Environmental Restoration Division
ORNL Environmental Restoration Program

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

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EXECUTIVE SUMMARY

This report documents the drilling and installation of 18 groundwater quality monitoring (GQM) wells on the perimeter of Waste Area Grouping (WAG) 11. WAG 11 (White Wing Scrap Yard) is located on the west end of East Fork Ridge between White Wing Road and the Oak Ridge Turnpike. The scrap yard is approximately 25 acres in size. The wells at WAG 11 were drilled and developed between January 1990 and October 1990. These wells were installed to characterize and assess the WAG in accordance with applicable Department of Energy, state, and Environmental Protection Agency regulatory requirements.

Well design and placement were performed by Martin Marietta Energy Systems, Inc. (Energy Systems) geologic staff and their subcontractors. The wells were drilled, installed, and developed by the subcontractor (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 11 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 11. 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) 11. 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 wells in WAG 11 were drilled and developed from January 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 11

WAG 11 (White Wing Scrap Yard) is located on the west end of East Fork Ridge between White Wing Road and the Oak Ridge Turnpike [Fig. 1, map pocket (MMES map #C3E20004A123, Rev. 0)]. The scrap yard is approximately 25 acres in size.

This area was first used in the early 1950s for aboveground storage of contaminated material from the Oak Ridge National Laboratory (ORNL), the Oak Ridge Gaseous Diffusion Plant (ORGDP), and the Oak Ridge Y-12 Plant. Information about the exact dates during which material was stored in this area and the amounts of material contributed by the respective plants is limited. The material consisted largely of contaminated steel tanks, trucks, earth-moving equipment, and large pieces of steel, stainless steel, and aluminum, as well as reactor vessels used in Building 3019 of ORNL.

Efforts were made from 1966 to 1971 to remove the contaminated material and clean up the site. These efforts included the survey of material to identify the amount of contamination present in order to dispose of the material properly. Approximately 6000 yd³ of contaminated soil that gave radiation readings ranging from 1 to 50 mR/hr was removed during cleanup operations from an area south of the access road.

A radiological survey conducted on June 5, 1971, led to the conclusion that the entire area of White Wing Scrap Yard (WAG 11) was still extensively contaminated and that there was a problem with subsurface conditions. Eleven groundwater quality monitoring wells were installed along the perimeter of WAG 11 (Fig. 1, map pocket).

2. INSTALLATION METHODS

Four basic types of well construction were used during the GQM installation program at ORNL. Schematic diagrams of these four well types are shown on Fig. 2. Three of the four types (A, B, and C) were used at WAG 11. These types are described in Sects. 2.1 through 2.3. The specific details of each well installation are included in the monitoring well narratives (Appendix A). The specifications for drilling and well installation were provided in *Construction Specifications for Monitoring Wells Installation Construction Project*, K-4491G-G1.¹ The proposed well design criteria for the WAG 11 wells can be found in the report *Preliminary Geohydrologic Site Characterization and Proposed Water Quality Well Locations for WAG 11*, ORNL/RAP/Sub/87-SB189/1.² Actual completion data for WAG 11 are listed in Table 1.

2.1 TYPE A WELL

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

2.2 TYPE B WELL

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

2.3 TYPE D WELL

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

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

Table 1. Actual completion data for WAG 11

Well	Depth clean to (ft) ^a	SST casing diam(in.)	Well type	Screened interval (ft)	Water level (ft) ^b
1139	33.0	2	A	7.8–32.8	–5.1
1140	62.5	2	D	32.2–62.3	–51.1
1141	97.4	4	B	82.2–97.2	–58.3
1143	52.5	4	B	37.5–52.2	–24.8
1144	122.3	4	B	102.1–122.1	–21.1
1145	59.1	2	A	38.0–58.9	–52.3
1146	117.3	4	B	107.1–117.1	–79.4
1147	97.9	4	B	77.7–97.7	–82.1
1148	67.5	4	B	52.2–67.2	–9.5
1149	32.8	4	B	17.5–32.5	–10.2
1246	86.63	4	B	56.4–71.4	–31.5

^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 11 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 probability 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 construction contractor Geotek Engineering Company, whose contract began in May 1989, installed the GQM wells in WAG 11. ORNL Engineering administered the drilling contract through Energy Systems Procurement. The management organization chart for the project is in the *Task Management Plan for Groundwater Quality Monitoring Well Installation*, ORNL/RAP/LTR-88/29.⁴

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

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

5. DRILLING RECORDS

A complete data package has been compiled for each of the 11 GQM wells drilled in WAG 11. 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 also 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 11 wells in WAG 11, 9 had turbidities less than or equal to 5 NTUs. The number of well volumes removed ranged from 4.0 to 34.2, with an average of 15.6 well volumes. 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 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

The following special events took place during the drilling of the GQM wells in WAG 11.

8.1 CONTAMINATION DETECTED

The ERCE hydrogeologist detected an unusual reddish color in the drill water generated in well 1149

8.2 DEVIATIONS FROM THE SPECIFICATIONS

- An obstruction was encountered in well 1146 at a depth of 118 ft. Well casing was set above it. Filling the annulus required an excessive amount of grout. During the grouting process, a 30-ft section of tremie pipe was dropped into the annulus and was encapsulated in grout.
- A stainless steel weighted tape was dropped into the well annulus of well 1148 and was encapsulated in bentonite and grout.

8.3 HYDRAULIC FLUID SPILLS

A hydraulic hose broke during drilling of well 1140, but the boring was not contaminated.

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. Engineering, Design and Geosciences Group, Inc., *Preliminary Geohydrologic/Site Characterization and Proposed Water Quality Well Locations for WAG 11 AND Upper WAG 2*, ORNL/RAP/Sub-87/SB189/1, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., September 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 1139 is located in WAG 11. It is located in the southern boundary of White Wing Scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 34,507.9669, E 28,700.6980 (Y-12 grid) or latitude 35°-57'-05.50" and longitude 84°-20'-48.93". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from Y-12 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 1139 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. Drilling commenced on 1-19-90 and was finished on 1-22-90. 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.

- 1-19-90 The rig was mobilized to the staked location and set up on plastic sheeting. Split spoon samples were taken from surface to refusal at 7.5 feet. The boring was deepened with a 6-inch auger to 22.5 feet.
- 1-22-90 The boring was deepened from 22.5 feet to auger refusal at 33.5 feet with a 6-inch auger. Two inch stainless steel screen and casing was then set with sand pack and bentonite pellet seal.
- 1-23-90 The annulus was grouted to surface with 1 sack cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500 feet thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale, and, locally, dolomite.

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 1139S01 was collected in the split spoon interval from 6.2 to 6.5 feet on 1-19-90.

A bulk density soil sample was collected from the split spoon sample interval from 1.0 to 1.3 feet. The sample was measured and weighed, and a bulk density of 2.22 grams/cm³ was calculated.

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 33.5 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 7.8 feet to 33.0 feet. A 2-inch diameter stainless steel casing was installed above the screen from 7.8 feet to 2.2 feet above ground surface. A sandpack was then tremied into the annular space from 4.4 to 33.9 feet, with a 1.6 foot bentonite pellet seal poured into the annular space above the sandpack from 2.8 to 4.4 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 1139 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 565 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 7/31/90 at a depth of 29.8 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 1139 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 2.71×10^{-3} 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.

1.0 General Information

1.1 Well Location

Monitoring well number 1140 is located in WAG 11. It is located in the southern boundary of White Wing Scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 34,497.9754, E 28,111.2064 (Y-12 grid) or latitude 35°-57'-02.17" and longitude 84°-20'-54.82".

Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from Y-12 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 1140 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. Drilling commenced on 1-31-90 and was finished on 3-5-90. 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.

- 1-19-90 The rig was mobilized to the staked location and set up on plastic sheeting. The boring was augered to 6.0 feet with a 14-inch auger. Set 6.0 feet of 10 3/4-inch decontaminated steel diverter casing and grouted it into place. Moved rig from location.
- 3-2-90 The rig was moved to location. Drilled to 62.5 feet using an 8.0-inch air rotary tricone bit.
- 3-5-90 Set 2-inch stainless steel screen and casing with sandpack and bentonite pellet seal. Move rig from location.
- 3-6-90 Grouted annulus with 7.0 sacks cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500' thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale, and, locally, dolomite.

2.3 Sample Collection

A bulk density soil sample was collected from the split spoon sample interval from 3.5 to 3.8 feet. The sample was measured and weighed, and a bulk density of 2.22 grams/cm³ was calculated. No samples were collected during drilling for chemical analysis.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 3/2/90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 6.0 feet and a 10 3/4-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 6.0 to 62.5 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 32.3 to 62.5 feet. A 2-inch diameter stainless steel casing was installed above the screen at 32.3 feet and extended 2.8 feet above ground surface. A sandpack was then tremied into the annular space from 30.5 to 62.5 feet, with a 1.5 foot bentonite pellet seal poured into the annular space above the sandpack from 29.0 to 30.5 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 1140 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 120 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 61.6 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 1140 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 1.17×10^{-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.

1.0 General Information

1.1 Well Location

Monitoring well number 1141 is located in WAG 11. It is located in the southern boundary of White Wing scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 34,488.6430, E 28,148.8969 (Y-12 grid) or latitude 35°-57'-02.30" and longitude 84°-20'-54.38". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from Y-12 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 1141 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. Drilling commenced on 1-30-90 and was finished on 2-14-90. 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.

- 1-30-90 The rig was mobilized to location and set up on plastic sheeting. Split spoon samples were taken from surface to first refusal at 5.6 feet. The boring was deepened with a 6-inch auger to 29.0 feet. Split spoons were taken from 29.0 feet to refusal at 34.7 feet. The boring was deepened from 34.7 feet to refusal at 58.0 feet using a 6-inch auger. Six feet of 15 1/4-inch decontaminated diverter casing was set and grouted. The rig was moved from location.
- 2-8-90 The rig was moved to location. Drill from 6.0 feet to 60.5 feet using a 14 1/2-inch air rotary tricone bit. Set 60.5 feet of 10 3/4-inch decontaminated steel surface casing and grouted it to surface. The rig was moved from location.
- 2-14-90 Move rig to location. Drill from 60.5 feet to 97.5 feet using an 8-inch air rotary tricone bit. Set 97.4 feet of 4-inch stainless steel screen and casing with sandpack and bentonite seal.
- 2-15-90 Grouted stainless steel casing annulus with 17 sacks cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500 feet thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale, and, locally, dolomite.

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 1141S01 was collected in the split spoon interval from 4.0 to 4.3 feet on 1-30-90.

A bulk density soil sample was collected from the split spoon sample interval from 3.5 to 3.8 feet. The sample was measured and weighed, and a bulk density of 2.11 grams/cm³ was calculated.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 2-14-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 6.0 feet. A 15 1/4-inch diverter casing was installed from surface to 6.0 feet below ground surface and grouted in place. The boring was then extended past the refusal depth with a 14.5-inch air rotary tricone roller bit from 6.0 feet to 60.5 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 60.5 feet, sealed with a 1.5 foot bentonite pellet layer from 59.0

feet to 60.5 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 97.5 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 82.2 feet to 97.4 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 82.2 feet and extended 2.8 feet above ground surface. A sandpack was then tremied into the annular space from 77.9 to 97.4 feet, with a 1.8 foot bentonite pellet seal poured into the annular space above the sandpack from 76.1 to 77.9 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 1141 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 160 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 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 7/27/90 at a depth of 89.8 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 1141 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 1.45×10^{-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.

1.0 General Information

1.1 Well Location

Monitoring well number 1143 is located in WAG 11. It is located in the southern boundary of White Wing Scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,068.4127, E 27,569.5606 (Y-12 grid) or latitude 35°-57'-03.88" and longitude 84°-21'-04.16". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from Y-12 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 1143 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. Drilling commenced on 1-23-90 and was finished on 3-6-90. 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.

- 1-23-90 The rig was mobilized to the staked location and set up on plastic sheeting. The boring was augered to 6.5 feet using a 22-inch auger. Set 6.5 feet of 15 1/4-inch decontaminated steel diverter casing and grouted it to surface.
- 1-24-90 Augered from 6.5 feet to refusal at 27.5 feet using a 14.0-inch auger. Rig up a 14.0-inch air rotary tricone and drill from 27.5 feet to 30.0 feet.
- 1-25-90 Set 30.0 feet 10 1/4-inch decontaminated steel surface casing with bentonite seal and tremie grouted it to surface with 15 sacks grout.
- 2-1-90 Rig up and drill from 30.0 feet to 38.0 feet using an 8.0-inch air rotary tricone bit.
- 2-2-90 Drill from 38.0 feet to total depth at 52.5 feet. Rig down.
- 3-6-90 Set 4-inch stainless steel well casing and screens with sandpack and bentonite seal.
- 3-7-90 Tremie grouted well casing annulus with 9.0 sacks of cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologists Bruce McMaster and 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500 feet thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale, and, locally, dolomite.

2.3 Sample Collection

No soil or water samples were collected during drilling.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 2-2-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 6.5 feet. A 15 1/4-inch diverter casing was installed from surface to 6.5 feet below ground surface and grouted in place. A 14.5-inch diameter boring was augered from 6.5 feet to 27.5 feet (auger refusal). The boring was then extended past the refusal depth with a 14.0-inch air rotary tricone roller bit from 27.5 feet to 30.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 30.0 feet, sealed with a 1.5 foot bentonite pellet layer from 28.5 feet to 30.0 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 52.5 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 37.5 feet to 52.5 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 37.5 feet and

extended 2.5 feet above ground surface. A sandpack was then tremied into the annular space from 30.4 to 52.5 feet, with a 3.6 foot bentonite pellet seal poured into the annular space above the sandpack from 26.8 to 30.4 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 1143 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 161 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 7/27/90 at a depth of 51.5 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 1143 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously removing a known quantity of water from 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 1.45×10^{-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.

1.0 General Information

1.1 Well Location

Monitoring well number 1144 is located in WAG 11. It is located in the northwestern boundaries of White Wing Scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,339.3270, E 27,421.6061 (Y-12 grid) or latitude 35°-57'-05.29" and longitude 84°-21'-07.49". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from Y-12 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 1144 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. Drilling commenced on 1-10-90 and was finished on 2-15-90. 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.

- 1-10-90 The rig was mobilized to location and set up on plastic sheeting. Split spoon samples were taken from surface to refusal at 39.1 feet. The boring was reamed to 6.0 feet using a 22.0-inch auger.
- 1-11-90 Set and grouted 6.0 feet of 15.0-inch decontaminated steel diverter casing. Moved rig from hole
- 1-31-90 Moved rig back over hole. Drilled to 44.0 feet using a 14.0-inch air rotary tricone bit.
- 2-1-90 Set 44.0 feet of 10 3/4-inch decontaminated steel surface casing. Moved rig from location.
- 2-2-90 Grouted surface casing with 15 sacks cement.
- 2-15-90 Move back to location. Drill from 44.0 to 122.5 feet using an 8.0-inch air rotary tricone bit. Run stainless steel 4-inch well casing and screen and set with sand pack and bentonite seal.
- 2-16-90 Grouted well casing annulus with 13 sacks cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500 feet thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale and locally, dolomite.

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 1144S01 was collected in the split spoon interval from 29.8 to 30.1 feet on 1-10-90.

A bulk density soil sample was collected from the split spoon sample interval from 6.5 to 6.8 feet. The sample was measured and weighed, and a bulk density of 2.04 grams/cm³ was calculated.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 2-15-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 6.0 feet. A 15 1/4-inch diverter casing was installed from surface to 6.0 feet below ground surface and grouted in place. A 14.5-inch diameter boring was augered from 6.0 feet to 39.1 feet (auger refusal). The boring was then extended past the refusal depth with a 14.0-inch air rotary tricone roller bit from 39.1 feet to 44.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was

installed from 0.0 feet to 44.0 feet, sealed with a 2.0 foot bentonite pellet layer from 42.0 feet to 44.0 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 122.5 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 102.1 feet to 122.3 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 102.1 feet and extended 2.9 feet above ground surface. A sandpack was then tremied into the annular space from 98.5 to 122.3 feet, with a 1.4 foot bentonite pellet seal poured into the annular space above the sandpack from 97.1 to 98.5 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 1144 was developed to remove drill cuttings, silt, and other fines. The monitoring 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 970 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 5 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 9-16-90 at a depth of 119.6 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 1144 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 1.58×10^{-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.

1.0 General Information

1.1 Well Location

Monitoring well number 1145 is located in WAG 11. It is located in the northwest boundary of White Wing Scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,589.3486, E 27,674.9621 (Y-12 grid) or latitude 35°-57'-08.74" and longitude 84°-21'-06.62". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from Y-12 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 1145 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. Drilling commenced on 1-11-90 and was finished on 1-15-90. 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.

- 1-11-90 The rig was mobilized to location and set up on plastic sheeting. Split spoon samples were taken from surface to 45.0 feet.
- 1-12-90 The boring was deepened from 45.0 feet to auger refusal at 59.1 feet using a 6-inch auger. The well was bailed to 58.0 feet.
- 1-15-90 The boring was bailed to 59.0 feet. Two-inch stainless steel casing and screen was set with sand pack and bentonite seal.
- 1-16-90 The stainless steel casing was grouted into place with 6 sacks cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologists Timothy A. Lee 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500 feet thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale, and, locally, dolomite.

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 1145S01 was collected in the split spoon interval from 20.2 to 20.6 feet on 1-11-90 and soil sample 1145S02 was collected in the split spoon interval from 27.8 to 28.4 on 1-11-90.

A bulk density soil sample was collected from the split spoon sample interval from 10.2 to 10.5 feet. The sample was measured and weighed, and a bulk density of 2.30 grams/cm³ was calculated.

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 59.1 feet. A 2-inch diameter stainless steel screen with welded bottom cap was installed from 38.0 feet to 59.1 feet. A 2-inch diameter stainless steel casing was installed above the screen from 38.0 feet to 2.0 feet above ground surface. A sandpack was then tremied into the annular space from 36.2 to 59.1 feet, with a 1.1 foot bentonite pellet seal poured into the annular space above the sandpack from 35.1 to 36.2 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 1145 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 331 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 8-2-90 at a depth of 58.3 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1145 was not tested for hydraulic conductivity. The water level in the well was too low for a falling head test. A stainless steel slug would not pass by a tight spot in the well screen thus prohibiting a rising head test.

1.0 General Information

1.1 Well Location

Monitoring well number 1146 is located in WAG 11. It is located in the northwestern portion of White Wing Scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,704.1986, E 28,337.7057 (Y-12 grid) or latitude 35°-57'-13.33" and longitude 84°-21'-00.70". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from Y-12 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 1146 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. Drilling commenced on 1-5-90 and was finished on 2-27-90. 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.

- 1-4-90 The rig was mobilized to location and set up on plastic sheeting.
- 1-5-90 Split spoon samples were taken from surface to refusal at 38.0 feet. The boring was augered to 28.0 feet with a 14.0-inch auger.
- 1-8-90 Set 10 3/4-inch decontaminated steel diverter casing at 28.0 feet with a 2.0 feet bentonite pellet seal. The rig was moved from location. The casing annulus was grouted with 10 sacks cement.
- 2-22-90 Move rig to location and drill to 62.5 feet with an 8.0-inch air rotary tricone bit.
- 2-23-90 Drill to 122.5 feet with 8.0-inch air rotary tricone bit.
- 2-26-90 The well was deepened from 122.5 feet to 132.5 feet. Ran 4.0-inch stainless steel casing which stopped at 121.0 feet. Decided to pull casing and redrill hole.
- 2-27-90 Re-drill hole with 8.0-inch air rotary tricone bit to 132.5 feet. After pulling drill steel out of hole, weighted tape showed total depth of hole at 118.0 feet. Decide to run 4.0-inch stainless steel casing to 117.3 feet and set it with sand pack and bentonite pellet seal. The rig was moved from location.
- 2-28-90 Tremie grouted annulus with 25 sacks cement with flocele.*

- 3-2-90 Tremie grouted annulus with 27 more sacks
cement with flocele.
- 3-6-90 Tremie grouted annulus with 12 more sacks
cement with flocele.
- 3-7-90 Tremie grouted annulus with 1 more sack cement
to surface.

* After the stainless steel casing was set with sandpack and bentonite seal, 30.0 feet of P.V.C. tremie pipe was dropped into the annulus of this well. After a few attempts to "fish", this pipe was encapsulated in the grout.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500 feet thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale, and, locally, dolomite.

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 1146S01 was collected in the split spoon interval from 37.0 to 38.0 feet on 1-5-90.

A bulk density soil sample was collected from the split spoon sample interval from 4.1' to 4.5'. The sample was measured, weighed and a bulk density of 1.74 grams/cm³ was calculated.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 2-26-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

2.4 Installation and Development

2.4.1 Installation

This was a Type B well. A 14.0-inch diameter boring was augered from surface to 28.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 28.0 feet, sealed with a 2.0 foot bentonite pellet layer from 26.0 feet to 28.0 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 132.5 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 107.1 feet to 117.3 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 107.1 feet and extended 2.9 feet above ground surface. A sandpack was then tremied into the annular space from 103.8 to 117.3

feet, with a 1.4 foot bentonite pellet seal poured into the annular space above the sandpack from 102.4 to 103.8 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/ completion form.

2.4.2 Well Development

Well number 1146 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 501 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 8/9/90 at a depth of 112.0 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 1146 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 1.06×10^{-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.

1.0 General Information

1.1 Well Location

Monitoring well number 1147 is located in WAG 11. It is located in the northeastern portion of White Wing Scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,696.4970, E 28,354.4126 (Y-12 grid) or latitude 35°-57'-13.36" and longitude 84°-21'-00.48". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from Y-12 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 1147 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. Drilling commenced on 1-4-90 and was finished on 1-29-90. 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.

- 1-4-90 Mobilize rig to staked location and set up on plastic sheeting. Augered from surface to 7.0 feet using a 22.0-inch auger. Set 6.0 feet of 14.0-inch decontaminated steel diverter casing. The rig was moved from location.
- 1-5-90 The diverter casing was grouted with 5 sacks cement.
- 1-8-90 The rig moved over hole and augered to refusal at 39.5 feet with a 14.5-inch auger.
- 1-9-90 The boring was deepened from 39.5 feet to 45.8 feet using air rotary method with a 14.5-inch air rotary tricone bit. Set 45.8 feet of 10 3/4-inch decontaminated steel surface casing and sealed with bentonite seal. Move rig from location.
- 1-10-90 Grouted surface casing annulus with 10 sacks of cement.
- 1-25-90 Move rig over hole.
- 1-26-90 Deepened boring from 45.8 feet to 97.9 feet using an 8.0-inch air rotary tricone bit.
- 1-29-90 Set stainless steel 4-inch screen and casing with sand pack and bentonite seal.
- 1-30-90 Grouted well casing with 19 sacks cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500 feet thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale, and, locally, dolomite.

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 1139S01 was collected in the split spoon interval from 6.2 to 6.5 feet on 1-19-90.

A drill water sample was collected from the water pump on the drill rig on 1-29-90. Analytical results for the Ingersoll Rand T-4 drill water samples described above can be obtained from the Remedial Action Program data base at ORNL.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 1-29-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 6.0 feet. A 15 1/4-inch diverter casing was installed from surface to 6.0 feet below ground surface and grouted in place. A 14.0-inch diameter boring was augered from 6.0 feet to 39.5 feet (auger refusal). The boring was then extended past the refusal depth with a 14.0-inch air rotary tricone roller bit from 0.0 feet to 45.8 feet. A 10.0-inch diameter

string of decontaminated steel surface casing was installed from 0.0 feet to 45.8 feet, sealed with a 2.0-foot bentonite pellet layer from 43.8 feet to 45.8 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 97.9 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 77.7 feet to 97.9 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 7.77 feet and extended 2.2 feet above ground surface. A sandpack was then tremied into the annular space from 73.5 to 97.9 feet, with a 1.3-foot bentonite pellet seal poured into the annular space above the sandpack from 72.2 to 73.5 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 1147 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 550 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'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 8/10/90 at a depth of 93.3 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1147 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously removing a known quantity of water from 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 9.18×10^{-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.

1.0 General Information

1.1 Well Location

Monitoring well number 1148 is located in WAG 11. It is located in the southwest portion of White Wing Scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,000.4186, E 29,698.6994 (Y-12 grid) or latitude 35°-57'-15.04" and longitude 84°-20'-42.18". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from Y-12 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 1148 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. Drilling commenced on 1-16-90 and was finished on 3-1-90. 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.

- 01-16-90 The rig was mobilized to the staked location and set up on plastic sheeting. Auger to 10.4 feet using a 14-inch auger. Set 10.4 feet of decontaminated 10 3/4-inch steel diverter casing and grouted surface.
- 02-14-90 Cut casing below ground level and plug well with cement due to crooked hole.
- 02-16-90 Auger to 6.0 feet using a 22-inch auger and grouted 6.0 feet of 15 3/4-inch decontaminated steel diverter casing with 5 sacks cement.
- 02-21-90 Drill from 6.0 feet to 37.0 feet using a 14 1/2-inch air rotary tricone bit.
- 02-22-90 Set 36.8 feet of 10 3/4-inch decontaminated steel surface casing.
- 02-23-90 Grouted surface casing annulus with 16 sacks cement.
- 03-01-90 Drill to 67.5 feet using a 8.0-inch air rotary tricone bit. Set 4-inch stainless steel well casing and screen with sand pack and bentonite seal.
- 03-02-90 Tremie grouted well casing annulus with 21 sacks cement with bentonite powder and flocele.
- 03-06-90 Tremie grouted to surface with 6 sacks cement with flocele.

Note: A stainless steel weighted tape broke and fell into hole at 49.6 feet. It was encapsulated with bentonite pellets and grouted up.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500 feet thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with

varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale, and, locally, dolomite.

2.3 Sample Collection

No soil samples were collected during drilling.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 3-1-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 6.0 feet. A 15 3/4-inch diverter casing was installed from surface to 6.0 feet below ground surface and grouted in place. The boring was then extended past the casing depth with a 14.0-inch air rotary tricone roller bit from 6.0 feet to 37.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 36.8 feet, sealed with a 2.0-foot bentonite pellet layer from 34.8 feet to 36.8 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 67.5 feet. A 4-inch diameter stainless

steel screen with threaded bottom cap was installed from 52.2 feet to 67.5 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 52.2 feet and extended 2.8 feet above ground surface. A sandpack was then tremied into the annular space from 49.6 to 67.5 feet, with a 2.1-foot bentonite pellet seal poured into the annular space above the sandpack from 47.5 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 1148 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 207 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 7/30/90 at a depth of 65.8 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 1148 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.40×10^{-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.

1.0 General Information

1.1 Well Location

Monitoring well number 1149 is located in WAG 11. It is located in the southwestern portion of White Wing Scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 34,973.5615, E 29,702.2786 (Y-12 grid) or latitude 35°-57'-14.83" and longitude 84°-20'-41.96". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from Y-12 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 1149 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. Drilling commenced on 1-16-90 and was finished on 3-1-90. 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.

- 01-16-90 The rig was mobilized to the staked location and set up on plastic sheeting. Split spoon samples were taken from surface to refusal at 12.5 feet. The boring was reamed using a 22-inch auger to 7.2 feet. Set 7.2 feet of 15 3/4-inch decontaminated steel diverter casing and grouted it to surface. Move rig from location.
- 01-18-90 Move rig back to location. Drill from 7.2 feet to 18.5 feet using a 14-inch air rotary tricone bit. Set 13.9 feet of 10 3/4-inch decontaminated steel surface casing. Move rig from location.
- 01-19-90 Grouted surface casing annulus to surface iwth 8.0 sacks cement.
- 02-13-90 Move rig to location. Drill to 35.0 feet using an 8.0-inch air rotary.
- 03-01-90 Set 2-inch stainless steel well casing and screen with sand pack and bentonite seal.
- 03-02-90 Tremie grouted annulus with 4.0 sacks of cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologists Timothy A. Lee and C. Allison Bailey. 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500 feet thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale and locally, dolomite.

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 1149S01 was collected in the split spoon interval from 10.3 feet to 10.7 feet on 1-16-90.

A bulk density soil sample was collected from the split spoon sample interval from 10.3 to 10.7 feet. The sample was measured and weighed, and a bulk density of 1.78 grams/cm³ was calculated.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 2-13-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 7.2 feet. A 15 3/4-inch diverter casing was installed from surface to 7.2 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 7.2 feet to 18.5 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 13.9 feet, sealed with a 2.0-foot bentonite

pellet layer from 11.9 feet to 13.9 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 35.0 feet. A two-inch diameter stainless steel screen with threaded bottom cap was installed from 17.5 feet to 32.8 feet. A 2-inch diameter stainless steel casing was installed from the top of the screen at 17.5 feet and extended 2.4 feet above ground surface. A sandpack was then tremied into the annular space from 16.0 to 32.8 feet, with a 1.9-foot bentonite pellet seal poured into the annular space above the sandpack from 14.1 to 16.0 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 1149 was developed to remove drill cuttings, silt, and other fines. The monitoring 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 221 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 7/30/90 at a depth of 31.3 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1149 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 4.62×10^{-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.

1.0 General Information

1.1 Well Location

Monitoring well number 1246 is located in WAG 11. It is located on the western boundary of White Wing Scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,090.0576, E 27,507.5298 (Y-12 grid) or latitude 35°-57'-03.51" and longitude 84°-21'-05.21". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from Y-12 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 1246 was drilled by Geotek Engineering Company. A Ingersoll Rand rig was used to drill this boring for monitor well installation under the operation of Larry Ledbetter with the assistance of Fred Dixon. Drilling commenced on 1-23-90 and was finished on 3-6-90. 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.

- 1-23-90: The rig was mobilized to the staked location and set up a plastic sheeting. Split spoon samples were taken from surface to refusal at 22.0 feet.
- 2-2-90: Augered from surface to 6.0 feet using a 22-inch auger and set 6.0 feet of 15 3/4-inch decontaminated steel diverter casing. Grouted diverter casing annulus to surface with 10 sacks cement.
- 2-9-90: Drill to 18.0 feet using a 14.0-inch air rotary tricone bit.
- 2-12-90: Drill to 20.0 feet and diverter casing began to leak. Decide to abandon well, skid 10.0 feet and drill new hole. Move to new location, auger to 10.5 feet using a 22-inch augers and set 10.5 feet of 15 3/4-inch decontaminated steel diverter casing.
- 2-13-90: Grouted diverter casing annulus to surface with 15 sacks cement.
- 2-16-90: Drill to 20.0 feet using a 14.0-inch air rotary tricone bit.
- 2-20-90: Drill from 20.0 feet to 40.0 feet using a 14.0-inch air rotary tricone bit. Set 40.0 feet of 10 3/4-inch decontaminated steel surface casing.
- 2-21-90: Grouted surface casing annulus with 24 sacks cement.
- 3-6-90: Drilled from 40.0 feet to 85.0 feet using an 8.0-inch air rotary tricone bit. A mud filled cavity was encountered from 66.0 feet to 85.0 feet. The hole would not clean up.

- 9-20-90: Decontaminated drill rig, tools, and 100 feet of 8-inch hollow stem augers.
- 9-21-90: Mobilized rig to location and set up. Ran in 55 feet of 8-inch hollow stem augers.
- 9-24-90: Ran in 8-inch hollow stem augers to 85.5 feet. Auger refusal at 85.5 feet. Ran in 85 feet of AW drill rods and punched out stainless steel plug. Ran in 2-inch stainless steel screen and casing. Tremied in 12 sacks of sand through hollow stem augers.
- 9-25-90: Checked top of sand. Had dropped 2 feet overnight so tremied in one more sack of sand. Grouted annular space with two sacks of cement.
- 9-26-90: Finished grouting annular space with 19 sacks of cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologists Bruce McMaster, Timothy A. Lee 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500 feet thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale, and, locally, dolomite.

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 22.0-inch diameter boring was augered from ground surface to 6.0 feet. A 15 3/4-inch diverter casing was installed from surface to 6.0 feet below ground surface and grouted in place. The boring was drilled with a 14.0-inch air rotary tricone roller bit from 6.0 feet to 40.0 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 86.63 feet. A 2-inch diameter stainless steel silt trap was installed from 71.4 feet to 86.63 feet. A 2-inch diameter stainless steel screen was installed from 56.4 feet to 71.4 feet. A 2-inch diameter stainless steel casing was installed from the top of the screen at 56.4 feet and extended 2.05 feet above ground surface. A sandpack was then tremied into the annular space from 86.63 up to 53.0 feet, with a 2.6 foot bentonite pellet seal poured into the annular space above the sandpack from 50.4 to 53.0 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 1246 was developed to remove drill cuttings, silt, and other fines. The monitoring was

developed using a Geoguard pump with an air rotary. 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 552 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 10/10/90 at a depth of 62.0 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 1246 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

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MONITORING WELL PROGRAM
WELL DATA NARRATIVE
WELL No. 1246

conductivity value of 4.89×10^{-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.

1.0 General Information

1.1 Well Location

Monitoring well number 1139 is located in WAG 11. It is located in the southern boundary of "White Wing Scrap Yard" or WAG 11. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 34,507.9669, E 28,700.6980 (X-10 grid) or latitude 35°-57'-05.50" and longitude 84°-20'-48.93". 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 1139 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. Drilling commenced on 1-19-90 and was finished on 1-22-90. 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.

- 1-19-90 The rig was mobilized to the staked location and set up on plastic sheeting. Split spoon samples were taken from surface to refusal at 7.5 feet. The boring was deepened with a 6-inch auger to 22.5 feet.
- 1-22-90 The boring was deepened from 22.5 feet to auger refusal at 33.5 feet with a 6-inch auger. Two inch stainless steel screen and casing was then set with sand pack and bentonite pellet seal.
- 1-23-90 The annulus was grouted to surface with 1 sack cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500' thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale and locally, dolomite.

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 1139S01 was collected in the split spoon interval from 6.2' to 6.5' on 1-19-90.

A bulk density soil sample was collected from the split spoon sample interval from 1.0' to 1.3'. The sample was

measured, weighed and a bulk density of 2.22 grams/cm³ was calculated.

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 33.5 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 7.8 feet to 33.0 feet. A 2-inch diameter stainless steel casing was installed above the screen from 7.8 feet to 2.2 feet above ground surface. A sandpack was then tremied into the annular space from 4.4 to 33.9 feet, with a 1.6 foot bentonite pellet seal poured into the annular space above the sandpack from 2.8 to 4.4 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 1139 was developed to remove drill cuttings, silt, and other fines. The monitoring 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 565 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 7/31/90 at a depth of 29.8 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 1139 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 2.71×10^{-3} 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

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>01-19-90</u>	<u>Tbm</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>01-19-90</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>_____</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>01-22-90</u>	<u>Tbm</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>01-22-90</u>	<u>Tbm</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>01-19-90</u>	<u>Tbm</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>01-22-90</u>	<u>Tbm</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>_____</u>	<u>_____</u>

RESULTS: _____
_____

ADDITIONAL NOTES/OBSERVATIONS: _____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE Timothy A. Lee 01-22-90
Timothy A. Lee

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
BAILER	X	X	X	X	X

OBSERVER SIGNATURE/DATE

Timothy A. Lee

01-22-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1139

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG 11
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersol Rand T-4

DATE: START: 01-19-90
FINISH: 01-22-90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: Carl Stooksbarry

TYPE DRILLING: Split Spoon, Auger LUBRICANT TYPE: Green Stuff
No. SAMPLES TAKEN: One TYPE: Soil
CONTAINMENT TYPE: Plastic pan

THICKNESS OF SOIL (REFUSAL DEPTH): 33.5

DEPTH DRILLED IN ROCK: 0.0

TOTAL DEPTH OF WELL: 33.5

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	1.0		augered	Gravel fill
1.0	2.7		100	Clay, mottled, moderate yellowish brown and dark yellowish orange, dry, black streaks and iron stains.
2.7	3.0		100	Clay mottled, dark yellowish orange and light olive gray, dry, iron stains.
3.0	3.6		65	Clay, mottled, light olive gray, and dark yellowish orange, dry, iron stains.
3.6	5.0		65	Clay, grayish olive green, dry, plastic, scattered fragments of green (glauconite?) and dark yellowish orange sandstone.
5.0	5.5		100	Clay, light olive gray, damp, and shale, grayish blue green, iron stains.
5.5	6.7	1139S01	100	Clay, mottled, light olive gray and dark yellowish orange, wet, very wet from 6.0' to 6.3', iron stains.
6.7	7.0		100	Shale, dark yellowish orange, iron stains.
7.0	7.5		100	Shale, dark yellowish orange.
	7.5			Split Spoon refusal.
7.5	33.5		Augered	Shale with harder sandstone lenses.

33.5

Total depth

PAGE 8 OF 17

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

EQUIPMENT ☒ 6 INCH AUGER 32.5 L.F.
☐ INCH AUGER L.F.

MATERIALS USED

EST. USED
VOL. VOL.

25.0 FEET OF 2 IN. S.S. SCREEN
10.0 FEET OF 2 IN. S.S. CASING
4.1 8.0 SACKS OF SAND
25.0 25.0 POUNDS OF BENTONITE PELLETS
0.4 1.0 SACKS OF CEMENT
5.0 POUNDS OF POWDERED BENTONITE
8.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and irregular boring
diameters.

WELL COVER USED

☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 29.8 FEET.

CENTRALIZERS AT 7.0 FEET.
31.0 FEET.
FEET.

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

HOLE CLEANED OUT
TO 33.0 FEET
BOTTOM OF BOREHOLE
33.5 FEET

LOCATION WAG 11
ORNL GRID COORDINATES
N 34.507.9669
E 28.700.6980
ELEV. GROUND 814.31
ELEV. TOP STAINLESS
STEEL CASING 816.02
DRILLING DATES:
STARTED: 01-19-90
FINISHED: 01-22-90

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

GROUT SEAL 0.0 TO
2.8 FEET
6 INCH DIAMETER
BOREHOLE
2 INCH DIAMETER STAINLESS
STEEL CASING 1.71 FT. ABOVE
GROUND SURFACE TO 7.8 FT.
BELOW GROUND SURFACE
CENTRALIZER (TYP.)

BENTONITE PELLET SEAL
2.8 TO 4.4 FEET

SAND PACK
4.4 TO 33.0 FEET

2 INCH DIAMETER
STAINLESS STEEL 0.010
SLOTTED SCREEN
7.8 TO 32.8 FEET

2 INCH DIAMETER STAINLESS
STEEL SILT TRAP/CAP
32.8 TO 33.0 FEET

TYPE A WELL

NOT TO SCALE

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and Energy
Services Co.

WELL No. 1139

DATE: 01-22-90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			01-22-90	2
BENTONITE			Pellets 01-22-90	1
			Powder 01-23-90	4
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	01-22-90	3
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	01-22-90	3
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	01-22-90	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	01-22-90	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	07-31-90	8
			01-23-90	5
GROUT				
WELL COVERS				
SURFACE CASING			N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

01-22-90

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

	COMPLIANCE DATE	INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>01-22-90</u>	<u>TJm</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>01-22-90</u>	<u>TJm</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>07-31-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>01-22-90</u>	<u>TJm</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

01-22-90

Timothy A. Lee

D. Charles Lytle

07-31-90

D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1139

LOCATION: WAG 11

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 07-30-90

TIME: _____

DEVELOPMENT
ENDING DATE: 07-31-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 16.5 GALLONS

TOTAL GALLONS PUMPED: 565 TOTAL WELL VOLUMES PUMPED: 34.2

INITIAL pH: 8.8 FINAL pH: 8.8

INITIAL CONDUCTIVITY ($\mu S/cm$): 502 FINAL CONDUCTIVITY ($\mu S/cm$): 550

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Muddy

FINAL MEASURED TURBIDITY: > 100NTU's

WELL APPROVED BY: R.C. Williams MMES.

ODOR
OF WATER: None

WATER
DISCHARGED
TO:

☒ GROUND SURFACE
☐ STORM SEWERS
☐ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 5.1 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle 07-31-90
D. Charles Lytle

DATE: 07-30-90

ONE WELL VOLUME = 16.5 GALLONS

COMMENTS Excellent recharger and producer. Passed with 34.2 well volumes. Water remains muddy. Moved to another hole.

* Greater than 100 NTU's.

OBSERVER SIGNATURE/DATE D. Charles Lytle 07-31-90
D. Charles Lytle

M:\INFORM05.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.: 1139

DATE OF TEST: 9-19-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-11

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 = 25.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 30.05 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 = 13

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

SUCCESSIVE COMPUTED VALUES FOR H₀ (FEET)

7.3643
6.2378
5.9709

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
2.00	4.040	3.040
4.00	3.970	2.970
6.00	3.550	2.550
8.00	2.740	1.740
10.00	2.180	1.180
12.00	1.760	.760
14.00	1.500	.500
16.00	1.360	.360
18.00	1.250	.250
20.00	1.180	.180
22.00	1.120	.120
24.00	1.070	.070
26.00	1.020	.020

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $8.91\text{E-}05$ FT/SEC = $2.71\text{E-}03$ CM/SEC

TRANSMISSIVITY = $2.23\text{E-}03$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.12\text{E-}04$ FT/SEC = $3.42\text{E-}03$ CM/SEC

TRANSMISSIVITY = $2.80\text{E-}03$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

Engineering, Design & Geosciences Group, Inc.
726 Pellissippi Parkway
P.O. Box 23010 Knoxville, TN 37033-1010

CHAIN OF CUSTODY RECORD

FOR

MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE
NUMBER

1139501

WELL NO.

1139

LOCATION:

WAG II

TYPE:

Soil

SAMPLER:

Dr. W. H. G. Jones

SAMPLE INTERVAL:

6.2' to 6.5'

DATE:

1-19-90

TIME:

1410

RELINQUISHED BY:
(SIGNATURE)

Dr. W. H. G. Jones

DATE:

1-31-90

TIME:

1500

WTH:

ERC

RECEIVED BY:
(SIGNATURE)

W. H. G. Jones

DATE:

1/31/90

TIME:

1500

WTH:

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:

1.0 General Information

1.1 Well Location

Monitoring well number 1140 is located in WAG 11. It is located in the southern boundary of "White Wing Scrap Yard" or WAG 11. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 34,497.9754, E 28,111.2064 (X-10 grid) or latitude 35°-57'-02.17" and longitude 84°-20'-54.82". 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 1140 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. Drilling commenced on 1-31-90 and was finished on 3-5-90. 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.

- 1-19-90 The rig was mobilized to the staked location and set up on plastic sheeting. The boring was augered to 6.0 feet with a 14-inch auger. Set 6.0 feet of 10 3/4-inch decontaminated steel diverter casing and grouted it into place. Moved rig from location.
- 3-2-90 The rig was moved to location. Drilled to 62.5 feet using an 8.0-inch air rotary tricone bit.
- 3-5-90 Set 2-inch stainless steel screen and casing with sandpack and bentonite pellet seal. Move rig from location.
- 3-6-90 Grouted annulus with 7.0 sacks cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500' thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale and locally, dolomite.

2.3 Sample Collection

No samples were collected during drilling.

A bulk density soil sample was collected from the split spoon sample interval from 3.5' to 3.8'. The sample was measured, weighed and a bulk density of 2.22 grams/cm³ was calculated.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 3/2/90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 6.0 feet and a 10 3/4-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 6.0 to 62.5 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 32.3 to 62.5 feet. A 2-inch diameter stainless steel casing was installed above the screen at 32.3 feet and extended 2.8 feet above ground surface. A sandpack was then tremied into the annular space from 30.5 to 62.5 feet, with a 1.5 foot bentonite pellet seal poured into the annular space above the sandpack from 29.0 to 30.5 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 1140 was developed to remove drill cuttings, silt, and other fines. The monitoring 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 120 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 61.6 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 1140 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 1.17×10^{-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.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>01-31-90</u>	<u>Tbz</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>03-02-90</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>_____</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>03-05-90</u>	<u>Tbz</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>03-02-90</u>	<u>Tbz</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>03-02-90</u>	<u>Tbz</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>03-05-90</u>	<u>Tbz</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>03-05-90</u>	<u>Tbz</u>

RESULTS: No hydrocarbons detected under ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS: _____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

03-05-90

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

03-02-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1140

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG 11
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersol Rand T-4

DATE: START: 01-31-90
FINISH: 03-05-90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: N/A

TYPE DRILLING: Auger/Air Rotary LUBRICANT TYPE: Green Stuff
No. SAMPLES TAKEN: None TYPE: N/A
CONTAINMENT TYPE: Pan, plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 56.0
DEPTH DRILLED IN ROCK: 6.5
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	1.0		Augered	Gravel fill
1.0	2.0		Augered	Clay, dark yellowish orange, sandy plastic, dry; scattered vegetation.
2.0	3.0		Augered	Clay, very sandy, dark yellowish orange, dry, crumbly, black streaks.
3.0	4.3		Augered	Clay and sand, dark yellowish orange, black streaks, dry.
4.3	5.6		Augered	Clay and shale, light olive brown, black streaks, dry.
5.6	10.6		Air Rotary	Clay and shale, light olive brown, dry, crumbly.
10.6	15.6			Siltstone and shale, reddish brown.
15.6	29.0			Siltstone and shale, reddish brown.
29.0	30.9			Siltstone and shale, light brownish gray, iron stains, moist but crumbly.
30.9	31.0			Clay, dark yellowish orange, silty, moist, iron stains.
31.0	32.5			Clay, very silty, mottled dark yellowish orange and light brownish grey, very wet.
32.5	33.0			Siltstone and shale, sandy, brownish gray, dry and crumbly.

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 9 OF 18.

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

EQUIPMENT ☒ 14.0 INCH AUGER 6.0 L.F.

☐ INCH AUGER L.F.

☒ 8.0 INCH ROTARY 56.5 L.F.

MATERIALS USED

EST. USED
VOL. VOL.

30.0 FEET OF 2.0 IN. S.S. SCREEN

35.0 FEET OF 2.0 IN. S.S. CASING

9.7 12.0 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

5.6 7.0 SACKS OF CEMENT

35.0 POUNDS OF POWDERED BENTONITE

56.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED
VOLUMES AND USED VOLUMES

Fractures and irregular boring

diameters.

WELL COVER USED

☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED

YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 61.6 FEET.

CENTRALIZERS AT 22.0 FEET.

41.0 FEET.

60.0 FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT
TO 62.5 FEET

BOTTOM OF BOREHOLE
62.5 FEET

LOCATION WAG 11

ORNL GRID COORDINATES

N 34,497.9754

E 28,111.2064

ELEV. GROUND 871.89

ELEV. TOP STAINLESS

STEEL CASING 873.98

DRILLING DATES:

STARTED: 01-31-90

FINISHED: 03-05-90

LOCKING STEEL COVER

10 INCH DIAMETER

STEEL PROTECTIVE CASING

3.01 FT. ABOVE GROUND

TO 0.0 FT. BELOW

GROUND SURFACE

CONCRETE PAD

10 3/4

INCH DIVERTER

CASING 0.0 FT. ABOVE

GROUND SURFACE TO

6.0 FT. BELOW GROUND

SURFACE

14.0 INCH BOREHOLE

0.0 TO 6.0 FEET

GROUT SEAL 0.0 TO

29.0 FEET

8.0 INCH DIAMETER

BOREHOLE

2 INCH DIAMETER STAINLESS

STEEL CASING 2.09 FT. ABOVE

GROUND SURFACE TO 32.2 FT.

BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL

29.0 TO 30.5 FEET

SAND PACK

30.5 TO 62.5 FEET

2 INCH DIAMETER

STAINLESS STEEL 0.010

SLOTTED SCREEN

32.2 TO 62.3 FEET

2 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP

62.3 TO 62.5 FEET

TYPE D WELL

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1140

DATE: 03-05-90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			03-05-90	3
BENTONITE				
Pellets			03-05-90	1
Powder			03-06-90	6
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	03-05-90	3
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	03-05-90	3
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	03-05-90	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	03-05-90	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	08-06-90	8
GROUT				
Diverter Casing			01-31-90	6
Well Casing			03-06-90	6
WELL COVERS				
SURFACE CASING/DIVERTER CASING			01-31-90	4

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee

03-05-90

Timothy A. Lee

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

	COMPLIANCE	
	DATE	INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>03-05-90</u>	<u>Tbz</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>03-05-90</u>	<u>Tbz</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>08-06-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>03-05-90</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

03-05-90

Timothy A. Lee

D. Charles Lytle

08-06-90

D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1140
LOCATION: WAG 11

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 08-03-90

TIME: _____

DEVELOPMENT
ENDING DATE: 08-06-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 15.2 GALLONS

TOTAL GALLONS PUMPED: 120 TOTAL WELL VOLUMES PUMPED: 8.0

INITIAL pH: 8.7 FINAL pH: 8.8

INITIAL CONDUCTIVITY ($\mu S/cm$): 226 FINAL CONDUCTIVITY ($\mu S/cm$): 279

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clean

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: 51.1 feet from ground surface.

DEVELOPMENT OBSERVATIONS

_____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE D. Charles Lytle 08-06-90

D. Charles Lytle

HYDROLOG

ERCE
Environmental
and Energy
Services Co.

WELL NO. 1140

LOCATION: WAG 11

DATE: 08-03-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 152 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
08-03-90	1330	72	Cloudy	-----	8.7	226	72	4.7	
08-06-90	1315	18	Cloudy	-----	8.8	275	90	6.0	
08-07-90	1330	30	Clean	4.0	8.8	279	120	8.0	
RESULTS AT END OF DEVELOPMENT			Clean	4.0	8.8	279	120	8.0	

COMMENTS Poor recharger and poor producer. Water remained clean even after surging. Passed with 4.0 NTU's and moved to the next hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 08-06-90
D. Charles Lytle

MWF00005.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.: 1140

DATE OF TEST: 9-20-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-11

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 = 30.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 8.99 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 30.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 8.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 0 ("1" IF FALLING, "0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 24

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

.5868
.5964

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	6.660	1.340
20.00	7.000	1.000
30.00	7.230	.770
40.00	7.340	.660
50.00	7.410	.590
60.00	7.460	.540
75.00	7.510	.490
90.00	7.540	.460
105.00	7.550	.450
120.00	7.590	.410
150.00	7.580	.420
180.00	7.610	.390
240.00	7.650	.350
300.00	7.660	.340
360.00	7.690	.310
420.00	7.690	.310
480.00	7.690	.310
540.00	7.710	.290
600.00	7.740	.260
720.00	7.750	.250
840.00	7.700	.300
960.00	7.740	.260
1080.00	7.770	.230
1200.00	7.790	.210

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $3.83\text{E-}06$ FT/SEC = $1.17\text{E-}04$ CM/SECTRANSMISSIVITY = $1.15\text{E-}04$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.45\text{E-}06$ FT/SEC = $4.41\text{E-}05$ CM/SECTRANSMISSIVITY = $4.34\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 1141 is located in WAG 11. It is located in the southern boundary of "White Wing scrap Yard" or WAG 11. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 34,488.6430, E 28,148.8969 (X-10 grid) or latitude 35°-57'-02.30" and longitude 84°-20'-54.38". 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 1141 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. Drilling commenced on 1-30-90 and was finished on 2-14-90. 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.

- 1-30-90 The rig was mobilized to location and set up on plastic sheeting. Split spoon samples were taken from surface to first refusal at 5.6 feet. The boring was deepened with a 6-inch auger to 29.0 feet. Split spoons were taken from 29.0 feet to refusal at 34.7 feet. The boring was deepened from 34.7 feet to refusal at 58.0 feet using a 6-inch auger. Six feet of 15 1/4-inch decontaminated diverter casing was set and grouted. The rig was moved from location.
- 2-8-90 The rig was moved to location. Drill from 6.0 feet to 60.5 feet using a 14 1/2-inch air rotary tricone bit. Set 60.5 feet of 10 3/4-inch decontaminated steel surface casing and grouted it to surface. The rig was moved from location.
- 2-14-90 Move rig to location. Drill from 60.5 feet to 97.5 feet using an 8-inch air rotary tricone bit. Set 97.4 feet of 4-inch stainless steel screen and casing with sandpack and bentonite seal.
- 2-15-90 Grouted stainless steel casing annulus with 17 sacks cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500' thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow

and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale and locally, dolomite.

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 1141S01 was collected in the split spoon interval from 4.0' to 4.3' on 1-30-90.

A bulk density soil sample was collected from the split spoon sample interval from 3.5' to 3.8'. The sample was measured, weighed and a bulk density of 2.11 grams/cm³ was calculated.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 2-14-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 6.0 feet. A 15 1/4-inch diverter casing was installed from surface to 6.0 feet below ground surface and grouted in place. The boring was then extended past the refusal depth with a 14.5-inch

air rotary tricone roller bit from 6.0 feet to 60.5 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 60.5 feet, sealed with a 1.5 foot bentonite pellet layer from 59.0 feet to 60.5 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 97.5 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 82.2 feet to 97.4 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 82.2 feet and extended 2.8 feet above ground surface. A sandpack was then tremied into the annular space from 77.9 to 97.4 feet, with a 1.8 foot bentonite pellet seal poured into the annular space above the sandpack from 76.1 to 77.9 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 1141 was developed to remove drill cuttings, silt, and other fines. The monitoring was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 160 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 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 7/27/90 at a depth of 89.8 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 1141 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 1.45×10^{-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.

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>01-30-90</u>	<u>Tbz</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>01-30-90</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>02-14-90</u>	<u>Tbz</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>01-30-90</u>	<u>Tbz</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>01-30-90</u>	<u>Tbz</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>01-30-90</u>	<u>Tbz</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>02-14-90</u>	<u>Tbz</u>

RESULTS: No detectable hydrocarbons under ultra violet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

_____
_____
_____
_____

OBSERVER SIGNATURE/DATE Timothy A. Lee 01-30-90
Timothy A. Lee

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

02-14-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1141

ORNL MONITORING WELL LOG

PAGE 1 OF 3

LOCATION: WAG 11 "White Wing Scrap Yard"

DRILLER: Larry Ledbetter

HELPER: Fred Dixon

DRILL: Ingersol Rand T-4

DATE: START: 01-30-90

FINISH: 02-14-90

LOGGED BY: Timothy A. Lee

HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Split Spoon, Auger, Air Rotary LUBRICANT TYPE: Green Stuff

No. SAMPLES TAKEN: Two TYPE: Soil

CONTAINMENT TYPE: Plastic, Pan

THICKNESS OF SOIL (REFUSAL DEPTH): 58.0'

DEPTH DRILLED IN ROCK: 39.5

TOTAL DEPTH OF WELL: 97.5

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	1.0		Shoveled	Gravel fill
1.0	2.0		75	Clay, dark yellowish orange, sandy, plastic, dry; scattered vegetation roots.
2.0	3.0		75	Clay, very sandy, dark yellowish orange, dry, crumbly, black streaks.
3.0	4.3	1141S01	100	Clay and sand, dark yellowish orange, black streaks, mostly dry except moist at 4.1'. Bulk Density taken from 3.5' to 3.8' = 2.11 g/cm ³ .
4.3	5.0	from 4.0' to 4.3'	100	Clay and shale, light olive brown, black-brown streaks, dry, crumbly.
5.0	5.6		100	Clay and shale, light olive brown, black streaks, dry, crumbly.
	5.6			First Split Spoon refusal.
5.6	10.6		Augered	Clay and shale, light olive brown.
10.6	15.6		Augered	Clay, siltstone, shale, reddish brown.
15.6	29.0		Augured	Siltstone, shale, clay.
29.0	29.5		100	Clay, dark yellowish orange, sandy, black streaks, (from above?).
29.5	29.9		100	Siltstone and shale, light grayish green, dry, crumbly (from above?).

ORNL MONITORING WELL LOG

PAGE 2 OF 3

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
29.9	30.9		100	Siltstone and shale, light brownish gray, iron stains, moist but crumbly.
30.9	31.0		100	Clay, dark yellowish orange, silty, moist, iron stains.
31.0	32.5	1141S02 from 31.0' to 32.5'	50	Siltstone and shale, mottled dark yellowish orange and light brownish gray, very wet and gooshy.
32.5	33.0		50	Siltstone, sandstone, shale, brownish gray, dry and crumbly.
33.0	33.9		100	Siltstone and shale, mottled dark yellowish orange and light brownish gray, very wet.
33.9	34.7		100	Siltstone and shale, brownish gray, sandy, dry and crumbly, iron stains.
	34.7			Second Split Spoon refusal.
34.7	39.0		Augered	No returns, soupy, mud.
39.0	58.0		Augered	Siltstone and shale.
	58.0			Auger refusal.
58.0	60.5		Air Rotary	Limestone and chert, light olive gray, medium crystalline limestone with scattered rusty biege chert fragments. Many fragments of brownish gray and light olive gray siltstone and shale (from above?).
60.5	65.0		Air Rotary	Siltstone, Shaley, reddish brown and greenish gray.
65.0	70.0		Air Rotary	Siltstone, slightly shaley, reddish brown to greenish gray.
70.0	75.0		Air Rotary	Siltstone, greenish gray, scattered fragments of sandstone, medium grained, pale yellowish brown; scattered chert fragments.
75.0	80.0		Air Rotary	Siltstone, greenish gray, scattered fragments of sandstone, medium grained, pale yellowish brown.

WELL No. 1141

ORNL MONITORING WELL LOG

PAGE 3 OF 3

PAGE 11 OF 22

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

DRILLING METHOD: ☒ 22.0 INCH AUGER 6.0 L.F.
☐   INCH AUGER   L.F.
☒ 14.5 INCH ROTARY 54.5 L.F.
☒ 8.0 INCH ROTARY 37.0 L.F.

MATERIALS USED

EST. USED
VOL. VOL.
50.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
60.5 FT. OF 10 3/4 IN. SURFACE CASING
16.5 16.5 SACKS OF CEMENT (SURFACE CASING)
82.5 POUNDS OF POWERED BENTONITE (SURFACE CASING)
132.0 GALLONS OF WATER (SURFACE CASING)
82.2 FT. OF 4 IN. DIA. STAINLESS STEEL CASING
15.0 FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
5.0 5.0 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
12.5 17.0 SACKS OF CEMENT (WELL CASING)
85.0 POUNDS OF POWERED BENTONITE (WELL CASING)
136.0 GALLONS OF WATER (WELL CASING)
2.76 FT. OF 10 3/4 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES
AND USED VOLUMES

Fractures and irregular boring diameters
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 89.8 FEET.

CENTRALIZERS AT 20.0 FEET.
40.0 FEET.
60.0 FEET.
80.0 FEET
NOTE: 96.0 FEET

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

TYPE B WELL

LOCATION WAG 11

ORNL GRID COORDINATES

N 34,488.6430

E 28,148.8969

ELEV. GROUND 872.57

ELEV. TOP STAINLESS

STEEL CASING 874.03

DRILLING DATES:

STARTED: 01-30-90

FINISHED: 02-14-90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			02-14-90	2
BENTONITE	Pellets		02-14-90	1
	Powder		02-15-90	4
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	02-14-90	2
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	02-14-90	2
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	02-14-90	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	02-14-90	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	07-27-90	8
GROUT	Surface Casing		02-09-90	6
			02-15-90	
	S.S.	Well Casing	02-16-90	6
WELL COVERS				
SURFACE CASING			02-08-90	4

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

02-15-90

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>02-14-90</u>	<u>TJ</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>02-14-90</u>	<u>TJ</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>07-27-90</u>	<u>DC</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>02-14-90</u>	<u>TJ</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

02-14-90

Timothy A. Lee

D. Charles Lytle

07-27-90

D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1141
LOCATION: WAG 11

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 07-27-90

TIME: _____

DEVELOPMENT
ENDING DATE: 07-27-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 40.0 GALLONS

TOTAL GALLONS PUMPED: 160 TOTAL WELL VOLUMES PUMPED: 4.0

INITIAL pH: 9.1 FINAL pH: 9.1

INITIAL CONDUCTIVITY ($\mu S/cm$): 369 FINAL CONDUCTIVITY ($\mu S/cm$): 369

DESCRIPTION OF INITIAL TURBIDITY: Clean

DESCRIPTION OF FINAL TURBIDITY: Clean

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: 58.3 feet from ground surface.

DEVELOPMENT OBSERVATIONS

_____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE D. Charles Lytle 07-27-90

D. Charles Lytle

DATE: 07-27-90

DATE: 07-27-90

ONE WELL VOLUME = 40.0 GALLONS

COMMENTS	Fast recharger and good producer. Water remained clear even after surging. Passed with 4.0 NTU's.

OBSERVER SIGNATURE/DATE D. Charles Lytle 7-27-90
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.: 1141

DATE OF TEST: 9-19-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-11

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 = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 37.80 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)

3.3405
3.3258

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.130	3.130
20.00	4.140	3.140
30.00	4.120	3.120
40.00	4.080	3.080
50.00	4.070	3.070
60.00	4.040	3.040
75.00	3.970	2.970
90.00	3.940	2.940
105.00	3.880	2.880
120.00	3.810	2.810
150.00	3.700	2.700
180.00	3.600	2.600
240.00	3.370	2.370
300.00	3.170	2.170
360.00	2.980	1.980
420.00	2.810	1.810
480.00	2.640	1.640
540.00	2.500	1.500
600.00	2.360	1.360
720.00	2.120	1.120
840.00	1.950	.950
960.00	1.800	.800
1080.00	1.670	.670
1200.00	1.570	.570
1320.00	1.490	.490
1440.00	1.420	.420
1560.00	1.320	.320
1680.00	1.270	.270
1800.00	1.210	.210
1920.00	1.190	.190
2040.00	1.170	.170
2160.00	1.120	.120

1221-K-0106

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $4.75\text{E-}06$ FT/SEC = $1.45\text{E-}04$ CM/SEC

TRANSMISSIVITY = $7.13\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $5.57\text{E-}06$ FT/SEC = $1.70\text{E-}04$ CM/SEC

TRANSMISSIVITY = $8.36\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

1141-501

WELL NO.

1141

LOCATION:

WAS 11

TYPE:

SOIL

SAMPLER:

Timothy A. Jaz

(SIGNATURE)

SAMPLE INTERVAL:

4.0' To 4.3'

DATE:

1-30-90

TIME:

0935

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Timothy A. Jaz

1-31-90

1500

ERC

MAJAN

1/31/90

1500

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:

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**

1141502

WELL NO. 1141		LOCATION: WAG 11		TYPE: SOIL			
SAMPLER: <i>Timothy O. By</i> (SIGNATURE)		SAMPLE INTERVAL: 31.0' TO 32.5'		DATE: 1-30-90		TIME: 1115	
RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<i>Timothy O. By</i>	1-31-90	1500	ERC	<i>NE Owen</i>	1/31/90	1500	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: _____
_____
_____
_____
_____

1.0 General Information

1.1 Well Location

Monitoring well number 1143 is located in WAG 11. It is located in the southern boundary of "White Wing Scrap Yard" or WAG 11. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,068.4127, E 27,569.5606 (X-10 grid) or latitude 35°-57'-03.88" and longitude 84°-21'-04.16". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 1143 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. Drilling commenced on 1-23-90 and was finished on 3-6-90. 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.

- 1-23-90 The rig was mobilized to the staked location and set up on plastic sheeting. The boring was augered to 6.5 feet using a 22-inch auger. Set 6.5 feet of 15 1/4-inch decontaminated steel diverter casing and grouted it to surface.
- 1-24-90 Augered from 6.5 feet to refusal at 27.5 feet using a 14.0-inch auger. Rig up a 14.0-inch air rotary tricone and drill from 27.5 feet to 30.0 feet.
- 1-25-90 Set 30.0 feet 10 1/4-inch decontaminated steel surface casing with bentonite seal and tremie grouted it to surface with 15 sacks grout.
- 2-1-90 Rig up and drill from 30.0 feet to 38.0 feet using an 8.0-inch air rotary tricone bit.
- 2-2-90 Drill from 38.0 feet to total depth at 52.5 feet. Rig down.
- 3-6-90 Set 4-inch stainless steel well casing and screens with sandpack and bentonite seal.
- 3-7-90 Tremie grouted well casing annulus with 9.0 sacks of cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologists Bruce McMaster and 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500' thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale and locally, dolomite.

2.3 Sample Collection

No soil or water samples were collected during drilling.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 2-2-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 6.5 feet. A 15 1/4-inch diverter casing was installed from surface to 6.5 feet below ground surface and grouted in place. A 14.5-inch diameter boring was augered from 6.5 feet to 27.5 feet (auger refusal). The boring was then extended past the refusal depth with a 14.0-inch air rotary tricone roller bit from 27.5 feet to 30.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 30.0 feet, sealed with a 1.5 foot bentonite pellet layer from 28.5 feet to 30.0 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 52.5 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 37.5 feet to 52.5 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 37.5 feet and

extended 2.5 feet above ground surface. A sandpack was then tremied into the annular space from 30.4 to 52.5 feet, with a 3.6 foot bentonite pellet seal poured into the annular space above the sandpack from 26.8 to 30.4 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 1143 was developed to remove drill cuttings, silt, and other fines. The monitoring 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 161 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 7/27/90 at a depth of 51.5 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 1143 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously removing a known quantity of water from 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 1.45×10^{-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.

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>01-23-90</u>	<u>Tbz</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>01-23-90</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>03-06-90</u>	<u>Tbz</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>01-23-90</u>	<u>Tbz</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>01-23-90</u>	<u>Tbz</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>03-06-90</u>	<u>Tbz</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>03-06-90</u>	<u>Tbz</u>

RESULTS: No hydrocarbons detected under ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

_____

_____

_____

_____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 03-06-90
Timothy A. Lee

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

03-06-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1143

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG 11
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersol Rand T-4

DATE: START: 01-23-90
FINISH: 03-06-90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: N/A

TYPE DRILLING: Auger, Air Rotary LUBRICANT TYPE: Green Stuff
No. SAMPLES TAKEN: None TYPE: N/A
CONTAINMENT TYPE: Plastic, pan

THICKNESS OF SOIL (REFUSAL DEPTH): 27.5
DEPTH DRILLED IN ROCK: 25.0
TOTAL DEPTH OF WELL: 52.5

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	3.0		Augered	Gravel fill.
3.0	6.0		Augered	Clay, moderate brown, with minor light brown siltstone fragments, some dark organic, dry.
6.0	10.0		Augered	Clay, dry, moderate yellowish brown, silty; minor fragments of siltstone, maroon.
10.0	11.0		Augered	Shale and siltstone, dry, grayish to red, with minor tan silty lenses.
11.0	15.0		Augered	Clay, wet, dark yellowish orange to pale orange, scattered shales, pale brown to light olive gray.
15.0	20.0		Augered	Shales and siltstone, pale brown to maroon, damp, scattered greenish yellow clays.
20.0	25.0		Augered	Siltstone, pale olive to grayish brown, scattered fragments of sandstone, yellowish gray medium grained, damp.
25.0	30.0		Augered	Siltstone, pale olive to grayish brown, scattered fragments of sandstone, medium grained.
30.0	35.0		Air Rotary	Siltstone, light olive and moderate brown, moderate crumbly, dry.

PAGE 2 OF 2

PAGE 10 OF 19

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED

PROOFED

BY: B.M. Masters/Timothy A.

BY: Michael L. Ebers

Lee

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter

HELPER: Fred Dixon

DRILLING METHOD: ☒ 22 INCH AUGER 6.5 L.F.
☒ 14 1/2 INCH AUGER 21.0 L.F.
☒ 6 INCH ROTARY 25.0 L.F.
☐ INCH ROTARY L.F.

MATERIALS USED

EST. VOL. USED VOL.
50.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
29.5 FT. OF 10 3/4 IN. SURFACE CASING
10.0 15.0 SACKS OF CEMENT (SURFACE CASING)
75.0 POUNDS OF POWDERED BENTONITE (SURFACE CASING)
120.0 GALLONS OF WATER (SURFACE CASING)
40.0 FT. OF 4.0 IN. DIA. STAINLESS STEEL CASING
15.0 FT. OF 4.0 IN. DIA. STAINLESS STEEL SCREEN
4.5 6.0 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
8.3 9.0 SACKS OF CEMENT (WELL CASING)
45.0 POUNDS OF POWDERED BENTONITE (WELL CASING)
72.0 GALLONS OF WATER (WELL CASING)
2.97 FT. OF 10 3/4 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and irregular 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 51.5 FEET.

CENTRALIZERS AT 12.0 FEET.
32.0 FEET.
51.0 FEET.

NOTE:

ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

TYPE B WELL

LOCATION WAG 11

ORNL GRID COORDINATES
N 35,068.4127

E 27,569.5606

ELEV. GROUND 827.80

ELEV. TOP STAINLESS

STEEL CASING 829.79

DRILLING DATES:

STARTED: 01-23-90

FINISHED: 03-06-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1143

DATE: 03-06-90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			03-06-90	3
BENTONITE				
Pellets			03-06-90	1
Powder			03-07-90	6
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	03-06-90	3
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	03-06-90	3
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	03-06-90	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	03-06-90	2
MONITORING WELL PUMP	(PREPACKAGED	☐ YES ☐ NO		
GROUT				
Surface Casing			01-24-90	6
Well Casing			03-06-90	6
WELL COVERS				
SURFACE CASING			01-24-90	4

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

03-06-90

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

	COMPLIANCE	
	DATE	INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>01-23-90</u>	<u>Ton</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>01-23-90</u>	<u>Ton</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>07-27-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>03-06-90</u>	<u>Ton</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 03-06-90
Timothy A. Lee

D. Charles Lytle 07-27-90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1143

LOCATION: WAG 11

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF

DEVELOPMENT: Surging and Pumping

DEVELOPMENT

BEGAN DATE: 07-27-90

TIME: _____

DEVELOPMENT

ENDING DATE: 07-27-90

DEVELOPMENT

OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 34.7 GALLONS

TOTAL GALLONS PUMPED: 161 TOTAL WELL VOLUMES PUMPED: 4.6

INITIAL pH: 8.8 FINAL pH: 8.8

INITIAL CONDUCTIVITY ($\mu S/cm$): 409 FINAL CONDUCTIVITY ($\mu S/cm$): 409

DESCRIPTION OF INITIAL TURBIDITY: Clear

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: 24.8 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle 07-27-90
D. Charles Lytle

DATE: 07-27-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 34.7 GALLONS

COMMENTS	Fast recharger and good producer. Water remained clear even after surging. Passed with 4.0 NTU's.

OBSERVER SIGNATURE/DATE D. Charles Lytle 07-27-90
D. Charles Lytle

MWFORM05.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

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

- (1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967
(ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED
"RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS
CHARGE OF WATER")
- (2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN
VOL. 12, NO.3 OF WRR ENTITLED
"A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY
OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY
PENETRATING WELLS")

WELL NO.: 1143

DATE OF TEST: 9-26-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-11

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 = 6.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 14.70 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 23.30 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 14.70 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 8.80 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 0 ("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)

1.6552
1.6374

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	6.990	1.810
20.00	7.040	1.760
30.00	7.110	1.690
40.00	7.160	1.640
50.00	7.210	1.590
60.00	7.240	1.560
75.00	7.300	1.500
90.00	7.340	1.460
105.00	7.370	1.430
120.00	7.430	1.370
150.00	7.500	1.300
180.00	7.560	1.240
240.00	7.690	1.110
300.00	7.810	.990
360.00	7.910	.890
420.00	7.980	.820
480.00	8.060	.740
540.00	8.140	.660
600.00	8.190	.610
720.00	8.260	.540
840.00	8.350	.450
960.00	8.410	.390
1080.00	8.460	.340
1200.00	8.540	.260
1320.00	8.560	.240
1440.00	8.610	.190
1560.00	8.640	.160
1680.00	8.650	.150
1800.00	8.680	.120
1920.00	8.710	.090
2040.00	8.710	.090
2160.00	8.750	.050

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $4.77\text{E-}06$ FT/SEC = $1.45\text{E-}04$ CM/SEC

TRANSMISSIVITY = $7.01\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $5.25\text{E-}06$ FT/SEC = $1.60\text{E-}04$ CM/SEC

TRANSMISSIVITY = $7.71\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 1144 is located in WAG 11. It is located in the northwestern boundaries of "White Wing Scrap Yard" or WAG 11. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,339.3270, E 27,421.6061 (X-10 grid) or latitude 35°-57'-05.29" and longitude 84°-21'-07.49". 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 1144 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. Drilling commenced on 1-10-90 and was finished on 2-15-90. 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.

- 1-10-90 The rig was mobilized to location and set up on plastic sheeting. Split spoon samples were taken from surface to refusal at 39.1 feet. The boring was reamed to 6.0 feet using a 22.0-inch auger.
- 1-11-90 Set and grouted 6.0 feet of 15.0-inch decontaminated steel diverter casing. Moved rig from hole
- 1-31-90 Moved rig back over hole. Drilled to 44.0 feet using a 14.0-inch air rotary tricone bit.
- 2-1-90 Set 44.0 feet of 10 3/4-inch decontaminated steel surface casing. Moved rig from location.
- 2-2-90 Grouted surface casing with 15 sacks cement.
- 2-15-90 Move back to location. Drill from 44.0 to 122.5 feet using an 8.0-inch air rotary tricone bit. Run stainless steel 4-inch well casing and screen and set with sand pack and bentonite seal.
- 2-16-90 Grouted well casing annulus with 13 sacks cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500' thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale and locally, dolomite.

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 1144S01, was collected in the split spoon interval from 29.8' to 30.1' on 1-10-90.

A bulk density soil sample was collected from the split spoon sample interval from 6.5' to 6.8'. The sample was measured, weighed and a bulk density of 2.04 grams/cm³ was calculated.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 2-15-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 6.0 feet. A 15 1/4-inch diverter casing was installed from surface to 6.0 feet below ground surface and grouted in place. A 14.5-inch diameter boring was augered from 6.0 feet to 39.1 feet (auger refusal). The boring was then extended past the refusal depth with a 14.0-inch air rotary tricone roller bit from 39.1 feet to 44.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was

1221-4.016

installed from 0.0 feet to 44.0 feet, sealed with a 2.0 foot bentonite pellet layer from 42.0 feet to 44.0 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 122.5 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 102.1 feet to 122.3 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 102.1 feet and extended 2.9 feet above ground surface. A sandpack was then tremied into the annular space from 98.5 to 122.3 feet, with a 1.4 foot bentonite pellet seal poured into the annular space above the sandpack from 97.1 to 98.5 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 1144 was developed to remove drill cuttings, silt, and other fines. The monitoring 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 970 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 5 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 9-16-90 at a depth of 119.6 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 1144 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 1.58×10^{-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

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>01-10-90</u>	<u>MLE</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>01-10-90</u>	<u>MLE</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>02-15-90</u>	<u>Tomy</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>01-10-90</u>	<u>MLE</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>01-10-90</u>	<u>MLE</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>01-10-90</u>	<u>MLE</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>01-10-90</u>	<u>MLE</u>

RESULTS: No hydrocarbons detected under ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

_____

_____

_____

_____

OBSERVER SIGNATURE/DATE

Michael L. Ebers
Timothy A. Lee

01-10-90

02-15-90

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

01-10-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1144

ORNL MONITORING WELL LOG

PAGE 1 OF 3

LOCATION: WAG 11

DATE: START: 01-10-90

DRILLER: Larry Ledbetter

FINISH: 02-15-90

HELPER: Fred Dixon

LOGGED BY: Michael Ebers/Timothy Lee

DRILL: Ingersol Rand T-4

HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Split Spoon, Auger and Air Rotary LUBRICANT TYPE: Green Stuff

No. SAMPLES TAKEN: One TYPE: Soil

CONTAINMENT TYPE: Auger Pan, Plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 39.1

DRILLING FLUID SAMPLES:

DEPTH DRILLED IN ROCK: 83.4

TYPE: N/A DATE: N/A

TOTAL DEPTH OF WELL: 122.5

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	1.0		---	Gravel pad
1.0	2.8		100%	Clay, moderate reddish brown, loose to medium dense, slightly damp, medium stiff.
2.8	3.3		100%	Clay, moderate reddish brown, with grayish orange speckles, damp.
3.3	5.0		100%	Clay, reddish brown, grayish orange along relict jointing planes, blocky, crumbly, dry.
5.0	7.5		100%	Clay, moderate reddish brown, with scattered small yellowish orange blocks of clay, damp, fine crumbly to medium dense, bulk density at 6.5' - 6.8'. Bulk density equals 2.04 grams/cm ³ .
7.5	9.2		100%	Clay, moderate reddish brown with blocks of grayish orange sandy clay, crumbly to medium dense, slightly damp.
9.2	9.8		100%	Clay, moderate reddish brown, dense, stiff, plastic, slightly damp.
9.8	16.0			Clay, moderate reddish brown, blocky, loose, crumbly, thin grayish orange zones, relict bedding and jointing visible.
16.0	17.0		100%	Clay, moderate reddish brown, crumbly,

ORNL MONITORING WELL LOG

PAGE 2 OF 3

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
				slightly damp, very faint relict bedding--
				"Ghost" bedding.
17.0	17.2		100%	Clay, reddish brown, dense, stiff.
17.2	18.2		100%	Clay, reddish brown and grayish orange, and
				deeply weathered blocky shale.
18.2	21.0		100%	Clay, reddish brown with blotches and
				speckles of reddish orange and grayish
				yellow, crumbly.
21.0	22.2		100%	Clay, reddish brown, few thin streaks of
				brownish orange, very damp, soft, loose.
22.2	23.0		100%	Clay, pale olive and moderate yellow, very
				distinct color change, damp.
23.0	27.0		100%	Clay, banded with alternating colors of
				reddish brown, moderate yellow and light
				brown, damp, soft to stiff, crumbly to plastic,
				(reddish brown clay is crumbly, other colors
				are stiff and plastic).
27.0	30.2	1144S01	100%	Clay, moderate yellow, pale olive and reddish
		@ 29.8 -		brown, blotchy, crumbly and stiff, damp.
		30.1		
30.2	39.1		100%	Clay, moderate yellow, fine silty, relict
				thing laminations, 50° to horizontal, damp,
				crumbly, free water in boring starting at 29'.
	39.1			Split Spoon refusal and auger refusal.
39.1	44.0		Air Rotary	Siltstone, slightly shaley, olive gray.
44.0	50.0		Air Rotary	Siltstone, slightly shaley, olive gray;
				scattered fragments of sandstone, medium
				grained, moderate yellowish brown, scattered
				fragments of grout.
50.0	55.0		Air Rotary	Siltstone, slightly shaley, olive gray.
55.0	60.0		Air Rotary	Siltstone, slightly shaley, olive gray.
60.0	65.0		Air Rotary	Siltstone, slightly shaley, olive gray,

WELL No. 1144

ORNL MONITORING WELL LOG

PAGE 3 OF 3

PAGE 11 OF 21

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED

PROOFED

BY: Michael L. Ebers/Timothy A. BY: Michael L. Ebers

Lee.

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter HELPER: Fred Dixon

DRILLING METHOD:

■	22.0	INCH AUGER	6.0	L.F.
■	6.0	INCH AUGER	33.1	L.F.
■	14.5	INCH ROTARY	4.9	L.F.
■	8.0	INCH ROTARY	78.5	L.F.

MATERIALS USED

EST. USED VOL. VOL. 50.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
44.0 FT. OF 10 3/4 IN. SURFACE CASING

15.0 15.0 SACKS OF CEMENT (SURFACE CASING)

82.5 POUNDS OF POWERED BENTONITE (SURFACE CASING)

132.0 GALLONS OF WATER (SURFACE CASING)

102.1 FT. OF 4 IN. DIA. STAINLESS STEEL CASING

20.0 FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN

6.0 6.0 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

13.0 13.0 SACKS OF CEMENT (WELL CASING)

80.0 POUNDS OF POWERED BENTONITE (WELL CASING)

128.0 GALLONS OF WATER (WELL CASING)

2.76 FT. OF 10 3/4 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and irregular 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 119.6 FEET.

CENTRALIZERS AT 24.0 FEET.

44.0 FEET.

69.0 FEET.

80.0 FEET.

100.0 FEET.

121.0 FEET.

NOTE:

ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT TO 122.3 FEET

BOTTOM OF BORE HOLE 122.3 FEET

LOCATION WAG 11
ORNL GRID COORDINATES
N 35,339.3270
E 27,421.6061
ELEV. GROUND 846.15
ELEV. TOP STAINLESS
STEEL CASING 847.82
DRILLING DATES:
STARTED: 01-10-90
FINISHED: 02-15-90

TYPE B WELL

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		02-15-90	2
BENTONITE	Pellets	02-15-90	1
	Powder	02-16-90	4
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	02-15-90	2
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	02-15-90	2
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	02-15-90	2
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	02-15-90	2
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	09-12-90	8
GROUT	Well Casing	02-16-90	5
	Surface Casing	02-01-90	5
WELL COVERS			
SURFACE CASING		02-01-90	4

COMMENTS:

OBSERVER SIGNATURE/DATE Timothy A. Lee 02-15-90

Timothy A. Lee

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

	COMPLIANCE	
	DATE	INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>02-15-90</u>	<u>Tbz</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>02-15-90</u>	<u>Tbz</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>09-12-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>02-15-90</u>	<u>Pms</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

02-15-90

D. Charles Lytle
D. Charles Lytle

09-12-90

ERCE
Environmental
and Energy
Services Co.

WELL No. 1144
LOCATION: WAG 11

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 08-02-90

TIME: _____

DEVELOPMENT
ENDING DATE: 09-12-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 86.6 GALLONS

TOTAL GALLONS PUMPED: 970 TOTAL WELL VOLUMES PUMPED: 11.2

INITIAL pH: 9.5 FINAL pH: 9.6

INITIAL CONDUCTIVITY ($\mu S/cm$): 356 FINAL CONDUCTIVITY ($\mu S/cm$): 250

DESCRIPTION OF INITIAL TURBIDITY: Slightly cloudy

DESCRIPTION OF FINAL TURBIDITY: Clean

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: 21.1 feet from ground surface.

DEVELOPMENT OBSERVATIONS

_____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE D. Charles Lytle 9-12-90
D. Charles Lytle

WATER/09/90

ERCE
Environmental
and Energy
Services Co.

WELL NO. 1144

LOCATION: WAG 11

DATE: 08-02-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 86.6 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
08-02-90	1330	295	Cloudy	---	9.5	356	295	3.4	
08-03-90	0930	38	Cloudy	---	9.4	280	333	3.8	
08-03-90	1330	12	Cloudy	---	9.3	252	345	4.0	
08-06-90	1315	108	Cloudy	---	9.2	234	453	5.2	
08-07-90	1330	40	Cloudy	---	9.0	214	493	5.7	
08-09-90	0910	35	Cloudy	---	8.8	200	528	6.0	
08-09-90	1100	20	Cloudy	---	9.1	232	548	6.3	
08-27-90	1330	292	Cloudy	---	8.9	236	840	9.7	
09-05-90	0900	10	Cloudy	---	10.3	270	850	9.8	
09-06-90	0900	30	Cloudy	---	10.0	255	880	10.2	
09-06-90	1430	35	Cloudy	---	9.3	305	915	10.7	
09-12-90	0900	20	Cloudy	---	8.9	220	935	10.8	
09-12-90	1430	35	Clear	5.0	9.6	250	970	11.2	
RESULTS AT END OF DEVELOPMENT			Clear	5.0	9.6	250	970	11.2	

COMMENTS Okay recharger and producer. Passed with 5.0 NTU's and moved to
another well.

OBSERVER SIGNATURE/DATE D. Charles Lytle 09-12-90
D. Charles Lytle

M:\FORMS.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.: 1144

DATE OF TEST: 9-20-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-11

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 = 98.70 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 = 27

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

SUCCESSIVE COMPUTED VALUES FOR H0 (FEET)

2.6631
2.6641

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.690	2.690
20.00	3.680	2.680
30.00	3.690	2.690
40.00	3.690	2.690
50.00	3.690	2.690
60.00	3.690	2.690
75.00	3.660	2.660
90.00	3.650	2.650
105.00	3.650	2.650
120.00	3.650	2.650
150.00	3.650	2.650
180.00	3.630	2.630
240.00	3.630	2.630
300.00	3.610	2.610
360.00	3.610	2.610
420.00	3.610	2.610
480.00	3.610	2.610
540.00	3.630	2.630
600.00	3.650	2.650
720.00	3.650	2.650
840.00	3.660	2.660
960.00	3.610	2.610
1080.00	3.610	2.610
1200.00	3.610	2.610
1320.00	3.610	2.610
1440.00	3.600	2.600
1560.00	3.610	2.610

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $5.19\text{E-}08$ FT/SEC = $1.58\text{E-}06$ CM/SEC

TRANSMISSIVITY = $1.04\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $5.96\text{E-}08$ FT/SEC = $1.82\text{E-}06$ CM/SEC

TRANSMISSIVITY = $1.19\text{E-}06$ 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

1144301

WELL NO.

1144

LOCATION:

WAG 11

TYPE:

SOIL

SAMPLER:

[Signature]
(SIGNATURE)

SAMPLE INTERVAL:

29.8' - 30.1'

DATE:

1/10/90

TIME:

1500

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

[Signature]

1/10/90

0950

ERC/EDGE

[Signature]

1/16/90

0950

14/11

TYPE OF SAMPLE: ☒ SPLIT SPOON CORES-SOIL

☐ AUGER CUTTINGS-SOIL

☐ AUGER CUTTINGS-ROCK

☐ AIR ROTARY CUTTINGS-ROCK

☐ DRILL WATER (NO AIR IN SAMPLE)

☐ OTHER _____

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

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 1145 is located in WAG 11. It is located in the northwest boundary of "White Wing Scrap Yard" or WAG 11. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,589.3486, E 27,674.9621 (X-10 grid) or latitude 35°-57'-08.74" and longitude 84°-21'-06.62". 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 1145 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. Drilling commenced on 1-11-90 and was finished on 1-15-90. 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.

- 1-11-90 The rig was mobilized to location and set up on plastic sheeting. Split spoon samples were taken from surface to 45.0 feet.
- 1-12-90 The boring was deepened from 45.0 feet to auger refusal at 59.1 feet using a 6-inch auger. The well was bailed to 58.0 feet.
- 1-15-90 The boring was bailed to 59.0 feet. Two-inch stainless steel casing and screen was set with sand pack and bentonite seal.
- 1-16-90 The stainless steel casing was grouted into place with 6 sacks cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologists Timothy A. Lee 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500' thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale and locally, dolomite.

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 1145S01 was collected in the split spoon interval from 20.2' to 20.6' on 1-11-90 and soil sample 1145S02 was collected in the split spoon interval from 27.8 to 28.4 on 1-11-90.

A bulk density soil sample was collected from the split spoon sample interval from 10.2' to 10.5'. The sample was measured, weighed and a bulk density of 2.30 grams/cm³ was calculated.

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 59.1 feet. A 2-inch diameter stainless steel screen with welded bottom cap was installed from 38.0 feet to 59.1 feet. A 2-inch diameter stainless steel casing was installed above the screen from 38.0 feet to 2.0 feet above ground surface. A sandpack was then tremied into the annular space from 36.2 to 59.1 feet, with a 1.1 foot bentonite pellet seal poured into the annular space above the sandpack from 35.1 to 36.2 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 1145 was developed to remove drill cuttings, silt, and other fines. The monitoring 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 331 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 8-2-90 at a depth of 8.3 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1145 was not tested for hydraulic conductivity. The water level in the well was too low for a falling head test. A stainless steel slug would not pass by a tight spot in the well screen thus prohibiting a rising head test.

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>01-11-90</u>	<u>MLE</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>01-11-90</u>	<u>MLE</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>01-15-90</u>	<u>TBL</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>01-11-90</u>	<u>MLE</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>01-11-90</u>	<u>MLE</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>01-11-90</u>	<u>MLE</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>01-11-90</u>	<u>MLE</u>

RESULTS: _____
_____

ADDITIONAL NOTES/OBSERVATIONS: _____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE Michael L. Ebers 01-11-90
Michael L. Ebers
Timothy A. Lee 01-15-90
Timothy A. Lee

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

01-11-90

Michael L. Ebers

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1145

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG 11
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersol Rand T-4

DATE: START: 01-11-90
FINISH: 01-15-90
LOGGED BY: Michael L. Ebers/Timothy A. Lee
HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Split Spoon, Auger LUBRICANT TYPE: Green Stuff
No. SAMPLES TAKEN: Two TYPE: Soil
CONTAINMENT TYPE: Plastic, Pan

THICKNESS OF SOIL (REFUSAL DEPTH): 59.1
DEPTH DRILLED IN ROCK: 0.0
TOTAL DEPTH OF WELL: 59.1

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	1.0		Augered	Gravel pad.
1.0	1.8		70%	Topsoil, medium dark brown.
1.8	3.2		90%	Clay, moderate reddish brown, slighty damp, medium dense, soft, scattered black pinhead size specks.
3.2	5.0		90%	Clay, moderate reddish brown, medium dense, with black blotches up to 1/2".
5.0	7.0		25%	Clay, moderate yellowish brown with siltstone fragments up to 3/4", siltstone is weathered and varies from yellowish orange to moderate red medium dense, damp.
7.0	13.5		85%	Clay with abundant weathered to deeply weathered siltstone fragments. Siltstone is yellowish orange and moderate red, few small weathered iron stained sandstone cobbles, scattered black mottling, bulk density @ 10.2'-10.5' = 2.30 g/cm ³ .
13.5	19.4		90)	Clay, moderate yellowish brown with abundant fine sandstone and siltstone fragments, slightly weathered, hard. Sandstone is dark yellowish orange and dark reddish brown, clay

WELL No. 1145

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 9 OF 16

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

EQUIPMENT

☒ 6 INCH AUGER 57.9 L.F.

☐ INCH AUGER L.F.

MATERIALS USED

EST. USED
VOL. VOL.

20.9 FEET OF 2 IN. S.S. SCREEN

40.0 FEET OF 2 IN. S.S. CASING

4.3 11.0 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

4.0 6.0 SACKS OF CEMENT

30.0 POUNDS OF POWDERED BENTONITE

48.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED
VOLUMES AND USED VOLUMES

Fractures nine irregular boring
diameters.

WELL COVER USED

☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED

YES ☐ NO ☒

MONITORING WELL PUMP BASE SET AT 58.3 FEET.

CENTRALIZERS AT 16.0 FEET.

36.0 FEET.

46.0 FEET.

56.0 FEET

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT
TO 59.1 FEET

BOTTOM OF BOREHOLE
59.1 FEET

LOCATION WAG 11

ORNL GRID COORDINATES
N 35,589.3486

E 27,674.9621

ELEV. GROUND 844.34

ELEV. TOP STAINLESS
STEEL CASING 846.42

DRILLING DATES:

STARTED: 01-11-90

FINISHED: 01-15-90

LOCKING STEEL COVER

8.0 INCH DIAMETER

STEEL PROTECTIVE CASING

3.03 FT. ABOVE GROUND

TO 2.0 FT. BELOW

GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO

35.1 FEET

6 INCH DIAMETER

BOREHOLE

2 INCH DIAMETER STAINLESS

STEEL CASING 2.08 FT. ABOVE

GROUND SURFACE TO 38.0 FT.

BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL

35.1 TO 36.2 FEET

SAND PACK

36.2 TO 59.1 FEET

2 INCH DIAMETER

STAINLESS STEEL 0.010

SLOTTED SCREEN

38.0 TO 58.9 FEET

2 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP

58.9 TO 59.1 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE
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and Energy
Services Co.

WELL No. 1145

DATE: 01-15-90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			01-15-90	2
BENTONITE				
	Powder		01-16-90	4
	Pellets		01-15-90	1
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	01-15-90	MMES Stores
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	01-15-90	MMES Stores
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	01-15-90	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	01-15-90	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	08-02-90	8
GROUT				
			01-16-90	5
WELL COVERS				
SURFACE CASING			N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

01-16-90

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>01-18-90</u>	<u>Tom</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>01-18-90</u>	<u>Tom</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>08-02-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>01-18-90</u>	<u>Tom</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 01-18-90
Timothy A. Lee
D. Charles Lytle 08-02-90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1145

LOCATION: WAG 11

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 07-31-90 TIME: _____

DEVELOPMENT
ENDING DATE: 08-02-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 10.8 GALLONS

TOTAL GALLONS PUMPED: 331 TOTAL WELL VOLUMES PUMPED: 30.6

INITIAL pH: 8.8 FINAL pH: 8.7

INITIAL CONDUCTIVITY ($\mu S/cm$): --- FINAL CONDUCTIVITY ($\mu S/cm$): 479

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Milky

FINAL MEASURED TURBIDITY: 100 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: 52.3 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 08-02-90

D. Charles Lytle

DATE: 07-31-90

ONE WELL VOLUME = 10.8 GALLONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 08-02-90
D. Charles Lytle

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

1145501

WELL NO.

1145

LOCATION:

WAG 11

TYPE:

SOIL

SAMPLER:

(SIGNATURE)

SAMPLE INTERVAL:

20.2' TO 20.6'

DATE:

1/11/90

TIME:

1330

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

1/16/90

0950

ERC/EDGE

1-16-90

0950

M. N. 1

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:

EDGE 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 1145 S02	
		WELL NO 1145		LOCATION: WAG 11		TYPE: SOIL	
SAMPLER: 		SAMPLE INTERVAL: 27.8' to 28.4'		DATE: 1/11/90		TIME: 1400	
RELINQUISHED BY: 		RECEIVED BY: 		DATE: 1/11/90		TIME: 1400	
DATE: 1/16/90		TIME: 0950		DATE: 1/16/90		TIME: 0950	
WTH: 1/1 M		WTH: 1/1 M		DATE: 1/16/90		TIME: 0950	
TYPE OF SAMPLE: ☒ SPLIT SPOON CORES-SOIL ☐ AUGER CUTTINGS-SOIL ☐ AUGER CUTTINGS-ROCK		ALL SAMPLES ARE IMMEDIATELY PLACED IN I-CHEM SPECIALTY CLEANED CONTAINERS AND SEALED.					
REMARKS:							

1.0 General Information

1.1 Well Location

Monitoring well number 1146 is located in WAG 11. It is located in the northwestern portion of "White Wing Scrap Yard" or WAG 11. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,704.1986, E 28,337.7057 (X-10 grid) or latitude 35°-57'-13.33" and longitude 84°-21'-00.70". 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 1146 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. Drilling commenced on 1-5-90 and was finished on 2-27-90. 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.

- 1-4-90 The rig was mobilized to location and set up on plastic sheeting.
- 1-5-90 Split spoon samples were taken from surface to refusal at 38.0 feet. The boring was augered to 28.0 feet with a 14.0-inch auger.
- 1-8-90 Set 10 3/4-inch decontaminated steel diverter casing at 28.0 feet with a 2.0 feet bentonite pellet seal. The rig was moved from location. The casing annulus was grouted with 10 sacks cement.
- 2-22-90 Move rig to location and drill to 62.5 feet with an 8.0-inch air rotary tricone bit.
- 2-23-90 Drill to 122.5 feet with 8.0-inch air rotary tricone bit.
- 2-26-90 The well was deepened from 122.5 feet to 132.5 feet. Ran 4.0-inch stainless steel casing which stopped at 121.0 feet. Decided to pull casing and redrill hole.
- 2-27-90 Re-drill hole with 8.0-inch air rotary tricone bit to 132.5 feet. After pulling drill steel out of hole, weighted tape showed total depth of hole at 118.0 feet. Decide to run 4.0-inch stainless steel casing to 117.3 feet and set it with sand pack and bentonite pellet seal. The rig was moved from location.
- 2-28-90 Tremie grouted annulus with 25 sacks cement with flocele.*
- 3-2-90 Tremie grouted annulus with 27 more sacks cement with flocele.

- 3-6-90 Tremie grouted annulus with 12 more sacks
cement with flocele.
- 3-7-90 Tremie grouted annulus with 1 more sack cement
to surface.

* After the stainless steel casing was set with sandpack and bentonite seal, 30.0 feet of P.V.C. tremie pipe was dropped into the annulus of this well. After a few attempts to "fish", this pipe was encapsulated in the grout.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500' thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale and locally, dolomite.

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 1146S01 was collected in the split spoon interval from 37.0' to 38.0' on 1-5-90.

A bulk density soil sample was collected from the split spoon sample interval from 4.1' to 4.5'. The sample was measured, weighed and a bulk density of 1.74 grams/cm³ was calculated.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 2-26-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

2.4 Installation and Development

2.4.1 Installation

This was a Type B well. A 14.0-inch diameter boring was augered from surface to 28.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 28.0 feet, sealed with a 2.0 foot bentonite pellet layer from 26.0 feet to 28.0 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 132.5 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 107.1 feet to 117.3 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 107.1 feet and extended 2.9 feet above ground surface. A sandpack was then tremied into the annular space from 103.8 to 117.3 feet, with a 1.4 foot bentonite pellet seal poured into the annular space above the sandpack from 102.4 to 103.8 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/ completion form.

2.4.2 Well Development

Well number 1146 was developed to remove drill cuttings, silt, and other fines. The monitoring 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 501 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 8/9/90 at a depth of 112.0 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 1146 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 1.06×10^{-4} cm/second (shown as permeability on

1221-A0106

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MONITORING WELL PROGRAM
WELL DATA NARRATIVE
WELL No. 1146

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

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>01-04-90</u>	<u>Tbz</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>01-04-90</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>02-27-90</u>	<u>Tbz</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>01-04-90</u>	<u>Tbz</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>01-05-90</u>	<u>Tbz</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>01-05-90</u>	<u>Tbz</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>02-26-90</u>	<u>Tbz</u>

RESULTS: Showed no detectable signs of hydrocarbons under ultra violet
light.

ADDITIONAL NOTES/OBSERVATIONS: _____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 02-26-90
Timothy A. Lee

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 Bailey

01-04-90

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and Energy
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WELL No. 1146

ORNL MONITORING WELL LOG

PAGE 1 OF 5

LOCATION: WAG-11

DRILLER: Larry Ledbetter

HELPER: Fred Dixon

DRILL: Ingersol Rand T-4

DATE: START: 01-05-90

FINISH: 02-27-90

LOGGED BY: C. Allison Bailey / Timothy A. Lee

HEALTH PHYSICIST: L. C. Johnson

TYPE DRILLING: Split Spoon, Auger, Air Rotary LUBRICANT TYPE: Green Stuff

No. SAMPLES TAKEN: One (# 1146S01) TYPE: Soil

CONTAINMENT TYPE: Plastic, Pan

THICKNESS OF SOIL (REFUSAL DEPTH): 38.0

DEPTH DRILLED IN ROCK: 94.5

TOTAL DEPTH OF WELL: 132.5

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	0.4		100%	Clay, moderate brown, with roots and gravel. Soft, moist to wet.
0.4	2.0		100%	Clay, mottled, light brown, moderate reddish brown and dark yellowish orange, contains some roots. Hard and moist.
2.0	4.0		100%	Clay, mottled, light brown, moderate reddish brown, dark yellowish orange and dusky yellow with moderate red streaks. Slightly shaley. Hard and firm, damp, slightly crumbly.
4.0	5.5	Bulk den- sity 4.1 - 4.5	100%	Clay, mottled, dark yellowish orange, pale olive and light brown with moderate red streaks. Slightly shaley, hard and firm, damp. Slightly crumbly. Bulk density = 1.74 g/cm ³ .
5.5	6.0		100%	Clay, mottled, dark yellowish orange, moderate red and pale olive. Layered in thin laminae, hard, firm, damp, crumbly.
6.0	7.3		100%	Clay, shaley, mottled, dark yellowish orange, moderate red and pale olive. Hard, firm, damp.
7.3	8.0		100%	Clay, dark yellowish orange with few moderate red and pale olive streaks. Slightly shaley with same thin laminae. Hard, firm, damp.

ORNL MONITORING WELL LOG

PAGE 2 OF 5

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
8.0	9.0		Augered	Clay, dark yellowish orange, moderate red and pale olive, slightly shaley. Firm, damp.
9.0	10.3		100%	Clay, dark yellowish orange with few moderate red and pale olive streaks. Slightly shaley with some thin laminae. Hard, firm, damp.
10.3	11.0		100%	Clay, shaley, mottled, pale olive, pale red and dark yellowish orange. Contains thin laminae. Some layers are dark black (iron stained or organic mineral), slightly crumbly, firm, dry to damp.
11.0	12.5		100%	Clay, dark yellowish orange, firm, partially crumbly, damp to moist.
12.5	13.0		100%	Clay, mottled, dark yellowish orange and moderate reddish brown. Layered with thin beds. Some layers are pale olive and dark brown. Hard and firm. Damp to moist.
13.0	15.0		100%	Clay, mottled, dark yellowish orange with some moderate reddish brown. Layered with thin beds. Some layers are dark brown. Hard and firm. Damp to moist.
15.0	17.0			Clay, shaley, dark yellowish orange with moderate reddish brown streaks and contains dark mineral streaks. Contains thin laminae of pale olive. Soft and firm, moist.
17.0	19.0		100%	Clay, dark yellowish orange with moderate reddish brown streaks and dark mineral streaks with some pale olive. Soft, very clayey, moist to wet.
19.0	21.0		100%	Clay, dark yellowish orange with moderate reddish brown streaks and pale olive. Soft, very clayey, moist to wet. From 20.0 to 20.3 there is a shaley layer which is dark brown to black (Orange mineral).

ORNL MONITORING WELL LOG

PAGE 4 OF 5

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
37.5	38.0		100%	mineral specks. Contains a lot of crushed
				(sand sized) chert fragments. The bottom of
				the split spoon contains limestone, weathered,
				crushed form, light gray, wet.
	38.0			Split spoon and auger refusal.
38.0	45.0		Air Rotary	Limestone, light olive gray, microcrystalline,
				scattered fragments of dolomite, fine grained.
45.0	50.0		Air Rotary	Limestone, light olive gray, microcrystalline,
				scattered fragments of dolomite, fine grained,
				dark yellowish orange.
50.0	55.0		Air Rotary	Limestone, light olive gray, microcrystalline,
				scattered fragments of dolomite, fine grained,
				scattered fragments of chert and siliceous
				limestone.
55.0	62.5		Air Rotary	Limestone, light olive gray, microcrystalline,
				scattered veinlets of secondary calcite,
				scattered fragments of chert.
62.5	73.0		Air Rotary	Poor returns, no cuttings back
73.0	75.0		Air Rotary	Limestone, light olive gray, microcrystalline,
				scattered fragments of dolomite, fine grained
				and scattered fragments of chert.
75.0	80.0		Air Rotary	Limestone, light olive gray, microcrystalline,
				scattered chert fragments, scattered dolomite,
				dark yellowish orange, fine grained.
80.0	85.0		Air Rotary	Limestone, siliceous, light olive gray,
				microcrystalline, scattered chert fragments
				and scattered dolomite fragments.
85.0	90.0		Air Rotary	Limestone, light olive gray, microcrystalline,
				veinlets of secondary calcite and calcite
				rhombohedron.
90.0	95.0		Air Rotary	Limestone, light olive gray, microcrystalline,
				calcite and calcite rhombohedrons, scattered

ORNL MONITORING WELL LOG

PAGE 3 OF 5

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
21.0	22.2		100%	Clay, dark yellowish orange, with some moderate reddish brown streaks. Contains thin layers that are dark brown to black. Soft, moist to wet.
22.2	23.0		100%	Clay, shaley, grayish orange to a dusky yellow clay matrix, with pale olive layers, red and black streaks. Soft, crumbly, damp.
23.0	25.0		100%	Clay, dark yellowish orange with moderate red and black streaks. Moist, soft.
25.0	27.0		100%	Clay, dusky yellow to light olive brown with moderate red streaks. Slightly shaley. Hard, firm, crumbly.
27.0	29.0		100%	Clay, dusky yellow to light olive brown with red streaks. Slightly shaley. Moist to wet. Very soft and moist from 27.0 - 28.0.
29.0	31.0		100%	Clay, dusky yellow to light olive brown with red streaks. Slightly shaley. Moist to wet. Very soft and moist from 29.0 - 30.0.
31.0	33.0		100%	Clay, dusky yellow to light olive brown with red streaks. Shaley, wet.
33.0	35.0		100%	Clay, light brown, contains some dark mineral specks. Soft, moist to wet (sticky).
35.0	36.8		100%	Clay, dusky yellow and light olive brown. Contains some dark mineral specks. Soft, moist to wet (sticky).
36.8	37.0			Clay, dusky yellow and moderate brown with dark mineral specks. Contains small crushed chert fragments, earthy.
37.0	37.5	1146S01	100%	Clay, dusky yellow and moderate brown with dark mineral specks. Contains few crushed (sand sized) chert fragments.
		37.0 - 38.0		
37.5	38.0		100%	Clay, light brown and moderate brown with dark

PAGE 5 OF 5

PAGE 14 OF 24

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

DRILLING METHOD: ☒ 14.0 INCH AUGER 28.0 L.F.
☐ INCH AUGER L.F.
☐ INCH ROTARY L.F.
☒ 8.0 INCH ROTARY 104.5 L.F.

MATERIALS USED

EST. VOL.	USED VOL.	DESCRIPTION
50.0	50.0	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
28.0	28.0	FT. OF 10 3/4 IN. SURFACE CASING
7.0	10.0	SACKS OF CEMENT (SURFACE CASING)
50.0	50.0	POUNDS OF POWDERED BENTONITE (SURFACE CASING)
80.0	80.0	GALLONS OF WATER (SURFACE CASING)
110.0	110.0	FT. OF 4.0 IN. DIA. STAINLESS STEEL CASING
10.0	10.0	FT. OF 4.0 IN. DIA. STAINLESS STEEL SCREEN
3.0	4.5	SACKS OF SAND
50.0	50.0	POUNDS OF BENTONITE PELLETS
17.5	65.0	SACKS OF CEMENT (WELL CASING)
325.0	325.0	POUNDS OF POWDERED BENTONITE (WELL CASING)
520.0	520.0	GALLONS OF WATER (WELL CASING)
3.21	3.21	FT. OF 10 3/4 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and irregular boring diameters.

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 112.0 FEET.

CENTRALIZERS AT 18.0 FEET.

38.0 FEET.

58.0 FEET.

78.0 FEET.

98.0 FEET.

118.0 FEET.

NOTE:

ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

TYPE B WELL

LOCATION WAG 11
ORNL GRID COORDINATES
N. 35.704.1986
E. 28.337.7057
ELEV. GROUND 875.09
ELEV. TOP STAINLESS
STEEL CASING 877.26
DRILLING DATES:
STARTED: 01-05-90
FINISHED: 02-27-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1146

DATE: 02-27-90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			02-27-90	2
BENTONITE				
Pellets			01-08-90	1
Powder			02-28-90	5
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	02-27-90	3
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	02-27-90	3
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	02-27-90	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	02-27-90	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	08-09-90	8
GROUT				
Diverter			01-08-90	3
Well Casing			02-27-90	6
WELL COVERS				
SURFACE CASING/DIVERTER			01-08-90	3

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

02-27-90

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>02-27-90</u>	<u>Tbz</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>02-27-90</u>	<u>Tbz</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>08-09-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>02-27-90</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

02-27-90

D. Charles Lytle
D. Charles Lytle

08-09-90

ERCE
Environmental
and Energy
Services Co.

WELL No. 1146

LOCATION: WAG 11

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 07-31-90

TIME: _____

DEVELOPMENT
ENDING DATE: 08-09-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 35.3 GALLONS

TOTAL GALLONS PUMPED: 501 TOTAL WELL VOLUMES PUMPED: 14.2

INITIAL pH: 8.7 FINAL pH: 8.6

INITIAL CONDUCTIVITY ($\mu S/cm$): 563 FINAL CONDUCTIVITY ($\mu S/cm$): 330

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Clean

FINAL MEASURED TURBIDITY: 2.0 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR
OF WATER: None

WATER
DISCHARGED
TO:

☒ GROUND SURFACE
☐ STORM SEWERS
☐ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 79.4 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle 08-09-90
D. Charles Lytle

DATE: 07-31-90

ONE WELL VOLUME = 35.3 GALLONS

COMMENTS	Good recharger and a good producer. Water cleaned to 2.0 NTU's and passed. Moved to next hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 8-09-90
D. Charles Lytle

MWF08M05.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.: 1146

DATE OF TEST: 9-21-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-11

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 = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 34.72 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 = 32

H₀ WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIMESUCCESSIVE COMPUTED
VALUES FOR H₀
(FEET)

2.0339

2.0272

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.060	2.060
20.00	3.080	2.080
30.00	3.060	2.060
40.00	3.050	2.050
50.00	3.040	2.040
60.00	3.030	2.030
75.00	3.010	2.010
90.00	2.990	1.990
105.00	2.950	1.950
120.00	2.940	1.940
150.00	2.880	1.880
180.00	2.840	1.840
240.00	2.730	1.730
300.00	2.610	1.610
360.00	2.540	1.540
420.00	2.430	1.430
480.00	2.360	1.360
540.00	2.260	1.260
600.00	2.190	1.190
720.00	2.060	1.060
840.00	1.980	.980
960.00	1.890	.890
1080.00	1.790	.790
1200.00	1.740	.740
1320.00	1.660	.660
1440.00	1.580	.580
1560.00	1.530	.530
1680.00	1.640	.640
1800.00	1.600	.600
1920.00	1.550	.550
2040.00	1.530	.530
2160.00	1.360	.360

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $3.47\text{E-}06$ FT/SEC = $1.06\text{E-}04$ CM/SEC

TRANSMISSIVITY = $3.47\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $4.11\text{E-}06$ FT/SEC = $1.25\text{E-}04$ CM/SEC

TRANSMISSIVITY = $4.11\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

114650

WELL NO.

1146

LOCATION:

WAG-11

TYPE:

Soil

SAMPLER:

C. Wilson Early

(SIGNATURE)

SAMPLE INTERVAL:

37.0 - 38.0

DATE:

01-25-90

TIME:

1030

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

C. Wilson Early

01-15-90

1500

EDGE

J. P. ...

1-15-90

1500

1/4 1/1

TYPE OF SAMPLE:

☒ SPLIT SPOON CORES-SOIL

☐ AUGER CUTTINGS-SOIL

☐ AUGER CUTTINGS-ROCK

☐ AIR ROTARY CUTTINGS-ROCK

☐ DRILL WATER (NO AIR IN SAMPLE)

☐ OTHER _____

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

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 1148 is located in WAG 11. It is located in the southwest portion of White Wing Scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,000.4186, E 29,698.6994 (X-10 grid) or latitude 35°-57'-15.04" and longitude 84°-20'-42.18". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 1148 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. Drilling commenced on 1-16-90 and was finished on 3-1-90. 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.

- 01-16-90 The rig was mobilized to the staked location and set up on plastic sheeting. Auger to 10.4 feet using a 14-inch auger. Set 10.4 feet of decontaminated 10 3/4-inch steel diverter casing and grouted surface.
- 02-14-90 Cut casing below ground level and plug well with cement due to crooked hole.
- 02-16-90 Auger to 6.0 feet using a 22-inch auger and grouted 6.0 feet of 15 3/4-inch decontaminated steel diverter casing with 5 sacks cement.
- 02-21-90 Drill from 6.0 feet to 37.0 feet using a 14 1/2-inch air rotary tricone bit.
- 02-22-90 Set 36.8 feet of 10 3/4-inch decontaminated steel surface casing.
- 02-23-90 Grouted surface casing annulus with 16 sacks cement.
- 03-01-90 Drill to 67.5 feet using a 8.0-inch air rotary tricone bit. Set 4-inch stainless steel well casing and screen with sand pack and bentonite seal.
- 03-02-90 Tremie grouted well casing annulus with 21 sacks cement with bentonite powder and flocele.
- 03-06-90 Tremie grouted to surface with 6 sacks cement with flocele.

Note: A stainless steel weighted tape broke and fell into hole at 49.6 feet. It was encapsulated with bentonite pellets and grouted up.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500' thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying

amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale and locally, dolomite.

2.3 Sample Collection

No soil samples were collected during drilling.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 3-1-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 6.0 feet. A 15 3/4-inch diverter casing was installed from surface to 6.0 feet below ground surface and grouted in place. The boring was then extended past the casing depth with a 14.0-inch air rotary tricone roller bit from 6.0 feet to 37.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 36.8 feet, sealed with a 2.0-foot bentonite pellet layer from 34.8 feet to 36.8 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 67.5 feet. A 4-inch diameter stainless

steel screen with threaded bottom cap was installed from 52.2 feet to 67.5 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 52.2 feet and extended 2.8 feet above ground surface. A sandpack was then tremied into the annular space from 49.6 to 67.5 feet, with a 2.1-foot bentonite pellet seal poured into the annular space above the sandpack from 47.5 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 1148 was developed to remove drill cuttings, silt, and other fines. The monitoring 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 207 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 7/30/90 at a depth of 65.8 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 1148 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.40×10^{-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.

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>1-16-90</u>	<u>Tbz</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>1-16-90</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>_____</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>03-1-90</u>	<u>Tbz</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>01-16-90</u>	<u>Tbz</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>01-16-90</u>	<u>Tbz</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>01-16-90</u>	<u>Tbz</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>_____</u>	<u>_____</u>

RESULTS: _____
_____

ADDITIONAL NOTES/OBSERVATIONS: _____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE Timothy A. Lee 03-2-90
Timothy A. Lee

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

01-16-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1148

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG 11
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersol Rand T-4

DATE: START: 01-16-90
FINISH: 03-01-90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: N/A

TYPE DRILLING: Auger, Air Rotary LUBRICANT TYPE: Green Stuff
No. SAMPLES TAKEN: N/A TYPE: N/A
CONTAINMENT TYPE: Plastic, Pan

THICKNESS OF SOIL (REFUSAL DEPTH): 16.0'
DEPTH DRILLED IN ROCK: 51.5
TOTAL DEPTH OF WELL: 67.5

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	4.0		Augered	Gravel fill.
4.0	6.0		Augered	Clay, mottled, dark yellowish orange and light yellowish brown, slightly sandy.
6.0	10.0		Air Rotary	Clay, mottled, dark yellowish orange and moderate brown, streaks, light gray and reddish brown siltstone.
10.0	16.0		Air Rotary	Clay, light olive gray to dark yellowish orange organic streaks, scattered siltstone.
16.0	20.0		Air Rotary	Shale, light greenish gray; scattered fragments of limestone, light olive gray; scattered fragments of chert.
20.0	25.0		Air Rotary	Limestone, light olive gray, fine crystalline, scattered greenish gray siltstone.
25.0	30.0		Air Rotary	Limestone, light olive gray, fine crystalline, siltstone, shaley, greenish gray.
30.0	35.0		Air Rotary	Limestone, light olive gray, fine crystalline, siltstone, shaley, greenish gray. Scattered fragments of secondary calcite.
35.0	37.0		Air Rotary	Limestone, microcrystalline, olive gray; scattered fragments of secondary calcite.

WELL No. 1148

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 10 OF 19

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

DRILLING METHOD: ☐ 22.0 INCH AUGER 6.0 L.F.
☐ INCH AUGER L.F.
☐ 14.0 INCH ROTARY 31.0 L.F.
☐ 8.0 INCH ROTARY 30.5 L.F.

MATERIALS USED

EST. VOL.	USED VOL.	DESCRIPTION
50.0	50.0	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
36.8	36.8	FT. OF 10 3/4 IN. SURFACE CASING
12.0	16.0	SACKS OF CEMENT (SURFACE CASING)
80.0	80.0	POUNDS OF POWERED BENTONITE (SURFACE CASING)
128.0	128.0	GALLONS OF WATER (SURFACE CASING)
55.0	55.0	FT. OF 4.0 IN. DIA. STAINLESS STEEL CASING
15.0	15.0	FT. OF 4.0 IN. DIA. STAINLESS STEEL SCREEN
4.0	4.0	SACKS OF SAND
50.0	50.0	POUNDS OF BENTONITE PELLETS
7.8	27.0	SACKS OF CEMENT (WELL CASING)
135.0	135.0	POUNDS OF POWERED BENTONITE (WELL CASING)
216.0	216.0	GALLONS OF WATER (WELL CASING)
2.93	2.93	FT. OF 10 3/4 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and irregular boring diameters

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 65.8 FEET.

CENTRALIZERS AT 21.0 FEET.
41.0 FEET.
66.0 FEET.

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

TYPE B WELL

LOCATION WAG 11

ORNL GRID COORDINATES
N 35,000.4186
E 29,698.6994

ELEV. GROUND 831.00

ELEV. TOP STAINLESS

STEEL CASING 833.08

DRILLING DATES:

STARTED: 01-16-90

FINISHED: 03-01-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1148

DATE: 03-02-90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			03-01-90	3
BENTONITE				
Pellets			03-01-90	1
Powder			03-02-90	6
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	03-01-90	3
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	03-01-90	3
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	03-01-90	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	03-01-90	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	07-30-90	8
GROUT				
Surface Casing			02-23-90	6
Well Casing			03-02-90	6
WELL COVERS				
SURFACE CASING			02-22-90	4

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

03-02-90

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>03-02-90</u>	<u>TKM</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>03-02-90</u>	<u>TKM</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>07-30-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>03-02-90</u>	<u>TKM</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 03-02-90
Timothy A. Lee

D. Charles Lytle 07-30-90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1148

LOCATION: WAG 11

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 07-30-90

TIME: _____

DEVELOPMENT
ENDING DATE: 07-30-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 16.3 GALLONS

TOTAL GALLONS PUMPED: 207 TOTAL WELL VOLUMES PUMPED: 12.7

INITIAL pH: 8.7 FINAL pH: 8.7

INITIAL CONDUCTIVITY ($\mu S/cm$): 598 FINAL CONDUCTIVITY ($\mu S/cm$): 598

DESCRIPTION OF INITIAL TURBIDITY: Clear

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0

WELL APPROVED BY: R.C. Williams MMES

ODOR
OF WATER: None

WATER
DISCHARGED
TO:

☒ GROUND SURFACE
☐ STORM SEWERS
☐ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER _____

INITIAL PRE-DEVELOPMENT

WATER DEPTH: 9.5 feet from ground surface.

DEVELOPMENT OBSERVATIONS

_____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE

D. Charles Lytle 07-30-90
D. Charles Lytle

DATE: 07-30-90

DATE: 07-30-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 16.3 GALLONS

COMMENTS Fast recharger, made a lot of water in a short time. Passed with 2.0 NTU's and moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 07-30-90
D. Charles Lytle

MINFORMOLDING

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.: 1148

DATE OF TEST: 9-14-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-11

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 = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 59.77 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)

.4642

.4751

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	2.710	1.710
20.00	2.260	1.260
30.00	2.050	1.050
40.00	1.860	.860
50.00	1.760	.760
60.00	1.650	.650
75.00	1.570	.570
90.00	1.510	.510
105.00	1.430	.430
120.00	1.390	.390
150.00	1.320	.320
180.00	1.260	.260
240.00	1.200	.200
300.00	1.170	.170
360.00	1.150	.150
420.00	1.120	.120
480.00	1.130	.130
540.00	1.130	.130
600.00	1.100	.100
720.00	1.100	.100
840.00	1.080	.080
960.00	1.100	.100
1080.00	1.070	.070
1200.00	1.080	.080
1320.00	1.070	.070
1440.00	1.070	.070
1560.00	1.180	.180
1680.00	1.060	.060
1800.00	1.060	.060
1920.00	1.060	.060
2040.00	1.040	.040
2160.00	1.050	.050

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $4.60\text{E-}06$ FT/SEC = $1.40\text{E-}04$ CM/SEC

TRANSMISSIVITY = $6.91\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $5.36\text{E-}06$ FT/SEC = $1.63\text{E-}04$ CM/SEC

TRANSMISSIVITY = $8.04\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 1246 is located in WAG 11. It is located on the western boundary of White Wing Scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,090.0576, E 27,507.5298 (X-10 grid) or latitude 35°-57'-03.51" and longitude 84°-21'-05.21". 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 1246 was drilled by Geotek Engineering Company. A Ingersoll Rand rig was used to drill this boring for monitor well installation under the operation of Larry Ledbetter with the assistance of Fred Dixon. Drilling commenced on 1-23-90 and was finished on 3-6-90. 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.

- 1-23-90: The rig was mobilized to the staked location and set up a plastic sheeting. Split spoon samples were taken from surface to refusal at 22.0 feet.
- 2-2-90: Augered from surface to 6.0 feet using a 22-inch auger and set 6.0 feet of 15 3/4-inch decontaminated steel diverter casing. Grouted diverter casing annulus to surface with 10 sacks cement.
- 2-9-90: Drill to 18.0 feet using a 14.0-inch air rotary tricone bit.
- 2-12-90: Drill to 20.0 feet and diverter casing began to leak. Decide to abandon well, skid 10.0 feet and drill new hole. Move to new location, auger to 10.5 feet using a 22-inch augers and set 10.5 feet of 15 3/4-inch decontaminated steel diverter casing.
- 2-13-90: Grouted diverter casing annulus to surface with 15 sacks cement.
- 2-16-90: Drill to 20.0 feet using a 14.0-inch air rotary tricone bit.
- 2-20-90: Drill from 20.0 feet to 40.0 feet using a 14.0-inch air rotary tricone bit. Set 40.0 feet of 10 3/4-inch decontaminated steel surface casing.
- 2-21-90: Grouted surface casing annulus with 24 sacks cement.
- 3-6-90: Drilled from 40.0 feet to 85.0 feet using an 8.0-inch air rotary tricone bit. A mud filled cavity was encountered from 66.0 feet to 85.0 feet. The hole would not clean up.

- 9-20-90: Decontaminated drill rig, tools, and 100 feet of 8-inch hollow stem augers.
- 9-21-90: Mobilized rig to location and set up. Ran in 55 feet of 8-inch hollow stem augers.
- 9-24-90: Ran in 8-inch hollow stem augers to 85.5 feet. Auger refusal at 85.5 feet. Ran in 85 feet of AW drill rods and punched out stainless steel plug. Ran in 2-inch stainless steel screen and casing. Tremied in 12 sacks of sand through hollow stem augers.
- 9-25-90: Checked top of sand. Had dropped 2 feet overnight so tremied in one more sack of sand. Grouted annular space with two sacks of cement.
- 9-26-90: Finished grouting annular space with 19 sacks of cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist Bruce McMaster, Timothy A. Lee 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500 feet thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale and locally, dolomite.

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 22.0-inch diameter boring was augered from ground surface to 6.0 feet. A 15 3/4-inch diverter casing was installed from surface to 6.0 feet below ground surface and grouted in place. The boring was drilled with a 14.0-inch air rotary tricone roller bit from 6.0 feet to 40.0 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 86.63 feet. A 2-inch diameter stainless steel silt trap was installed from 71.4 feet to 86.63 feet. A 2-inch diameter stainless steel screen was installed from 56.4 feet to 71.4 feet. A 2-inch diameter stainless steel casing was installed from the top of the screen at 56.4 feet and extended 2.05 feet above ground surface. A sandpack was then tremied into the annular space from 86.63 up to 53.0 feet, with a 2.6 foot bentonite pellet seal poured into the annular space above the sandpack from 50.4 to 53.0 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 installatin/completion form.

2.4.2 Well Development

Well number 1246 was developed to remove drill cuttings, silt, and other fines. The monitoring was

developed using a Geoguard pump with an air rotary. 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 552 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 completions 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 10/10/90 at a depth of 62.0 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 1246 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 4.89×10^{-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.

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>1/23/90</u>	<u>TBL</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>1/23/90</u>	<u>TBL</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></u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>9/24/90</u>	<u>TBL</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>1/23/90</u>	<u>TBL</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>1/23/90</u>	<u>TBL</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>1/23/90</u>	<u>TBL</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>N/A</u>	<u></u>

RESULTS: _____
_____

ADDITIONAL NOTES/OBSERVATIONS: _____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE Timothy A. Lee 1/23/90
Timothy A. Lee

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

1/23/90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1246

ORNL MONITORING WELL LOG

PAGE 1 OF 3

LOCATION: WAG 11

DATE: START: 1/23/90

DRILLER: Larry Ledbetter

FINISH: 3/7/90

HELPER: Fred Dixon

LOGGED BY: R. McMaster/Timothy A. Lee

DRILL: IR-T-4

HEALTH PHYSICIST: N/A

TYPE DRILLING: Auger/Split Spoon/Air Rotary LUBRICANT TYPE: Green Stuff

No. SAMPLES TAKEN: None TYPE: N/A

CONTAINMENT TYPE: Metal Pan/plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 22.5

DRILLING FLUID SAMPLES:

DEPTH DRILLED IN ROCK: 62.5

TYPE: N/A DATE: N/A

TOTAL DEPTH OF WELL: 85.0

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	3.0			Gravel pad
3.0	5.0		10%	Clay, moderate brown with minor light brown siltstone fragments. Some dark organics
5.0	7.0		0%	
7.0	8.0		100%	Moderate yellowish-brown clay with light tan
8.0	9.0			Silty lenses-minor organics- minor maroon siltstone fragments
9.0	10.0		100%	Dry grayish-red silty shale with minor tan
10.0	10.5			Silty lenses, pale brown silty clay with minor siltstone lenses-slightly damp
10.5	11.0			Moderate yellowish brown clay, slightly damp with minor light tan silty clay lenses
11.0	12.0		100%	Dark yellowish orange clay, wet
12.0	13.0			Pale brown silty shale with minor pale orange sandy lenses
13.0	14.0		100%	Wet, mottled clays with minor siltstone fragments ranging from dark yellowish orange to pale orange
14.0	14.5			Pale brown and light olive gray shales with minor orange yellow clays, bedding distinctly dipped in spoon

ORNL MONITORING WELL LOG

PAGE 2 OF 3

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
14.5	15.0		100%	Pale brown - maroon siltstone with minor clays. pale orange - light gray
15.0	15.5		100%	Moderate brown silty shale with fragments of blackish-red siltstone- damp
15.5	17.0		100%	Wet, moderate brown siltstones with pale greenish-yellow shaley clays. Minor pale yellow siltstone fragments to pale orange
17.0	19.0			Wet, pale brown silty shale, minor pale orange clays and greenish-yellow clays. Bulk density taken from 18.0' to 18.4' equals 2.00 g/cm ³
19.0	20.0		100%	Wet, pale yellow brown-yellow orange silty shale with pale brown siltstone lenses
20.0	21.0		100%	Light olive gray - yellowish gray silty shale; slightly calcareous at 20.7' - dry
21.0	22.0		50%	Dark yellowish orange silty clay with minor pale greenish yellow silty clay - wet
	22.0			Split spoon refusal
	22.5			Auger refusal
22.5	25.0		Air Rotary	Siltstone, pale olive to grayish brown, black streaks, scattered fragments of sandstone, yellowish-gray medium grained
25.0	30.0		Air Rotary	Siltstone, pale olive to grayish-brown, scattered, fragments of sandstone
30.0	35.0		Air Rotary	Siltstone: pale olive to grayish brown, scattered fragments of yellowish gray, medium grained sandstones
35.0	40.0		Air Rotary	Siltstone, pale olive to grayish brown, scattered fragments of yellowish gray, medium grained sandstones
45.0	50.0		Air Rotary	Tan - light gray calcareous siltstone - highly weathered, crumbly. Minor green siltstone
50.0	55.0		Air Rotary	Tan to light maroon siltstone, highly weathered,

ORNL MONITORING WELL LOG

PAGE 3 OF 3

PAGE 12 OF 21

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED

PROOFED

BY: Michael L. Ebers

BY: James Caruthers

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter

HELPER: Fred Dixon

DRILLING METHOD: ☐ 22 INCH AUGER 10.5 L.F.
☐ INCH AUGER L.F.
☐ 14.5 INCH ROTARY 29.5 L.F.
☐ 8.0 INCH ROTARY 46.63 L.F.

MATERIALS USED

EST. VOL. USED VOL.

N/A POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)

10.5 FT. OF 16 IN. SURFACE CASING - Diverter

8.2 15.0 SACKS OF CEMENT (SURFACE CASING) - Diverter

75.0 POUNDS OF POWERED BENTONITE (SURFACE CASING) Diverter

90.0 GALLONS OF WATER (SURFACE CASING) - Diverter

40.0 FT. OF 10 IN. SURFACE CASING

12.8 24.0 SACKS OF CEMENT (SURFACE CASING)

120 POUNDS OF POWERED BENTONITE (SURFACE CASING)

144 GALLONS OF WATER (SURFACE CASING)

75.0 FT. OF 2 IN. DIA. STAINLESS STEEL CASING

15.0 FT. OF 2 IN. DIA. STAINLESS STEEL SCREEN

8.2 13.0 SACKS OF SAND

50 50.0 POUNDS OF BENTONITE PELLETS

7.5 21.0 SACKS OF CEMENT (WELL CASING)

95.0 POUNDS OF POWERED BENTONITE (WELL CASING)

126.0 GALLONS OF WATER (WELL CASING)

43.12 FT. OF 10 3/4 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Large void at 60' to 85'

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 62.0 FEET.

CENTRALIZERS AT N/A FEET.

FEET.

FEET.

FEET.

TYPE B WELL

HOLE CLEANED OUT TO 86.63 FEET

BOTTOM OF BORE HOLE 86.63 FEET

LOCATION WAG11

ORNL GRID COORDINATES

N 35,090.0576

E 27,507.5298

ELEV. GROUND 825.90

ELEV. TOP STAINLESS

STEEL CASING 827.95

DRILLING DATES:

STARTED: 1/23/90

FINISHED: 9/26/90

NOTE:
ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1246

DATE: 9/24/90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			9/24/90	2
BENTONITE				
			9/26/90	6
			9/25/90	1
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	9/24/90	4
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	9/24/90	4
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	9/24/90	4
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	9/24/90	4
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	10/10/90	8
GROUT	surface casing		2/21/90	7
	well casing		9/26/90	7
WELL COVERS				
SURFACE CASING			2/20/90	4

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 9/26/90

Michael L. Ebers

POST-WELL COMPLETION
CHECKLIST

	COMPLIANCE	
	<u>DATE</u>	<u>INITIALS</u>
<u>POST-WELL COMPLETION TASKS</u>		
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>9/25/90</u>	<u>MLE</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>9/25/90</u>	<u>MLE</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>10/10/90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>9/26/90</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 9/26/90
Michael L. Ebers

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

ERCE
Environmental
and Energy
Services Co.

WELL No. 1246

LOCATION: WAG11

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 10-04-90

TIME: _____

DEVELOPMENT
ENDING DATE: 10-10-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 22.1 GALLONS

TOTAL GALLONS PUMPED: 552 TOTAL WELL VOLUMES PUMPED: 25.0

INITIAL pH: 9.0 FINAL pH: 8.6

INITIAL CONDUCTIVITY ($\mu S/cm$): 347 FINAL CONDUCTIVITY ($\mu S/cm$): 373

DESCRIPTION OF INITIAL TURBIDITY: Muddy

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: 31.5 feet from ground surface

DEVELOPMENT OBSERVATIONS

_____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE

D. Charles Lytle
D. Charles Lytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL NO. 1246

LOCATION: WAG11

DATE: 10-04-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 22.1 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
10-04-90		202					202	9.1	
10-05-90	1000	55	Muddy	---	9.0	347	257	11.6	
10-05-90	1300	115	Muddy	---	8.9	379	372	16.8	
10-08-90	1300	55	Muddy	---	8.2	462	427	19.3	
10-09-90	0830	10	Muddy	---	9.1	365	437	19.7	
10-09-90	1300	60	Muddy	---	8.9	419	497	22.5	
10-10-90	1000	20	Milky	---	8.9	357	517	23.4	
10-10-90	1300	35	Clear	4.0	8.6	373	552	25.0	
RESULTS AT END OF DEVELOPMENT			Clear	4.0	8.6	373	552	25.0	

COMMENTS Excellent recharger and producer. Water cleared and remained clear at 4.0 NTU's. Passed and moved off hole

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

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

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

- (1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967
(ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED
"RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS
CHARGE OF WATER")
- (2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN
VOL. 12, NO.3 OF WRR ENTITLED
"A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY
OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY
PENETRATING WELLS")

WELL NO.: 1246

DATE OF TEST: 10-12-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-11

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 = 55.40 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)

1.7625
1.7666

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
5.00	3.560	2.560
10.00	3.130	2.130
15.00	2.730	1.730
20.00	2.470	1.470
25.00	2.270	1.270
30.00	2.100	1.100
35.00	1.940	.940
40.00	1.820	.820
45.00	1.690	.690
50.00	1.600	.600
55.00	1.520	.520
60.00	1.440	.440
65.00	1.410	.410
70.00	1.350	.350
75.00	1.300	.300
80.00	1.300	.300
85.00	1.280	.280
90.00	1.240	.240
95.00	1.230	.230
100.00	1.220	.220
105.00	1.210	.210
110.00	1.210	.210
115.00	1.200	.200
120.00	1.190	.190
125.00	1.190	.190
130.00	1.170	.170
135.00	1.160	.160
140.00	1.160	.160
145.00	1.150	.150
150.00	1.140	.140
155.00	1.130	.130
160.00	1.090	.090

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.61\text{E-}05$ FT/SEC = $4.89\text{E-}04$ CM/SECTRANSMISSIVITY = $2.41\text{E-}04$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $2.13\text{E-}05$ FT/SEC = $6.50\text{E-}04$ CM/SECTRANSMISSIVITY = $3.20\text{E-}04$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

CHANGE IN WATER LEVEL IN FEET

1.0 General Information

1.1 Well Location

Monitoring well number 1149 is located in WAG 11. It is located in the southwestern portion of White Wing Scrap Yard. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 34,973.5615, E 29,702.2786 (X-10 grid) or latitude 35°-57'-14.83" and longitude 84°-20'-41.96". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 1149 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. Drilling commenced on 1-16-90 and was finished on 3-1-90. 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.

- 01-16-90 The rig was mobilized to the staked location and set up on plastic sheeting. Split spoon samples were taken from surface to refusal at 12.5 feet. The boring was reamed using a 22-inch auger to 7.2 feet. Set 7.2 feet of 15 3/4-inch decontaminated steel diverter casing and grouted it to surface. Move rig from location.
- 01-18-90 Move rig back to location. Drill from 7.2 feet to 18.5 feet using a 14-inch air rotary tricone bit. Set 13.9 feet of 10 3/4-inch decontaminated steel surface casing. Move rig from location.
- 01-19-90 Grouted surface casing annulus to surface with 8.0 sacks cement.
- 02-13-90 Move rig to location. Drill to 35.0 feet using an 8.0-inch air rotary.
- 03-01-90 Set 2-inch stainless steel well casing and screen with sand pack and bentonite seal.
- 03-02-90 Tremie grouted annulus with 4.0 sacks of cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologists Timothy A. Lee and C. Allison Bailey. 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500' thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale and locally, dolomite.

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 1149S01 was collected in the split spoon interval from 10.3 feet to 10.7 feet on 1-16-90.

A bulk density soil sample was collected from the split spoon sample interval from 10.3 to 10.7 feet. The sample was measured, weighed and a bulk density of 1.78 grams/cm³ was calculated.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 2-13-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 7.2 feet. A 15 3/4-inch diverter casing was installed from surface to 7.2 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 7.2 feet to 18.5 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 13.9 feet, sealed with a 2.0-foot bentonite

pellet layer from 11.9 feet to 13.9 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 eight-inch diameter boring to a total depth of 35.0 feet. A two-inch diameter stainless steel screen with threaded bottom cap was installed from 17.5 feet to 32.8 feet. A two-inch diameter stainless steel casing was installed from the top of the screen at 17.5 feet and extended 2.4 feet above ground surface. A sandpack was then tremied into the annular space from 16.0 to 32.8 feet, with a 1.9-foot bentonite pellet seal poured into the annular space above the sandpack from 14.1 to 16.0 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 1149 was developed to remove drill cuttings, silt, and other fines. The monitoring 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 221 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 7/30/90 at a depth of 31.3 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1149 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 4.62×10^{-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.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>01-16-90</u>	<u>Tbz</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>01-15-90</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>03-01-90</u>	<u>Tbz</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>01-16-90</u>	<u>Tbz</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>01-16-90</u>	<u>Tbz</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>01-16-90</u>	<u>Tbz</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>02-13-90</u>	<u>Tbz</u>

RESULTS: No hydrocarbons detected under ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

_____
_____
_____
_____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 03-01-90
Timothy A. Lee

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

03-01-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1149

ORNL MONITORING WELL LOG				PAGE <u>1</u> OF <u>2</u>	
LOCATION: <u>WAG-11</u>				DATE: START: <u>01-16-90</u>	
DRILLER: <u>Larry Ledbetter</u>				FINISH: <u>03-01-90</u>	
HELPER: <u>Fred Dixon</u>				LOGGED BY: <u>Timothy A. Lee</u>	
DRILL: <u>Ingersol Rand T-4</u>				HEALTH PHYSICIST: <u>N/A</u>	
TYPE DRILLING: <u>Split Spoon, Auger</u>				LUBRICANT TYPE: <u>Green Stuff</u>	
No. SAMPLES TAKEN: <u>One</u>				TYPE: <u>Soil</u>	
CONTAINMENT TYPE: <u>Plastic, Pan</u>					
THICKNESS OF SOIL (REFUSAL DEPTH): <u>12.5</u>				DRILLING FLUID SAMPLES:	
DEPTH DRILLED IN ROCK: <u>22.5</u>				TYPE: <u>N/A</u> DATE: <u>N/A</u>	
TOTAL DEPTH OF WELL: <u>35.0</u>					
DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION	
FROM	TO				
0.0	4.0			Gravel pad.	
4.0	4.9		100%	Clay, mottled, dark yellowish orange, light brown and grayish; slightly sandy, silty, some organic material, dry to moist, clay matrix.	
4.9	6.0			Light gray-moist, with grayish red siltstone with organics.	
6.0	8.0		100%	Clay, mottled, dark yellowish to moderate brown streaks. Light gray-red siltstone.	
8.0	10.0		100%	Sandy--sand lenses and organics--very hard and dense clay. Water out of spoon.	
10.0	12.0	1149S01		Wet clay, light gray-dark yellowish orange; organics present with pale yellowish orange	
		10.3-10.7		silty lenses of clay. Minor siltstone	
		Bulk density		fragments. Bulk density = 1.78 grams/cm ³ .	
		10.3-10.7			
12.0	12.2		100%	Wet clay--dark yellowish brown to brown with dark organics.	
	12.2			Spoon refusal.	
12.2	12.5		Augered		
	12.5			Auger refusal.	

PAGE 2 OF 2

PAGE 10 OF 19.

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

DRILLING METHOD: ☐ 22.0 INCH AUGER 7.2 L.F.
☐   INCH AUGER   L.F.
☐ 14.0 INCH ROTARY 6.7 L.F.
☐ 8.0 INCH ROTARY 21.1 L.F.

MATERIALS USED

EST. VOL.	USED VOL.	
<u>50.0</u>	<u>50.0</u>	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
<u>13.9</u>	<u>13.9</u>	FT. OF <u>10 3/4</u> IN. SURFACE CASING
<u>3.9</u>	<u>8.0</u>	SACKS OF CEMENT (SURFACE CASING)
<u>40.0</u>	<u>40.0</u>	POUNDS OF POWERED BENTONITE (SURFACE CASING)
<u>64.0</u>	<u>64.0</u>	GALLONS OF WATER (SURFACE CASING)
<u>20.0</u>	<u>20.0</u>	FT. OF <u>2.0</u> IN. DIA. STAINLESS STEEL CASING
<u>15.0</u>	<u>15.0</u>	FT. OF <u>2.0</u> IN. DIA. STAINLESS STEEL SCREEN
<u>4.5</u>	<u>38.0</u>	SACKS OF SAND
<u>50.0</u>	<u>50.0</u>	POUNDS OF BENTONITE PELLETS
<u>2.6</u>	<u>4.0</u>	SACKS OF CEMENT (WELL CASING)
<u>20.0</u>	<u>20.0</u>	POUNDS OF POWERED BENTONITE (WELL CASING)
<u>32.0</u>	<u>32.0</u>	GALLONS OF WATER (WELL CASING)
<u>3.05</u>	<u>3.05</u>	FT. OF <u>10 3/4</u> IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and irregular boring diameters.

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 31.3 FEET.

CENTRALIZERS AT 16.0 FEET.
31.0 FEET.
       FEET.

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

TYPE B WELL

LOCATION WAG 11
ORNL GRID COORDINATES
N 34,973.5615
E 29,702.2786
ELEV. GROUND 830.38
ELEV. TOP STAINLESS
STEEL CASING 832.29
DRILLING DATES:
STARTED: 01-16-90
FINISHED: 03-01-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1149

DATE: 03-01-90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			03-01-90	3
BENTONITE	Pellets		03-01-90	1
	Powder		03-02-90	6
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	03-01-90	3
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	03-01-90	3
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	03-01-90	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	03-01-90	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	07-30-90	8
GROUT	Surface Casing		01-19-90	6
	Well Casing		03-02-90	6
WELL COVERS				
SURFACE CASING			01-19-90	4

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee 03-02-90
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>03-01-90</u>	<u>Tbz</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>03-01-90</u>	<u>Tbz</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>07-30-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>03-01-90</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 03-01-90

D. Charles Lytle 07-30-90

OBSERVER SIGNATURE/DATE D. Charles Lytle
07-30-90

DEVELOPMENT OBSERVATIONS

INITIAL PRE-DEVELOPMENT
 WATER DEPTH: 10.2 feet from ground surface.

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

WELL APPROVED BY: R.C. Williams MMES

FINAL MEASURED TURBIDITY: 5.0 NTU's

DESCRIPTION OF FINAL TURBIDITY: Clear

DESCRIPTION OF INITIAL TURBIDITY: Slightly cloudy

INITIAL CONDUCTIVITY (uS/cm): 270 FINAL CONDUCTIVITY (uS/cm): 126

INITIAL pH: 8.6 FINAL pH: 8.6

TOTAL GALLONS PUMPED: 221 TOTAL WELL VOLUMES PUMPED: 8.0

ONE WELL VOLUME: 27.7 GALLONS

DEVELOPMENT OBSERVED BY: D. Charles Lytle

DEVELOPMENT ENDING DATE: 07-30-90

DEVELOPMENT BEGAN DATE: 07-30-90

TIME:

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT DETAILS

MONITORING WELL DEVELOPMENT FORM

WELL No. 1149

LOCATION: WAG 11

ERCE
 Environmental
 and Energy
 Services Co.

ONE WELL VOLUME = 27.7 GALLONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 07-30-90
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.: 1149

DATE OF TEST: 9-14-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-11

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 = 27.15 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)

3.6130
3.7348

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	7.820	6.820
20.00	7.240	6.240
30.00	6.710	5.710
40.00	6.290	5.290
50.00	5.900	4.900
60.00	5.580	4.580
75.00	5.160	4.160
90.00	4.790	3.790
105.00	4.460	3.460
120.00	4.190	3.190
150.00	3.740	2.740
180.00	3.380	2.380
240.00	2.860	1.860
300.00	2.490	1.490
360.00	2.230	1.230
420.00	2.050	1.050
480.00	1.900	.900
540.00	1.770	.770
600.00	1.670	.670
720.00	1.520	.520
840.00	1.420	.420
960.00	1.360	.360
1080.00	1.300	.300
1200.00	1.260	.260
1320.00	1.210	.210
1440.00	1.190	.190
1560.00	1.170	.170
1680.00	1.170	.170
1800.00	1.140	.140
1920.00	1.130	.130
2040.00	1.120	.120
2160.00	1.120	.120

1221-M.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.52\text{E-}06$ FT/SEC = $4.62\text{E-}05$ CM/SEC

TRANSMISSIVITY = $2.28\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $2.06\text{E-}06$ FT/SEC = $6.29\text{E-}05$ CM/SEC

TRANSMISSIVITY = $3.09\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

HYDRAULIC CONDUCTIVITY CALCULATIONS

CHANGE IN WATER LEVEL IN FEET

1.0 General Information

1.1 Well Location

Monitoring well number 1147 is located in WAG 11. It is located in the northeastern portion of "White Wing Scrap Yard" or WAG 11. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 35,696.4970, E 28,354.4126 (X-10 grid) or latitude 35°-57'-13.36" and longitude 84°-21'-00.48". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 1147 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. Drilling commenced on 1-4-90 and was finished on 1-29-90. 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.

- 1-4-90 Mobilize rig to staked location and set up on plastic sheeting. Augered from surface to 7.0 feet using a 22.0-inch auger. Set 6.0 feet of 14.0-inch decontaminated steel diverter casing. The rig was moved from location.
- 1-5-90 The diverter casing was grouted with 5 sacks cement.
- 1-8-90 The rig moved over hole and augered to refusal at 39.5 feet with a 14.5-inch auger.
- 1-9-90 The boring was deepened from 39.5 feet to 45.8 feet using air rotary method with a 14.5-inch air rotary tricone bit. Set 45.8 feet of 10 3/4-inch decontaminated steel surface casing and sealed with bentonite seal. Move rig from location.
- 1-10-90 Grouted surface casing annulus with 10 sacks of cement.
- 1-25-90 Move rig over hole.
- 1-26-90 Deepened boring from 45.8 feet to 97.9 feet using an 8.0-inch air rotary tricone bit.
- 1-29-90 Set stainless steel 4-inch screen and casing with sand pack and bentonite seal.
- 1-30-90 Grouted well casing with 19 sacks cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., 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

The northeastern half of WAG 11 is underlain by Chickamauga Limestone. The Rome Formation underlies the southwestern half of WAG 11. The Chickamauga Limestone is brought into contact with the Rome Formation by the White Oak Mountain thrust fault, the trace of which bisects WAG 11 from northwest to southeast. The lowermost beds of the Chickamauga are composed of thin bentonitic beds, gray clay shale, and maroon to gray calcareous siltstone. The majority of the Chickamauga, approximately 1,500' thick, is a dominantly gray, dense, finely crystalline, thin bedded limestone with varying amounts of chert. The uppermost beds consist of yellow and maroon calcareous siltstone and blue-gray limestone. The Rome Formation is composed of interbedded sandstone, siltstone, shale and locally, dolomite.

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 forms for this sample is included with this data package. Soil sample 1139S01 was collected in the split spoon interval from 6.2' to 6.5' on 1-19-90.

A drill water sample was collected from the water pump on the drill rig on 1-29-90. Analytical results for the Ingersoll Rand T-4 drill water samples described above can be obtained from the Remedial Action Program data base at ORNL.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 1-29-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

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 6.0 feet. A 15 1/4-inch diverter casing was installed from surface to 6.0 feet below ground surface and grouted in place. A 14.0-inch diameter boring was augered from 6.0 feet to 39.5 feet (auger refusal). The boring was then extended past the refusal depth with a 14.0-inch air rotary tricone roller bit from 0.0 feet to 45.8 feet. A 10.0-inch diameter

string of decontaminated steel surface casing was installed from 0.0 feet to 45.8 feet, sealed with a 2.0 foot bentonite pellet layer from 43.8 feet to 45.8 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 97.9 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 77.7 feet to 97.9 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 7.77 feet and extended 2.2 feet above ground surface. A sandpack was then tremied into the annular space from 73.5 to 97.9 feet, with a 1.3 foot bentonite pellet seal poured into the annular space above the sandpack from 72.2 to 73.5 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 1147 was developed to remove drill cuttings, silt, and other fines. The monitoring 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 550 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'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 8/10/90 at a depth of 93.3 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1147 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously removing a known quantity of water from 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 9.18×10^{-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.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE
DATE   INITIALS

1. EXCAVATION PERMIT OBTAINED.	<u>01-04-90</u>	<u>CAB</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>01-04-90</u>	<u>CAB</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>01-29-90</u>	<u>CAB</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>01-04-90</u>	<u>CAB</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	<u>01-04-90</u>	<u>CAB</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>01-04-90</u>	<u>CAB</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>01-29-90</u>	<u>Tim</u>

ADDITIONAL NOTES/OBSERVATIONS: _____

RESULTS: No hydrocarbons detected under ultra violet light. _____

OBSERVER SIGNATURE/DATE

C. Allison Bailey
C. Allison Bailey

01-30-90

Timothy A. Lee
Timothy A. Lee

01-30-90

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 Bailey 01/04/90
C. Allison Bailey

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1147

ORNL MONITORING WELL LOG

PAGE 1 OF 3

LOCATION: WAG -11

DRILLER: Larry Ledbetter

HELPER: Fred Dixon

DRILL: Ingersol Rand T-4

DATE: START: 01-04-90

FINISH: 01-29-90

LOGGED BY: C. Allison Bailey

HEALTH PHYSICIST: N/A

TYPE DRILLING: Auger, Air Rotary

LUBRICANT TYPE: Green Stuff

No. SAMPLES TAKEN: N/A

TYPE: N/A

CONTAINMENT TYPE: Plastic, Pan

THICKNESS OF SOIL (REFUSAL DEPTH): 39.5

DEPTH DRILLED IN ROCK: 58.4

TOTAL DEPTH OF WELL: 97.9

DRILLING FLUID SAMPLES:

TYPE: Water DATE: 01-26-90

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	5.5		Augered	Clay, moderate brown and reddish brown. contains roots and gravel. Hard and moist, slightly crumbly.
5.5	10.5		Augered	Clay, dark yellowish orange, and moderate red slightly shaley, hard, firm and damp.
10.5	12.5		Augered	Clay, shaley, pale olive and pale red. Contains some iron stained layers. Slightly crumbly, firm, dry to damp.
12.5	20.0		Augered	Clay, dark yellowish orange and moderate reddish brown. Contains some thin layers of pale olive and dark brown. Hard, firm, damp to moist.
20.0	25.0		Augered	Clay, dark yellowish orange and moderate reddish brown. Contains some pale olive and brown. Very clayey, moist to wet, soft.
25.0	28.0		Augered	Clay, dusky yellow to light olive brown and moderate red. Hard, firm and crumbly. Slightly shaley.
28.0	36.5		Augered	Clay, dusky yellow to light olive brown and moderate red. Shaley, very soft, moist to wet. Wet at 33.0'.

ORNL MONITORING WELL LOG

PAGE 2 OF 3

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
36.5	39.5		Augered	Clay, dusky yellow and moderate brown with dark mineral specks. Contains some small chert, earthy. Came out of borehole with clay.
	39.5			Auger refusal.
39.5	45.8		Air Rotary	Poor samples.
45.8	50.0		Air Rotary	Limestone, light olive gray, microcrystalline, scattered vienlets of white secondary calcite, scattered fragments of limestone, dark yellowish orange microcrystalline.
50.0	55.0		Air Rotary	Limestone, light olive gray microcrystalline to medium grained, scattered fragments of limestone medium grained, dark yellowish orange.
55.0	60.0		Air Rotary	Limestone, microcrystalline to medium grained, light olive gray; soft from 58' to 59' (fracture?), hard from 59' to 59.5' with scattered fragments of chert and siliceous limestone.
60.0	65.0		Air Rotary	Limestone, light olive gray, microcrystalline to medium grained, soft from 60.0 to 61.5' (fractured?).
65.0	69.0		Air Rotary	Limestone, light olive gray, microcrystalline to coarse grained, scattered vienlets of calcite, very soft from 64.5' to 66.8' with scattered fragments of greenish gray siltstone clay (Bentonite Beds?).
69.0	71.5		Air Rotary	Very soft clayey siltstone, greenish gray (Bentonite Beds?).
71.5	75.0		Air Rotary	Limestone, light olive gray, microcrystalline to medium grained, scattered fragments of dolomite, dark olive gray, fine grained, and scattered fragments of chert.
75.0	80.0		Air Rotary	Limestone, light olive gray, microcrystalline,

WELL No. 1147

ORNL MONITORING WELL LOG

PAGE 3 OF 3

PAGE 11 OF 21

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED Timothy A. Lee

PROOFED

BY: C. Allison Bailey

BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter

HELPER: Fred Dixon

DRILLING METHOD: ☐ 22.0 INCH AUGER 6.0 L.F.
☐ 14.0 INCH AUGER 33.5 L.F.
☐ 14.0 INCH ROTARY 6.3 L.F.
☐ 8.0 INCH ROTARY 52.1 L.F.

MATERIALS USED

EST. USED
VOL. VOL.
50.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
46.0 FT. OF 10.0 IN. SURFACE CASING
10.0 10.0 SACKS OF CEMENT (SURFACE CASING)
50.0 POUNDS OF POWERED BENTONITE (SURFACE CASING)
80.0 GALLONS OF WATER (SURFACE CASING)
77.7 FT. OF 4 IN. DIA. STAINLESS STEEL CASING
20.0 FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
7.0 11.0 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
18.1 19.0 SACKS OF CEMENT (WELL CASING)
95.0 POUNDS OF POWERED BENTONITE (WELL CASING)
152.0 GALLONS OF WATER (WELL CASING)
3.01 FT. OF 10.0 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES
AND USED VOLUMES

Fractures and irregular boring diameters.

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 93.3 FEET.

CENTRALIZERS AT 10.0 FEET.
30.0 FEET.
62.0 FEET.
92.0 FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

TYPE B WELL

LOCATION WAG-11

ORNL GRID COORDINATES

N 35,696.4970

E 28,354.4126

ELEV. GROUND 875.19

ELEV. TOP STAINLESS

STEEL CASING 876.95

DRILLING DATES:

STARTED: 01-04-90

FINISHED: 01-29-90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL	DATE USED	BATCH NUMBER
SAND	01-29-90	2
BENTONITE Powder	01-09-90	4
Pellets	01-29-90	1
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	01-29-90	3
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	01-29-90	3
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	01-29-90	2
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	01-29-90	2
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	08-10-90	8
GROUT Surface Casing	01-09-90	5
	01-29-90	5
WELL COVERS		
SURFACE CASING	01-09-90	MMES Stores

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

01-29-90

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>01-29-90</u>	<u>Tbm</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>01-29-90</u>	<u>Tbm</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>08-10-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>01-29-90</u>	<u>Tbm</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

01-29-90

D. Charles Lytle
D. Charles Lytle

08-10-90

WELL No. 1147
LOCATION: WAG 11

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 08-03-90

TIME:

DEVELOPMENT
ENDING DATE: 08-10-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 28.4 GALLONS

TOTAL GALLONS PUMPED: 550 TOTAL WELL VOLUMES PUMPED: 19.4

INITIAL pH: 8.7 FINAL pH: 8.6

INITIAL CONDUCTIVITY (uS/cm): 332 FINAL CONDUCTIVITY (uS/cm): 401

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 ☒ GROUND SURFACE ☐ STORM SEWERS ☐ DRUMS ☐ OTHER
☐ TANK TRUCK ☐ STORAGE TANKS

INITIAL PRE-DEVELOPMENT

WATER DEPTH: 82.1 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle

WELL NO. 1147

LOCATION: WAG 11

DATE: 03-03-90

ONE WELL VOLUME = 28.4 GALLONS

COMMENTS

OBSERVER SIGNATURE/DATE D. Charles Lytle 08-10-90
D. Charles Lytle

M:\WORK\03.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")
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"A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY
OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY
PENETRATING WELLS")

WELL NO.: 1147

DATE OF TEST: 9-28-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-11

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 = 17.00 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 14.60 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 0 ("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)

.6513
.6559

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	13.250	1.350
20.00	13.500	1.100
30.00	13.680	.920
40.00	13.780	.820
50.00	13.880	.720
60.00	13.930	.670
75.00	13.980	.620
90.00	14.040	.560
105.00	14.070	.530
120.00	14.090	.510
150.00	14.110	.490
180.00	14.160	.440
240.00	14.190	.410
300.00	14.200	.400
360.00	14.200	.400
420.00	14.240	.360
480.00	14.240	.360
540.00	14.260	.340
600.00	14.230	.370
720.00	14.250	.350
840.00	14.280	.320
960.00	14.290	.310
1080.00	14.330	.270
1200.00	14.340	.260
1320.00	14.390	.210
1440.00	14.410	.190
1560.00	14.430	.170
1680.00	14.430	.170
1800.00	14.440	.160
1920.00	14.400	.200
2040.00	14.450	.150
2160.00	14.460	.140

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $3.01\text{E-}06$ FT/SEC = $9.18\text{E-}05$ CM/SECTRANSMISSIVITY = $6.03\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $2.25\text{E-}06$ FT/SEC = $6.86\text{E-}05$ CM/SECTRANSMISSIVITY = $4.50\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

ERC / EDGE
Environmental
and Energy
Services Co.

CHAIN OF CUSTODY RECORD

FOR

MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE
NUMBER

1147w01

WELL NO.

1147

LOCATION:

WAG 11

TYPE:

WATER

SAMPLER:

Smith (Signature)

SAMPLE INTERVAL:

N/A

DATE:

1-26-90

TIME:

0910

RELINQUISHED BY:
(SIGNATURE)

Smith (Signature)

DATE:

1-31-90

TIME:

1500

WITH:

ERC

RECEIVED BY:
(SIGNATURE)

NG Owen

DATE:

1/31/90

TIME:

14:55

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:

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 11/16/90
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~~ ^{MSB} 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. Hankford	9/15/89
	Division Director	
	Associate Division Director	
	Section Head	
A	Other Project Manager J.A. GREENE	11/19/89
A	Other Environmental Compliance C.E. Nix	10/5/89
R	Other Waste Management C.B. Scott	11/1/89

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

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*Testing for tritium will be done for wells located in areas where tritium contamination is suspected. This decision will be made between RP and EM&C.

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WELL

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X 854.7

X 854.6

X 845.0

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LEGEND

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PERIMETER OF VISIBLE SCRAP MATERIAL
AND CLEARED OPERATING AREAS (1952)

PERIMETER OF VISIBLE SCRAP MATERIAL
AND CLEARED OPERATING AREAS (1967)

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NOTE: Y-12 COORDINATE GRID SYSTEM

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