER (WELL CASING)
3.07 FT. OF 10.0 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures, spillage

SURFACE CASING TREME GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREME 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 60.6 FEET.

CENTRALIZERS AT 3.0 FEET.

21.0 FEET.

41.0 FEET.

61.0 FEET

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

TYPE B WELL

LOCATION WAG4
ORNL GRID COORDINATES
N 19,252.0613
E 29,252.9303
ELEV. GROUND 768.70
ELEV. TOP STAINLESS
STEEL CASING 770.57
DRILLING DATES:
STARTED: 4/10/90
FINISHED: 4/17/90

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and Energy
Services Co.

WELL No. 954

DATE: 4/18/90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND				
			4/17/90	2
BENTONITE	Powder		4/18/90	6
	Pellets		4/17/90	1
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	4/17/90	3
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	4/17/90	3
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	4/17/90	3
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	4/17/90	3
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	9/17/90	8
GROUT	surface casing		4/12/90	7
	well casing		4/18/90	7
WELL COVERS				
SURFACE CASING			4/11/90	4

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

4/18/90

ERC / EDGE
Environmental
and Energy
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WELL No. 954

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>4/17/90</u>	<u>T Lee</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>4/17/90</u>	<u>T Lee</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>9/17/90</u>	<u>DCC</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>4/17/90</u>	<u>T Lee</u>

* 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

Timothy A. Lee

4/17/90

D. Charles Lytle

9/17/90

ERCE
Environmental
and Energy
Services Co.

WELL No. 954
LOCATION: WAG4

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Pumping with Geoguard pump

DEVELOPMENT
BEGAN DATE: 8/13/90 TIME: _____

DEVELOPMENT
ENDING DATE: 9/17/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 54.6 GALLONS

TOTAL GALLONS PUMPED: 825 TOTAL WELL VOLUMES PUMPED: 15.1

INITIAL pH: 11.0 FINAL pH: 9.3

INITIAL CONDUCTIVITY ($\mu S/cm$): 935 FINAL CONDUCTIVITY ($\mu S/cm$): 090

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

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 ☐ TANK TRUCK
☐ STORM SEWERS ☐ STORAGE TANKS
☒ DRUMS ☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 2.3 feet from ground surface

DEVELOPMENT OBSERVATIONS

OVA tests read anywhere from 100 to 1000 ppm coming from well and barrels,
breathing zone was fine.

OBSERVER SIGNATURE/DATE D. Charles Lytle /17/90

D. Charles Lytle

ERC / EDGE
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and Energy
Services Co.

WELL NO. 954
Lower
LOCATION: WAG4
DATE: 8/13/90

MONITORING WELL DEVELOPMENT PROGRESS

Page 1 of 2

ONE WELL VOLUME = 54.6 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
8/13/90	1100	22	Cloudy	---	11.0	935	22		
8/13/90	1300	10	Cloudy	---	10.7	964	32		
8/16/90	1300	55	Cloudy	---	11.0	025	87	1.6	
8/17/90	0800	78	Cloudy	---	12.7	369	165	3.0	
8/17/90	1100	55	Cloudy	---	10.0	039	220	4.0	
8/17/90	1430	48	Cloudy	---	9.9	061	268	4.9	
8/20/90	0800	17	Cloudy	---	9.9	062	285	5.2	
8/27/90	1330	53	Cloudy	---	11.9	264	338	6.2	
8/28/90	0830	10	Milky	---	10.7	086	348	6.3	
8/28/90	1430	20	Milky	---	11.1	201	368	6.7	
8/29/90	0900	5	Milky	---	10.3	075	373	6.8	
8/29/90	1100	10	Milky	---	10.4	097	383	7.0	
8/30/90	0800	5	Milky	---	10.2	065	388	7.1	
8/30/90	1400	20	Milky	---	10.0	140	408	7.5	
8/31/90	0800	5	Milky	---	10.4	057	413	7.5	
8/31/90	1430	20	Milky	---	9.9	066	433	7.9	
9/4/90	0900	5	Milky	---	9.9	067	438	8.0	
RESULTS AT END OF DEVELOPMENT									

COMMENTS

OBSERVER SIGNATURE/DATE

D. Charles Sytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL NO. 954
Lower
LOCATION: WAG4
DATE: 8/13/90

MONITORING WELL DEVELOPMENT PROGRESS

Page 2 of 2

ONE WELL VOLUME = 54.6 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
9/4/90	1430	45	Cloudy	----	9.5	162	483	8.8	
9/5/90	0800	5	Muddy	----	10.6	093	488	8.9	
9/5/90	1400	15	Cloudy	----	9.9	055	503	9.2	
9/6/90	0900	5	Cloudy	----	9.9	081	508	9.3	
9/6/90	1430	45	Cloudy	----	9.5	140	553	10.1	
9/12/90	0900	107	Cloudy	----	9.8	056	660	12.1	
9/12/90	1430	30	Cloudy	----	9.7	047	690	12.6	
9/13/90	0800	20	Cloudy	----	9.7	062	710	13.0	
9/13/90	1000	15	Cloudy	----	9.6	089	725	13.3	
9/14/90	1100	75	Cloudy	----	----	----	800	14.7	
9/17/90	1400	25	Clear	4.0	9.3	090	825	15.1	
RESULTS AT END OF DEVELOPMENT			Clear	4.0	9.3	090	825	15.1	

COMMENTS Excellent recharger and producer. Water finally cleared and passed
with 4.0 NTU's.

OBSERVER SIGNATURE/DATE Charles Lytle 9/17/90
D: Charles Lytle

WFO0000000

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.: 954

DATE OF TEST: 10-30-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

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 = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 59.80 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 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

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

4.4044
4.4074

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	5.430	4.430
20.00	5.430	4.430
30.00	5.430	4.430
40.00	5.430	4.430
50.00	5.410	4.410
60.00	5.400	4.400
75.00	5.360	4.360
90.00	5.360	4.360
105.00	5.340	4.340
120.00	5.320	4.320
150.00	5.300	4.300
180.00	5.290	4.290
240.00	5.240	4.240
300.00	5.230	4.230
360.00	5.180	4.180
420.00	5.140	4.140
480.00	5.100	4.100
540.00	5.070	4.070
600.00	5.010	4.010
720.00	4.930	3.930
840.00	4.900	3.900
960.00	4.810	3.810
1080.00	4.750	3.750
1200.00	4.700	3.700
1320.00	4.670	3.670
1440.00	4.590	3.590
1560.00	4.560	3.560
1680.00	4.480	3.480
1800.00	4.430	3.430
1920.00	4.390	3.390
2040.00	4.340	3.340
2160.00	4.310	3.310

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $3.73\text{E-}07$ FT/SEC = $1.14\text{E-}05$ CM/SEC

TRANSMISSIVITY = $7.47\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $4.31\text{E-}07$ FT/SEC = $1.32\text{E-}05$ CM/SEC

TRANSMISSIVITY = $8.63\text{E-}06$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 955 is located in WAG 4. It is located approximately 650 feet southwest from the intersection of Melton Valley Drive and Lagoon Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 19,243.5391, E 29,239.1533 (X-10 grid) or latitude 35°-55'-03.03" and longitude 84°-19'-00.23". 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 955 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4 rig was used to drill this boring for monitor well installation under the operation of Larry Ledbetter with the assistance of Fred Dixon, Tom Doonan and Tracy Mitchell. Drilling commenced on 4/12/90 and was finished on 4/17/90. 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. This

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

- 4/12/90: This location was determined to be Class III. The rig was moved to location and set up as 2 sheets of plastic. Augered from surface to 9.5 feet using a 14.0 inch auger. (RAD = 10,000 cpm, OVA = <0.05 ppm). Set 10.0 feet of 10 inch decontaminated steel diverter casing with 50.0 lbs bentonite pellets and grouted it to surface with 5.0 sacks cement.
- 4/17/90: Drill from 9.5 to 22.5 feet using an 8.0 inch air rotary tricone bit into a containment box (RAD $\leq$ Background, OVA = <0.05 ppm). Set 2 inch stainless steel well screen and casing with sandpack and bentonite seal.
- 4/18/90: Grout annulus with 3.5 sacks cement. (OVA = 1 ppm, RAD $\leq$ Background)

This well was logged by ERC Environmental and Energy Services Co. (ERC) hydrogeologist Timothy A. Lee. 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

2.3 Sample Collection

No samples were collected.

2.4 Installation and Development

2.4.1 Installation

This was a Type D well. The air rotary method was required to complete the boring to the specified total well depth. Therefore, a 14.0-inch diameter boring was augered from ground surface to 9.5 feet and a 10.0-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 9.5 to 22.5 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 12.2 to 22.4 feet. A 2-inch diameter stainless steel casing was installed above the screen at 12.2 feet and extended 2.8 feet above ground surface. A sandpack was then tremied into the annular space from 22.4 feet up to 10.8 feet, with a 1.7-foot bentonite pellet seal poured into the annular space above the sandpack from 9.1 to 10.8 feet. The annular space from the top of the bentonite seal to the surface was tremied-grouted with a cement/bentonite slurry. A detail of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 955 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 220 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 4.0 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 8/16/90 at a depth of 20.8 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 955 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 2.42×10^{-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.

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and Energy
Services Co.

WELL No. 955

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>4/12/90</u>	<u>Tbm</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>4/12/90</u>	<u>Tbm</u>
3a. SCREEN AND CASING HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	<u>N/A</u>	<u>N/A</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>4/17/90</u>	<u>Tbm</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>4/12/90</u>	<u>Tbm</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>4/12/90</u>	<u>Tbm</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>4/17/90</u>	<u>Tbm</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>4/17/90</u>	<u>Tbm</u>

RESULTS: No detectable signs of hydrocarbons under ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee

4/17/90

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and Energy
Services Co.

WELL No. 955

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

Timothy A. Lee
Timothy A. Lee 4/17/90

WELL No. 955

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG4

DRILLER: Larry Ledbetter

HELPER: Fred Dixon, Tom Doonan, Tracy Mitchell

DRILL: Ingersoll Rand T-4

DATE: START: 4/12/90
FINISH: 4/17/90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: C.E. Stooksbury

TYPE DRILLING: Auger, air rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: None TYPE: N/A
CONTAINMENT TYPE: Plastic, pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 13.5'
DEPTH DRILLED IN ROCK: 9.0'
TOTAL DEPTH OF WELL: 22.5'

DRILLING FLUID SAMPLES:
TYPE: N/A DATE: N/A

* No detailed lithologic descriptions available from 9.5 to 22.5 feet due to the use of a containment box.

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WELL No. 955

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Timothy A. Lee PROOFED BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter HELPER: Fred Dixon, Tom Doonan,
Tracy Mitchell

EQUIPMENT ☒ 14.0 INCH AUGER 9.5 L.F.

☐ INCH AUGER L.F.

☒ 8.0 INCH ROTARY 13.0 L.F.

MATERIALS USED

EST. USED
VOL. VOL.

10.0 FEET OF 2.0 IN. S.S. SCREEN

15.0 FEET OF 2.0 IN. S.S. CASING

3.5 5.0 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

3.0 3.5 SACKS OF CEMENT

17.5 POUNDS OF POWDERED BENTONITE

28.5 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED
VOLUMES AND USED VOLUMES

Fractures and spillage

WELL COVER USED

☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED

YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 20.8 FEET.

CENTRALIZERS AT 2.0 FEET.

21.0 FEET.

 FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT
TO 22.4 FEET

BOTTOM OF BOREHOLE
22.5 FEET

LOCATION WAG4
ORNL GRID COORDINATES
N 19,243.5391
E 29,239.1533
ELEV. GROUND 768.72
ELEV. TOP STAINLESS
STEEL CASING 770.60
DRILLING DATES:
STARTED: 4/12/90
FINISHED: 4/17/90

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

CONCRETE PAD

10.0 INCH DIVERTER
CASING 0.5 FT. ABOVE
GROUND SURFACE TO
9.5 FT. BELOW GROUND
SURFACE

14.0 INCH BOREHOLE
0.0 TO 9.5 FEET

GROUT SEAL 0.0 TO
9.1 FEET

8.0 INCH DIAMETER
BOREHOLE

2.0 INCH DIAMETER STAINLESS
STEEL CASING 1.88 FT. ABOVE
GROUND SURFACE TO 12.2 FT.
BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL
9.1 TO 10.8 FEET

SAND PACK
10.8 TO 22.4 FEET

2.0 INCH DIAMETER
STAINLESS STEEL 0.010
SLOTTED SCREEN
12.2 TO 22.2 FEET

2.0 INCH DIAMETER STAINLESS
STEEL SILT TRAP/CAP
22.2 TO 22.4 FEET

TYPE D WELL

NOT TO SCALE

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WELL No. 955

DATE: 4/18/90

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	4/17/90	2
BENTONITE	4/18/90	6
	4/17/90	1
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	4/17/90	3
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	4/17/90	3
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	4/17/90	3
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	4/17/90	3
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	8/16/90	8
GROUT		
well casing	4/18/90	7
WELL COVERS		
SURFACE CASING	N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE Timothy A. Lee 4/18/90

Timothy A. Lee

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

	COMPLIANCE	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>4/17/90</u>	<u>Tbz</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>4/17/90</u>	<u>Tbz</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>8/16/90</u>	<u>DCC</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>4/17/90</u>	<u>Tbz</u>

* 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

Timothy A. Lee
Timothy A. Lee

4/17/90

D. Charles Lytle
D. Charles Lytle

8/16/90

WELL No. 955
Lower
LOCATION: WAG4

**MONITORING WELL
DEVELOPMENT FORM**

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Pumping with Geoguard pump

DEVELOPMENT BEGAN DATE: 8/13/90 TIME: _____

DEVELOPMENT ENDING DATE: 8/16/90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 11.5 GALLONS

TOTAL GALLONS PUMPED: 220

INITIAL PH: 9.4 FINAL PH: 8.4

INITIAL CONDUCTIVITY (uS/cm): 843 FINAL CONDUCTIVITY (uS/cm): 773

DESCRIPTION OF INITIAL TURBIDITY: Slightly cloudy

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 ☐ TANK TRUCK ☐ STORAGE TANKS ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 6.4 feet from ground surface

DEVELOPMENT OBSERVATIONS

Saw vapors coming from barrels. Used OVA on X 10 setting. Went of scale then switched to X 100 setting went of scale again. The OVA went off only when around the barrels, breathing zone was fine.

OBSERVER SIGNATURE/DATE: D. Charles Lytle 8/16/90

WELL NO. 955
Lower
LOCATION: WAG4
DATE: 8/13/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 11.5 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS OVA
8/13/90	1100	55	Slightly Cloudy	---	9.4	843	55	4.9	x10 setting 100 ppm
8/13/90	1300	22	Slightly Cloudy	---	9.0	849	77	6.7	x10 setting 100 ppm
8/16/90	0815	88	Cloudy	---	8.9	805	165	14.3	x100 setting 1000 ppm
8/16/90	1300	55	Clear	4.0	8.4	773	220	19.1	x100 setting 1000 ppm
RESULTS AT END OF DEVELOPMENT			Clear	4.0	8.4	773	220	19.1	x100setting 1000 ppm

COMMENTS Developed well according to specifications, no surging at all. Used OVA first thing in the morning while they opened well heads checked barrels and breathing zone and periodically throughout the day while taking water samples. Only detected contamination coming from the barrels. Could see the vapors. Read 1000 ppm on X100 setting breathing zone was fine.

OBSERVER SIGNATURE/DATE D. Charles Lytle 8/16/90
D. Charles Lytle

ERC / EDGE
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WELL No. 955

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.: 955

DATE OF TEST: 10-09-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 17.10 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 = 20

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

SUCCESSIVE COMPUTED
VALUES FOR H₀
(FEET)

2.4339
2.4700

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	5.000	4.000
20.00	4.230	3.230
30.00	3.640	2.640
40.00	3.230	2.230
50.00	2.900	1.900
60.00	2.620	1.620
75.00	2.290	1.290
90.00	2.040	1.040
105.00	1.860	.860
120.00	1.730	.730
150.00	1.520	.520
180.00	1.390	.390
240.00	1.200	.200
300.00	1.150	.150
360.00	1.120	.120
420.00	1.100	.100
480.00	1.080	.080
540.00	1.060	.060
600.00	1.020	.020
720.00	1.010	.010

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $7.94E-06$ FT/SEC = $2.42E-04$ CM/SEC

TRANSMISSIVITY = $7.94E-05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.12E-05$ FT/SEC = $3.40E-04$ CM/SEC

TRANSMISSIVITY = $1.12E-04$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 956 is located in WAG 4. It is located approximately 900 feet southwest from the intersection of Melton Valley Drive and Lagoon Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 19,123.7187, E 29,935.5110 (X-10 grid) or latitude 35°-55'-00.38" and longitude 84°-19'-02.49". 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 956 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4 rig was used to drill this boring for monitor well installation under the operation of Larry Ledbetter with the assistance of Fred Dixon, Tom Doonan and Tracy Mitchell. Drilling commenced on 4/19/90 and was finished on 4/20/90. 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. This

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

4/19/90: This location was determined to be Class III. The rig was moved on the staked location and set up on 2 sheets plastic. Split spoon samples were taken from surface to refusal at 13.5 feet (RAD $\leq$ Background, OVA = 30 to 45 ppm). The boring was augered to refusal at 15.5 feet using a 6 inch auger (RAD $\leq$ Background, OVA = <0.05 ppm). The location was down graded to Class II. The boring was reamed using a 14.0 inch auger to 7.0 feet (RAD $\leq$ Background, OVA = <0.5 ppm). Set 7.0 feet of 10.0 inch decontaminated steel diverter casing and grouted it to surface with 3.0 sacks cement.

4/20/90: Drill from 15.5 to 22.5 feet using an 8.0 inch air rotary tricone bit (RAD $\leq$ Background, OVA = 0.2 ppm). At 22.5 feet while cleaning up hole by blowing, a hole blew out of the surface of the ground approximately 20 feet away from the well bore. A strong sewer gas smell was reported with OVA readings of >100 ppm. Immediately shut down drilling operations and moved workers up wind. The gas dissipated rapidly to OVA readings of less than 0.5 ppm. Therefore, removed drill steel from well, set 2 inch stainless steel screen and casing with sandpack and bentonite seal. Grouted annulus with 3.0 sacks cement.

This well was logged by ERC Environmental and Energy Services Co. (ERC) hydrogeologist Timothy A. Lee. 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and

dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

2.3 Sample Collection

A bulk density soil sample was collected from the split spoon sample interval from 4.3 to 4.6 feet. The sample was measured and weighed, and a bulk density of 2.08 grams/cm³ was calculated. No samples were collected for chemical analysis.

2.4 Installation and Development

2.4.1 Installation

This was a Type D well. A 6-inch diameter boring was split spooned and augered from ground surface to auger refusal (13.5 feet). The air rotary method was required to complete the boring to the specified total well depth. Therefore, a 14.0-inch diameter boring was augered from ground surface to 7.0 feet and a 10.0-inch diameter diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 7.0 to 22.5 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 12.3 to 22.5 feet. A 2-inch diameter stainless steel casing was installed above the screen at 12.3 feet and extended 2.7 feet above ground surface. A sandpack was then tremied into the annular space from 9.0 to 22.5 feet, with a 1.5-foot bentonite pellet seal poured into the annular space above the sandpack from 7.5 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 detail of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 956 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 270 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 >100 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 8/17/90 at a depth of 19.7 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 956 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

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MONITORING WELL PROGRAM
WELL DATA NARRATIVE
WELL No. 956

changing water levels were measured using a Druck 15 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 9.08×10^{-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.

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WELL No. 956

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>4/19/90</u>	<u>Tbm</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>4/19/90</u>	<u>Tbm</u>
3a. SCREEN AND CASING HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	<u>N/A</u>	<u>N/A</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>4/20/90</u>	<u>Tbm</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>4/20/90</u>	<u>Tbm</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>4/20/90</u>	<u>Tbm</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>4/20/90</u>	<u>Tbm</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>4/20/90</u>	<u>Tbm</u>

RESULTS: No detectable signs of hydrocarbons under ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 4/20/90

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WELL No. 956

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

4/20/90

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WELL No. 956

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG4
DRILLER: Larry Ledbetter
HELPER: Fred Dixon, Tom Doonan, Tracy Mitchell
DRILL: Ingersoll Rand T-4

DATE: START: 4/19/90
FINISH: 4/20/90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: C.E. Stooksbury

TYPE DRILLING: Split spoon, auger LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: None TYPE: N/A
CONTAINMENT TYPE: plastic, pan

THICKNESS OF SOIL (REFUSAL DEPTH): 15.5'
DEPTH DRILLED IN ROCK: 7.0'
TOTAL DEPTH OF WELL: 22.5'

DRILLING FLUID SAMPLES:
TYPE: N/A DATE: N/A

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	2.0		Augered	Gravel fill
2.0	2.2		50%	Gravel fill
2.2	4.0		50%	Clay, dark yellowish orange and pale olive, dry streaks, scarlet red streaks, OVA = 30 - 45 ppm
				RAD $\leq$ Background
4.0	6.0		50%	Clay, light olive gray, moist, scattered vegetation, OVA = 20-30 ppm
				RAD $\leq$ Background
				Bulk Density taken from 4.3' to 4.6' = 2.08 g/cm ³
6.0	8.0		10%	Clay, dark yellowish orange, moist, OVA = 5 ppm, RAD $\leq$ Background
8.0	10.0		100%	Shale, grayish green, dripping wet, crumbly, OVA = 10 - 20 ppm (Spiked over 100 ppm when first open spoon), RAD $\leq$ Background
10.0	11.3		80%	Clay and shale, grayish green, dripping wet and soupy, OVA = 5 ppm, RAD $\leq$ Background
11.3	12.0		80%	Shale, light olive gray, iron stains, crumbly, moist
12.0	13.0		100%	Clay and shale, grayish green, dripping wet and

WELL No. 956

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 10 OF 19

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WELL No. 956

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED

PROOFED

BY: Timothy A. Lee

BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter

HELPER: Fred Dixon, Tom Doonan

Tracy Mitchell

EQUIPMENT

☒ 14.0 INCH AUGER 7.0 L.F.

☐ _____ INCH AUGER _____ L.F.

☒ 8.0 INCH ROTARY 15.5 L.F.

MATERIALS USED

EST. USED

VOL. VOL.

10.0 FEET OF 2.0 IN. S.S. SCREEN

15.0 FEET OF 2.0 IN. S.S. CASING

3.3 7.0 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

1.5 3.0 SACKS OF CEMENT

15.0 POUNDS OF POWDERED BENTONITE

24.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED
VOLUMES AND USED VOLUMES

Fractures, irregular boring diameter
and spillage

WELL COVER USED

☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED

YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 19.7 FEET.

CENTRALIZERS AT 2.0 FEET.

21.0 FEET.

_____ FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT

TO 22.5 FEET

BOTTOM OF BOREHOLE

22.5 FEET

LOCATION WAG4

ORNL GRID COORDINATES

N 19,123.7187

E 28,935.5110

ELEV. GROUND 774.04

ELEV. TOP STAINLESS

STEEL CASING 776.00

DRILLING DATES:

STARTED: 4/19/90

FINISHED: 4/20/90

LOCKING STEEL COVER

8 INCH DIAMETER

STEEL PROTECTIVE CASING
3.08 FT. ABOVE GROUND
TO 2.0 FT. BELOW
GROUND SURFACE

CONCRETE PAD

10.0 INCH DIVERTER
CASING 0.0 FT. ABOVE
GROUND SURFACE TO
7.0 FT. BELOW GROUND
SURFACE

14.0 INCH BOREHOLE
0.0 TO 7.0 FEET

GROUT SEAL 0.0 TO
7.5 FEET

8.0 INCH DIAMETER
BOREHOLE

2.0 INCH DIAMETER STAINLESS
STEEL CASING 1.96 FT. ABOVE
GROUND SURFACE TO 12.3 FT.
BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL
7.5 TO 9.0 FEET

SAND PACK
9.0 TO 22.5 FEET

2.0 INCH DIAMETER
STAINLESS STEEL 0.010

SLOTTED SCREEN
12.3 TO 22.3 FEET

2.0 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP
22.3 TO 22.5 FEET

TYPE D WELL

NOT TO SCALE

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WELL No. 956

DATE: 4/20/90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL	DATE USED	BATCH NUMBER
SAND	4/20/90	2
BENTONITE Powder Pellets	4/20/90	6
	4/20/90	1
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	4/20/90	3
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	4/20/90	3
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	4/20/90	3
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	4/20/90	3
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	8/17/90	8
GROUT Diverter well casing	4/19/90	7
	4/20/90	7
WELL COVERS		
SURFACE CASING	N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

4/20/90
Timothy A. Lee

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WELL No. 956

POST-WELL COMPLETION
CHECKLIST

	COMPLIANCE	
	DATE	INITIALS
<u>POST-WELL COMPLETION TASKS</u>		
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>4/20/90</u>	<u>Tm</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>4/20/90</u>	<u>Tm</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>8/17/90</u>	<u>DCC</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>4/20/90</u>	<u>Tm</u>

* 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

Timothy A. Lee 4/20/90
Timothy A. Lee

D. Charles Lytle 8/17/90
D. Charles Lytle

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WELL No. 956
Lower
LOCATION: WAG4

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Pumping with Geoguard pump

DEVELOPMENT
BEGAN DATE: 8/13/90 TIME: _____

DEVELOPMENT
ENDING DATE: 8/17/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 8.5 GALLONS

TOTAL GALLONS PUMPED: 270 TOTAL WELL VOLUMES PUMPED: 31.7

INITIAL pH: 8.1 FINAL pH: 7.8

INITIAL CONDUCTIVITY ($\mu\text{S}/\text{cm}$): 797 FINAL CONDUCTIVITY ($\mu\text{S}/\text{cm}$): 747

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Slightly Cloudy

FINAL MEASURED TURBIDITY: 100 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR
OF WATER: None

WATER	☐ GROUND SURFACE	☐ TANK TRUCK
DISCHARGED	☐ STORM SEWERS	☐ STORAGE TANKS
TO:	☒ DRUMS	☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 3.8 feet from ground surface

DEVELOPMENT OBSERVATIONS

Vapors were coming from barrels. Used OVA at x10 setting pegged instrument.
Water came out in sample tube clean within 5 to 10 minutes. Changed to a
yellow-orange color. Collected liter bottle sample to have analyzed.

OBSERVER SIGNATURE/DATE D. Charles Lytle 8/17/90
D. Charles Lytle

WELL NO. 956
Lower
LOCATION: WAG4
DATE: 8/13/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 8.5 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
8/13/90	1300	30	Cloudy	---	8.1	797	30	3.5	
8/16/90	0815	80	Cloudy	---	8.0	725	110	13.0	
8/16/90	1300	45	Slightly Cloudy	---	8.0	743	155	18.2	
8/17/90	0800	65	Slightly Cloudy	---	8.3	723	220	25.8	
8/17/90	1100	50	Slightly Cloudy	*	7.8	747	270	31.7	
RESULTS AT END OF DEVELOPMENT			Slightly Cloudy	*	7.8	747	270	31.7	

COMMENTS	Excellent producer and recharger. Water came out clean and within 5 to 10 minutes it would turn to a yellow-orange color. Passed with 31.7 well volumes.
----------	--

OBSERVER SIGNATURE/DATE

D. Charles Lytle 8/17/90

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WELL No. 956

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.: 956

DATE OF TEST: 10-09-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 18.60 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 = 19

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

1.0365
1.1687
1.3177
1.4718
1.7833
2.1866
2.5997
3.2586
3.7559
4.1242
4.2089

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.330	3.330
20.00	3.430	2.430
30.00	2.780	1.780
40.00	2.310	1.310
50.00	1.930	.930
60.00	1.640	.640
75.00	1.450	.450
90.00	1.300	.300
105.00	1.220	.220
120.00	1.140	.140
150.00	1.090	.090
180.00	1.070	.070
240.00	1.040	.040
300.00	1.020	.020
360.00	1.020	.020
420.00	1.020	.020
480.00	1.010	.010
540.00	1.010	.010
600.00	1.010	.010

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WELL No. 956

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $2.98\text{E-}05$ FT/SEC = $9.08\text{E-}04$ CM/SEC

TRANSMISSIVITY = $2.98\text{E-}04$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $4.17\text{E-}05$ FT/SEC = $1.27\text{E-}03$ CM/SEC

TRANSMISSIVITY = $4.17\text{E-}04$ FT**2/SEC

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and Energy
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WELL No. 956

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 957 is located in WAG 4. It is located approximately 1400 feet southwest of the intersection of Melton Valley Drive and Lagoon Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 18,908.9269, E 28,861.0044 (X-10 grid) or latitude 35°-54'-58.20" and longitude 84°-19'-01.79". 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 957 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4 rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter with the assistance of Fred Dixon, Tom Doonan and Tracy Mitchell. Drilling commenced on 4/4/90, and was finished on 4/9/90. 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. This

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

- 4/4/90: This location has been determined Class III. Move rig to location and set up on 2 sheets of plastic. Split spoon samples taken from surface to refusal at 12.5 feet. Reamed hole using a 22-inch auger to 12.0 feet. Set 11.2 feet 15-inch decontaminated steel diverter casing and grouted it to surface with 3 sacks cement. (OVA = <.05 ppm, RAD = not over background).
- 4/5/90: Drill from 12.0 to 30.0 feet using an 14-inch air rotary tricone bit into containment box. Set 29.0 feet of 10-inch decontaminated steel surface casing with bentonite seal. Grouted annular with 9.0 sacks cement downgrade location to Class II.
- 4/6/90: Drill from 30.0 to 82.5 feet using an 8.0-inch air rotary tricone bit into containment box (OVA = <.05 ppm, RAD = not over background).
- 4/9/90: Set 82.2 feet of stainless steel 4-inch screen and casing with bentonite seal and sandpack.
- 4/10/90: Grouted annulus with 11.0 sacks cement.

This well was logged by ERC Environmental and Energy Services Co. (ERC) hydrogeologist Timothy A. Lee. 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

2.3 Sample Collection

A bulk density soil sample was collected from the split spoon sample interval from 11.8 to 12.0 feet. The sample was measured and weighed, and a bulk density of 1.98 grams/cm³ was calculated. No samples were collected for chemical analysis.

2.4 Installation and Development

2.4.1 Installation

This was a Type B well. A 22.0-inch diameter boring was augered from ground surface to 7.0 feet. A 15 1/4-inch diverter casing was installed from surface to 11.2 feet below ground surface and grouted in place. A 14.0-inch diameter boring was drilled from 4.0 feet to 30.0 feet with a 14.0-inch air rotary tricone roller bit. A 10.0-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 29.0 feet, sealed with a 3.3-foot bentonite pellet layer from 25.7 feet to 29.0 feet, and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. After the surface casing was installed, the air rotary method was used to drill an 8-inch diameter boring to a total depth of 82.5 feet. A 4-inch diameter stainless steel screen with welded bottom cap was installed from 52.0 feet to 82.2 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 52.0 feet and extended 2.04 feet above ground surface. A sandpack was then tremied into the annular space from 82.2 feet up to 49.6 feet, with a 1.8-foot bentonite pellet seal poured into the annular space

above the sandpack from 47.8 to 49.6 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 957 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 1233 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 4.0 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 10/9/90 at a depth of 80.0 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 957 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 3.54×10^{-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.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED.	<u>4/4/90</u>	<u>Tbz</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>4/4/90</u>	<u>Tbz</u>
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.	<u>N/A</u>	<u>N/A</u>
3b. PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	<u>4/9/90</u>	<u>Tbz</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>4/9/90</u>	<u>Tbz</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	<u>4/4/90</u>	<u>Tbz</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>4/4/90</u>	<u>Tbz</u>

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee 4/9/90

ERC / EDGE
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and Energy
Services Co.

WELL No. 957

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

4/9/90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 957

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG4
DRILLER: Larry Ledbetter
HELPER: Fred Dixon, Tracey Mitchell, Tom Doonan
DRILL: Ingersoll Rand T-4

DATE: START: 4/5/90
FINISH: 4/9/90
LOGGED BY: Bruce McMaster/Timothy A. Lee
HEALTH PHYSICIST: C.E. Stooksbury

TYPE DRILLING: Split spoon, auger, air rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: None TYPE: N/A
CONTAINMENT TYPE: Plastic, pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 22.5'
DEPTH DRILLED IN ROCK: 60.0'
TOTAL DEPTH OF WELL: 82.5'

DRILLING FLUID SAMPLES:
TYPE: N/A DATE: N/A

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	7.0		Auger	Gravel fill
7.0	9.0		100%	Dark yellowish-orange clay-slightly silty- organics present, some iron staining
9.0	11.0		100%	Clay, yellowish-orange with sandy lenses, some water out of spoon (around 9.0')
				Bulk Density taken from 11.8'-12.0' = 1.98g/cc
				OVA $\leq$ 0.05 ppm, RAD = not over background
11.0	12.0	Spoon Refusal	100%	Weathered shale, slightly damp, mottled dark yellowish-orange to yellowish-gray, iron staining present
12.0	22.5	Auger Refusal		Olive green, fine grained, fissile shale, slightly calcareous with nodules of very dense shale. Calcite clasts and veinlets in nodules
				Downgrade hole to Class II
22.5	30.0			Hard-even drilling, shale
30.0	35.0			Hard-even drilling, shale
35.0	36.0			Limestone stringer, rough drilling
36.0	38.0			Alternating rough to even drilling thin limestone and shale stringers
38.0	45.0			Hard-even drilling and shale

WELL No. 957

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 10 OF 21.

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 957

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED PROOFED
BY: Bruce McMaster/Timothy A. Lee BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter HELPER: Fred Dixon, Tracey Mitchell

DRILLING METHOD: ☒ 22 INCH AUGER 11.2 L.F.
☐ INCH AUGER L.F.
☒ 14 INCH ROTARY 18.8 L.F.
☒ 8 INCH ROTARY 52.5 L.F.

MATERIALS USED

EST. VOL.	USED VOL.	
<u>50</u>	<u>50</u>	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
<u>29.0</u>	<u>29.0</u>	FT. OF <u>10</u> IN. SURFACE CASING
<u>7.0</u>	<u>9.0</u>	SACKS OF CEMENT (SURFACE CASING)
<u>45.0</u>	<u>45.0</u>	POUNDS OF POWDERED BENTONITE (SURFACE CASING)
<u>72.0</u>	<u>72.0</u>	GALLONS OF WATER (SURFACE CASING)
<u>55.0</u>	<u>55.0</u>	FT. OF <u>4.0</u> IN. DIA. STAINLESS STEEL CASING
<u>30.0</u>	<u>30.0</u>	FT. OF <u>4.0</u> IN. DIA. STAINLESS STEEL SCREEN
<u>8.5</u>	<u>9.0</u>	SACKS OF SAND
<u>50.0</u>	<u>50.0</u>	POUNDS OF BENTONITE PELLETS
<u>10.2</u>	<u>11.0</u>	SACKS OF CEMENT (WELL CASING)
<u>55.0</u>	<u>55.0</u>	POUNDS OF POWDERED BENTONITE (WELL CASING)
<u>88.0</u>	<u>88.0</u>	GALLONS OF WATER (WELL CASING)
<u>3.0</u>	<u>3.0</u>	FT. OF <u>10</u> IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and spillage

SURFACE CASING TREME GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREME 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 80.0 FEET.

CENTRALIZERS AT 21 FEET.
41 FEET.
61 FEET.
81 FEET

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

TYPE B WELL

LOCATION WAG4
ORNL GRID COORDINATES
N 18,908.9269
E 28,861.0044
ELEV. GROUND 767.00
ELEV. TOP STAINLESS
STEEL CASING 769.04
DRILLING DATES:
STARTED: 4/4/90
FINISHED: 4/9/90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 957

DATE: 4/9/90

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	4/9/90	2
BENTONITE Powder Pellets	4/10/90	6
	4/9/90	1
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	4/9/90	3
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	4/9/90	3
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	4/9/90	3
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	4/9/90	3
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	10/9/90	8
GROUT surface casing	4/5/90	7
well casing	4/10/90	7
WELL COVERS		
SURFACE CASING	4/5/90	4

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee 4/10/90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 957

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

	COMPLIANCE	
	DATE	INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>4/9/90</u>	<u>TBL</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>4/9/90</u>	<u>TBL</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>10/9/90</u>	<u>DCC</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>4/9/90</u>	<u>TBL</u>

* 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

Timothy A. Lee

4/9/90

D. Charles Lytle

10/9/90

ERCE
Environmental
and Energy
Services Co.

WELL No. 957
Lower
LOCATION: WAG4

**MONITORING WELL
DEVELOPMENT FORM**

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Pumping and Geoguard pump

DEVELOPMENT
BEGAN DATE: 8/13/90

TIME: _____

DEVELOPMENT
ENDING DATE: 10/9/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 75.5 GALLONS

TOTAL GALLONS PUMPED: 1233 TOTAL WELL VOLUMES PUMPED: 16.3

INITIAL pH: 9.6 FINAL pH: 9.8

INITIAL CONDUCTIVITY ($\mu S/cm$): 837 FINAL CONDUCTIVITY ($\mu S/cm$): 043

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

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: 1.0 foot from ground surface

DEVELOPMENT OBSERVATIONS

OVA read anywhere from 100-1000 ppm. Vapors coming from well and barrels.

Breathing zone was fine.

OBSERVER SIGNATURE/DATE

D. Charles Lytle 10/9/90
D. Charles Lytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL NO. 957
LOCATION: Lower WAG4
DATE: 8/13/90

MONITORING WELL DEVELOPMENT PROGRESS

Page 1 of 3

ONE WELL VOLUME = 75.5 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
8/20/90	0800	10	Cloudy	---	9.6	837	10	.13	
8/20/90	1410	35	Cloudy	---	9.6	839	45	.59	
8/21/90	0810	10	Cloudy	---	9.8	746	55	.72	
8/21/90	1430	60	Muddy	---	9.7	972	115	1.5	
8/22/90	0900	15	Muddy	---	10.0	957	130	1.7	
8/22/90	1330	45	Milky	---	9.6	006	175	2.3	
8/23/90	0800	5	Milky	---	9.7	993	180	2.4	
8/23/90	1430	30	Milky	---	9.5	038	210	2.7	
8/24/90	0800	5	Cloudy	---	9.8	994	215	2.8	
8/24/90	1330	35	Cloudy	---	9.5	002	250	3.3	
8/27/90	0800	20	Slightly Cloudy	---	9.8	995	270	3.6	
8/27/90	1330	20	Cloudy	---	10.0	068	290	3.8	
8/28/90	0830	10	Slightly Cloudy	---	9.6	938	300	4.0	
8/28/90	1400	35	Slightly Cloudy	---	9.7	072	335	4.4	
8/30/90	0800	5	Cloudy	---	10.0	021	340	4.5	
8/30/90	1400	30	Cloudy	---	9.9	095	370	4.9	
8/30/90	0800	30	Cloudy	---	10.0	952	400	5.3	
RESULTS AT END OF DEVELOPMENT									

COMMENTS

OBSERVER SIGNATURE/DATE

D. Charles Sytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL NO. 957
Lower
LOCATION: WAG4
DATE: 8/13/90

MONITORING WELL DEVELOPMENT PROGRESS

Page 2 of 3

ONE WELL VOLUME = 75.5 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
8/31/90	1400	40	Cloudy	----	9.9	040	440	5.8	
9/4/90	0900	5	Cloudy	----	10.0	062	445	5.9	
9/5/90	1400	20	Cloudy	----	10.0	031	465	6.1	
9/7/90	1300	10	Cloudy	----	9.9	074	477	6.3	
9/7/90	1400	10	Cloudy	----	9.8	037	487	6.5	
9/10/90	1330	30	Slightly Cloudy	----	9.8	028	517	6.8	
9/10/90	1430	10	Slightly Cloudy	----	9.6	044	527	7.0	
9/13/90	0800	20	Slightly Cloudy	----	10.0	058	547	7.2	
9/13/90	1000	15	Slightly Cloudy	----	9.8	049	562	7.4	
9/14/90	1400	20	Slightly Cloudy	----	9.9	050	582	7.7	
9/17/90	0800	10	Slightly Cloudy	----	10.3	052	592	7.8	
9/17/90	1000	35	Slightly Cloudy	----	9.7	020	627	8.3	
9/17/90	1400	10	Cloudy	----	9.6	093	637	8.4	
9/18/90	0800	10	Slightly Cloudy	----	10.0	007	647	8.6	
9/18/90	1000	55	Slightly Cloudy	----	9.8	042	702	9.3	
9/18/90	1300	20	Slightly Cloudy	----	9.7	052	722	9.6	
9/19/90	0800	10	Slightly Cloudy	----	9.9	007	732	9.7	
RESULTS AT END OF DEVELOPMENT									

COMMENTS

OBSERVER SIGNATURE/DATE D. Charles Sytle

WAG40808.DWG

ERC / EDGE
Environmental
and Energy
Services Co.

WELL NO. 957
Lower
LOCATION: WAG4
DATE: 8/13/90

MONITORING WELL DEVELOPMENT PROGRESS

Page 3 of 3

ONE WELL VOLUME = 75.5 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
9/19/90	1300	40	Slightly Cloudy	---	9.7	036	772	10.2	
9/19/90	1400	10	Slightly Cloudy	---	9.7	035	782	10.3	
9/21/90	0830	55	Slightly Cloudy	---	10.1	995	837	11.1	
9/24/90	1300	10	Slightly Cloudy	---	10.1	054	847	11.2	
9/24/90	1400	20	Slightly Cloudy	---	9.9	056	867	11.5	
9/25/90	1300	10	Slightly Cloudy	---	9.7	038	877	11.6	
9/26/90	1000	85	Slightly Cloudy	---	10.1	998	962	12.7	
9/26/90	1400	20	Slightly Cloudy	---	9.7	079	082	13.0	
9/27/90	0800	20	Slightly Cloudy	---	9.8	027	1002	13.3	
9/27/90	1400	40	Slightly Cloudy	---	9.9	114	1042	13.8	
9/28/90	0800	20	Slightly Cloudy	---	9.8	048	1062	14.1	
10/2/90	0830	6	Slightly Cloudy	---	9.7	087	1068	14.1	
10/2/90	1100	20	Slightly Cloudy	---	9.7	071	1088	14.4	
10/2/90	1400	20	Slightly Cloudy	---	9.8	083	1108	14.7	
10/4/90	1300	20	Slightly Cloudy	---	9.9	040	1128	14.9	
10/9/90	0830	75	Slightly Cloudy	---	9.8	034	1203	15.9	
10/9/90	1400	30	Clear	4.0	9.8	043	1233	16.3	
RESULTS AT END OF DEVELOPMENT			Clear	4.0	9.8	043	1233	16.3	

COMMENTS Excellent recharger and producer. Made plenty of water, water cleared and remained clear. Passed with 4.0 NTU's.

OBSERVER SIGNATURE/DATE D. Charles Lytle 10/9/90
D. Charles Lytle

MMF0805.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.: 957

DATE OF TEST: 10-17-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

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 = 80.40 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 30.00 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

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

1.4738
1.4745

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	2.530	1.530
20.00	2.480	1.480
30.00	2.510	1.510
40.00	2.500	1.500
50.00	2.460	1.460
60.00	2.470	1.470
75.00	2.470	1.470
90.00	2.460	1.460
105.00	2.450	1.450
120.00	2.460	1.460
150.00	2.460	1.460
180.00	2.450	1.450
240.00	2.450	1.450
300.00	2.430	1.430
360.00	2.430	1.430
420.00	2.430	1.430
480.00	2.430	1.430
540.00	2.430	1.430
600.00	2.400	1.400
720.00	2.400	1.400
840.00	2.390	1.390
960.00	2.360	1.360
1080.00	2.360	1.360
1200.00	2.360	1.360
1320.00	2.360	1.360
1440.00	2.350	1.350
1560.00	2.340	1.340
1680.00	2.350	1.350
1800.00	2.340	1.340
1920.00	2.320	1.320
2040.00	2.310	1.310
2160.00	2.310	1.310

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.16\text{E-}07$ FT/SEC = $3.54\text{E-}06$ CM/SEC

TRANSMISSIVITY = $3.48\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.33\text{E-}07$ FT/SEC = $4.05\text{E-}06$ CM/SEC

TRANSMISSIVITY = $3.99\text{E-}06$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 958 is located in WAG 4. It is located approximately 1400 feet southwest from the intersection of Melton Valley Drive and Lagoon Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 18,900.3704, E 28,857.0538 (X-10 grid) or latitude 35°-54'-58.11" and longitude 84°-19'-01.77". 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 958 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4 rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter with the assistance of Fred Dixon, Tom Doonan and Tracy Mitchell. Drilling commenced on 4/5/90 and was finished on 4/9/90. 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. This

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

4/5/90: The location was determined to be Class III. The rig was moved to location and set up on two layers of plastic sheeting. Augered to 11.0 feet using a 14.0 inch auger. Set 11.0 feet of 10.0-inch decontaminated diverter casing and grouted with 7 sacks cement. (RAD = <0.1 MR/hr and OVA = <.05 ppm). The location was downgraded to Class II.

4/9/90: Drill from 11.0 to 27.5 feet using an 8.0-inch air rotary tricone bit. Set 27.3 feet of 2-inch stainless steel screen and casing with sandpack and bentonite seal.

4/10/90: Grout annulus with 4.0 sacks cement.

This well was logged by ERC Environmental and Energy Services Co. (ERC) hydrogeologist Timothy A. Lee. 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

2.3 Sample Collection

No samples were collected.

2.4 Installation and Development

2.4.1 Installation

This is a Type D well. A 14.0-inch diameter boring was augered from ground surface to 11.0 feet. The air rotary method was required to complete the boring to the specified

total well depth. Therefore, 10.0-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 11.0 to 27.5 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 12.1 to 27.3 feet. A 2-inch diameter stainless steel casing was installed above the screen at 12.1 feet and extended 2.9 feet above ground surface. A sandpack was then tremied into the annular space from 27.3 feet up to 11.0 feet, with a 1.5-foot bentonite pellet seal poured into the annular space above the sandpack from 9.5 to 11.0 feet. The annular space from the top of the bentonite seal to the surface was tremie-grouted with a cement/bentonite slurry. A detail of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 958 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 130 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 1.0 NTU. 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 8/21/90 at a depth of 26.1 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 958 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 2.42×10^{-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. 958

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

DATE **INITIALS**

1.	EXCAVATION PERMIT OBTAINED.	<u>4/5/90</u>	<u>TML</u>
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>4/5/90</u>	<u>TML</u>
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.	<u>N/A</u>	<u>N/A</u>
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	<u>4/9/90</u>	<u>TML</u>
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>4/9/90</u>	<u>TML</u>
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	<u>4/9/90</u>	<u>TML</u>
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>4/9/90</u>	<u>TML</u>

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee

4/9/90

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WELL No. 958

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

4/16/90

WELL No. 958

ORNL MONITORING WELL LOG

PAGE 1 OF 1

DATE: START: 4/5/90

FINISH: 4/9/90

LOGGED BY: Timothy A. Lee

HEALTH PHYSICIST: C.E. Stooksbury

LUBRICANT TYPE: Green stuff

TYPE: N/A

CONTAINMENT TYPE: Plastic, pan, containment box

DRILLING FLUID SAMPLES:

TYPE: N/A DATE: N/A

TOTAL DEPTH OF WELL: 27.5'

[illegible]

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WELL No. 958

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED

PROOFED

BY: Timothy A. Lee

BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter HELPER: Fred Dixon, Tom Doonan
Tracey Mitchell

EQUIPMENT ☒ 14.0 INCH AUGER 11.0 L.F.
☐ INCH AUGER L.F.
☒ 8.0 INCH ROTARY 16.5 L.F.

MATERIALS USED

EST. USED
VOL. VOL.

15.0 FEET OF 2.0 IN. S.S. SCREEN

15.0 FEET OF 2.0 IN. S.S. CASING

4.1 5.5 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

2.3 4.0 SACKS OF CEMENT

20.0 POUNDS OF POWDERED BENTONITE

32.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED
VOLUMES AND USED VOLUMES

Fractures, irregular boring diameters
and spillage

WELL COVER USED

☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED

YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 26.1 FEET.

CENTRALIZERS AT 8.0 FEET.

26.0 FEET.

 FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT
TO 27.3 FEET

BOTTOM OF BOREHOLE
27.5 FEET

LOCATION WAG4

ORNL GRID COORDINATES

N 18,900.3704

E 28,857.0538

ELEV. GROUND 767.03

ELEV. TOP STAINLESS

STEEL CASING 769.03

DRILLING DATES:

STARTED: 4/5/90

FINISHED: 4/9/90

LOCKING STEEL COVER

8 INCH DIAMETER
STEEL PROTECTIVE CASING
3.03 FT. ABOVE GROUND
TO 2.0 FT. BELOW
GROUND SURFACE

CONCRETE PAD

10.0 INCH DIVERTER
CASING 0.0 FT. ABOVE
GROUND SURFACE TO
11.0 FT. BELOW GROUND
SURFACE

14.0 INCH BOREHOLE
0.0 TO 1.0 FEET

GROUT SEAL 0.0 TO
9.5 FEET

8.0 INCH DIAMETER
BOREHOLE

2.0 INCH DIAMETER STAINLESS
STEEL CASING 2.0 FT. ABOVE
GROUND SURFACE TO 12.1 FT.
BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL
9.5 TO 11.0 FEET

SAND PACK
11.0 TO 27.3 FEET

2.0 INCH DIAMETER
STAINLESS STEEL 0.010

SLOTTED SCREEN
12.1 TO 27.1 FEET

2.0 INCH DIAMETER STAINLESS
STEEL SILT TRAP/CAP
27.1 TO 27.3 FEET

TYPE D WELL

NOT TO SCALE

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WELL No. 958

DATE: 4/9/90

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL DATE USED BATCH NUMBER

SAND	DATE USED	BATCH NUMBER
	4/9/90	2

BENTONITE	DATE USED	BATCH NUMBER
Powder Pellets	4/10/90	6
	4/9/90	1

STAINLESS STEEL SCREEN	DATE USED	BATCH NUMBER
(PREPACKAGED) ☒ YES ☐ NO	4/9/90	3

STAINLESS STEEL CASING	DATE USED	BATCH NUMBER
(PREPACKAGED) ☒ YES ☐ NO	4/9/90	3

STAINLESS STEEL CENTRALIZERS	DATE USED	BATCH NUMBER
(PREPACKAGED) ☒ YES ☐ NO	4/9/90	3

STAINLESS STEEL CAPS	DATE USED	BATCH NUMBER
(PREPACKAGED) ☒ YES ☐ NO	4/9/90	3

MONITORING WELL PUMP	DATE USED	BATCH NUMBER
(PREPACKAGED) ☒ YES ☐ NO	8/21/90	8

GROUT

WELL COVERS	DATE USED	BATCH NUMBER
well casing	4/10/90	7

SURFACE CASING	DATE USED	BATCH NUMBER
	N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
 4/9/90

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>4/9/90</u>	<u>TAS</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>4/9/90</u>	<u>TAS</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>8/21/90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>4/9/90</u>	<u>TAS</u>

* 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

Timothy A. Lee
Timothy A. Lee

4/9/90

D. Charles Lytle
D. Charles Lytle

8/21/90

ERCE
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WELL No. 958
Lower
LOCATION: WAG4

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Pumping with Geoguard pump

DEVELOPMENT
BEGAN DATE: 8/20/90 TIME: _____

DEVELOPMENT
ENDING DATE: 8/21/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 10.2 GALLONS

TOTAL GALLONS PUMPED: 130 TOTAL WELL VOLUMES PUMPED: 12.7

INITIAL pH: 9.9 FINAL pH: 8.9

INITIAL CONDUCTIVITY ($\mu S/cm$): 849 FINAL CONDUCTIVITY ($\mu S/cm$): 948

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 1.0 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: 4.5 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle /21/90
D. Charles Lytle

WELL NO. 958
Lower
LOCATION: WAG4
DATE: 8/20/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 10.2 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
8/20/90	0800	10	Muddy	----	9.9	849	10	1.0	
8/20/90	1410	30	Cloudy	---	8.8	946	40	3.9	
8/21/90	0810	10	Cloudy	---	9.0	866	50	4.9	
8/21/90	1430	80	Clear	1.0	8.9	948	130	12.7	
RESULTS AT END OF DEVELOPMENT			Clear	1.0	8.9	948	130	12.7	

COMMENTS

COMMENTS Okay recharger and producer. Pumped more air than water. Water cleared rapidly. Passed with 1.0 NTU's. OVA test was fine nothing coming from well, barrels, or breathing zone.

OBSERVER SIGNATURE/DATE D. Charles Lytle 8/21/90
D. Charles Lytle

ERC / EDGE
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and Energy
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WELL No. 958

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.: 958

DATE OF TEST: 10-10-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 22.90 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

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

2.8636

2.8997

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.860	3.860
20.00	4.680	3.680
30.00	4.530	3.530
40.00	4.410	3.410
50.00	4.290	3.290
60.00	4.160	3.160
75.00	4.050	3.050
90.00	3.890	2.890
105.00	3.780	2.780
120.00	3.660	2.660
150.00	3.450	2.450
180.00	3.300	2.300
240.00	3.010	2.010
300.00	2.810	1.810
360.00	2.630	1.630
420.00	2.470	1.470
480.00	2.360	1.360
540.00	2.280	1.280
600.00	2.160	1.160
720.00	2.050	1.050
840.00	1.930	.930
960.00	1.840	.840
1080.00	1.760	.760
1200.00	1.680	.680
1320.00	1.620	.620
1440.00	1.590	.590
1560.00	1.550	.550
1680.00	1.530	.530
1800.00	1.480	.480
1920.00	1.460	.460
2040.00	1.430	.430
2160.00	1.390	.390

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $7.95E-07$ FT/SEC = $2.42E-05$ CM/SEC

TRANSMISSIVITY = $1.19E-05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.09E-06$ FT/SEC = $3.32E-05$ CM/SEC

TRANSMISSIVITY = $1.63E-05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 959 is located in WAG 4. It is located approximately 1500 feet southwest from the intersection of Melton Valley Drive and Lagoon Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 18,729.0653, E 28,682.4383 (X-10 grid) or latitude 35°-54'-55.74" and longitude 84°-19'-02.38". 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 959 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4 rig was used to drill this boring for monitor well installation under the operation of Larry Ledbetter with the assistance of Fred Dixon, Tom Doonan and Tracy Mitchell. Drilling commenced on 3/28/90 and was finished on 4/3/90. 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. This

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

- 3/28/90: The location was determined to be Class III. The rig was moved to location and set up on two sheets of plastic sheeting. Split spoon samples were taken from surface to refusal at 10.8 feet. The boring was deepened with 6-inch augers to refusal at 13.0 feet. The location was downgraded to Class II at this time (the highest RAD reading was <0.2 MR/hr). A 22-inch auger was used from surface to 10.0 feet (RAD = 1 MR/hr in some roots at 5.0 feet). A 10.0 feet string of 16-inch decontaminated steel diverter casing was set and grouted to surface with 8.0 sacks cement.
- 3/29/90: Drill from 10.0 feet to 35.0 feet using a 14.0 inch air rotary tricone bit into a containment box (RAD = 0 MR/hr, OVA = $<.05$ ppm).
- 3/30/90: Set 35.0 feet decontaminated 10.0 inch steel surface casing with 50.0 lbs bentonite pellets. Grouted surface casing with 11.0 sacks cement.
- 4/2/90: Drill from 35.0 feet to 72.5 feet using an 8.0 inch air rotary tricone bit using a containment box (RAD = <0.1 MR/hr, OVA = $<.05$ ppm).
- 4/3/90: Set 4 inch stainless steel screen and casing with sandpack and bentonite seal. Grout annulus with 12.0 sack cement.

This well was logged by ERC Environmental and Energy Services Co. (ERC) hydrogeologist Timothy A. Lee. 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

2.3 Sample Collection

A bulk density soil sample was collected from the split spoon sample interval from 6.0 to 6.3 feet. The sample was measured and weighed, and a bulk density of 2.24 grams/cm³ was calculated. No samples were collected for chemical analysis.

2.4 Installation and Development

2.4.1 Installation

This was a Type B well. A 22.0-inch diameter boring was augered from ground surface to 10.0 feet. A 15 1/4-inch diverter casing was installed from surface to 10.0 feet below ground surface and grouted in place. The boring was then extended past the diverter casing depth with a 14.0-inch air rotary tricone roller bit from 10.0 feet to 35.0 feet. A 10.0-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 35.0 feet, sealed with a 2.0-foot bentonite pellet layer from 33.0 feet to 35.0 feet, and tremie-grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. After the surface casing was installed, the air rotary method was used to drill an 8-inch diameter boring to a total depth of 72.5 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 51.9 feet to 72.1 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 51.9 feet and extended 3.1 feet above ground surface. A sandpack was then tremied into the annular space from 72.1 feet up to 49.0 feet, with a 2.2-foot bentonite pellet seal

poured into the annular space above the sandpack from 46.8 to 49.0 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 959 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 556 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 10/11/90 at a depth of 69.4 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 959 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.36×10^{-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.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED.	<u>3/28/90</u>	<u>Tbz</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>3/28/90</u>	<u>Tbz</u>
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.	<u>N/A</u>	<u>N/A</u>
3b. PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	<u>4/3/90</u>	<u>Tbz</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>3/28/90</u>	<u>Tbz</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	<u>3/28/90</u>	<u>Tbz</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>4/3/90</u>	<u>Tbz</u>

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

4/3/90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 959

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 Timothy A. Lee 4/1/90

Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 959

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG4
DRILLER: Larry Ledbetter
HELPER: Fred Dixon, Tom Doonan, Tracey Mitchell
DRILL: Ingersoll Rand T-4

DATE: START: 3/28/90
FINISH: 4/3/90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: L.C. Johnson/
Jerry Grey/C.E. Stooksbury

TYPE DRILLING: Split spoon, auger, air rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: None TYPE: N/A
CONTAINMENT TYPE: Plastic, pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 13.0'
DEPTH DRILLED IN ROCK: 59.5'
TOTAL DEPTH OF WELL: 72.5'

DRILLING FLUID SAMPLES:

TYPE: N/A DATE: _____

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	3.0		Augered	Gravel fill
3.0	3.6		100%	Clay, dark yellowish brown, slightly silty, scattered vegetation, dry
3.6	5.0		100%	Clay, mottled moderate yellowish brown to dark yellowish orange, iron stains, black streaks, dry
5.0	6.5		100%	Clay, mottled dark yellowish orange to yellowish gray, dry, plastic, iron stains, black streaks RAD < .05 MR/hr. Bulk density taken from 6.0 to 6.3 feet equals 2.24 g/cm ³
6.5	7.0		90%	Clay and shale, mottled dark yellowish orange to yellowish gray, iron stains, dry
7.0	9.0		100%	Shale, yellowish gray, heavy iron stains, dry crumbly
9.0	10.8		100%	Shale, yellowish gray, iron stains, dry, very crumbly
	10.8			Split spoon refusal
10.8	13.0		Augered	Limestone and shale, dark olive gray, medium crystalline
	13.0			Auger refusal

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 10 OF 21

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 959

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED

BY: Timothy A. Lee

PROOFED

BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter

HELPER: Fred Dixon, Tom Doonan

DRILLING METHOD:

☒ 22 INCH AUGER Tracey Mitchell L.F.
☐ INCH AUGER L.F.
☐ 14.0 INCH ROTARY L.F.
☐ 8.0 INCH ROTARY L.F.

MATERIALS USED

EST. USED
VOL. VOL.
50.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)

35.0 FT. OF 10.0 IN. SURFACE CASING

11.0 11.0 SACKS OF CEMENT (SURFACE CASING)

55.0 POUNDS OF POWDERED BENTONITE (SURFACE CASING)

88.0 GALLONS OF WATER (SURFACE CASING)

55.0 FT. OF 4.0 IN. DIA. STAINLESS STEEL CASING

20.0 FT. OF 4.0 IN. DIA. STAINLESS STEEL SCREEN

5.5 5.5 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

12.0 12.0 SACKS OF CEMENT (WELL CASING)

60.0 POUNDS OF POWDERED BENTONITE (WELL CASING)

92.0 GALLONS OF WATER (WELL CASING)

3.0 FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES
AND USED VOLUMES

N/A

SURFACE CASING TREME GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING
TREME 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 69.4 FEET.

CENTRALIZERS AT 11 FEET.

31 FEET.

51 FEET.

71 FEET

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

TYPE B WELL

LOCATION WAG4

ORNL GRID COORDINATES

N 18,729.0653

E 28,682.4383

ELEV. GROUND 770.75

ELEV. TOP STAINLESS

STEEL CASING 772.78

DRILLING DATES:

STARTED: 3/28/90

FINISHED: 4/3/90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 959

DATE: 4/3/90

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>		<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND			
		4/3/90	6
BENTONITE	Powder	4/3/90	4
	Pellets	4/3/90	5
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	4/3/90	3
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	4/3/90	3
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	4/3/90	2
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	4/3/90	2
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	10/11/90	8
GROUT	surface casing	3/30/90	7
	well casing	4/3/90	7
WELL COVERS			
SURFACE CASING		3/30/90	5

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

4/3/90

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>4/3/90</u>	<u>Tor</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>4/3/90</u>	<u>Tor</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>10/11/90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>4/3/90</u>	<u>Tor</u>

* 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

Timothy A. Lee

4/3/90

D. Charles Lytle

10/11/90

ERCE
Environmental
and Energy
Services Co.

WELL No. 959
Lower
LOCATION: WAG4

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Pumping with Geoguard pump

DEVELOPMENT
BEGAN DATE: 8/13/90 TIME: _____

DEVELOPMENT
ENDING DATE: 10/11/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 60.2 GALLONS

TOTAL GALLONS PUMPED: 556 TOTAL WELL VOLUMES PUMPED: 9.2

INITIAL pH: 9.9 FINAL pH: 10.4

INITIAL CONDUCTIVITY ($\mu S/cm$): 814 FINAL CONDUCTIVITY ($\mu S/cm$): 741

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: 4.5 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 10/11/90

D. Charles Lytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL NO. 959
Lower
LOCATION: WAG4
DATE: 8/13/90

MONITORING WELL DEVELOPMENT PROGRESS

Page 1 of 3

ONE WELL VOLUME = 60.2 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
8/13/90	1100	90	Cloudy	---	9.9	814	90	1.5	
8/17/90	0800	20	Cloudy	---	9.9	756	110	1.8	
8/17/90	1100	20	Cloudy	---	9.9	818	130	2.2	
8/17/90	1430	35	Cloudy	---	9.9	898	165	2.7	
8/20/90	0800	10	Cloudy	---	10.1	864	175	2.9	
8/21/90	0810	45	Cloudy	---	10.0	869	220	3.7	
8/22/90	0900	10	Cloudy	---	10.3	912	230	3.8	
8/23/90	1330	50	Cloudy	---	9.8	914	280	4.6	
8/23/90	0800	5	Cloudy	---	10.0	914	285	4.7	
8/23/90	1430	10	Cloudy	---	10.1	938	295	4.9	
8/24/90	0800	5	Cloudy	---	10.2	904	300	5.0	
8/24/90	1330	10	Cloudy	---	10.1	923	310	5.1	
8/27/90	0800	40	Cloudy	---	10.0	894	350	5.8	
8/27/90	1330	15	Cloudy	---	10.2	926	365	6.1	
8/28/90	0830	10	Slightly Cloudy	---	10.3	892	375	6.2	
8/28/90	1400	10	Slightly Cloudy	---	10.1	902	385	6.3	
8/29/90	0900	5	Slightly Cloudy	---	10.2	921	390	6.5	
RESULTS AT END OF DEVELOPMENT									

COMMENTS

OBSERVER SIGNATURE/DATE

D. Charles Lytle
D. Charles Lytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL NO. 959
LOCATION: Lower WAG4
DATE: 8/13/90

MONITORING WELL DEVELOPMENT PROGRESS

Page 2 of 3

ONE WELL VOLUME = 60.2 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
8/29/90	1400	5	Slightly Cloudy	----	10.3	902	395	6.6	
8/30/90	0800	5	Cloudy	----	10.2	904	400	6.6	
8/30/90	1400	10	Cloudy	----	9.8	960	410	6.8	
8/31/90	0800	5	Cloudy	----	10.2	873	415	7.0	
8/31/90	1400	11	Cloudy	----	10.2	949	426	7.1	
9/4/90	0900	5	Cloudy	----	10.3	951	431	7.2	
9/6/90	0900	10	Cloudy	----	10.2	950	441	7.3	
9/7/90	1400	5	Cloudy	----	10.3	960	446	7.4	
9/10/90	1030	5	Slightly Cloudy	----	10.4	926	451	7.5	
9/10/90	1430	5	Milky	----	10.0	924	456	7.6	
9/12/90	1300	5	Milky	----	10.0	863	461	7.7	
9/12/90	0800	15	Cloudy	----	10.4	908	476	7.9	
9/14/90	1400	15	Cloudy	----	10.0	942	491	8.2	
9/17/90	1000	10	Cloudy	----	10.0	914	501	8.3	
9/18/90	0800	10	Slightly Cloudy	----	10.5	923	511	8.5	
9/18/90	1000	5	Slightly Cloudy	----	10.3	876	516	8.6	
9/21/90	1400	10	Slightly Cloudy	----	10.1	977	526	8.7	
RESULTS AT END OF DEVELOPMENT									

COMMENTS

OBSERVER SIGNATURE/DATE

MYFORMS.DWG

Page 3 of 3

ONE WELL VOLUME = 60.2 GALLONS

COMMENTS Very poor recharger and producer. Pumped dry in under a 1/2 hour.
Water finally cleared to 5.0 NTU's.

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ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 959

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.: 959

DATE OF TEST: 10-30-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

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 = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 51.25 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 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

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

2.5847
2.5854

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.620	2.620
20.00	3.620	2.620
30.00	3.620	2.620
40.00	3.600	2.600
50.00	3.580	2.580
60.00	3.580	2.580
75.00	3.580	2.580
90.00	3.580	2.580
105.00	3.570	2.570
120.00	3.570	2.570
150.00	3.570	2.570
180.00	3.560	2.560
240.00	3.560	2.560
300.00	3.560	2.560
360.00	3.560	2.560
420.00	3.560	2.560
480.00	3.560	2.560
540.00	3.560	2.560
600.00	3.540	2.540
720.00	3.540	2.540
840.00	3.540	2.540
960.00	3.540	2.540
1080.00	3.540	2.540
1200.00	3.530	2.530
1320.00	3.530	2.530
1440.00	3.530	2.530
1560.00	3.510	2.510
1680.00	3.510	2.510
1800.00	3.510	2.510
1920.00	3.510	2.510
2040.00	3.510	2.510
2160.00	3.510	2.510

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $4.45\text{E-}08$ FT/SEC = $1.36\text{E-}06$ CM/SEC

TRANSMISSIVITY = $8.89\text{E-}07$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $5.15\text{E-}08$ FT/SEC = $1.57\text{E-}06$ CM/SEC

TRANSMISSIVITY = $1.03\text{E-}06$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 960 is located in WAG 4. It is located approximately 1500 feet southwest from the intersection of Melton Valley Drive and Lagoon Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 18,742.0354, E 28,674.3737 (X-10 grid) or latitude 35°-54'-55.81" and longitude 84°-19'-02.55". 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 960 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4 rig was used to drill this boring for monitor well installation under the operation of Larry Ledbetter with the assistance of Fred Dixon, Tom Doonan and Tracy Mitchell. Drilling commenced on 3/30/90 and was finished on 4/4/90. 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. This

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

3/30/90: This location was determined to be a Class III. Moved rig to location and set up a two layers of plastic sheeting. Augered from surface to 10.0 feet using a 14.0 inch auger (RAD = <0.1 MR/hr, OVA = $<.05$ ppm). The location was downgraded to Class II. Set 10.0 feet of decontaminated 10.0 inch steel diverter casing. Grouted annulus with 5.0 sacks cement.

4/3/90: Drill from 10.0 to 32.5 feet using an 8.0 inch air rotary tricone bit into containment box (RAD = <0.1 MR/hr, OVA = $<.05$ ppm).

4/4/90: Set 2.0 inch stainless steel screen and casing with sandpack and bentonite seal. Grouted annulus with 4.5 sacks cement.

This well was logged by ERC Environmental and Energy Services Co. (ERC) hydrogeologist Timothy A. Lee. 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 is underlain by limestone, 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

2.3 Sample Collection

No samples were collected.

2.4 Installation and Development

2.4.1 Installation

This was a Type D well. A 14.0-inch diameter boring was augered from ground surface to 10.0 feet. The air rotary method was required to complete the boring to the specified

total well depth. Therefore, a 10.0-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 10.0 to 32.5 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 17.2 to 32.5 feet. A 2-inch diameter stainless steel casing was installed above the screen at 17.2 feet and extended 2.08 feet above ground surface. A sandpack was then tremied into the annular space from 32.5 feet up to 14.5 feet, with a 3.3-foot bentonite pellet seal poured into the annular space above the sandpack from 11.2 to 14.5 feet. The annular space from the top of the bentonite seal to the surface was tremie-grouted with a cement/bentonite slurry. A detail of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 960 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 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 8/17/90 at a depth of 32.2 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 960 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 2.46×10^{-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. 960

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED.	<u>3/30/90</u>	<u>TML</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>3/30/90</u>	<u>TML</u>
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.	<u>N/A</u>	<u>N/A</u>
3b. PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	<u>4/4/90</u>	<u>TML</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>4/4/90</u>	<u>TML</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	<u>3/30/90</u>	<u>TML</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>4/4/90</u>	<u>TML</u>

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

4/4/90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 960

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

4/4/90

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG4

DRILLER: Larry Ledbetter

HELPER: Fred Dixon, Tracey Mitchell, Tom
Doonan

DRILL: Ingersoll Rand T-4

DATE: START: 3/30/90
FINISH: 4/4/90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: C.E. Stooksbury

TYPE DRILLING: Auger, Air rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: None TYPE: N/A
CONTAINMENT TYPE: Plastic, pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 13.0'

DEPTH DRILLED IN ROCK: 20.5'

TOTAL DEPTH OF WELL: 32.5'

DRILLING FLUID SAMPLES:
TYPE: N/A DATE: N/A

PAGE 8 OF 17

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Timothy Lee, Bruce
PROOFED BY: Michael L. Ebers
McMaster

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter
HELPER: Fred Dixon, Tracey Mitchell
Tom Doonan

EQUIPMENT
☒ 14 INCH AUGER 10 L.F.
☐ INCH AUGER L.F.
☒ 8 INCH ROTARY 22.5 L.F.

MATERIALS USED

EST. USED
VOL. VOL.
15.0 FEET OF 2 IN. S.S. SCREEN
20.0 FEET OF 2 IN. S.S. CASING
4.0 4.5 SACKS OF SAND
50 50 POUNDS OF BENTONITE PELLETS
3.5 4.5 SACKS OF CEMENT
17.5 POUNDS OF POWDERED BENTONITE
28.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and spillage

WELL COVER USED
☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER
SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 32.2 FEET.

CENTRALIZERS AT 19.5 FEET.
31.0 FEET.
FEET.

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

HOLE CLEANED OUT
TO 32.5 FEET

BOTTOM OF BOREHOLE
32.5 FEET

LOCATION WAG4
ORNL GRID COORDINATES
N 18,742.0354
E 28,674.3737
ELEV. GROUND 770.94
ELEV. TOP STAINLESS
STEEL CASING 773.02
DRILLING DATES:
STARTED: 3/30/90
FINISHED: 4/4/90

LOCKING STEEL COVER
8 INCH DIAMETER
STEEL PROTECTIVE CASING
3.04 FT. ABOVE GROUND
TO 2.0 FT. BELOW
GROUND SURFACE
CONCRETE PAD
10 INCH DIVERTER
CASING 0.0 FT. ABOVE
GROUND SURFACE TO
10.0 FT. BELOW GROUND
SURFACE
14 INCH BOREHOLE
0 TO 10 FEET
GROUT SEAL 0.0 TO
11.2 FEET
8 INCH DIAMETER
BOREHOLE
2 INCH DIAMETER STAINLESS
STEEL CASING 2.08 FT. ABOVE
GROUND SURFACE TO 17.2 FT.
BELOW GROUND SURFACE
CENTRALIZER (TYP.)
BENTONITE PELLET SEAL
11.2 TO 14.5 FEET
SAND PACK
14.5 TO 32.5 FEET
2 INCH DIAMETER
STAINLESS STEEL 0.010
SLOTTED SCREEN
17.2 TO 32.2 FEET
2 INCH DIAMETER STAINLESS
STEEL SILT TRAP/CAP
32.2 TO 32.5 FEET

TYPE D WELL

NOT TO SCALE

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and Energy
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WELL No. 960

DATE: 4/4/90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL	DATE USED	BATCH NUMBER
SAND	4/4/90	6
BENTONITE	4/4/90	4
	4/4/90	5
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	4/4/90	3
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	4/4/90	3
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	4/4/90	2
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	4/4/90	2
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	8/17/90	8
GROUT		
well casing	4/4/90	7
WELL COVERS		
SURFACE CASING		

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

4/4/90

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>4/4/90</u>	<u>Tbz</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>4/4/90</u>	<u>Tbz</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>8/17/90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>4/4/90</u>	<u>Tbz</u>

* 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

Timothy A. Lee 4/4/90
Timothy A. Lee

D. Charles Lytle 8/17/90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 960
Lower
LOCATION: WAG4

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Pumping with Geoguard pump

DEVELOPMENT
BEGAN DATE: 8/13/90 TIME: _____

DEVELOPMENT
ENDING DATE: 8/17/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 11.1 GALLONS

TOTAL GALLONS PUMPED: 165 TOTAL WELL VOLUMES PUMPED: 14.8

INITIAL pH: 8.9 FINAL pH: 8.5

INITIAL CONDUCTIVITY ($\mu S/cm$): 567 FINAL CONDUCTIVITY ($\mu S/cm$): 508

DESCRIPTION OF INITIAL TURBIDITY: Slightly 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	☐ GROUND SURFACE	☐ TANK TRUCK
DISCHARGED	☐ STORM SEWERS	☐ STORAGE TANKS
TO:	☒ DRUMS	☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 8.1 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 8/17/90

D. Charles Lytle

ONE WELL VOLUME = 11.1 GALLONS

COMMENTS	Excellent recharger and producer. OVA test didn't detect anything.
	Checked first thing every morning and periodically through out the day with OVA.

8/17/90

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WELL No. 960

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.: 960

DATE OF TEST: 10-10-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 25.30 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

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

3.0774
3.1179

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.820	3.820
20.00	4.700	3.700
30.00	4.600	3.600
40.00	4.480	3.480
50.00	4.390	3.390
60.00	4.300	3.300
75.00	4.190	3.190
90.00	4.080	3.080
105.00	3.970	2.970
120.00	3.890	2.890
150.00	3.690	2.690
180.00	3.550	2.550
240.00	3.270	2.270
300.00	3.020	2.020
360.00	2.850	1.850
420.00	2.680	1.680
480.00	2.560	1.560
540.00	2.440	1.440
600.00	2.330	1.330
720.00	2.150	1.150
840.00	2.010	1.010
960.00	1.890	.890
1080.00	1.840	.840
1200.00	1.740	.740
1320.00	1.730	.730
1440.00	1.630	.630
1560.00	1.590	.590
1680.00	1.550	.550
1800.00	1.510	.510
1920.00	1.470	.470
2040.00	1.460	.460
2160.00	1.430	.430

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WELL No. 960

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $8.06E-07$ FT/SEC = $2.46E-05$ CM/SEC

TRANSMISSIVITY = $1.21E-05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.10E-06$ FT/SEC = $3.35E-05$ CM/SEC

TRANSMISSIVITY = $1.65E-05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 961 is located in WAG 4. It is located along the southwest perimeter of WAG 4 approximately 500 feet west of Chemical Waste Pit Number 6. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 18,799.1817, E 27,371.3767 (X-10 grid) or latitude 35°-54'-49.11" and longitude 84°-19'-16.10". 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 961 was drilled by Geotek Engineering Company. A Mobile B-50 and Ingersoll Rand T-4 rig were used to drill this boring for monitor well installation under the operation of Rick Herron and Larry Ledbetter with the assistance of James Shelton and Fred Dixon. Drilling commenced on 9/26/89 and was finished on 10/16/89. 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. This information was typed directly from field notes and was edited only when necessary for clarification.

- 9/26/89: The Mobile B-50 rig and tools were steam cleaned and mobilized to the staked location. The boring was split spooned and drilled with 8" hollow stem augers from 0.0 to 15.17 feet and augered to 28.0 feet. No radiation was detected, so Carl Stooksbury temporarily deregulated the boring to a Class I. The boring was reamed with 22-inch augers from 0.0 to 6.5 feet. Decontaminated and installed a 7.0 feet joint of 15 1/4-inch diverter casing.
- 10/3/89: The Ingersoll Rand T-4 and tools were steam cleaned and mobilized to the site.
- 10/4/89: The boring was drilled from 6.5 to 10.0 feet with 14-inch tricone and containment, changed to 14-inch augers and augered from 10.0 to 28.0 feet. Deepened boring from 28.0 to 33.0 feet with 14-inch tricone air rotary. Decontaminated 32.5 feet of 10 3/4-inch surface casing and ran in hole. Pulled rig off hole.
- 10/5/89: Grouting annulus of surface casing.
- 10/9/89: Steam cleaned Ingersoll Rand T-4 and tools and mobilized to location. Deepened boring from 33.0 to 80.3 feet with 8-inch tricone air rotary. Checked for water at 60 and 80 feet. Had 2 feet of water in 10 minutes at 60 and 4.5 feet of water in 10 feet at 80 feet.
- 10/10/89: Had 48 feet of water overnight. Blew boring clean and ran in 4-inch stainless steel casing and screen. Tremied in sandpack and installed

bentonite seal above sandpack. Grouted annulus through 1-inch tremie pipe.

10/16/89: Well tested with "Go-No Go Gauge" and passed.

This well was logged by ERC Environmental and Energy Services Co. (ERC) hydrogeologists C. Allison Hodges and 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

2.3 Sample Collection

One soil/rock 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. Soil sample 961SO1 was collected in the augered interval from 23.0 to 28.0 feet on 9/26/89. A drill water sample was collected from the water pump on the drill rig on 10/9/89. Analytical results for the 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 4.6 to 5.0 feet. The sample was measured and weighed, and a bulk density of 2.06 grams/cm³ was calculated.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 10/9/89. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter did not fluoresce.

2.4 Installation and Development

2.4.1 Installation

This was a Type B well. A 22.0-inch diameter boring was augered from ground surface to 4.0 feet. A 15 1/4-inch diverter casing was installed from surface to 6.5 feet below ground surface and grouted in place. A 14-inch diameter boring was augered from 6.5 feet to 28.0 feet (auger refusal). The boring was then extended past the refusal depth with a 14-inch air rotary tricone roller bit from 28.0 feet to 33.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 32.5 feet, sealed with a 3.2 foot bentonite pellet layer from 53.3 feet to 56.5 feet, and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. After the surface casing was installed, the air rotary method was used to drill an 8-inch diameter boring to a total depth of 80.3 feet. A 4-inch diameter stainless steel screen with a silt trap/cap was installed from 60.0 feet to 80.3 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 60.0 feet and extended 2.3 feet above ground surface. A sandpack was then tremied into the annular space from 80.3 feet up to 56.5 feet, with a 3.2-foot bentonite pellet seal poured into the annular space above the sandpack from 53.3 to 56.5 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 961 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 490 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 8/17/90 at a depth of 78.8 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 961 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 4.60×10^{-6} cm/second (shown as permeability on the hydraulic

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MONITORING WELL PROGRAM
WELL DATA NARRATIVE
WELL No. 961

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.

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WELL No. 961

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

DATE **INITIALS**

1.	EXCAVATION PERMIT OBTAINED.	<u>9/26/89</u>	<u>CAH</u>
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>9/26/89</u>	<u>CAH</u>
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.	<u>N/A</u>	<u>N/A</u>
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	<u>10/10/89</u>	<u>ME</u>
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>9/26/89</u>	<u>CAH</u>
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	<u>9/26/89</u>	<u>CAH</u>
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>9/26/89</u>	<u>CAH</u>

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

C. Allison Hodges 9/26/89
Michael E. Ebers 10/10/89

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WELL No. 961

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE C. Allison Hodges 9/26/89
C. Allison Hodges

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and Energy
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WELL No. 961

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG4
DRILLER: Rick Herron/Larry Ledbetter
HELPER: James Shelton/Fred Dixon
DRILL: Mobile B-50/Ingersoll Rand T-4

DATE: START: 9/26/89
FINISH: 10/10/89
LOGGED BY: C. Allison Hodges
Michael L. Ebers
HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Split spoon, auger, Air rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: One TYPE: Soil/rock
CONTAINMENT TYPE: Plastic, auger pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 28.0'
DEPTH DRILLED IN ROCK: 52.3'
TOTAL DEPTH OF WELL: 80.3'

DRILLING FLUID SAMPLES:
TYPE: Drill Water DATE: 10/9/89
(961W01)

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	2.0			Gravel and clay
2.0	3.7		100%	Shale, light brown, moderate brown and pale olive, claylike, moist, highly weathered, thinly laminated bedding, breaks at 45° angle, silty, crumbly, dry
3.7	4.0		100%	Shale, pale olive, sandy, micaceous
4.0	4.4		75%	Shale, very sandy, crumbly, dark yellowish orange, pale olive, micaceous
4.4	5.0			Shale, light brown, hard, layered, brittle, with pale olive and dusky yellow clay lenses, iron stained, with dark yellowish green and bright green silty to sandy, micaceous lenses Bulk density @ 4.6 to 5.0 feet = 2.06g/cm ³
5.0	6.0		100%	Shale, thinly laminated, grayish orange and dusky yellow, micaceous, dry
6.0	8.5		100%	Shale, mottled, dark yellowish orange, light brown with greenish gray to light gray lenses, bedded, crumbly, iron stained; silty, sandy micaceous, dry, grayish black lenses
8.5	9.8		30%	Shale, mottled, dark yellowish orange and light

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WELL No. 961

ORNL MONITORING WELL LOG

PAGE 2 OF 2

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
				brown with greenish gray to light gray lenses, crumbly, dry, with clay, silty, sandy and micaceous lenses, horizontal bedding
9.8	13.5		80%	Shale, very clayey, dry, weathered, mottled, dark yellowish orange, light brown, crumbly, almost layered with thin lenses of pale blue green clay, moist, cracks filled with a reddish brown silty sand, iron stained
13.5	14.0		100%	Shale, medium dark gray, bedded, with silt lenses horizontal bedding
14.0	15.2		20%	Shale, medium dark gray, bedded, sandy, micaceous fairly hard, damp
	15.2			Split spoon refusal
15.2	23.0			Shale, medium gray, thin bedded, crumbly, brittle silty, micaceous, moist
23.0	28.0	961S01 @ 23.0 - 28.0		Shale, medium dark gray, with thinly laminated silt beds, greenish gray
	28.0			Auger refusal
28.0	30.5			*Fairly hard drilling, smooth
30.5	33.0			Hard rough drilling, irregular drilling, slow
33.0	66.0			Fairly soft, smooth drilling, thin hard streaks @ 51' to 55'
66.0	70.0			Fairly hard
70.0	80.3			Alternating soft and hard drilling
	80.3			Total Depth
				* Detailed lithologic log not available from 28.0' to 80.3' T.D. due to the use of a containment box.

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WELL No. 961

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED C. Allison Hodges & PROOFED
BY: Michael L. Ebers BY: Michael L. Ebers

DRILLING COMPANY: Geotek

Rick Herron/

DRILLER: Larry Ledbetter HELPER: James Shelton/Fred Dixon

DRILLING METHOD: ☒ 22 INCH AUGER 6.5 L.F.
☒ 14 INCH AUGER 26.0 L.F.
☐ INCH ROTARY L.F.
☒ 8 INCH ROTARY 47.8 L.F.

MATERIALS USED

EST. USED
VOL. VOL.
50.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
32.5 FT. OF 10 IN. SURFACE CASING
7.8 7.0 SACKS OF CEMENT (SURFACE CASING)
35.0 POUNDS OF POWERED BENTONITE (SURFACE CASING)
42.0 GALLONS OF WATER (SURFACE CASING)
62.3 FT. OF 4 IN. DIA. STAINLESS STEEL CASING
20.0 FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
6.0 5.5 SACKS OF SAND
64.0 50.0 POUNDS OF BENTONITE PELLETS
12.1 18 SACKS OF CEMENT (WELL CASING)
90 POUNDS OF POWERED BENTONITE (WELL CASING)
108 GALLONS OF WATER (WELL CASING)
3.11 FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES
AND USED VOLUMES

Wash out zones 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 78.8 FEET.

CENTRALIZERS AT 18 FEET.

38 FEET.

58 FEET.

78 FEET

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

LOCATION WAG4

ORNL GRID COORDINATES

N 18,799.1817

E 27,371.3767

ELEV. GROUND 837.66

ELEV. TOP STAINLESS

STEEL CASING 839.50

DRILLING DATES:

STARTED: 9/26/89

FINISHED: 10/10/89

TYPE B WELL

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 961

DATE: 10/10/89

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL	DATE USED	BATCH NUMBER
SAND	10/10/89	1
BENTONITE	10/10/89	MMES Stores
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	10/10/89	MMES Stores
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	10/10/89	MMES Stores
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	10/10/89	MMES Stores
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	10/10/89	MMES Stores
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	6/7/90	8
GROUT	10/5/89	1
	10/10/89	2
WELL COVERS		
SURFACE CASING	10/4/89	1

COMMENTS:

OBSERVER SIGNATURE/DATE

Michael L. Ebers

10/10/89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 961

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

	<u>COMPLIANCE</u> <u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>10/10/89</u>	<u>MLE</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>10/10/89</u>	<u>MLE</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>6/7/90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>10/11/89</u>	<u>MLE</u>

* 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
Michael L. Ebers

10/10/89

D. Charles Lytle
D. Charles Lytle

6/7/90

ERCE
Environmental
and Energy
Services Co.

WELL No. 961
Upper
LOCATION: WAG4

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 5/25/90

TIME: _____

DEVELOPMENT
ENDING DATE: 6/7/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 57.0 GALLONS

TOTAL GALLONS PUMPED: 490 TOTAL WELL VOLUMES PUMPED: 8.6

INITIAL pH: 7.9 FINAL pH: 8.4

INITIAL CONDUCTIVITY ($\mu S/cm$): 500 FINAL CONDUCTIVITY ($\mu S/cm$): 510

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: 17.8 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle 6/7/90
D. Charles Lytle

HYDROLOG

WELL NO. 961
Upper
LOCATION: WAG4
DATE: 5/25/90

ONE WELL VOLUME = 57.0 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU/ S)	pH	CONDUCTIVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
5/25/90	1400	36	Cloudy	---	7.9	500	36		
5/29/90	0900	25	Cloudy	---	8.0	441	61	1.1	
5/29/90	1100	10	Cloudy	---	8.4	468	71	1.2	
6/3/90	1430	170	Cloudy	---	8.6	514	241	4.2	
6/4/90	1100	70	Slightly Cloudy	---	8.3	477	311	5.5	
6/5/90	1300	20	Slightly Cloudy	---	8.4	473	331	5.8	
6/6/90	1003	46	Slightly Cloudy	---	8.4	567	377	6.6	
6/6/90	1303	55	Slightly Cloudy	---	8.5	543	432	7.6	
6/7/90	1000	58	Clear	5.0	8.4	510	490	8.6	
RESULTS AT END OF DEVELOPMENT			Clear	5.0	8.4	510	490	8.6	

COMMENTS

Good producer. Water remained clear after surging. Passed with
moved to another hole.

OBSERVER SIGNATURE/DATE

D. Charles Lytle 6/7/90
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.: 961

DATE OF TEST: 10-30-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

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 = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 60.00 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 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

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

SUCCESSIVE COMPUTED
VALUES FOR H₀
(FEET)

2.7082
2.7092

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.750	2.750
20.00	3.750	2.750
30.00	3.750	2.750
40.00	3.710	2.710
50.00	3.710	2.710
60.00	3.700	2.700
75.00	3.700	2.700
90.00	3.700	2.700
105.00	3.680	2.680
120.00	3.680	2.680
150.00	3.680	2.680
180.00	3.670	2.670
240.00	3.650	2.650
300.00	3.650	2.650
360.00	3.650	2.650
420.00	3.630	2.630
480.00	3.630	2.630
540.00	3.630	2.630
600.00	3.590	2.590
720.00	3.570	2.570
840.00	3.560	2.560
960.00	3.530	2.530
1080.00	3.530	2.530
1200.00	3.530	2.530
1320.00	3.530	2.530
1440.00	3.510	2.510
1560.00	3.510	2.510
1680.00	3.480	2.480
1800.00	3.450	2.450
1920.00	3.420	2.420
2040.00	3.420	2.420
2160.00	3.420	2.420

1221-H.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 1.51E-07 FT/SEC = 4.60E-06 CM/SEC

TRANSMISSIVITY = 3.02E-06 FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 1.74E-07 FT/SEC = 5.31E-06 CM/SEC

TRANSMISSIVITY = 3.49E-06 FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

Engineering, Design & Geosciences Group, Inc.
726 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

961501

WELL NO.

961

LOCATION:

UAG-4

TYPE:

Soil / Rock

SAMPLER:

C. Johnson (SIGNATURE)

SAMPLE INTERVAL:

2' to 4'

DATE:

9-26-89

TIME:

1108

RELINQUISHED BY:
(SIGNATURE)

C. Johnson

DATE:

10-3-89

TIME:

WITH:

EDC

RECEIVED BY:
(SIGNATURE)

J. P. ...

DATE:

10-3-89

TIME:

1530

WITH:

TYPE OF SAMPLE:

☐ SPLIT SPOON CORES-SOIL

☐ AUGER CUTTINGS-SOIL

☐ AUGER CUTTINGS-ROCK

☐ AIR ROTARY CUTTINGS-ROCK

☐ DRILL WATER (NO AIR IN SAMPLE)

☒ OTHER

Auger Cuttings - Soil/Rock

ALL SAMPLES ARE IMMEDIATELY PLACED IN I-CHEM SPECIALTY CLEANED CONTAINERS AND SEALED.

REMARKS:

Engineering, Design & Geosciences Group, Inc.
726 Pellissippi Parkway
P.O. Box 23010 Knoxville, TN 37833-1010

CHAIN OF CUSTODY RECORD

FOR

MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE
NUMBER

961W61

WELL NO.

961

LOCATION:

WAG 4

TYPE:

DRILL WATER

SAMPLER:

Michael J. Shum

SAMPLE INTERVAL:

NA

(SIGNATURE)

DATE:

10/9/89

TIME:

1600

RELINQUISHED BY:
(SIGNATURE)

Michael J. Shum

DATE:

10/16/89

TIME:

EDGE

WITH:

RECEIVED BY:
(SIGNATURE)

J.P. Allen

DATE:

10-16-89

TIME:

10:15

WITH:

ORAL

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 1-CHEM SPECIALTY CLEANED CONTAINERS AND SEALED.

REMARKS: SAMPLE TAKEN FROM WATER PUMP ON SIDE OF RIG

1.0 General Information

1.1 Well Location

Monitoring well number 962 is located in WAG 4. It is located along the southwest perimeter of WAG 4 approximately 500 feet west of Chemical Waste Pit Number 6. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 18,809.0525, E 27,387.5223 (X-10 grid) or latitude 35°-54'-49.28" and longitude 84°-19'-16.00". 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 962 was drilled by Geotek Engineering Company. A Mobile B-50 rig was used to drill this boring for monitor well installation under the operation of Rick Herron with the assistance of Fred Dixon. Drilling commenced on 10/11/89 and was finished on 10/11/89. 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. This information was typed directly from field notes and was edited only when necessary for clarification.

10/11/89: The Mobile B-50 auger rig and tools were steam cleaned and mobilized to the staked location. The boring was augered from 0.0 to 37.7 feet with 8-inch hollow stem augers. Water was encountered at 30 feet. The boring was bailed dry to remove the cuttings and mud. Two inch stainless steel screen and casing were installed. The sandpack was tremied in place and a bentonite seal was placed above the sand. The annulus was grouted to the surface.

This well was logged by ERC Environmental and Energy Services Co. (ERC) 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 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 4 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 4 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. The Pumpkin Valley Shale and Rutledge Limestone underlie WAG 4. Strike in and near WAG 4 ranges from N 85° E to N 15° E and dip varies from 27° to vertical. These variations in strike and dip indicate that the Conasauga has been deformed in the locale of WAG 4.

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 2-inch diameter stainless steel silt trap was installed from 36.94 to 37.18 feet. Above the silt trap a 2-inch diameter stainless steel screen was installed from 26.6 to 36.94 feet. A 2-inch diameter stainless steel casing was installed above the screen from

26.6 feet to 2.3 feet above ground surface. A sandpack was then poured into the annular space from 37.18 feet up to 25.2 feet, with a 2.5-foot bentonite pellet seal poured into the annular space above the sandpack from 22.7 to 25.2 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 962 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 790 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 6/14/90 at a depth of 34.5 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 962 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 4.74×10^{-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. 962

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED.	<u>10/11/89</u>	<u>MJE</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>10/11/89</u>	<u>MJE</u>
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.	<u>N/A</u>	<u>N/A</u>
3b. PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	<u>10/11/89</u>	<u>MJE</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>10/11/89</u>	<u>MJE</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	<u>10/11/89</u>	<u>MJE</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>10/11/89</u>	<u>MJE</u>

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Michael L. Ebers
Michael L. Ebers

10/11/89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 962

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Michael L. Ebers

10/11/89

Michael L. Ebers

WELL No. 962

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG4

DRILLER: Rick Herron

HELPER: Fred Dixon

DRILL: Mobile B-50

DATE: START: 10/11/89
FINISH: 10/11/89
LOGGED BY: Michael L. Ebers
HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Auger LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: None TYPE: N/A
CONTAINMENT TYPE: Auger pan and plastic

THICKNESS OF SOIL (REFUSAL DEPTH): N/A
DEPTH DRILLED IN ROCK: N/A
TOTAL DEPTH OF WELL: 37.7'

DRILLING FLUID SAMPLES:

TYPE: N/A DATE:

[illegible]

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 962

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Michael L. Ebers PROOFED BY: C. Allison Bailey

DRILLING COMPANY: Geotek

DRILLER: Rick Herron HELPER: Fred Dixon

EQUIPMENT ☒ 8.0 INCH AUGER 38.0 L.F.
☐ _____ INCH AUGER _____ L.F.

MATERIALS USED

EST. USED
VOL. VOL.

10.34 FEET OF 2 IN. S.S. SCREEN
28.9 FEET OF 2 IN. S.S. CASING
2.8 3.0 SACKS OF SAND
35 30.0 POUNDS OF BENTONITE PELLETS
3.3 4.0 SACKS OF CEMENT
20.0 POUNDS OF POWDERED BENTONITE
24.0 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 34.5 FEET.

CENTRALIZERS AT 2 FEET.
17 FEET.
35 FEET.

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

HOLE CLEANED OUT
TO 37.18 FEET
BOTTOM OF BOREHOLE
38.0 FEET

LOCATION WAG4
ORNL GRID COORDINATES
N 18.809.0525
E 27.387.5223
ELEV. GROUND 835.77
ELEV. TOP STAINLESS
STEEL CASING 837.74
DRILLING DATES:
STARTED: 10/11/89
FINISHED: 10/11/89

LOCKING STEEL COVER
8 INCH DIAMETER
STEEL PROTECTIVE CASING
3.17 FT. ABOVE GROUND
TO 2.0 FT. BELOW
GROUND SURFACE
CONCRETE PAD
GROUT SEAL 0.0 TO
22.7 FEET
8.0 INCH DIAMETER
BOREHOLE
2 INCH DIAMETER STAINLESS
STEEL CASING 1.97 FT. ABOVE
GROUND SURFACE TO 26.6 FT.
BELOW GROUND SURFACE
CENTRALIZER (TYP.)
BENTONITE PELLET SEAL
22.7 TO 25.2 FEET
SAND PACK
25.2 TO 37.18 FEET
2 INCH DIAMETER
STAINLESS STEEL 0.010
SLOTTED SCREEN
26.6 TO 36.94 FEET
2 INCH DIAMETER STAINLESS
STEEL SILT TRAP/CAP
36.94 TO 37.18 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 962

DATE: 10/11/89

MONITORING WELL MATERIALS CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	10/11/89	1
BENTONITE	10/11/89	MMES Stores
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	10/11/89	MMES Stores
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	10/11/89	MMES Stores
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	10/11/89	MMES Stores
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	10/11/89	MMES Stores
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	6/14/90	8
GROUT	10/11/89	2
WELL COVERS		
SURFACE CASING	10/89	1

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 10/11/89
 Michael L. Ebers

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 962

POST-WELL COMPLETION
CHECKLIST

		COMPLIANCE	
		DATE	INITIALS
<u>POST-WELL COMPLETION TASKS</u>			
1.	MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>10/11/89</u>	<u>ME</u>
2.	ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>10/11/89</u>	<u>ME</u>
3.	WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>6/14/90</u>	<u>DCL</u>
4.	DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>10/12/89</u>	<u>ME</u>

* 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

10/11/89

D. Charles Lytle

6/14/90

OBSERVER SIGNATURE/DATE
 D. Charles Lytle 6/14/90

DEVELOPMENT OBSERVATIONS

INITIAL PRE-DEVELOPMENT
 WATER DEPTH: 8.5 feet from ground surface

TO: ☐ DRUMS ☐ OTHER
☐ STORM SEWERS ☐ STORAGE TANKS
☒ GROUND SURFACE ☐ TANK TRUCK
 DISCHARGED
 OF WATER: None
 ODOR

WELL APPROVED BY: R.C. Williams MRES

FINAL MEASURED TURBIDITY: 2.0 NTU's

DESCRIPTION OF FINAL TURBIDITY: Clear

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

INITIAL CONDUCTIVITY (uS/cm): 519
 FINAL CONDUCTIVITY (uS/cm): 534

INITIAL pH: 7.9
 FINAL pH: 8.2

TOTAL GALLONS PUMPED: 790
 TOTAL WELL VOLUMES PUMPED: 84.0

ONE WELL VOLUME: 9.4 GALLONS

OBSERVED BY: D. Charles Lytle

DEVELOPMENT
 ENDING DATE: 6/14/90

DEVELOPMENT
 BEGAN DATE: 6/1/90
 TIME:

METHOD OF
 DEVELOPMENT: Surging and pumping

DEVELOPMENT DETAILS

MONITORING WELL
 DEVELOPMENT FORM

ERCE
 Environmental
 and Energy
 Services Co.

WELL No. 962
 Upper
 LOCATION: WAG4

ERC / EDGE
Environmental
and Energy
Services Co.

WELL NO. 962
LOCATION: Upper WAG4
DATE: 6/1/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 9.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
6/1/90	1430	48	Cloudy	---	7.9	519	48	5.1	
6/4/90	1300	34	Cloudy	---	8.0	476	82	8.7	
6/5/90	1100	118	Muddy	---	8.5	517	200	21.2	
6/5/90	1430	90	Muddy	---	8.4	555	290	30.8	
6/6/90	1002	43	Cloudy	---	7.8	596	333	35.4	
6/6/90	1304	33	Cloudy	---	7.7	554	366	38.9	
6/7/90	1000	40	Cloudy	---	8.3	519	406	43.2	
6/7/90	1430	55	Cloudy	---	8.1	509	461	49.0	
6/8/90	1105	60	Cloudy	---	7.7	580	521	55.4	
6/11/90	1400	25	Cloudy	---	7.7	542	546	58.1	
6/12/90	1045	35	Cloudy	---	7.5	555	581	61.8	
6/12/90	1500	58	Cloudy	---	7.7	610	639	68.0	
6/13/90	1100	12	Slightly Cloudy	---	8.0	514	651	69.3	
6/13/90	1330	17	Slightly Cloudy	---	7.8	538	668	71.1	
6/14/90	1430	122	Clear	2.0	8.2	534	790	84.0	
6/12/90	*	45					835	88.8	
RESULTS AT END OF DEVELOPMENT			Clear	2.0	8.2	534	835	88.8	

COMMENTS Water started out cloudy when pumping was started on 6/1/90, then turned black on the 5th of June. Couldn't tell if it was mud or grout. Water would not clear up. On the 12th of June we took the work over rig and pumped all of the mud out. Water finally cleared on 6/14/90. Passed with 2.0 NTU's and 88.8 well volumes.

OBSERVER SIGNATURE/DATE D. Charles Lytle 6/14/90
D. Charles Lytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 962

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.: 962

DATE OF TEST: 10-30-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-4

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.34 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 26.60 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.34 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

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

SUCCESSIVE COMPUTED
VALUES FOR H₀
(FEET)

3.3657

3.3962

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	5.350	4.350
20.00	5.120	4.120
30.00	4.900	3.900
40.00	4.730	3.730
50.00	4.580	3.580
60.00	4.450	3.450
75.00	4.250	3.250
90.00	4.090	3.090
105.00	3.950	2.950
120.00	3.840	2.840
150.00	3.600	2.600
180.00	3.430	2.430
240.00	3.140	2.140
300.00	2.920	1.920
360.00	2.740	1.740
420.00	2.580	1.580
480.00	2.410	1.410
540.00	2.300	1.300
600.00	2.180	1.180
720.00	2.010	1.010
840.00	1.870	.870
960.00	1.750	.750
1080.00	1.640	.640
1200.00	1.570	.570
1320.00	1.470	.470
1440.00	1.420	.420
1560.00	1.360	.360
1680.00	1.300	.300
1800.00	1.250	.250
1920.00	1.240	.240
2040.00	1.190	.190
2160.00	1.180	.180

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.56E-06$ FT/SEC = $4.74E-05$ CM/SEC

TRANSMISSIVITY = $1.61E-05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $2.15E-06$ FT/SEC = $6.55E-05$ CM/SEC

TRANSMISSIVITY = $2.22E-05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

Reviewed by: Bene J. Bowles Date 1/16/90
Higher Level Manager
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 ^{ME} 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 <u>Project Manager</u>	J.A. GREENE	11/19/89
A other <u>Environmental Compliance</u>	C.E. Nix	10/5/89
R other <u>Waste Management</u>	C.B. Scott	11/1/89

Is revision of the SAR/OSR required? — YES ☒ 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 hydrogeologist.

- 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.

*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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1

FINAL ASS'Y.

2

NEXT ASS'Y.:

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FINAL ASS'Y.:

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NO REPRESENTATION OR WARRANTY, EXPRESSED OR IMPLIED, IS MADE AS TO THE ACCURACY, COMPLETENESS OR USEFULNESS OF THE INFORMATION OR STATEMENTS CONTAINED IN THESE DRAWINGS, OR THAT THE USE OR DISCLOSURE OF ANY INFORMATION, APPARATUS, METHOD OR PROCESS DISCLOSED IN THESE DRAWINGS MAY NOT INFRINGE PRIVATE RIGHTS OF OTHERS. NO LIABILITY IS ASSUMED WITH RESPECT TO THE USE OF, OR FOR DAMAGES RESULTING FROM THE USE OF ANY INFORMATION, APPARATUS, METHOD OR PROCESS DISCLOSED IN THESE DRAWINGS.

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WAG 4
BOUNDARY

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ILL. N. E. L. A. REA

7

STREAM
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<u>NORTHING</u>	<u>EASTING</u>
18,959.25	27,001.43
18,977.16	27,004.24
19,594.61	28,013.51
19,594.29	28,028.70
19,597.79	28,670.76
19,594.13	28,686.09
19,252.06	29,252.93
19,243.54	29,239.15
19,123.72	28,935.51
18,908.93	28,861.00
18,900.37	28,857.05
18,729.07	28,682.44
18,742.04	28,674.37
18,799.18	27,371.38
18,809.05	27,387.52

[illegible]

952

		TOLERANCES UNLESS OTHERWISE SPECIFIED	DES L.G. WILLIAMS	1-3-91
			DRW L.G. WILLIAMS	1-3-91
		FRACTIONS ±	CHK Chris Follen	8/22/91
		XX DECIMALS ±	SECT J. N. W. L.	8/22/91
		XXX DECIMALS ±	DEPT & PLANT	
		ANGLES		

MARTIN MARIETTA

operated for the DEPARTMENT OF
OAK RIDGE

COORDINATES

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MARTIN MARIETTA

MARTIN MARIETTA ENERGY SYSTEMS, INC.

operated for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC-05-84OR21400
OAK RIDGE, TENNESSEE • PADUCAH, KENTUCKY

GROUNDWATER QUALITY MONITORING WELL

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0	ISSUED APPROVED
REV	DESCI
	REVISION OR

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D	LGW		CDF	anw	anw	8-14-91			
DESCRIPTION	A-E	BY	CHK	SECT	DEPT	DATE	PE	REQ	DA
REVISION OR ISSUE PURPOSE					REVISION				

<u>WELL #</u>	<u>NORTHING</u>	<u>EASTING</u>
48	18,959.25	27,001.43
49	18,977.16	27,004.24
50	19,594.61	28,013.51
51	19,594.29	28,028.70
52	19,597.79	28,670.76
53	19,594.13	28,686.09
54	19,252.06	29,252.93
55	19,243.54	29,239.15
56	19,123.72	28,935.51
57	18,908.93	28,861.00
58	18,900.37	28,857.05
9	18,729.07	28,682.44
0	18,742.04	28,674.37
1	18,799.18	27,371.38
2	18,809.05	27,387.52

REVISION APPROVALS							SQUAD CHECK									
E	REQ	DATE	MM-ES	DATE	DOE	DATE	CA	EC	EE	EM	IE	M	PD	SE	XAD	

TOLERANCES
UNLESS OTHERWISE
SPECIFIED

FRACTIONS $\pm$
XX DECIMALS $\pm$
XXX DECIMALS $\pm$
ANGLES
BREAK SHARP EDGES MAX.
FINISH

ADAMS CRAFT HERZ WALKER
A-E

MM-ES

DOE

DES L.G. WILLIAMS

DRW L.G. WILLIAMS

CHK *Chris Foltan*

SECT *A. N. Wyli*

DEPT & PLANT

A. N. Wyli

1-3-91

1-3-91

8/22/91

8/22/91

8/22/91

MARTIN MARIETTA

operated for the DEPARTMENT OF ENERGY
OAK RIDGE, TENNE

GROUNDWATER QUALI

WAG 4 LOCA

SWSA 4 MON WE

1	48	49	50	PLANT
3	C	M	T	X-10

SCALE
1" = 200'

ID
PKX81202

C31

DRAWING APPROVALS

DATE

3

0"

1"

2"

2

B

C3D020004A120

MS	1-3-91	MARTIN MARIETTA MARTIN MARIETTA ENERGY SYSTEMS, INC. operated for the DEPARTMENT OF ENERGY under U.S. GOVERNMENT contract DE-AC-05-84OR21400 OAK RIDGE, TENNESSEE • PADUCAH, KENTUCKY	
MS	1-3-91		
	8/22/91		
2	8/22/91		
	8/22/91	GROUNDWATER QUALITY MONITORING WELLS WAG 4 LOCATION MAP	
		SWSA 4 MON WELL LOC MAP	TYPE M
		1 48 49 50 PLANT BLDG FL SHT OF CLASS 3 C M T X-10 - - 1 1 U	
		SCALE ID 1" = 200' PKX81202 C3D 020004A120	REV 0
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