Environmental Restoration Division
ORNL Environmental Restoration Program

**Groundwater Quality Monitoring Well Installation for
Lower Waste Area Grouping 2 at Oak Ridge National
Laboratory, Oak Ridge, Tennessee**

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EXECUTIVE SUMMARY

This report documents the drilling and installation of 11 groundwater quality monitoring (GQM) wells on the perimeter of Lower Waste Area Grouping (WAG) 2. Lower WAG 2 consists of White Oak Lake and the embayment below White Oak Dam above the Clinch River. The wells in Lower WAG 2 were drilled and developed between December 1989 and September 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 a drilling 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. 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 Lower WAG 2 were drilled with auger or air rotary rigs. Depending on the hydrogeologic conditions present at each proposed well location, one of three basic installation methods was utilized. Detailed procedures for well construction were specified by the Engineering Division to ensure that the wells would provide water samples representative of the aquifer. 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 Lower WAG 2. 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 Lower Waste Area Grouping (WAG) 2. 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 Lower WAG 2 were drilled and developed from December 1989 to September 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 LOWER WAG 2

WAG 2 consists of two SWMUs, (1) White Oak Lake and the embayment below White Oak Dam above the Clinch River and (2) WOC and its tributaries and their respective floodplains. These surface water bodies constitute the major drainage system for ORNL and its outlying support facilities. For the sake of better management of data, production of usable graphics, and presentation of concise descriptive information, WAG 2 has been divided into upper and lower sections.

Lower WAG 2 consists of White Oak Lake and the embayment below White Oak Dam above the Clinch River [Fig. 1, map pocket (MMES map #C3E020004A122, Rev. B)]. These surface water bodies constitute the major drainage system for ORNL and its outlying support facilities. Lower WAG 2 shares common boundaries with WAG 6, WAG 7, and a portion of WAG 5, all of which contribute surface runoff to Lower WAG 2. The subject site also receives drainage from Upper WAG 2 and its tributaries. Each of the above listed WAGs contains multiple SWMUs that have operating histories spanning as many as 40 years. During this extended period, surface runoff and groundwater transport of contaminants from the adjoining WAGs has occurred. Many of these contaminants have accumulated within the lakebed, streambed, and floodplain sediments of Lower WAG 2. Four monitoring wells were drilled along the south side of White Oak Lake, an additional 4 monitoring wells were drilled on or adjacent to White Oak Dam, and three wells were drilled along the east side of Watts Bar Lake near the confluence of White Oak Creek (Fig. 1, map pocket).

2. INSTALLATION METHODS

Four basic types of well construction were used during the GQM installation program at ORNL. Schematic diagrams of these four well types are shown on Fig. 2. Three of the four types (A, B, and D) were used at Lower WAG 2. These three types are described in Sects. 4.1 through 4.3. The specific details of each well installation are included in the monitoring well narratives (Appendix A). The specifications for drilling and well installation were provided in the *Construction Specifications for Monitoring Wells Installation Construction Project*, K-4491G-G1.¹ The proposed well design criteria for the Lower WAG 2 wells can be found in *Preliminary Geohydrologic Site Characterization and Proposed Water Quality Well Locations for WAG 17 and Lower WAG 2*, ORNL/RAP/Sub-87/SB189/2.² The actual completion data for Lower WAG 2 are listed in Table 1.

2.1 TYPE A WELL

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

2.2 TYPE B WELL

The first step in drilling the type B wells is to auger a boring from the surface to a depth of 4 ft. A steel diverter casing is installed, and the annulus is grouted up 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 were installed in the annular space by the same procedures as used for the type A well.

2.3 TYPE D WELL

A type D well is a type A well with a diverter casing. If the auger encounters refusal before reaching total depth on a type A well, the boring is reamed to refusal with a larger auger, and a steel diverter casing is installed. The annulus is grouted up to surface level. The boring is deepened to total depth with a tricone air rotary bit, 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 Lower WAG 2

Well	Depth clean to (ft) ^a	SST casing diam (in.)	Well type	Screened interval (ft)	Water level (ft) ^b
1185	27.15	2	D	16.91–26.91	–9.3
1186	68.1	4	B	52.85–67.85	–8.8
1187	85.0	4	B	67.70–82.70	–10.3
1188	27.26	2	D	17.02–27.02	–8.1
1189	27.5	2	D	12.3–27.3	–8.1
1190	47.4	4	B	37.2–47.2	–11.3
1191	26.0	2	D	15.8–25.8	–10.9
1192	18.0	2	A	7.8–17.8	–13.1
1193	84.8	4	B	64.6–84.6	–17.4
1194	97.3	4	B	77.1–97.1	–10.9
1195	31.4	2	A	16.2–31.2	–12.2

^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 Lower WAG 2 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 was a system for rating proposed well locations according to the degree of probability that contamination will be encountered. This rating determined the level of personnel training required and health and safety coverage to be used during drilling.

The Superfund Amendment Reauthorization Act required still more stringent health and safety measures for personnel working in waste areas. These workers were required to have 40 h of training for hazardous duty through an ORNL-approved course, 8 h of refresher training each year, 8 h of supervisor's training for field supervisors, a whole-body count, baseline urinalysis, respirator testing and fitting, and medical monitoring. Personnel were also required to take a construction-worker training course covering the 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 in Appendix B.

4. FIELD SUPPORT

The construction contractor, Geotek Engineering Company, whose contract began in May 1989, installed the GQM wells in Lower WAG 2. 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-88/28.⁴

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 Lower WAG 2. These data packages are 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 well. The contents of the wells were then pumped out using Geoguard airlift pumps and oilless air compressors. Development of a well was considered complete when at least three well volumes had been removed and the turbidity was measured at 5 nephelometric turbidity units (NTUs) or less. Several wells had turbidity ratings higher than 5 NTUs even after extensive pumping, but, in order to prevent the pulling in of groundwater from too far away, a maximum limit of 30 to 35 well volumes was determined by Energy Systems hydrogeologists to be the upper limit that should be removed. The contents of the wells were pumped out using Geoguard development pumps. The two-stage Geoguard pumps were converted to dedicated bladder pumps for sampling after development was complete. All development water was contained and disposed of according to the operating instructions in Appendix B.

Of the 11 wells in Lower WAG 2, 7 wells had turbidity ratings of less than or equal to 5 NTUs. The number of well volumes removed ranged from 4.1 to 37.0, with an average of 19.5. The procedure for measuring turbidity described in ORNL/RAP/LTR-88/28⁴ was replaced with a more accurate method. While the method previously used 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 analysis. Soil and rock samples were taken from the unsaturated and saturated zones. Samples of drilling water were collected from the water pump discharge on the drill rig when drilling with the air rotary took place. All samples were transferred using chain-of-custody forms, which are included in the data packages. The sampling procedures are explained in ORNL/RAP/LTR-88/28.⁴ Soil samples were collected from each single well and from one well of each well pair. A drilling-water sample was collected from each air-rotary-drilled boring.

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

8. SPECIAL NOTES ON INSTALLATION AND DEVELOPMENT

The following special events took place during the drilling of the GQM wells in Lower WAG 2.

8.1 CONTAMINATION DETECTED

- After well 1188 was drilled and the drill rods removed, debris such as wooden timbers and plastic sheeting were protruding into the well bore at 5.0 feet. Water was pouring into the well bore from this interval. The debris indicated that this was the site of a mud pit for a nearby well.
- Well 1189 was determined to be Class II (moderate probability of encountering contamination); however, no radioactivity over background was detected during drilling, so the location was downgraded to a Class I (low probability of encountering contamination).
- Well 1190 was determined to be Class II (moderate probability of encountering contamination), and radioactivity up to 50 cpm was detected during drilling.
- Well 1191 was determined to be Class II (moderate probability of encountering contamination); however, no radioactivity over background was detected during drilling. The location remained Class II due to suspected low-level radioactivity.

8.2 DEVIATIONS FROM SPECIFICATIONS

Due to the fluid nature of the unconsolidated soils, it was necessary to set an additional string of surface casing in wells 1193 and 1194.

8.3 DRILL RIG FLUID LEAKS

The drill rig turned over due to "washout" of the unconsolidated soils on well 1194. The rig leaked hydraulic fluid, diesel, and other rig fluids, but all fluids were contained, and the well was not contaminated.

REFERENCES

1. Engineering Division, *Construction Specifications for Monitoring Wells Installation Construction Project*, Rev. 2, K-4491G-G1, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., August 1988.
2. Engineering, Design & Geosciences Group, Inc., *Preliminary Geohydrologic Site Characterization and Proposed Water Quality Well Locations For WAG 17 and Lower WAG 2*, ORNL/RAP/Sub-87/SB189/2, 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 1185 is located in Lower WAG 2. It is on the south side of White Oak Creek approximately 1500' west of the new hydrofracture facility. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N16343.8538, E26464.8010 (X-10 grid) or latitude 35°-54'-23.94" and longitude 84°-19'-08.65". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 1185 was drilled by Geotek Engineering Company. An Ingersoll-Rand T-4 Air Rotary 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 December 11, 1989, and was finished on January 2, 1990. 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.

- 12-11-89 The Ingersoll-Rand T-4 and equipment were decontaminated, mobilized to the site and set up on plastic. A 14.0" boring was augered to 5.0'.
- 12-12-89 A 10" diameter diverter casing was installed and grouted.
- 12-21-89 The Ingersoll-Rand T-4 and equipment were decontaminated and mobilized to the site. The rig was set up and an 8 inch boring was advanced to 15.0' with a tricone bit. After allowing the boring to recharge for 1 hour, .5' of water was measured. A drill water and an air sample were taken. The boring was advanced to a total depth of 27.5'. After a 1 hour recharge, 3.5' of water was measured.
- 12-22-89 The drill rig would not start due to the severely cold weather (-5° F). Will set well after Christmas holidays.
- 01-02-90 The two-inch stainless steel and casing were set by hand to a total depth of 27.15'. Sand was poured to 15.35' and a bentonite seal installed to a depth of 13.36'. The remaining annulus was grouted with 3 bags of cement and 5% bentonite after allowing the bentonite to hydrate four hours.

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

Lower WAG 2 includes White Oak Creek, White Oak Lake and one of its feeder streams, the embayment between White Oak Dam and the Clinch River, and all adjacent floodplains. Lower WAG 2 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. Lower WAG 2 is underlain by two members of the Conasauga Group. These members are the Maryville Limestone and the Nolichucky Shale. The Maryville Limestone consists of intraclastic limestone conglomerate interbedded with calcareous mudstone, siltstone, and coarse grained limestone. The Nolichucky Shale is composed of coarse grained limestone, mudstone, siltstone, and shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The average strikes and dips appears to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

A drill water sample was collected from the water pump on the drill rig on December 21, 1989. Analytical results for the sample described above can be obtained from the Remedial Action Program data base at ORNL.

The Ingersoll-Rand T-4 Air Rotary Rig's compressed air was sampled with a cloth filter inserted between drill rods on December 21, 1989. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter indicated no evidence 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 5.0 feet and a 10.0-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 5.0 to 27.5 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 27.15 to 16.91 feet. A 2-inch diameter stainless steel casing was installed above the screen at 16.91 feet and extended 2.3 feet above ground surface. A sandpack was then tremied into the annular space from 27.15 to 15.35 feet, with a 1.99-foot bentonite pellet seal poured into the annular space above the sandpack from 15.35 to 13.36 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 1185 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 65 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 June 22, 1990, at a depth of 25.03 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 1185 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 2.37×10^{-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>12-11-89</u>	<u>CAB</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>12-11-89</u>	<u>CAB</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>01-02-90</u>	<u>CAB</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>N/A</u>	<u>N/A</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>12-11-89</u>	<u>CAB</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>12-11-89</u>	<u>CAB</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>12-11-89</u>	<u>CAB</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>12-21-89</u>	<u>CAB</u>

RESULTS: No hydrocarbons were detected under ultraviolet light

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

C. Allison Bailey 01-02-90
C. Allison Bailey

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1185

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE C. Allison Bailey 12-11-89
C. Allison Bailey

PAGE 1 OF 1

DATE: START: 12-11-89
FINISH: 01-02-90
 LOGGED BY: C. Allison Bailey
 HEALTH PHYSICIST: L.C. Johnson
Carl Stooksbury

THICKNESS OF SOIL (REFUSAL DEPTH): 12.5'
DEPTH DRILLED IN ROCK: 15.0'
TOTAL DEPTH OF WELL: 27.5'

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 12-21-89
#1185W01

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WELL No. 1185

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

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

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter
HELPER: Fred Dixon

EQUIPMENT
14.0 INCH AUGER 5.0 L.F.
8.0 INCH AUGER L.F.
8.0 INCH ROTARY 22.5 L.F.

MATERIALS USED

EST. USED VOL. VOL.
10.0 FEET OF 2.0 IN. S.S. SCREEN
20.0 FEET OF 2.0 IN. S.S. CASING
4.0 SACKS OF SAND
50.0 POUNDS OF BENTONITE PELLETS
2.7 SACKS OF CEMENT
15.0 POUNDS OF POWDERED BENTONITE
18.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Due to spillage

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

MONITORING WELL PUMP BASE SET AT 25.0 FEET

CENTRALIZERS AT 10.0 FEET

25.0 FEET

FEET

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

TYPE D WELL

HOLE CLEANED OUT TO 27.15 FEET
BOTTOM OF BOREHOLE 27.5 FEET

LOCATION Lower MAG-2
ORNL GRID COORDINATES
N 16.343.8538
E 26.464.8010
ELEV. GROUND 160.08
ELEV. TOP STAINLESS
STEEL CASING 162.15
DRILLING DATES
STARTED: 12-11-89
FINISHED: 01-02-90

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1185

DATE: 01-02-90

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	01-02-90	stores
BENTONITE	01-02-90	1
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	01-02-90	2
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	01-02-90	2
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	01-02-90	2
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	01-02-90	2
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	6-22-90	7
GROUT	01-02-90	3
WELL COVERS	01-02-90	3
SURFACE CASING		

COMMENTS:

OBSERVER SIGNATURE/DATE C. Allison Bailey 01-02-90
C. Allison Bailey

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1185

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>12-11-89</u>	<u>CAB</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>12-11-89</u>	<u>CAB</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>6-22-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>01-02-90</u>	<u>CAB</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 C. Allison Bailey 01-02-90

C. Allison Bailey

D. Charles Lytle 6-22-90

D. Charles Lytle

WELL No. 1185
LOCATION: Lower
WAG-2

**MONITORING WELL
DEVELOPMENT FORM**

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and pumping

DEVELOPMENT BEGAN DATE: 6/21/90 TIME: _____

DEVELOPMENT ENDING DATE: 6/22/90

DEVELOPMENT OBSERVED BY: Chuck Lytle

ONE WELL VOLUME: 7.7 GALLONS

TOTAL GALLONS PUMPED: 65 TOTAL WELL VOLUMES PUMPED: 8.4

INITIAL pH: 8.4 FINAL pH: 8.4

INITIAL CONDUCTIVITY ($\mu S/cm$): 462 FINAL CONDUCTIVITY ($\mu S/cm$): 462

DESCRIPTION OF INITIAL TURBIDITY: Clear

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 1.3 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO: ☒ GROUND SURFACE ☐ TANK TRUCK ☐ STORAGE TANKS ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 9.3 feet below ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE: D. Charles Lytle 6/22/90

ERCE
Environmental
and Energy
Services Co.

WELL NO. 1185

LOCATION: Lower WAG-2

DATE: 6/21/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 7.7 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
6/22/90	1442	65	Clear	1.3	8.4	462	65	8.5	
RESULTS AT END OF DEVELOPMENT			Clear	1.3	8.4	462	65	8.4	

COMMENTS	Fast recharger and good producer. Therefore, passed with 1.3 NTU's.
	Water remained clear; even after several cycles of surging.

OBSERVER SIGNATURE/DATE D. Charles Lytle 6/22/90
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.: 1185

DATE OF TEST: 10-15-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: L. WAG-2

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 17.20 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. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

3.7500
3.7770

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	5.310	4.310
20.00	5.200	4.200
30.00	5.130	4.130
40.00	5.050	4.050
50.00	4.960	3.960
60.00	4.850	3.850
75.00	4.780	3.780
90.00	4.700	3.700
105.00	4.610	3.610
120.00	4.520	3.520
150.00	4.370	3.370
180.00	4.220	3.220
240.00	3.980	2.980
300.00	3.780	2.780
360.00	3.610	2.610
420.00	3.480	2.480
480.00	3.360	2.360
540.00	3.220	2.220
600.00	3.120	2.120
720.00	2.910	1.910
840.00	2.760	1.760
960.00	2.620	1.620
1080.00	2.510	1.510
1200.00	2.390	1.390
1320.00	2.300	1.300
1440.00	2.210	1.210
1560.00	2.130	1.130
1680.00	2.070	1.070
1800.00	2.000	1.000
1920.00	1.960	.960
2040.00	1.930	.930
2160.00	1.860	.860

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $7.77\text{E-}07$ FT/SEC = $2.37\text{E-}05$ CM/SECTRANSMISSIVITY = $7.77\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.09\text{E-}06$ FT/SEC = $3.33\text{E-}05$ CM/SECTRANSMISSIVITY = $1.09\text{E-}05$ 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

1185001

WELL NO.

1185

LOCATION:

LOWER 10' 2'

TYPE:

WATER

SAMPLER:

1000-2-2-10

SAMPLE INTERVAL:

N/A

DATE:

12-21-89

TIME:

1513

RELINQUISHED BY:
(SIGNATURE)

1000-2-2-10

DATE:

1-13-90

TIME:

1300

WITH:

EDGE

RECEIVED BY:
(SIGNATURE)

John

DATE:

1-15-90

TIME:

1500

WITH:

1/4 M

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 1186 is located in Lower WAG 2. It is on the south side of White Oak Creek approximately 1500' west of the new hydrofracture facility. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N16346.3881, E26443.7832 (X-10 grid) or latitude 35°-54'-23.85" and longitude 84°-19'-08.88". 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 1186 was drilled by Geotek Engineering Company. An Ingersoll-Rand T-4 Air Rotary 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 December 11, 1989, and was finished on December 19, 1989. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

- 12-11-89 The Ingersoll-Rand T-4 and equipment were cleaned and mobilized to the site. Plastic was layed down and the rig set up. A 6.0" boring was augered and split spooned to a split spoon refusal depth of 11.0'. A soil sample and a bulk density sample were taken. The boring was then augered to a refusal depth of 12.5'. A 22.0" boring was then augered to 5.5'.
- 12-12-89 A 15 1/4" diverter casing was installed and grouted.
- 12-13-89 The Ingersoll-Rand T-4 and equipment were decontaminated, mobilized to the site and set up. A 14" boring was drilled to 16.0' with a tricone bit. A 10.0" diameter surface casing was installed to a depth of 16.0' and a bentonite seal poured to 14.0'.
- 12-14-89 An surface casing was grouted using 5.5 bags of cement and 5% bentonite.
- 12-18-89 An eight-inch boring was drilled from 16.0' to 48.3' with a tricone bit. The boring was cleaned and after 30 minutes of recharge, 0.0' of water was measured. The boring was advanced to 68.3', cleaned and after 2 hours of recharge, 21.9' of water was measured. The 4-inch stainless steel screen and casing were installed to a depth of 68.1'. The sand was tremied to a depth of 49.2' and a bentonite seal poured to 64.9'.
- 12-19-89 The remaining annulus was grouted with 8 bags of cement and 5% bentonite.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist C. Allison Bailey 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

Lower WAG 2 includes White Oak Creek, White Oak Lake and one of its feeder streams, the embayment between White Oak Dam and the Clinch River, and all adjacent floodplains. Lower WAG 2 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. Lower WAG 2 is underlain by two members of the Conasauga Group. These members are the Maryville Limestone and the Nolichucky Shale. The Maryville Limestone consists of intraclastic limestone conglomerate interbedded with calcareous mudstone, siltstone, and coarse grained limestone. The Nolichucky Shale is composed of coarse grained limestone, mudstone, siltstone, and shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The average strikes and dips

appears to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

One soil sample was collected during drilling, placed in an I-CHEM specialty cleaned glass container, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. A chain of custody form for this sample is included with this data package. Soil sample 1186S01 was collected in the split spoon interval from 9.5 to 11.0 feet on December 11, 1989. Drill water sample 1186W01 was collected from the water pump on the drill rig on December 18, 1989. Analytical results for the two samples described above can be obtained from the Remedial Action Program data base at ORNL.

A bulk density soil sample was collected from the split spoon sample interval from 2.4 to 2.7 feet. The sample was measured and weighed, and a bulk density of 2.05 grams/cm³ was calculated.

The Ingersoll-Rand T-4 Air Rotary Rig's compressed air was sampled with a cloth filter inserted between drill rods on December 18, 1989. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter indicated no signs of hydrocarbons.

2.4 Installation and Development

2.4.1 Installation

This was a Type B well. A 6.0-inch diameter boring was split spooned to a refusal depth of 11.0' and augered to a refusal depth of 12.5'. A 22.0-inch diameter boring was augered from ground surface to 5.5 feet. A 15 1/4-inch diverter casing was installed from surface to 5.5 feet below ground surface and grouted in place. The boring was then extended past the refusal depth with a 14.0-inch air rotary tricone roller bit from 12.5 feet to 16.0 feet. A 10-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 16.0 feet, sealed with a 2.0-foot bentonite pellet layer from 14.0 feet to 16.0 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 68.3 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 68.1 feet to 52.85 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 52.85 feet and extended 2.3 feet above ground surface. A sandpack was then tremied into the annular space from 68.1 to 49.2 feet, with a 2.3-foot bentonite pellet seal poured into the annular space above the sandpack from 49.2 to 46.9 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 1186 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 209 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 3.5 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 June 21, 1990, at a depth of 66.52' 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 1186 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 1.27×10^{-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>12-11-89</u>	<u>CAB</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>12-11-89</u>	<u>CAB</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>12-18-89</u>	<u>TJB</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>12-11-89</u>	<u>CAB</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>12-11-89</u>	<u>CAB</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>12-11-89</u>	<u>CAB</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>12-11-89</u>	<u>CAB</u>

RESULTS: No hydrocarbons detected under ultraviolet light

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 12-18-89
C. Allison Bailey 12-11-89
C. Allison Bailey

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and Energy
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WELL No. 1186

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 12-11-89
C. Allison Bailey

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and Energy
Services Co.

WELL No. 1186

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: Lower WAG-2
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersol Rand T-4 Air Rotary

DATE: START: 12-11-89
FINISH: 12-19-89
LOGGED BY: C. Allison Bailey
Timothy A. Lee
HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Split spoon LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: (1) #1186S01 TYPE: Soil

CONTAINMENT TYPE: Plastic, Pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 12.5'
DEPTH DRILLED IN ROCK: 55.8'
TOTAL DEPTH OF WELL: 68.3'

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 12-18-89
1186W01

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	2.0		100%	Clay, mottled pale olive and yellowish gray with light brown specks. Contains chert fragments, oolitic throughout sample. From 1.4 to 1.7. Sample contains roots and decayed organic material along with crushed chert flinty. Sample is firm, hard and plastic.
2.0	3.0	Bulk density 2.4 - 2.7	100%	Clay, shaley, pale olive and dark yellowish brown to light brown. Sample is layered, firm but crumbly. Moist
3.0	4.0		100%	Shale, clayey, pale olive and dark yellowish brown to light brown. Contains some dark black organic mineral layers. Shale is layered, hard, dry and brittle.
4.0	5.5		90%	Shale, light olive gray and light brown. Highly weathered, dry, very crumbly.
5.5	7.5		90%	Shale, clayey, mottled, light olive gray, dusky yellow and light brown gray. Very hard and firm, layered, not plastic. Damp to moist.
7.5	9.5		90%	Shale, slightly clayey, mottled, light olive gray, dusky yellow and light brown gray. Very

WELL No. 1186

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 11 OF 22.

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1186

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: C. Allison Bailey PROOFED BY: Michael L. Ebers
Timothy A. Lee
DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter HELPER: Fred Dixon

DRILLING METHOD: ☒ 22.0 INCH AUGER 5.5 L.F.
☐ INCH AUGER L.F.
☒ 14.0 INCH ROTARY 10.5 L.F.
☒ 8.0 INCH ROTARY 52.3 L.F.

MATERIALS USED

EST. VOL	USED VOL	
<u>50.0</u>	<u>50.0</u>	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
<u>16.0</u>	<u>16.0</u>	FT. OF 10.0 IN. SURFACE CASING
<u>4.5</u>	<u>5.5</u>	SACKS OF CEMENT (SURFACE CASING)
<u>30.0</u>	<u>30.0</u>	POUNDS OF POWDERED BENTONITE (SURFACE CASING)
<u>45.0</u>	<u>45.0</u>	GALLONS OF WATER (SURFACE CASING)
<u>55.0</u>	<u>4.0</u>	FT. OF 4.0 IN. DIA. STAINLESS STEEL CASING
<u>15.0</u>	<u>4.0</u>	FT. OF 4.0 IN. DIA. STAINLESS STEEL SCREEN
<u>4.75</u>	<u>5.0</u>	SACKS OF SAND
<u>50.0</u>	<u>50.0</u>	POUNDS OF BENTONITE PELLETS
<u>6.75</u>	<u>8.0</u>	SACKS OF CEMENT (WELL CASING)
<u>40.0</u>	<u>40.0</u>	POUNDS OF POWDERED BENTONITE (WELL CASING)
<u>50.0</u>	<u>50.0</u>	GALLONS OF WATER (WELL CASING)
<u>3.10</u>	<u>3.10</u>	FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

SURFACE CASING THEME GROUTED YES ☒ NO ☐
STAINLESS STEEL CASING THEME GROUTED YES ☒ NO ☐
WELL COVER USED ☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER
SLT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 66.52 FEET.

CENTRALIZERS AT 11.0 FEET.
27.0 FEET.
47.0 FEET.
67.0 FEET

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

TYPE B WELL

LOCATION Lower WAG-2
ORNL GRID COORDINATES
N 16.346.3881
E 26.443.7832
ELEV. GROUND 759.10
ELEV. TOP STAINLESS
STEEL CASING 760.98
DRILLING DATES:
STARTED 12-11-89
FINISHED 12-19-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1186

DATE: 12/13/89

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	12-18-89	1
BENTONITE	12-13-89	1
	12-18-89	1
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	12-18-89	2
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	12-18-89	2
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	12-18-89	2
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	12-18-89	2
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	6-21-90	7
GROUT	12-14-89	3
	12-19-89	3
WELL COVERS		
SURFACE CASING	12-13-89	1

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee 12/18/89
Timothy A. Lee

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>12-11-89</u>	<u>CAB</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>12-11-89</u>	<u>CAB</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>6-21-90</u>	<u>DCS</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>12-19-89</u>	<u>Tlee</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	<u>C. Allison Bailey</u>	<u>12-11-89</u>
	C. Allison Bailey	
	<u>Timothy A. Lee</u>	<u>12-19-89</u>
	Timothy A. Lee	
	<u>D. Charles Lytle</u>	<u>6-21-90</u>
	D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1186

LOCATION: L.WAG2

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 6-21-90

TIME: _____

DEVELOPMENT
ENDING DATE: 6-21-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 51.5 GALLONS

TOTAL GALLONS PUMPED: 209 TOTAL WELL VOLUMES PUMPED: 4.1

INITIAL pH: 9.0 FINAL pH: 9.0

INITIAL CONDUCTIVITY ($\mu S/cm$): 484 FINAL CONDUCTIVITY ($\mu S/cm$): 484

DESCRIPTION OF INITIAL TURBIDITY: Clear

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 3.5 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: 8.8 feet below ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 6/21/90
D. Charles Lytle

HYDRA-DVG

WELL NO. 1186
LOCATION: L. WAG-2
DATE: 6/21/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 51.5 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (U.S/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
6-21-90	1000	209	Clear	3.5	9.0	484	209	4.1	
RESULTS AT END OF DEVELOPMENT			Clear	3.5	9.0	484	209	4.1	

COMMENTS	Fast recharger and good producer. Water remained clear after surging. The well was passed with 3.5 NTU's and moved to another hole.
----------	---

OBSERVER SIGNATURE/DATE D. Charles Lytle 6/21/90
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.: 1186

DATE OF TEST: 10-15-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: L. WAG-2

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 = 58.80 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)

2.4937

2.4950

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.510	2.510
20.00	3.520	2.520
30.00	3.520	2.520
40.00	3.500	2.500
50.00	3.510	2.510
60.00	3.480	2.480
75.00	3.470	2.470
90.00	3.480	2.480
105.00	3.460	2.460
120.00	3.440	2.440
150.00	3.450	2.450
180.00	3.430	2.430
240.00	3.400	2.400
300.00	3.390	2.390
360.00	3.370	2.370
420.00	3.370	2.370
480.00	3.360	2.360
540.00	3.310	2.310
600.00	3.310	2.310
720.00	3.280	2.280
840.00	3.240	2.240
960.00	3.220	2.220
1080.00	3.170	2.170
1200.00	3.150	2.150
1320.00	3.120	2.120
1440.00	3.090	2.090
1560.00	3.080	2.080
1680.00	3.050	2.050
1800.00	3.000	2.000
1920.00	2.990	1.990
2040.00	2.970	1.970
2160.00	2.950	1.950

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $4.16\text{E-}07$ FT/SEC = $1.27\text{E-}05$ CM/SEC

TRANSMISSIVITY = $6.24\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $4.84\text{E-}07$ FT/SEC = $1.48\text{E-}05$ CM/SEC

TRANSMISSIVITY = $7.26\text{E-}06$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

EDGE Engineering, Design & Geosciences Group, Inc. 726 Mississippi Parkway P.O. Box 23010 Knoxville, TN 37933-1010		CHAIN OF CUSTODY RECORD FOR MARTIN MARIETTA ENERGY SYSTEMS OAK RIDGE NATIONAL LABORATORY				SAMPLE NUMBER 1186
WELL NO. 1186		LOCATION: LOOKY B W - 2		TYPE: 1		
SAMPLER: 1186		SAMPLE INTERVAL: 9.5-11.0		DATE: 12-11-77		
(SIGNATURE) <i>[Signature]</i>		DATE: 12-11-77		TIME: 11:00		
RELINQUISHED BY: <i>[Signature]</i>		DATE: 12-11-77		TIME: 11:00		
WTH: 11.00		RECEIVED BY: <i>[Signature]</i>		DATE: 12-11-77		
DATE: 12-11-77		TIME: 11:00		WTH: 11.00		
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:

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

1186W01

WELL NO. 1186		LOCATION: LOWER WAG 2		TYPE: DRILL WATER			
SAMPLER: <i>Smith</i> (SIGNATURE)		SAMPLE INTERVAL: N/A		DATE: 12-19-89		TIME: 1115	
RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<i>Smith</i>	12/19/89	1245	ERC	JHS	12/19/89	12:42	

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 1187 is located in Lower WAG 2. It is approximately 100 feet south of White Oak Lake. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N15183.2652, E24285.1271 (X-10 grid) or latitude 35°-54'-02.42" and longitude 84°-19'-22.82". 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 1187 was drilled by Geotek Engineering Company. An Ingersoll-Rand T-4 air rotary 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 December 12, 1989, and was finished on December 21, 1989. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

- 12-12-89 The Ingersoll-Rand T-4 Air Rotary Rig and equipment were decontaminated and mobilized to the site. Plastic was layed down and the equipment rigged up. An 8 inch boring was split spooned and augered to 7.5'. Soil sample 1187S01 was taken. A 22 inch boring was augered to 5.5' and 15' of 14" diverter casing set to 4.0'.
- 12-15-89 The Ingersoll-Rand and equipment were mobilized to the site and set up. A 14.5" boring was advanced to 15.0'. A 10 3/4" surface was installed to a depth of 14.5' and a bentonite seal poured to 11.5'. The remaining annulus was tremie grouted.
- 12-18-89 The drill rig and tools were decontaminated.
- 12-20-89 The rig and equipment were mobilized to the site and set up. The diverter head and blooeey line were installed. An 8 inch boring was advanced with a tricone bit from 15.0' to 55.0'. The boring was cleaned and after waiting 1 hour for recharge, 18.0' of water was measured (3.6 min./ft. H₂O). The boring was drilled to 70.0', the borehole cleaned and after 40 minutes, 13.0' of water was measured (3 min./ft.). The boring was then advanced to a total depth of 85.0'. An air and water sample were taken. The boring was cleaned and after waiting 1 hour on recharge, 32.0' of water was measured (2 min./ft.).
- 12-21-89 Fifteen feet of 4 inch stainless steel screen and 70.0' of 4 inch stainless steel casing were installed to a total depth of 82.95'. Sand was tremied to a depth of 61.40'. Bentonite was poured to a depth of 58.65'. The remaining annulus was tremie grouted to the surface.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist C. Allison Bailey 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

Lower WAG 2 includes White Oak Creek, White Oak Lake and one of its feeder streams, the embayment between White Oak Dam and the Clinch River, and all adjacent floodplains. Lower WAG 2 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. Lower WAG 2 is underlain by two members of the Conasauga Group. These members are the Maryville Limestone and the Nolichucky Shale. The Maryville Limestone consists of intraclastic limestone conglomerate interbedded with calcareous mudstone, siltstone, and coarse grained limestone. The Nolichucky Shale is composed of coarse grained limestone, mudstone, siltstone, and

shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The average strikes and dips appears to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

One soil sample was collected during drilling, placed in an I-CHEM specialty cleaned glass container, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. A chain of custody form for this sample is included with this data package. Soil sample 1187S01 was collected in the split spoon interval from 2.0 to 3.2 feet on December 12, 1989. Drill water sample 1187W01 was collected from the water pump on the drill rig on December 20, 1989. Analytical results for the two samples described above can be obtained from the Remedial Action Program data base at ORNL.

The Ingersoll-Rand T-4 Air Rotary Rig's compressed air was sampled with a cloth filter inserted between drill rods on December 20, 1989. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter indicated no evidence of hydrocarbons.

2.4 Installation and Development

2.4.1 Installation

This was a Type B well. An 8-inch boring was split spooned and augered to a refusal depth of 7.5'. A 22.0-inch diameter boring was augered from ground surface to 5.5 feet. A 15 1/4-inch diverter casing was installed from surface to 4.0 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 5.5 feet to 15.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 14.5 feet, sealed with a 3.0-foot bentonite pellet layer from 11.5 feet to 14.5 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 85.0 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 67.70 feet to 82.95 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 67.70 feet and extended 2.3 feet above ground surface. A sandpack was then tremied into the annular space from 85.0 to 61.40 feet, with a 2.75-foot bentonite pellet seal poured into the annular space above the sandpack from 61.40 feet to 58.65 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 1187 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps and/or bailers were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 1006 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 June 22, 1990, at a depth of 80.97' 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 1187 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 4.78×10^{-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

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>12-12-89</u>	<u>CAB</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>12-12-89</u>	<u>CAB</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>CAB</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>12-21-89</u>	<u>CAB</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>12-12-89</u>	<u>CAB</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>12-12-89</u>	<u>CAB</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>12-12-89</u>	<u>CAB</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>12-20-89</u>	<u>CAB</u>

RESULTS: No hydrocarbons detected under ultra violet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

C. Allison Bailey 12-21-89
C. Allison Bailey

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

C. Allison Bailey 12-12-89
C. Allison Bailey

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1187

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: Lower WAG-2
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersoll Rand T-4

DATE: START: 12-12-89
FINISH: 12-21-89
LOGGED BY: C. Allison Bailey/
Michael L. Ebers
HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Split Spoon, Auger, Air Rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: 1 (#1187S01) TYPE: Soil
CONTAINMENT TYPE: Plastic, Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 7.5'
DEPTH DRILLED IN ROCK: 77.5'
TOTAL DEPTH OF WELL: 85.0'

DRILLING FLUID SAMPLES:
TYPE: Drill Water DATE: 12-20-89
#1187W01

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	1.0		40%	Clay, light brown, moderate yellowish brown and dark orange, with chert fragments. Moist.
1.0	2.0		40%	Clay, pale brown to moderate brown and dark yellowish orange. Slightly shaley. Contains roots and other organic material. Not consolidated; firm but soft. Moist.
2.0	2.2	1187S01	100%	Clay, shaley, moderate yellowish orange, with crushed chert fragments. Hard and firm. Saturated.
2.2	3.2		100%	Shale, highly weathered, grayish red to reddish brown. Thin beds. Wet.
3.2	3.9		100%	Shale, highly weathered, grayish red to reddish brown. Thin beds. Dry, brittle.
3.9	5.0		100%	Shale, grayish pale brown and grayish orange, very hard but brittle. Contains limestone chunks, light gray, fine to medium grained, with quartz veins.
5.0	6.8		80%	Shale, highly weathered, grayish red to reddish brown thin beds. Tight, compact. Damp.
6.8	7.5		Auger	Shale, grayish red to reddish brown, damp.
	7.5			Refusal on limestone, light gray, fine to

PAGE 2 OF 2

PAGE 10 OF 21

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

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

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter HELPER: Fred Dixon

DRILLING METHOD: ☒ 22.0 INCH AUGER 5.5 L.F.
☐ INCH AUGER L.F.
☒ 14.5 INCH ROTARY 9.5 L.F.
☒ 8.0 INCH ROTARY 70.0 L.F.

MATERIALS USED

EST. USED
VOL. VOL.
50.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
14.5 FT. OF 10 IN. SURFACE CASING
3.68 4.0 SACKS OF CEMENT (SURFACE CASING)
20.0 POUNDS OF POWDERED BENTONITE (SURFACE CASING)
24.0 GALLONS OF WATER (SURFACE CASING)
70.0 FT. OF 4.0 IN. DIA. STAINLESS STEEL CASING
15.0 FT. OF 4.0 IN. DIA. STAINLESS STEEL SCREEN
5.90 6.0 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
8.50 10.0 SACKS OF CEMENT (WELL CASING)
20 POUNDS OF POWDERED BENTONITE (WELL CASING)
60 GALLONS OF WATER (WELL CASING)
3.28 FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Irregular boring diameter and spillage

SURFACE CASING TREME GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING
TREME GROUTED YES ☒ NO ☐

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

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 80.97 FEET.

CENTRALIZERS AT 22.0 FEET.
42.0 FEET.
62.0 FEET.
82.0 FEET

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

TYPE B WELL

LOCATION Lower WAG-2
ORNL GRID COORDINATES
N 15.183.2652
E 24.285.1271
ELEV. GROUND 755.61
ELEV. TOP STAINLESS
STEEL CASING 757.94
DRILLING DATES:
STARTED 12-12-89
FINISHED 12-21-89

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND				
			12-21-89	2
BENTONITE			12-15-89	3 4
			12-21-89	1
			12-21-89	2
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	12-21-89	2
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	12-21-89	2
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	12-21-89	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	12-21-89	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	6-22-90	7
GROUT			12-15-89	3
			12-21-89	4
WELL COVERS				
SURFACE CASING			12-15-89	3

COMMENTS:

OBSERVER SIGNATURE/DATE

Michael A. Ebers

12-21-89

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>12-12-89</u>	<u>CAB</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>12-12-89</u>	<u>CAB</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>06-22-90</u>	<u>DCS</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>12-21-89</u>	<u>CAB</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 C. Allison Bailey 12-22-89

C. Allison Bailey

D. Charles Lytle 06-22-90

D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1187
Lower
LOCATION: WAG-2

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 6/18/90

TIME: _____

DEVELOPMENT
ENDING DATE: 6/22/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 64.1 GALLONS

TOTAL GALLONS PUMPED: 1006 TOTAL WELL VOLUMES PUMPED: 15.7

INITIAL pH: 9.6 FINAL pH: 9.5

INITIAL CONDUCTIVITY ($\mu S/cm$): 845 FINAL CONDUCTIVITY ($\mu S/cm$): 880

DESCRIPTION OF INITIAL TURBIDITY: Slightly cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 5.0 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR
OF WATER: None

WATER
DISCHARGED
TO:

☒ GROUND SURFACE
☐ STORM SEWERS
☐ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 10.3 feet below ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle 6/22/90
D. Charles Lytle

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 64.1 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
6-19-90	1130	380	Slightly Cloudy	--	9.6	845	380	6.0	
6-19-90	1300	76	Slightly Cloudy	--	9.5	853	456	7.1	
6-22-90	1400	550	Clear	5.0	9.5	880	1006	15.7	
RESULTS AT END OF DEVELOPMENT			Clear	5.0	9.5	880	1006	15.7	

COMMENTS	Fast recharger and good producer. The well was passed with 5.0 NTU's and moved to another hole.
----------	---

OBSERVER SIGNATURE/DATE D. Charles Lytle 6-22-90
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.: 1187

DATE OF TEST: 10-15-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: L. WAG-2

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 = 74.50 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 1.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING, "0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

2.3695
2.3761

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.460	2.460
20.00	3.450	2.450
30.00	3.410	2.410
40.00	3.400	2.400
50.00	3.390	2.390
60.00	3.370	2.370
75.00	3.350	2.350
90.00	3.310	2.310
105.00	3.290	2.290
120.00	3.290	2.290
150.00	3.230	2.230
180.00	3.210	2.210
240.00	3.140	2.140
300.00	3.070	2.070
360.00	3.000	2.000
420.00	2.910	1.910
480.00	2.860	1.860
540.00	2.790	1.790
600.00	2.730	1.730
720.00	2.630	1.630
840.00	2.560	1.560
960.00	2.520	1.520
1080.00	2.430	1.430
1200.00	2.370	1.370
1320.00	2.300	1.300
1440.00	2.250	1.250
1560.00	2.200	1.200
1680.00	2.150	1.150
1800.00	2.090	1.090
1920.00	2.070	1.070
2040.00	2.040	1.040
2160.00	1.990	.990

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.57\text{E-}06$ FT/SEC = $4.78\text{E-}05$ CM/SEC

TRANSMISSIVITY = $2.35\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.82\text{E-}06$ FT/SEC = $5.55\text{E-}05$ CM/SEC

TRANSMISSIVITY = $2.73\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

**SAMPLE
NUMBER**

118751

WELL NO.

1187

LOCATION:

Lower Wing - 2

TYPE:

E: Sold 1/1/81

SAMPLER:

SAMPLE INTERVAL:

DATE: _____

TIME:

(SIGNATURE)

20-32

10 72 2

RELINQUISHED BY:
(SIGNATURE)

DATE: _____

TIME:

WTH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WTH:

7000.00 + 60

01-1540

1500

EDGE

Chris

1-1590

1570

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:

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

1187WD1

WELL NO.

1187

LOCATION:

LOWER Waq Z

TYPE:

DRILL WATER

SAMPLER:

(SIGNATURE)

SAMPLE INTERVAL:

DATE:

12/20/89

TIME:

1400

RELINQUISHED BY:
(SIGNATURE)

DATE:

1/16/90

TIME:

0950

WITH:

ERC/EDGE

RECEIVED BY:
(SIGNATURE)

DATE:

1-16-90

TIME:

0950

WITH:

M M I

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 1188 is located in Lower WAG 2. It is located on the south side of White Oak Lake, approximately 1000 feet east of White Oak Dam. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N15170.5132, E24267.2241 (X-10 grid) or latitude 35°-54'-02.21" and longitude 84°-19'-22.92". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 1188 was drilled by Geotek Engineering Company. An Ingersoll-Rand T-4 Air Rotary 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 December 12, 1989, and was finished on January 5, 1990. 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.

- 12-12-89 The rig and equipment were decontaminated and mobilized to the site. Plastic was layed down and the rig set up. A 14.0" auger was used to auger to 3.0' for the purpose of setting a diverter casing. Auger became difficult at 3.0' due to some type of obstruction in the borehole.
- 12-13-89 The 14.0" borehole was completed to a depth of 4.0' and a 10.0" diverter was set.
- 01-03-90 The Ingersoll-Rand T-4 and equipment were decontaminated, mobilized to the site and set up. An 8-inch boring was drilled to a depth of 16.5' with a tricone bit. The boring was cleaned and after a 30 minute recharge, 8.5' of water was measured. The boring was then completed to a total depth of 27.5'. A drill water sample and an air sample were taken. After the rods were removed, it was noted that a lot of debris such as wooden timbers and plastic were protruding into the annulus just below the diverter casing at 5.0'. Water is also running into the annulus at 5.0'. R.C. Williams stated that this area was a former site of a mud pit used for a nearby well.
- 01-04-90 The two-inch stainless steel casing and screen were set to a total depth of 27.26'. Sand was poured to a total depth of 13.98'. A bentonite seal was poured to a depth of 11.45'.
- 01-05-90 The remaining annulus was grouted using 2.0 bags of cement and 5% bentonite.

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

Lower WAG 2 includes White Oak Creek, White Oak Lake and one of its feeder streams, the embayment between White Oak Dam and the Clinch River, and all adjacent floodplains. Lower WAG 2 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. Lower WAG 2 is underlain by two members of the Conasauga Group. These members are the Maryville Limestone and the Nolichucky Shale. The Maryville Limestone consists of intraclastic limestone conglomerate interbedded with calcareous mudstone, siltstone, and coarse grained limestone. The Nolichucky Shale is

composed of coarse grained limestone, mudstone, siltstone, and shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The average strikes and dips appears to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

A drill water sample was collected from the water pump on the drill rig on January 3, 1990. Analytical results for the sample described above can be obtained from the Remedial Action Program data base at ORNL.

The Ingersoll-Rand T-4 air rotary rig's compressed air was sampled with a cloth filter inserted between drill rods on January 3, 1990. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter indicated no evidence 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 4.0 feet and a 10.0-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 4.0 to 27.5 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 27.26 to 17.02 feet. A 2-inch diameter stainless steel casing was installed above the screen at 17.02 feet and extended 2.3 feet above ground surface. A sandpack was then tremied into the annular space from 27.26 to 13.98 feet, with a 2.53-foot

bentonite pellet seal poured into the annular space above the sandpack from 13.98 to 11.45 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 1188 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 111 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 4.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on June 26, 1990, at a depth of 25.63' 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 1188 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 2.99×10^{-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

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>12-12-89</u>	<u>CAB</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>12-12-89</u>	<u>CAB</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>01-04-89</u>	<u>CAB</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>12-12-89</u>	<u>CAB</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>12-12-89</u>	<u>CAB</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>12-13-89</u>	<u>CAB</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>01-03-89</u>	<u>CAB</u>

RESULTS: No hydrocarbons detected under ultraviolet light

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

C. Allison Bailey
C. Allison Bailey

01-04-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1188

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

C. Allison Bailey
C. Allison Bailey

12-12-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1188

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: Lower WAG-2
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersoll Rand T-4

DATE: START: 12-12-89
FINISH: 01-04-90
LOGGED BY: C. Allison Bailey
HEALTH PHYSICIST: Carl Stooksbury
L.C. Johnson

TYPE DRILLING: Auger, Air Rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: None TYPE: None
CONTAINMENT TYPE: Plastic, Pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 7.5'
DEPTH DRILLED IN ROCK: 20.0'
TOTAL DEPTH OF WELL: 27.5'

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 01-03-89
#1188W01

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	2.5			Clay, light brown and moderate brown, slightly shaley. Contains roots and gravel. Firm, soft moist
2.5	4.0			Shale, highly weathered, grayish red to reddish brown. Thin beds. Dry. Brittle
	4.0			Auger refusal (not on rock).
				* This area is noted as being a former site of a mud pit for a nearby well. All this material is fill.
4.0	7.0			* Hard drilling
7.0	8.0			Soft, fast drilling
8.0	10.0			Hard, fast drilling
10.0	10.5			Soft, fast drilling
10.5	11.0			Hard drilling
11.0	13.0			Soft drilling
13.0	16.5			Hard, slow drilling
16.5	18.0			Soft, fast drilling
18.0	26.0			Hard, slow drilling
26.0	27.5			* Soft, fast drilling.
	27.5			Total Depth

WELL No. 1188

ORNL MONITORING WELL LOG

PAGE 2 OF 2

* No detailed lithologic log could be
provided from 4.0 - 27.5' due to use of
containment box

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

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

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter **HELPER:** Fred Dixon

EQUIPMENT

☒ 14.0 INCH AUGER 4.0 L.F.

☐ _____ INCH AUGER _____ L.F.

☒ 8.0 INCH ROTARY 23.5 L.F.

MATERIALS USED

EST. VOL.	USED VOL.
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
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91	91
92	92
93	93
94	94
95	95
96	96
97	97
98	98
99	99
100	100

<u>10</u>	FEET OF <u>2.0</u> IN. S.S. SCREEN
<u>20.0</u>	FEET OF <u>2.0</u> IN. S.S. CASING
<u>4.5</u> <u>5.0</u>	SACKS OF SAND
<u>50.0</u> <u>50.0</u>	POUNDS OF BENTONITE PELLETS
<u>1.9</u> <u>2.0</u>	SACKS OF CEMENT
<u>10.0</u>	POUNDS OF POWDERED BENTONITE
<u>16.0</u>	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED
VOLUMES AND USED VOLUMES
Spillage

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

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 25.63 FEET.

CENTRALIZERS AT 15.0 **FEET.**
25.0 **FEET.**
 _____ **FEET.**

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

HOLE CLEANED OUT
TO 27.26 FEET -
BOTTOM OF BOREHOLE
27.5 FEET

LOCATION Lower WAG-2
ORNL GRID COORDINATES
N 15,170.5132
E 24,267.2241
ELEV. GROUND 755.87
ELEV. TOP STAINLESS
STEEL CASING 758.04
DRILLING DATES:
STARTED: 12-12-89
FINISHED: 01-04-90

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

CONCRETE PAD
10.0 INCH DVERTER
CASING 0.0 FT. ABOVE
GROUND SURFACE TO
4.0 FT. BELOW GROUND
SURFACE

14.0 INCH BOREHOLE
0.0 TO 4.0 FEET

GROUT SEAL 0.0 TO
- 11.45 FEET

8.0 INCH DIAMETER
BOREHOLE

2.0 INCH DIAMETER STAINLESS
- STEEL CASING 2.17 FT. ABOVE
GROUND SURFACE TO 17.02 FT.
BELOW GROUND SURFACE

— BENTONITE PELLET SEAL
11.45 TO 13.98 FEET

SAND PACK
-13.98 TO 27.26 FEET

2.0 INCH DIAMETER
STAINLESS STEEL 0.010

17.02 ^{SLOTTED SCREEN} TO 27.02 FEET

2.0 INCH DIAMETER STAINLESS
STEEL SILT TRAP/CAP
27.02 TO 27.26 FEET

NOT TO SCALE

TYPE D WELL

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1188

DATE: 01-03-90

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
<u>SAND</u>	<u>01-03-90</u>	<u>1</u>
<u>BENTONITE</u>	<u>01-03-90</u>	<u>1</u>
<u>STAINLESS STEEL SCREEN</u> (PREPACKAGED ☒ YES ☐ NO)	<u>01-03-90</u>	<u>2</u>
<u>STAINLESS STEEL CASING</u> (PREPACKAGED ☒ YES ☐ NO)	<u>01-03-90</u>	<u>2</u>
<u>STAINLESS STEEL CENTRALIZERS</u> (PREPACKAGED ☒ YES ☐ NO)	<u>01-03-90</u>	<u>2</u>
<u>STAINLESS STEEL CAPS</u> (PREPACKAGED ☒ YES ☐ NO)	<u>01-03-90</u>	<u>2</u>
<u>MONITORING WELL PUMP</u> (PREPACKAGED ☒ YES ☐ NO)	<u>06-26-90</u>	<u>7</u>
<u>GROUT</u>	<u>01-04-90</u>	<u>3</u>
<u>WELL COVERS</u>	<u>01-03-90</u>	<u>2</u>
<u>SURFACE CASING</u>		

COMMENTS:

OBSERVER SIGNATURE/DATE C. Allison Bailey 01-04-90
C. Allison Bailey

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>12-13-89</u>	<u>CAB</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>12-13-89</u>	<u>CAB</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>06-26-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>01-04-90</u>	<u>CAB</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 C. Allison Bailey 01-04-90
C. Allison Bailey

D. Charles Lytle 06-26-90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1188
Lower
LOCATION WAG-2

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 6-25-90

TIME: _____

DEVELOPMENT
ENDING DATE: 6-26-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 8.4 GALLONS

TOTAL GALLONS PUMPED: 111 TOTAL WELL VOLUMES PUMPED: 13.2

INITIAL pH: 8.6 FINAL pH: 8.2

INITIAL CONDUCTIVITY ($\mu S/cm$): 755 FINAL CONDUCTIVITY ($\mu S/cm$): 730

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 4.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR
OF WATER: None

WATER
DISCHARGED
TO:

☒ GROUND SURFACE
☐ STORM SEWERS
☐ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER _____

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

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle 6/26/90
D. Charles Lytle

HYDROLOG

ONE WELL VOLUME = 8.4 GALLONS

COMMENTS Good producer and fast recovery well. The well was passed with 4.0 NTU's and moved to another hole.

INFORMOS.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.: 1188

DATE OF TEST: 10-15-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: L. WAG-2

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 18.10 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 1.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING, "0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

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

SUCCESSIVE COMPUTED
VALUES FOR H₀
(FEET)

3.3776
3.4090

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.870	3.870
20.00	4.780	3.780
30.00	4.680	3.680
40.00	4.630	3.630
50.00	4.560	3.560
60.00	4.470	3.470
75.00	4.390	3.390
90.00	4.310	3.310
105.00	4.220	3.220
120.00	4.150	3.150
150.00	3.990	2.990
180.00	3.850	2.850
240.00	3.630	2.630
300.00	3.390	2.390
360.00	3.210	2.210
420.00	3.050	2.050
480.00	2.920	1.920
540.00	2.760	1.760
600.00	2.660	1.660
720.00	2.470	1.470
840.00	2.320	1.320
960.00	2.190	1.190
1080.00	2.080	1.080
1200.00	1.980	.980
1320.00	1.890	.890
1440.00	1.820	.820
1560.00	1.760	.760
1680.00	1.700	.700
1800.00	1.660	.660
1920.00	1.600	.600
2040.00	1.580	.580
2160.00	1.540	.540

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $9.82\text{E-}07$ FT/SEC = $2.99\text{E-}05$ CM/SEC

TRANSMISSIVITY = $9.82\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.38\text{E-}06$ FT/SEC = $4.20\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.38\text{E-}05$ 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

1188601

WELL NO.

1188

LOCATION:

Lawrenceburg

TYPE:

Drill Under

SAMPLER:

Core

SAMPLE INTERVAL:

N/A

DATE:

01-03-90

TIME:

1613

RELINQUISHED BY:
(SIGNATURE)

Core

DATE:

01-15-90

TIME:

1500

WITH:

EDS

RECEIVED BY:
(SIGNATURE)

Core

DATE:

1-15-90

TIME:

1500

WITH:

1/1/1

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 1189 is located in Lower WAG 2. It is located approximately 100 feet south of White Oak Dam on Highway 95. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N15146.7840, E23280.9455 (X-10 grid) or latitude 35°-53'-56.59" and longitude 84°-19'-32.72". 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 1189 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4 air rotary rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter with the assistance of Fred Dixon, Tom Doonan, and Tracy Mitchell. Drilling commenced on April 30, 1990, and was finished on May 1, 1990. 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.

04-30-90 This location was determined to be Class II. The rig was moved to location and set up on plastic. Split Spoon samples were taken from surface to refusal at 6.6 feet. No RAD was detected over background; therefore, location was downgraded to Class I. The boring was reamed with 14.0 inch auger to refusal at 6.6 feet. A 10.0 inch string of decontaminated steel diverter casing was set and grouted with 5.0 sacks cement.

05-01-90 Drilled from 6.6 feet to 27.5 feet using an 8.0 inch air rotary tricone bit into containment box. Set 2.0 inch stainless steel well screen and casing with sand pack and bentonite seal. Grouted annulus with 2.0 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

Lower WAG 2 includes White Oak Creek, White Oak Lake and one of its feeder streams, the embayment between White Oak Dam and the Clinch River, and all adjacent floodplains. Lower WAG 2 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. Lower WAG 2 is underlain by two members of the Conasauga Group. These members are the Maryville Limestone and the Nolichucky Shale. The Maryville Limestone consists of intraclastic limestone conglomerate interbedded with calcareous mudstone, siltstone, and coarse grained limestone. The Nolichucky Shale is composed of coarse grained limestone, mudstone, siltstone, and shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The average strikes and dips appears to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

No samples were collected during drilling.

A bulk density soil sample was collected from the split spoon sample interval from 3.4' to 3.7'. The sample was measured and weighed, and a bulk density of 2.15 grams/cm³ was calculated.

The Ingersoll-Rand T-4 air rotary rig's compressed air was sampled with a cloth filter inserted between drill rods on May 1, 1990. The sample was examined with an ultraviolet

light for the presence of hydrocarbons. The filter showed no signs of hydrocarbons.

2.4 Installation and Development

2.4.1 Installation

This was a Type D well. A 6-inch diameter boring was split spooned/augered from ground surface to auger refusal (7.3 feet). The air rotary method was required to complete the boring to the specified total well depth. Therefore, a 14.0- inch diameter boring was augered from ground surface to 6.6 feet and a 10.0-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 6.6 to 27.5 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 12.3 to 27.5 feet. A 2-inch diameter stainless steel casing was installed above the screen at 12.3 feet and extended 2.7 feet above ground surface. A sandpack was then tremied into the annular space from 10.1 to 27.5 feet, with a 1.7-foot bentonite pellet seal poured into the annular space above the sandpack from 8.4 to 10.1 feet. The annular space from the top of the bentonite seal to the surface was tremie-grouted with a cement/bentonite slurry. A detail of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 1189 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 310 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 July 18, 1990, at a depth of 25.24' 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 1189 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 1.44×10^{-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>4-30-90</u>	<u>TJm</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>4-30-90</u>	<u>TJm</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>5-1-90</u>	<u>TJm</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>4-30-90</u>	<u>TJm</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>4-30-90</u>	<u>TJm</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>4-30-90</u>	<u>TJm</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>5-1-90</u>	<u>TJm</u>

RESULTS: No detectable signs of hydrocarbons under ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

5/1/90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1189

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Timothy A. Lee 4/30/90
Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1189

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: Lower WAG-2 (White Oak Dam)

DATE: START: 4-30-90

DRILLER: Larry Ledbetter

FINISH: 5-1-90

HELPER: Tom Doonan, Fred Dixon

LOGGED BY: Timothy A. Lee

DRILL: Ingersoll Rand T-4

HEALTH PHYSICIST: C.E. Stooksbury

TYPE DRILLING: Split Spoon, Auger, Air
Rotary

LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: None

TYPE: None

CONTAINMENT TYPE: Plastic, Pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 7.3'

DRILLING FLUID SAMPLES:

DEPTH DRILLED IN ROCK: 20.2'

TYPE: N/A DATE: N/A

TOTAL DEPTH OF WELL: 27.5'

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	0.3		100%	Clay, grayish brown, moist, vegetation
0.3	0.6		100%	Gravel fill, dry
0.6	2.0		100%	Clay, dry, mottled pale yellowish brown and dark yellowish orange, scattered limestone gravel fragments
2.0	4.0		100%	Clay and shale, dry, crumbly, mottled moderate yellowish brown and dark yellowish orange. Bulk density taken from 3.4' to 3.7' is 2.15g/cm ³
4.0	4.6		75%	Clay and shale, moist, crumbly mottled moderate brown and dark yellowish orange, iron stains
4.6	5.0		75%	Clay, moist, plastic, dark yellowish orange, black streaks, iron stains
5.0	6.0		75%	Shale, moderate yellowish brown, dry, crumbly, scattered large fragments of limestone, medium crystalline, oolitic light olive gray
6.0	6.6		100%	Shale, pale yellowish brown, dry, crumbly, (RAD ~ background)

[illegible]

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED

BY: Timothy A. Lee

PROOFED

BY: Michael L. Ebers

DRILLING COMPANY: Geotek

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

LOCATION: WAG-2

ORNL GRID COORDINATES

N 15.146.7840

E 23.280.9455

ELEV. GROUND 758.51

ELEV. TOP STAINLESS

STEEL CASING 760.77

DRILLING DATES:

STARTED: 4-30-90

FINISHED: 5-1-90

EQUIPMENT

■ 14.0 INCH AUGER 6.6 L.F.

□ INCH AUGER L.F.

■ 8.0 INCH ROTARY 20.9 L.F.

MATERIALS USED

EST. USED

VOL. VOL.

15.0 FEET OF 2.0 IN. S.S. SCREEN

15.0 FEET OF 2.0 IN. S.S. CASING

4.8 7.0 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

1.5 2.0 SACKS OF CEMENT

10.0 POUNDS OF POWDERED BENTONITE

16.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED
VOLUMES AND USED VOLUMES

Fractures and spillage

WELL COVER USED

■ LOCKING STEEL COVER
□ FLUSH MOUNTED WELL COVER
□ OTHER

SILT TRAP USED

YES ■ NO □

MONITORING WELL PUMP BASE SET AT 25.24 FEET.

CENTRALIZERS AT 8.0 FEET.

26.0 FEET.

FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT

TO 27.5 FEET

BOTTOM OF BOREHOLE

27.5 FEET

LOCKING STEEL COVER

8 INCH DIAMETER

STEEL PROTECTIVE CASING

3.07 FT. ABOVE GROUND

TO 2.0 FT. BELOW

GROUND SURFACE

CONCRETE PAD

10.0 INCH DIVERTER

CASING 0.5 FT. ABOVE

GROUND SURFACE TO

6.5 FT. BELOW GROUND

SURFACE

14.0 INCH BOREHOLE

0.0 TO 6.6 FEET

GROUT SEAL 0.0 TO

8.4 FEET

8.0 INCH DIAMETER

BOREHOLE

2.0 INCH DIAMETER STAINLESS

STEEL CASING 2.26 FT. ABOVE

GROUND SURFACE TO 12.3 FT.

BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL

8.4 TO 10.1 FEET

SAND PACK

10.1 TO 27.5 FEET

2.0 INCH DIAMETER

STAINLESS STEEL 0.010

SLOTTED SCREEN

12.3 TO 27.3 FEET

2.0 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP

27.3 TO 27.5 FEET

TYPE D WELL

NOT TO SCALE

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND				
			5-1-90	2
BENTONITE	Pellets		5-1-90	1
	Powder		5-1-90	6
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	5-1-90	4
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	5-1-90	4
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	5-1-90	4
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	5-1-90	4
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	7-18-90	7
GROUT				
			5-1-90	8
WELL COVERS				
SURFACE CASING			N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee 5-1-90
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>5-1-90</u>	<u>TPL</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>5-1-90</u>	<u>TPL</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>7-18-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>5-1-90</u>	<u>TPL</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

5-1-90

Timothy A. Lee

D. Charles Lytle

7-18-90

D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1189
LOCATION: Lower WAG-2

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 7/12/90 TIME: _____

DEVELOPMENT
ENDING DATE: 7/18/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 9.7 GALLONS

TOTAL GALLONS PUMPED: 310 TOTAL WELL VOLUMES PUMPED: 31.9

INITIAL pH: 8.3 FINAL pH: 7.9

INITIAL CONDUCTIVITY ($\mu S/cm$): 815 FINAL CONDUCTIVITY ($\mu S/cm$): 808

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 5.0 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR
OF WATER: None

WATER
DISCHARGED TO: ☒ GROUND SURFACE
☐ STORM SEWERS
☐ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER _____

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

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 7-18-90
D. Charles Lytle

WELL NO. 1189
Lower
LOCATION: WAG-2
DATE: 7/12/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 9.7 GALLONS

COMMENTS	Good producer and fast recharger. Water cleared and remained clear even after surging. Passed with 5.0 NTU's and 31.9 well volumes
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OBSERVER SIGNATURE/DATE D. Charles Lytle 7-18-90
D. Charles Lytle/

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

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

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

WELL NO.: 1189

DATE OF TEST: 10-2-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: LOWER WAG-2

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 = 12.00 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)

10.1643
10.2888

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
5.00	12.980	11.980
10.00	12.130	11.130
15.00	11.240	10.240
20.00	10.600	9.600
25.00	10.000	9.000
30.00	9.330	8.330
35.00	8.780	7.780
40.00	8.310	7.310
45.00	7.840	6.840
50.00	7.460	6.460
55.00	7.090	6.090
60.00	6.760	5.760
65.00	6.490	5.490
70.00	6.210	5.210
75.00	6.000	5.000
80.00	5.790	4.790
85.00	5.610	4.610
90.00	5.460	4.460
95.00	5.340	4.340
100.00	5.240	4.240
105.00	5.150	4.150
110.00	5.060	4.060
115.00	5.000	4.000
120.00	4.910	3.910
125.00	4.850	3.850
130.00	4.760	3.760
135.00	4.690	3.690
140.00	4.630	3.630
145.00	4.560	3.560
150.00	4.530	3.530
155.00	4.460	3.460
160.00	4.440	3.440

1221-M.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $4.74\text{E-}06$ FT/SEC = $1.44\text{E-}04$ CM/SEC

TRANSMISSIVITY = $7.11\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $6.80\text{E-}06$ FT/SEC = $2.07\text{E-}04$ CM/SEC

TRANSMISSIVITY = $1.02\text{E-}04$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 1190 is located in Lower WAG 2. It is located on White Oak Dam. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N15358.2218, E23384.3602 (X-10 grid) or latitude 35°-53'-58.90" and longitude 84°-19'-33.10". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 1190 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4 air rotary rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter with the assistance of Fred Dixon, Tom Doonan, and Tracy Mitchell. Drilling commenced on May 2, 1990, and was finished on May 10, 1990. 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.

- 05-02-90 This location was determined to be a Class II. The rig was moved to location and set up on plastic sheeting. Split Spoon samples were taken from surface to refusal at 14.0 feet. The 6 inch auger refusal at 14.0 feet also. Since all other holes on the dam refused from 25.0 to 30.0 feet, decision was made to skid rig 5.0 feet to south and redrill hole. Split Spoon refusal in second hole was 29.1 feet. Reamed hole to 10.0 feet with 22 inch auger.
- 05-03-90 Reamed hole to refusal at 10.0 feet with 22 inch auger. Attempted to get deeper than 10.0 feet by using a 14.0 inch auger. 14.0 inch auger through obstruction at 14.0 to 16.0 feet. Set 13.8 feet of 16 inch decontaminated steel diverter casing and grouted it to surface with 31 sacks of cement.
- 05-04-90 Deepen boring from 14.0 feet to 31.0 feet using a 14.0 inch auger (RAD = 50 cpm over background, OVA <0.05 ppm). Last 3.0 feet was very hard and took most of the day.
- 05-07-90 Set 31.0 feet of 10.0 inch decontaminated steel surface casing and grouted annulus with 45 sacks of cement. Grout did not circulate to surface.
- 05-08-90 Grouted casing annulus to surface with 7 more sacks cement.
- 05-10-90 Drill from 31.0 feet to 47.5 feet using an 8.0 inch air rotary tricone bit into containment box. Set 4.0 inch stainless steel screen and casing with sandpack and bentonite pellet seal.
- 05-11-90 Grout well casing 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

Lower WAG 2 includes White Oak Creek, White Oak Lake and one of its feeder streams, the embayment between White Oak Dam and the Clinch River, and all adjacent floodplains. Lower WAG 2 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. Lower WAG 2 is underlain by two members of the Conasauga Group. These members are the Maryville Limestone and the Nolichucky Shale. The Maryville Limestone consists of intraclastic limestone conglomerate interbedded with calcareous mudstone, siltstone, and coarse grained limestone. The Nolichucky Shale is

composed of coarse grained limestone, mudstone, siltstone, and shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The average strikes and dips appears to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

No samples were collected during drilling.

A bulk density soil sample was collected from the split spoon sample interval from 3.5' to 3.8'. The sample was measured and weighed, and a bulk density of 2.19 grams/cm³ was calculated.

The Ingersoll-Rand T-4 air rotary rig's compressed air was sampled with a cloth filter inserted between drill rods on May 10, 1990. 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 14.0 feet. A 15 1/4-inch diverter casing was installed from surface to 13.8 feet below ground surface and grouted in place. A 14.0-inch diameter boring was augered from 14.0 feet to 31.0 feet (auger refusal). A 10.0-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 31.0 feet, sealed with a 1.0-foot bentonite pellet layer from 30.0 feet

to 31.0 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 47.5 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 37.2 feet to 47.4 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 37.2 feet and extended 2.8 feet above ground surface. A sandpack was then tremied into the annular space from 33.8 to 47.4 feet, with a 2.0-foot bentonite pellet seal poured into the annular space above the sandpack from 31.8 to 33.8 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 1190 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 199 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 July 12, 1990, at a depth of 45.47 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 1190 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 1.39×10^{-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>5-2-90</u>	<u>TJz</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>5-2-90</u>	<u>TJz</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>5-10-90</u>	<u>TJz</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>5-2-90</u>	<u>TJz</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>5-2-90</u>	<u>TJz</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>5-2-90</u>	<u>TJz</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>5-10-90</u>	<u>TJz</u>

RESULTS: There were no detectable hydrocarbons under
ultraviolet light

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 5-8-90
Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1190

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

5-2-90

Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1190

ORNL MONITORING WELL LOG

PAGE 1 OF 3

LOCATION: Lower WAG-2 (White Oak Dam)

DATE: START: 5-2-90

DRILLER: Larry Ledbetter

FINISH: 5-10-90

HELPER: Fred Dixon, Tom Doonan

LOGGED BY: Timothy A. Lee

DRILL: Ingersoll Rand T-4

HEALTH PHYSICIST: Jerry Gray/
C.E. Stooksbury

TYPE DRILLING: Split spoon, Auger, Air LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: Rotary None TYPE: N/A

CONTAINMENT TYPE: Plastic, pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 31.0'

DRILLING FLUID SAMPLES:

DEPTH DRILLED IN ROCK: 16.5'

TYPE: N/A DATE: N/A

TOTAL DEPTH OF WELL: 47.5'

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	1.0		Augered	Gravel fill and asphalt
1.0	3.0		60%	Clay, moist, mottled light brown and dark yellowish orange, plastic, black streaks (fill dirt?) (RAD ~ background)
3.0	5.0		60%	Clay, moist, mottled light brown and dark yellowish orange, plastic, black streaks (fill dirt?) Bulk density taken from 3.5' to 3.8' is 2.19g/cm ³ (RAD background)
5.0	7.0		100%	Clay, moist, mottled light brown and dark yellowish orange, plastic, black streaks (fill dirt?)
7.0	9.0		40%	Clay, moist, mottled light brown and dark yellowish orange, plastic, black streaks, (fill dirt?) (RAD ~ background)
9.0	9.8		50%	Clay, moist, mottled light brown and dark yellowish orange, plastic, black streaks (fill dirt?) (RAD ~ background)
9.8	11.0		50%	Clay, wet, moderate yellowish brown scattered fragments of olive gray, limestone medium grained

ORNL MONITORING WELL LOG

PAGE 2 OF 3

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
11.0	12.0		60%	Clay, dripping wet, mottled moderate yellowish brown and dark yellowish orange, sandy, scattered fragments of chert (RAD = 50 cpm over background)
12.0	13.0		60%	Clay, dripping wet, dark yellowish orange, abundant fragments of gravel sized chert, fragments of pale olive sandstone, medium grained (RAD = 75 cpm over background)
13.0	14.0		10%	Clay, very dripping wet, light brown, silty, fragments of chert (RAD = 30 cpm over background)
	14.0			1st split spoon refusal
14.0	14.5		Augered	Limestone, medium grained, fragments
14.5	18.0		0%	Clay, wet, light olive gray, plastic sandy, scattered pale green siltstone fragments, scattered vegetation (RAD ~ background)
18.0	18.8		100%	Clay, dripping wet, moderate yellowish brown, scattered chert fragments (from above?)
18.8	20.0		100%	Clay, moist, plastic and sticky, light olive gray; scattered pale green siltstone fragments of blackened vegetation.
20.0	22.0		100%	Clay, light olive gray, plastic, moist scattered fragments of vegetation (RAD ~ background)
22.0	23.0		60%	Clay, dripping wet, moderate yellowish brown, scattered chert fragments
23.0	23.8		60%	Clay, light olive gray, sandy scattered pale green siltstone, scattered

ORNL MONITORING WELL LOG

PAGE 3 OF 3

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
				vegetation
23.8	24.0		60%	Chert fragments, glauconitic sand fragments, pale green siltstone
24.0	25.0		50%	Clay, light olive gray, sandy, wet
25.0	26.0		50%	Chert fragments, glauconitic sand, pale green siltstone
26.0	27.0		25%	Chert fragments, dripping wet, glauconitic sand, pale green siltstone
27.0	27.5		25%	Shale and siltstone, reddish brown, calcite veins
27.5	28.0		25%	Siltstone, pale green
28.0	28.7		100%	Clay, olive gray, dripping wet, scattered chert fragments, glauconitic sand
28.7	29.1		100%	Shale and siltstone, pale green and reddish brown, calcite veins, dry crumbly .
	29.1			2nd split spoon refusal
	29.1			6" auger refusal
29.1	31.0			Shale, hard
	31.0			14" auger refusal
31.0	32.0			* Limestone hard
32.0	37.0			* Shale softer
37.0	40.0			* Limestone hard
40.0	41.5			* Shale softer
41.5	44.0			* Limestone hard
44.0	46.5			* Shale softer
46.5	47.5			* Limestone hard
	47.5			Total Depth
				* No detailed lithologic descriptions available from 31.0 to 47.5 feet due to the use of containment box

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED

PROOFED

BY: Timothy A. Lee

BY: Timothy A. Lee

DRILLING COMPANY: Geotek

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

DRILLING METHOD: ☒ 22 INCH AUGER 14.0 L.F.
☒ 14 INCH AUGER 17.0 L.F.
☐ INCH ROTARY L.F.
☒ 8 INCH ROTARY 16.5 L.F.

MATERIALS USED

EST. USED VOL. VOL.
50.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
31.0 FT. OF 10 IN. SURFACE CASING
8.2 45.0 SACKS OF CEMENT (SURFACE CASING)
225.0 POUNDS OF POWERED BENTONITE (SURFACE CASING)
360.0 GALLONS OF WATER (SURFACE CASING)
40.0 FT. OF 4.0 IN. DIA. STAINLESS STEEL CASING
10.0 FT. OF 4.0 IN. DIA. STAINLESS STEEL SCREEN
2.8 4.0 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
5.5 7.0 SACKS OF CEMENT (WELL CASING)
35.0 POUNDS OF POWERED BENTONITE (WELL CASING)
56.0 GALLONS OF WATER (WELL CASING)
3.92 FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and spillage

SURFACE CASING TREME GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREME GROUTED YES ☒ NO ☐

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

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 45.47 FEET.

CENTRALIZERS AT 6.0 FEET.
26.0 FEET.
46.0 FEET.

NOTE:

ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

LOCATION: L. WAG-2
ORNL GRID COORDINATES
N 15,358.2218
E 23,384.3602
ELEV. GROUND 755.19
ELEV. TOP STAINLESS STEEL CASING 757.92
DRILLING DATES:
STARTED: 5-2-90
FINISHED: 5-10-90

TYPE B WELL

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1190

DATE: 5-10-90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL	DATE USED	BATCH NUMBER
SAND	5-10-90	2
BENTONITE Pellets	5-10-90	1
Powder	5-11-90	7
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	5-10-90	3
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	5-10-90	3
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	5-10-90	4
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	5-10-90	4
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	7-12-90	7
GROUT Surface Casing	5-7-90	8
Well Casing	5-11-90	9
WELL COVERS		
SURFACE CASING	5-7-90	5

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

5-10-90

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>5-11-90</u>	<u>Tbz</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>5-11-90</u>	<u>Tbz</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>7-12-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>5-11-90</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

5-11-90

Timothy A. Lee

D. Charles Lytle

7-12-90

D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1190
Lower
LOCATION: WAG-2

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 7/12/90

TIME:

DEVELOPMENT
ENDING DATE: 7/12/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 32.7 GALLONS

TOTAL GALLONS PUMPED: 199 TOTAL WELL VOLUMES PUMPED: 6.1

INITIAL pH: 8.5 FINAL pH: 8.5

INITIAL CONDUCTIVITY ($\mu\text{S}/\text{cm}$): 792 FINAL CONDUCTIVITY ($\mu\text{S}/\text{cm}$): 792

DESCRIPTION OF INITIAL TURBIDITY: Clear

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 5.0 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR
OF WATER: None

WATER
DISCHARGED
TO:

☐ GROUND SURFACE
☐ STORM SEWERS
☒ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 11.3 feet below ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle 7-12-90
D. Charles Lytle

ONE WELL VOLUME = 32.7 GALLONS

COMMENTS Very fast recharger and made lots of water. Passed well with 5.0 NTU's and 6.1 well volumes

MWF08105.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
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"A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY
OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY
PENETRATING WELLS")

WELL NO.: 1190

DATE OF TEST: 9-24-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: LOWER WAG-2

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 = 35.90 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. TIME

SUCCESSIVE COMPUTED
VALUES FOR H₀
(FEET)

2.3081
2.3388

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.730	2.730
20.00	3.660	2.660
30.00	3.590	2.590
40.00	3.550	2.550
50.00	3.490	2.490
60.00	3.430	2.430
75.00	3.360	2.360
90.00	3.290	2.290
105.00	3.210	2.210
120.00	3.140	2.140
150.00	3.050	2.050
180.00	2.940	1.940
240.00	2.750	1.750
300.00	2.600	1.600
360.00	2.480	1.480
420.00	2.360	1.360
480.00	2.260	1.260
540.00	2.190	1.190
600.00	2.100	1.100
720.00	1.950	.950
840.00	1.840	.840
960.00	1.760	.760
1080.00	1.710	.710
1200.00	1.660	.660
1320.00	1.590	.590
1440.00	1.580	.580
1560.00	1.510	.510
1680.00	1.460	.460
1800.00	1.430	.430
1920.00	1.390	.390
2040.00	1.390	.390
2160.00	1.390	.390

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $4.57\text{E-}06$ FT/SEC = $1.39\text{E-}04$ CM/SEC

TRANSMISSIVITY = $4.57\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $5.42\text{E-}06$ FT/SEC = $1.65\text{E-}04$ CM/SEC

TRANSMISSIVITY = $5.42\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 1191 is located in Lower WAG 2. It is located on White Oak Dam. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N15373.8313, E23387.9774 (X-10 grid) or latitude 35°-53'-59.05" and longitude 84°-19'-33.17". 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 1191 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4 air rotary rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter with the assistance of Fred Dixon, Tom Doonan, and Tracy Mitchell. Drilling commenced on May 10, 1990, and was finished on May 14, 1990. 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.

- 05-10-90 The location was determined to be a Class II. Auger to refusal at 10.5 feet using a 6 inch auger.
- 05-11-90 Reamed hole to 10.5 feet using a 22 inch auger. Set 9.6 feet of 16 inch decontaminated steel diverter casing and grout annulus to surface with 16 sacks cement.
- 05-14-90 Drill from 10.5 to 15.0 feet using a 14 inch air rotary tricone bit into containment box. Augered from 15.0 to 26.2 feet with a 12 inch auger. Set 2 inch stainless steel screen and casing with sand pack and bentonite seal. (No RAD detected throughout drilling operations; however, location remains Class II due to suspected RAD.)
- 05-15-90 Grout well casing annulus with 6.0 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

Lower WAG 2 includes White Oak Creek, White Oak Lake and one of its feeder streams, the embayment between White Oak Dam and the Clinch River, and all adjacent floodplains. Lower WAG 2 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. Lower WAG 2 is underlain by two members of the Conasauga Group. These members are the Maryville Limestone and the Nolichucky Shale. The Maryville Limestone consists of intraclastic limestone conglomerate interbedded with calcareous mudstone, siltstone, and coarse grained limestone. The Nolichucky Shale is composed of coarse grained limestone, mudstone, siltstone, and shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The average strikes and dips appears to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

No samples were collected during drilling.

The Ingersoll-Rand T-4 air rotary rig's compressed air was sampled with a cloth filter inserted between drill rods on May 14, 1990. 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 6-inch diameter boring was augered from ground surface to auger refusal (10.5 feet). The air rotary method was required to complete the boring to the specified total well depth. Therefore, a 22.0-inch diameter boring was augered from ground surface to 10.5 feet and a 16-inch diverter casing was installed and grouted. A 14.0-inch diameter boring was then drilled with an air rotary tricone roller bit from 10.5 to 15.0 feet through the rock obstruction. A 12-inch diameter boring was augered from 15.0 feet to auger refusal at 26.2 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 15.8 to 26.0 feet. A 2-inch diameter stainless steel casing was installed above the screen at 15.8 feet and extended 4.2 feet above ground surface. A sandpack was then tremied into the annular space from 12.5 to 26.0 feet, with a 1.7-foot bentonite pellet seal poured into the annular space above the sandpack from 10.8 to 12.5 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 1191 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 310 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 July 13, 1990, at a depth of 26.16 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 1191 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 2.51×10^{-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

1. EXCAVATION PERMIT OBTAINED

DATE

INITIALS

5-10-90

Tbz

2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.

5-10-90

Tbz

3a. SCREEN AND CASING HAVE BEEN WASHED, STEAMED,
RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED
WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE
COVERING AND STORED OFF THE GROUND.

N/A

N/A

3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS
WERE USED.

5-14-90

Tbz

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

5-10-90

Tbz

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

5-10-90

Tbz

6. POLYETHYLENE COVER IN PLACE OVER HOLE.

5-10-90

Tbz

7. AIR ROTARY COMPRESSED AIR SAMPLED.

5-14-90

Tbz

RESULTS: Showed no detectable hydrocarbons under ultraviolet light

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee

5-14-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1191

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

5-10-90

WELL No. 1191

PAGE 1 OF 1

DATE: START: 5-10-90
FINISH: 5-14-90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: C.E. Stooksbury

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

THICKNESS OF SOIL (REFUSAL DEPTH): 26.2'

DEPTH DRILLED IN ROCK: 4.5'

TOTAL DEPTH OF WELL: 26.2'

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

[illegible]

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED

PROOFED

BY: Timothy A. Lee

BY: Timothy A. Lee

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter

HELPER: Fred Dixon, Tom Doonan
Tracy Mitchell

LOCATION Lower WAG-2

ORNL GRID COORDINATES

N 15,373.8313

E 23,387.9774

ELEV. GROUND 755.17

ELEV. TOP STAINLESS

STEEL CASING 758.11

DRILLING DATES:

STARTED: 5-10-90

FINISHED: 5-14-90

EQUIPMENT

■ 22.0 INCH AUGER 10.5 L.F.

■ 12.0 INCH AUGER 11.2 L.F.

■ 14.0 INCH ROTARY 4.5 L.F.

MATERIALS USED

EST. USED

VOL. VOL.

10.0 FEET OF 2.0 IN. S.S. SCREEN

20.0 FEET OF 2.0 IN. S.S. CASING

9.4 12.0 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

4.5 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 and spillage

WELL COVER USED

■ LOCKING STEEL COVER
□ FLUSH MOUNTED WELL COVER
□ OTHER

SILT TRAP USED

YES ■ NO □

MONITORING WELL PUMP BASE SET AT 26.16 FEET.

CENTRALIZERS AT 7.0 FEET.

25.0 FEET.

 FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT

TO 26.0 FEET

BOTTOM OF BOREHOLE

26.2 FEET

TYPE D WELL

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1191

DATE: 5-14-90

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	5-14-90	2
BENTONITE	5-14-90	1
Pellets	5-15-90	7
Powder		
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	5-14-90	5
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	5-14-90	5
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	5-14-90	5
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	5-14-90	5
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	7-13-90	7
GROUT	5-15-90	9
WELL COVERS		
SURFACE CASING	N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee 5-14-90
Timothy A. Lee

ERCE
Environmental
and Energy
Services Co.

WELL No. 1191
Lower
LOCATION: WAG-2

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 7/12/90

TIME: _____

DEVELOPMENT
ENDING DATE: 7/13/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 8.4 GALLONS

TOTAL GALLONS PUMPED: 310 TOTAL WELL VOLUMES PUMPED: 37.0

INITIAL pH: 8.1 FINAL pH: 7.8

INITIAL CONDUCTIVITY ($\mu S/cm$): 648 FINAL CONDUCTIVITY ($\mu S/cm$): 617

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Cloudy

FINAL MEASURED TURBIDITY: > 100 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR
OF WATER: None

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

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 10.9 feet below ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 7-13-90
D. Charles Lytle

DATE/TIME

WELL NO. 1191
Lower
LOCATION: WAG-2
DATE: 7/12/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 8.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (U.S./cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
7-12-90	1100	110	Cloudy	--	8.1	648	110	13.1	
7-12-90	1330	67	Slightly Muddy	--	7.9	644	177	21.1	
7-12-90	1500	33	Muddy	--	8.1	628	200	25.0	
7-13-90	0930	100	Cloudy	*	7.8	617	310	37.0	
RESULTS AT END OF DEVELOPMENT			Cloudy	*	7.8	617	310	37.0	

COMMENTS Very fast recharger and excellent producer. Passed with 37.0 well volumes. Water would not clean up; remains cloudy.

* > 100 NTU's

OBSERVER SIGNATURE/DATE D. Charles Lytle 7-13-90
D. Charles Lytle

MWEDM05.DWG

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>5-15-90</u>	<u>Tbz</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>5-15-90</u>	<u>Tbz</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>7-13-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>5-15-90</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 5-15-90
Timothy A. Lee

D. Charles Lytle 7-13-90
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.: 1191

DATE OF TEST: 10-1-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: LOWER WAG-2

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 = 12.00 INCHES
 LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
 DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 15.42 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. TIME

SUCCESSIVE COMPUTED
 VALUES FOR H0
 (FEET)

.6842
 .6872

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
5.00	2.900	1.900
10.00	1.840	.840
15.00	1.610	.610
20.00	1.560	.560
25.00	1.460	.460
30.00	1.480	.480
35.00	1.410	.410
40.00	1.390	.390
45.00	1.400	.400
50.00	1.350	.350
55.00	1.350	.350
60.00	1.330	.330
65.00	1.330	.330
70.00	1.290	.290
75.00	1.310	.310
80.00	1.280	.280
85.00	1.280	.280
90.00	1.240	.240
95.00	1.260	.260
100.00	1.240	.240
105.00	1.250	.250
110.00	1.210	.210
115.00	1.210	.210
120.00	1.210	.210
125.00	1.250	.250
130.00	1.210	.210
135.00	1.230	.230
140.00	1.190	.190
145.00	1.210	.210
150.00	1.190	.190
155.00	1.200	.200
160.00	1.160	.160

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $8.24\text{E-}06$ FT/SEC = $2.51\text{E-}04$ CM/SEC

TRANSMISSIVITY = $8.24\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.32\text{E-}05$ FT/SEC = $4.04\text{E-}04$ CM/SEC

TRANSMISSIVITY = $1.32\text{E-}04$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 1192 is located in Lower WAG 2. It is located just north of White Oak Dam. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N15542.3847, E23358.3925 (X-10 grid) or latitude 35°-54'-00.27" and longitude 84°-19'-34.61". 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 1192 was drilled by Geotek Engineering Company. An ATV Mobile drill rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter with the assistance of Fred Dixon, Tom Doonan, Tracy Mitchell. Drilling commenced on May 23, 1990, and was finished on May 23, 1990. 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.

05-23-90 The rig was moved to location and set up on plastic sheeting. Split spoon samples were taken from surface to refusal at 13.7 feet. The boring was augered to auger refusal at 19.0 feet using 6 inch augers. The hole was reamed to 18.8 feet using 12 inch augers. Set 2 inch stainless steel screen and casing with sandpack and bentonite seal.

05-24-90 Grout annulus with 2.0 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

Lower WAG 2 includes White Oak Creek, White Oak Lake and one of its feeder streams, the embayment between White Oak Dam and the Clinch River, and all adjacent floodplains. Lower WAG 2 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. Lower WAG 2 is underlain by two members of the Conasauga Group. These members are the Maryville Limestone and the Nolichucky Shale. The Maryville Limestone consists of intraclastic limestone conglomerate interbedded with calcareous mudstone, siltstone, and coarse grained limestone. The Nolichucky Shale is composed of coarse grained limestone, mudstone, siltstone, and shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The average strikes and dips appears to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

No samples were collected during drilling.

A bulk density soil sample was collected from the split spoon sample interval from 0.2' to 0.5'. The sample was measured and weighed, and a bulk density of 2.10 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

19.0 feet. A 12-inch diameter boring was augered from ground surface to 18.8 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed through twelve inch augers from 7.8 feet to 18.0 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 7.0 to 18.0 feet, with a 1.1-foot bentonite pellet seal poured into the annular space above the sandpack from 5.9 to 7.0 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 1192 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 239 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 September 18, 1990, at a depth of 17.08 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 1192 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 5.68×10^{-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>5-23-90</u>	<u>Tmz</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>5-23-90</u>	<u>Tmz</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>5-23-90</u>	<u>Tmz</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>5-23-90</u>	<u>Tmz</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>5-23-90</u>	<u>Tmz</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>5-23-90</u>	<u>Tmz</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>N/A</u>	<u>N/A</u>

RESULTS: N/A

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 5-23-90

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 7-22-90

Timothy A. Lee

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and Energy
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WELL No. 1192

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: Lower WAG-2
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: ATV Mobile Drill

DATE: START: 5-23-90
FINISH: 5-23-90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: C.E. Stooksbury

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

THICKNESS OF SOIL (REFUSAL DEPTH): 18.8'
DEPTH DRILLED IN ROCK: 0.0'
TOTAL DEPTH OF WELL: 18.8'

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	0.2		95%	Clay, dark yellowish brown, moist, scattered vegetation
0.2	0.5		95%	Clay, light brown, plastic, moist, roots, Bulk density taken from 0.2' to 0.5' is 2.10g/cm ³
0.5	2.0		95%	Clay, shaley, mottled dark yellowish orange and light brown, dry, crumbly
2.0	4.0		90%	Clay, shaley, mottled dark yellowish orange and light brown, dry, crumbly, silty
4.0	6.0		75%	Clay, shaley, mottled dark yellowish orange and moderate yellowish brown, silty, dry crumbly
6.0	8.0		75%	Clay, shaley, mottled, dark yellowish orange moderate yellowish brown and grayish orange silty, dry, crumbly
8.0	10.0		75%	Clay, shaley, mottled dark yellowish orange, grayish orange and moderate yellowish brown moist, plastic
10.0	11.0		60%	Clay, very moist, mottled dark yellowish orange and moderate yellowish brown, silty.
11.0	11.8		60%	Shale, dry, crumbly, moderate yellowish brown

PAGE 2 OF 2

PAGE 9 OF 17.

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WELL No. 1192

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED

PROOFED

BY: Timothy A. Lee

BY: Timothy A. Lee

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter

Fred Dixon, Tom Doonan
HELPER: Tracy Mitchell

EQUIPMENT ☒ 12.0 INCH AUGER 18.8 L.F.

☐ _____ INCH AUGER _____ L.F.

MATERIALS USED

EST. USED
VOL. VOL.

10.0 FEET OF 2 IN. S.S. SCREEN

10.0 FEET OF 2 IN. S.S. CASING

4.2 6.5 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

1.8 2.0 SACKS OF CEMENT

10.0 POUNDS OF POWDERED BENTONITE

16.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED
VOLUMES AND USED VOLUMES

Fractures and spillages

WELL COVER USED

☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED

YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 17.08 FEET.

CENTRALIZERS AT 2.0 FEET.

18.0 FEET.

_____ FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT
TO 18.0 FEET

BOTTOM OF BOREHOLE

18.8 FEET

LOCATION Lower WAG-2

ORNL GRID COORDINATES

N 15,542.3847

E 23,358.3925

ELEV. GROUND 756.48

ELEV. TOP STAINLESS

STEEL CASING 758.52

DRILLING DATES:

STARTED: 5-23-90

FINISHED: 5-23-90

LOCKING STEEL COVER

8 INCH DIAMETER

STEEL PROTECTIVE CASING

2.64 FT. ABOVE GROUND

TO 2.0 FT. BELOW

GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO

5.9 FEET

12 INCH DIAMETER

BOREHOLE

2 INCH DIAMETER STAINLESS

STEEL CASING 2.04 FT. ABOVE

GROUND SURFACE TO 7.8 FT.

BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL

5.9 TO 7.0 FEET

SAND PACK

7.0 TO 18.8 FEET

2 INCH DIAMETER

STAINLESS STEEL 0.010

SLOTTED SCREEN

7.8 TO 17.8 FEET

2 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP

17.8 TO 18.0 FEET

NOT TO SCALE

TYPE A WELL

ERC / EDGE
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WELL No. 1192

DATE: 5-23-90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL	DATE USED	BATCH NUMBER
SAND	5-23-90	2
BENTONITE	5-23-90	1
Pellets	5-24-90	7
Powder		
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	5-23-90	5
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	5-23-90	5
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	5-23-90	5
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	5-23-90	5
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	9-18-90	7
GROUT	5-24-90	9
WELL COVERS		
SURFACE CASING	N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

5-23-90

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>5-23-90</u>	<u>TML</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>5-23-90</u>	<u>TML</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>9-18-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>5-23-90</u>	<u>TML</u>

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

OBSERVER SIGNATURE/DATE Timothy A. Lee 5-23-90
Timothy A. Lee

D. Charles Lytle 9-18-90
D. Charles Lytle

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF

DEVELOPMENT: Surging and pumping

DEVELOPMENT

BEGAN DATE: 7/18/90

TIME:

DEVELOPMENT

ENDING DATE: 9/18/90

DEVELOPMENT

OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 7.3 GALLONS

TOTAL GALLONS PUMPED: 239 TOTAL WELL VOLUMES PUMPED: 32.7

INITIAL pH: 8.2

FINAL pH: 8.0

INITIAL CONDUCTIVITY (uS/cm): 567 FINAL CONDUCTIVITY (uS/cm): 508

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Muddy

FINAL MEASURED TURBIDITY: > 100 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR

OF WATER: None

WATER DISCHARGED TO: ☒ GROUND SURFACE

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER

INITIAL PRE-DEVELOPMENT

WATER DEPTH: 13.1 feet below ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 9-18-90

D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1192
Lower
LOCATION: WAG-2

WELL NO. 1192
Lower
LOCATION: WAG-2
DATE: 7-18-90

ONE WELL VOLUME = 7.3 GALLONS

COMMENTS Very poor recharger and producer. The water remains muddy and will not clean up. The well was passed with 32.7 well volumes; moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 9-18-90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

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

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

WELL NO.: 1192

DATE OF TEST: 9-28-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: LOWER WAG-2

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 = 12.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 5.90 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 7.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 0 ("1" IF FALLING, "0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 9

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

SUCCESSIVE COMPUTED VALUES FOR H0 (FEET)

.3247
.2686
.2948
.2885

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	6.780	.220
20.00	6.840	.160
30.00	6.850	.150
40.00	6.890	.110
50.00	6.920	.080
60.00	6.940	.060
75.00	6.960	.040
90.00	6.960	.040
105.00	6.990	.010

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 1.86E-04 FT/SEC = 5.68E-03 CM/SEC

TRANSMISSIVITY = 1.86E-03 FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 4.45E-05 FT/SEC = 1.36E-03 CM/SEC

TRANSMISSIVITY = 4.45E-04 FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

CHANGE IN WATER LEVEL IN FEET

1.0 General Information

1.1 Well Location

Monitoring well number 1193 is located in Lower WAG 2. It is located 100 feet NW of the confluence of White Oak Creek and the Clinch River. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N15021.2055, E21225.9089 (X-10 grid) or latitude 35°-53'-44.26" and longitude 84°-19'-52.62". 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 1193 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4/Schramm Rotadrill air rotary rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter and George Akins with the assistance of Fred Dixon, James Shelton, and Phil Getsi. Drilling commenced on December 14, 1989, and was finished on January 18, 1990. 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.

- 12-14-89 The rig was mobilized to the staked location and set up on plastic sheeting. Split spoon samples were taken from surface to refusal at 35.1 feet. The rig was moved from location.
- 12-19-89 Moved rig over hole. Augered to 33.6 feet with 14 1/2 inch auger and set 33.5 feet of decontaminated 10 3/4 inch steel casing. Moved rig to decon area.
- 12-20-89 Grouted casing annulus with 12 sacks cement.
- 12-21-89 Move rig over hole. Drill from 33.5 feet to 49.7 feet using a 7 7/8 inch tricone air rotary bit into a containment box.
- 12-22-89 Move rig to decon area.
- 01-03-90 Move rig over hole. Blow hole clean to 49.7 feet. Ream hole with 9 1/2 inch air rotary tricone bit to 49.7 feet.
- 01-05-90 Set 49.6 feet of decontaminated 7 inch steel casing and grouted annulus with 23 sacks of cement.
- 01-08-90 Grouted annulus to surface with 6 sacks cement.
- 01-09-90 Drill from 49.6 feet to 84.9 feet using a 5 7/8 inch air rotary tricone bit into containment box.
- 01-18-90 Set 2 inch stainless steel screen and casing with sandpack and bentonite seal.
- 01-19-90 Grouted annulus with 6 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

Lower WAG 2 includes White Oak Creek, White Oak Lake and one of its feeder streams, the embayment between White Oak Dam and the Clinch River, and all adjacent floodplains. Lower WAG 2 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. Lower WAG 2 is underlain by two members of the Conasauga Group. These members are the Maryville Limestone and the Nolichucky Shale. The Maryville Limestone consists of intraclastic limestone conglomerate interbedded with calcareous mudstone, siltstone, and coarse grained limestone. The Nolichucky Shale is composed of coarse grained limestone, mudstone, siltstone, and shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The average strikes and dips appears to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

One soil sample was collected during drilling, placed in an I-CHEM specialty cleaned glass container, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Soil sample 1193S01 was collected in the split spoon interval from 21.0' to 22.0' on December 14, 1989. A drill water sample was collected from the water pump on the drill rig on January 9, 1990. Chain of custody forms for these samples are included with this data package. Analytical results for the two samples described above can be obtained from the Remedial Action Program data base at ORNL.

A bulk density soil sample was collected from the split spoon sample interval from 5.0' to 5.4'. The sample was measured and weighed, and a bulk density of 2.38 grams/cm³ was calculated.

The Schramm Rotadrill compressed air was sampled with a cloth filter inserted between drill rods on January 9, 1990. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable 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 4.0 feet. A 15 1/4-inch diverter casing was installed from surface to 8.0 feet below ground surface and grouted in place. A 14 1/2-inch diameter boring was augered from 8.0 feet to 33.6 feet (auger refusal). A 10 3/4-inch diameter string of decontaminated steel surface

casing was installed from 0.0 feet to 33.5 feet, sealed with a 2.0 foot bentonite pellet layer from 31.5 feet to 33.5 feet, and tremie grouted in place. The boring was then extended past the refusal depth with a 9 1/2-inch air rotary tricone roller bit from 33.6 feet to 49.7 feet. A 7.0-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 49.6 feet and tremie grouted into 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 5 7/8-inch diameter boring to a total depth of 84.9 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 64.6 feet to 84.8 feet. A 2-inch diameter stainless steel casing was installed from the top of the screen at 64.6 feet and extended 2.2 feet above ground surface. A sandpack was then tremied into the annular space from 61.2 to 84.8 feet, with a 4.0-foot bentonite pellet seal poured into the annular space above the sandpack from 57.2 to 61.2 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 1193 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 295 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 July 10, 1990, at a depth of 82.23 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 1193 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously added a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.14×10^{-5} 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>12-14-89</u>	<u>TL</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>12-14-89</u>	<u>TL</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>1-18-90</u>	<u>TL</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>1-18-90</u>	<u>TL</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>12-14-89</u>	<u>TL</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>1-9-90</u>	<u>TL</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>1-9-90</u>	<u>TL</u>

RESULTS: No detectable hydrocarbons were observed under ultraviolet
light

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

1-19-90

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Timothy A. Lee 12-18-89
Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1193

ORNL MONITORING WELL LOG

PAGE 1 OF 3

LOCATION: Lower WAG-2
DRILLER: Larry Ledbetter/George Akins
HELPER: Fred Dixon/James Shelton
DRILL: Ingersoll Rand T-4/Schramm Rotadrill

DATE: START: 12-14-89
FINISH: 1-18-90
LOGGED BY: Allison Bailey/Timothy
A. Lee
HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Split spoon/Auger/Air Rotary LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: one TYPE: Soil

CONTAINMENT TYPE: Plastic, Pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 35.1'

DEPTH DRILLED IN ROCK: 49.9'

TOTAL DEPTH OF WELL: 85.0'

DRILLING FLUID SAMPLES:

TYPE: Water DATE: 1-9-90

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	2.0		75%	Gravel fill
2.0	4.0		100%	Clay, some sand, moderate yellowish brown, soft to firm, damp
4.0	6.0		100%	Clay, some sand, dark yellowish brown, firm, very sandy fine to medium, moist. Bulk density taken from 5.0' to 5.4' = 2.38g/cm ³
6.0	8.0		100%	Clay, moderate yellowish brown to dark yellowish brown, very sandy, moist to wet
8.0	9.5		100%	Clay, some sand, moderate yellowish brown, moist to wet
9.5	10.0		100%	Clay, and sand, moderate yellowish brown, moist to wet, sand grains are medium grained and rounded loose
10.0	12.0		100%	Clay and sand, moderate yellowish brown, wet, sand grains are coarser
12.0	13.3		100%	Clay and sand, moderate yellowish brown, wet, sand is coarse grained
13.3	14.0		100%	Clay and sand, moderate yellowish brown, moister, sand lenses with small quartz fragments; black decayed tree material

ORNL MONITORING WELL LOG

PAGE 2 OF 3

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
14.0	16.0		60%	Clay, some sand, moderate yellowish brown with dusky yellowish brown streaks, soft, wet
16.0	18.0		50%	Clay, some sand, moderate yellowish brown with dusky yellowish brown streaks, soft, wet. Very wet from 16.0' to 17.0'
18.0	20.0		95%	Clay and sand and silt, dark yellowish brown with dusky yellowish brown, sandy streaks, very soft and wet
20.0	22.0	1193S01 20.0' to 22.0'	100%	Clay and sand and silt, dark yellowish brown, very soft and wet, very wet from 21.0' to 22.0'
22.0	23.5		100%	Clay and sand and silt, dark yellowish brown, very soft and wet (Gooshy)
23.5	25.5		100%	Clay and sand, moderate yellowish brown, very soft and wet, very wet from 23.5' to 24.0', very sandy at 25.0'
25.5	25.9		100%	Clay and sand, moderate yellowish brown with dusky yellowish brown, sandy, hard, dry to damp
25.9	26.6		100%	Clay and silty sand, light brown, dry to damp
26.6	27.5		100%	Clay and sand, medium gray, firm
27.5	29.5		100%	Clay, medium gray, very sandy, wetter and loose from 27.5' to 28.5', soft
29.5	31.5		100%	Clay, very sandy, medium gray with blue tint, moist firm, sand is medium to coarse grained rounded to subrounded
31.5	33.0		100%	Clay, very sandy, medium gray, moist
33.0	33.5		100%	Sand and clay, very dark gray, quartz pebbles, moist to wet
33.5	35.0		Augered	Soupy, sandy clay
35.0	35.1		100%	Shale, very tight and hard, medium bluish gray to dark gray with bedded quartz veins, scattered oolitic limestone fragments with

PAGE 3 OF 3

PAGE 11 OF 22.

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1193

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Timothy A. Lee PROOFED BY: Timothy A. Lee

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter George Akins HELPER: Fred Dixon/James Shelton

DRILLING METHOD: ☒ 22 INCH AUGER 8.0 L.F.
☒ 14 1/2 INCH AUGER 25.0 L.F.
☒ 9 1/2 INCH ROTARY 16.1 L.F.
☒ 5 7/8 INCH ROTARY 35.3 L.F.

MATERIALS USED

EST. USED VOL. VOL.
25.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
33.5 FT. OF 3 1/4 IN. SURFACE CASING
11.0 12.0 SACKS OF CEMENT (SURFACE CASING)
60.0 POUNDS OF POWERED BENTONITE (SURFACE CASING)
96.0 GALLONS OF WATER (SURFACE CASING)
49.6 FT. OF 7.0 IN. SURFACE CASING
8.0 29.0 SACKS OF CEMENT (SURFACE CASING)
145.0 POUNDS OF POWERED BENTONITE (SURFACE CASING)
232.0 GALLONS OF WATER (SURFACE CASING)
64.6 FT. OF 2 IN. DIA. STAINLESS STEEL CASING
20.0 FT. OF 2 IN. DIA. STAINLESS STEEL SCREEN
3.5 4.0 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
5.3 6.0 SACKS OF CEMENT (WELL CASING)
30.0 POUNDS OF POWERED BENTONITE (WELL CASING)
48.0 GALLONS OF WATER (WELL CASING)
3.05 FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES
AND USED VOLUMES

Fractures and irregular well volumes

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 82.23 FEET.

CENTRALIZERS AT 16.0 FEET.

46.0 FEET.

66.0 FEET.

84.0 FEET.

TYPE B WELL

HOLE CLEANED OUT
TO 84.8 FEET

BOTTOM OF BORE
HOLE 85.0 FEET

LOCATION Lower WAG-2
ORNL GRID COORDINATES
N 15,021.2055
E 21,225.9089
ELEV. GROUND 759.16
ELEV. TOP STAINLESS
STEEL CASING 761.04
DRILLING DATES:
STARTED: 12-14-89
FINISHED: 1-19-90

NOTE:
ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>1-9-90</u>	<u>Tm</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>1-19-90</u>	<u>Tm</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>7-10-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>1-19-90</u>	<u>Tm</u>

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

OBSERVER SIGNATURE/DATE

Timothy A. Lee 1-19-90
Timothy A. Lee

D. Charles Lytle 7-10-90
D. Charles Lytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1193

DATE: 1-18-90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		1-18-90	2
BENTONITE		1-18-90	4
Powder Pellets		1-18-90	1
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	1-18-90	3
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	1-18-90	3
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	1-18-90	2
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	1-18-90	3
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	7-10-90	7
GROUT	7" casing	1-5-90	5
	S.S. casing	12-19-89	5
WELL COVERS			
SURFACE CASING	10 3/4" casing	12-19-89	MMES Stores
	7" casing	1-5-90	MMES Stores

COMMENTS:

OBSERVER SIGNATURE/DATE Timothy A. Lee 1-18-90

Timothy A. Lee

ERCE
Environmental
and Energy
Services Co.

WELL No. 1193
Lower
LOCATION: WAG-2

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 7/9/90

TIME: _____

DEVELOPMENT
ENDING DATE: 7/10/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 60.2 GALLONS

TOTAL GALLONS PUMPED: 295 TOTAL WELL VOLUMES PUMPED: 4.9

INITIAL pH: 10.0 FINAL pH: 9.6

INITIAL CONDUCTIVITY ($\mu S/cm$): 767 FINAL CONDUCTIVITY ($\mu S/cm$): 732

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 5.0 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR
OF WATER: None

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

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 17.4 feet below ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 7-10-90
D. Charles Lytle

WAG-2

DATE: 7-9-90

ONE WELL VOLUME = 60.2 GALLONS

COMMENTS Fair producer. Water cleaned rapidly and well was passed with 5.0 NTU's and 4.9 well volumes

OBSERVER SIGNATURE/DATE D. Charles Lytle 7-10-90
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.: 1193

DATE OF TEST: 9-25-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: LOWER WAG-2

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 = 5.88 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 67.76 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 1.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING, "0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

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

SUCCESSIVE COMPUTED VALUES FOR H0 (FEET)

4.6037
4.6217

1221-40103

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and Energy
Services Co.

WELL No. 1193

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	5.810	4.810
20.00	5.760	4.760
30.00	5.740	4.740
40.00	5.690	4.690
50.00	5.660	4.660
60.00	5.630	4.630
75.00	5.570	4.570
90.00	5.490	4.490
105.00	5.460	4.460
120.00	5.400	4.400
150.00	5.290	4.290
180.00	5.210	4.210
240.00	5.050	4.050
300.00	4.890	3.890
360.00	4.760	3.760
420.00	4.610	3.610
480.00	4.510	3.510
540.00	4.380	3.380
600.00	4.210	3.210
720.00	3.980	2.980
840.00	3.810	2.810
960.00	3.650	2.650
1080.00	3.510	2.510
1200.00	3.380	2.380
1320.00	3.280	2.280
1440.00	3.150	2.150
1560.00	3.050	2.050
1680.00	2.980	1.980
1800.00	2.890	1.890
1920.00	2.830	1.830
2040.00	2.750	1.750
2160.00	2.680	1.680

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $3.74E-07$ FT/SEC = $1.14E-05$ CM/SEC

TRANSMISSIVITY = $7.47E-06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $4.58E-07$ FT/SEC = $1.40E-05$ CM/SEC

TRANSMISSIVITY = $9.17E-06$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

EDGe

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

CHAIN OF CUSTODY RECORD FOR

MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE
NUMBER

117350

WELL NO.

1193

LOCATION:

Lower WAG-2

TYPE:

Soil Sample

SAMPLER:

C. Allen Bailey
(SIGNATURE)

SAMPLE INTERVAL:

20-22.0

DATE:

12-14-89

TIME:

1135

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

C. Allen Bailey

12-15-90

1500

EDGE

J. P. ...

12-15-90

1500

14/14

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

1193wo1

WELL NO. 1193		LOCATION: LOWER WAG 2			TYPE: DRILL WATER		
SAMPLER: <i>Smith G. J.</i> (SIGNATURE)		SAMPLE INTERVAL: N/A			DATE: 1-9-90		TIME: 1220
RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<i>Smith G. J.</i>	1-31-90	1500	ERC	<i>McQuinn</i>	1/31/90	14:55	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 1194 is located in Lower WAG 2. It is located approximately 200 feet north of the confluence of White Oak Creek with the Clinch River. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N15736.1075, E21046.7681 (X-10 grid) or latitude 35°-53'-49.15" and longitude 84°-19'-59.27". 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 1194 was drilled by Geotek Engineering Company. A Schramm Rotadrill/Ingersoll Rand T-4 rig was used to drill this boring for monitor well installation under operation of George Akins and Larry Ledbetter with the assistance of James Shelton and Fred Dixon. Drilling commenced on December 15, 1989, and was finished on February 12, 1990. 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.

- 12-15-89 The rig was moved to the staked location and set up on plastic sheeting. Split Spoon samples were taken from surface to refusal at 31.5 feet. A 22.0 inch auger was used to 8.0 feet and set and grout 8.0 feet of 15 1/4-inch diverter casing. The rig was moved from location.
- 01-02-90 Move rig to location. Augered with 14 1/2-inch auger to refusal at 31.8 feet.
- 01-03-90 Set and grouted 31.6 feet of decontaminated 10 3/4 inch steel casing. Move rig from location.
- 01-10-90 Move rig to location. Drill from 31.8 feet to 50.9 feet using a 9 1/2 inch air rotary tricone bit into a containment box.
- 01-11-90 Set and grout 50.6 feet of decontaminated 7.0 inch steel surface casing.
- 01-12-90 Rig turned over. Pick up rig and move from location.
- 02-05-90 Move rig to location. Drill from 50.9 feet to 97.5 feet using a 6 1/2-inch air rotary tricone bit into a containment box.
- 02-06-90 Move rig from location.
- 02-12-90 Set 2 inch stainless steel casing and screen with sandpack and bentonite seal.
- 02-13-90 Grout stainless steel casing annulus with 12 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

Lower WAG 2 includes White Oak Creek, White Oak Lake and one of its feeder streams, the embayment between White Oak Dam and the Clinch River, and all adjacent floodplains. Lower WAG 2 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. Lower WAG 2 is underlain by two members of the Conasauga Group. These members are the Maryville Limestone and the Nolichucky Shale. The Maryville Limestone consists of intraclastic limestone conglomerate interbedded with calcareous mudstone, siltstone, and coarse grained limestone. The Nolichucky Shale is composed of coarse grained limestone, mudstone, siltstone, and shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The average strikes and dips appears to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

One water sample and three 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 1194S01 was collected in the split spoon interval from 13.0' to 13.5' on December 15, 1989, soil sample 1194S02 was collected in the split spoon interval from 23.0' to 23.5' on December 15, 1989 and soil sample 1194S03 was collected in the split spoon interval from 29.5 to 30.0 feet on December 15, 1989. A drill water sample was collected from the water pump on the drill rig on February 5, 1990. Analytical results for the four samples described above can be obtained from the Remedial Action Program data base at ORNL.

A bulk density soil sample was collected from the split spoon sample interval from 9.0' to 9.3'. The sample was measured and weighed, and a bulk density of 2.31 grams/cm³ was calculated.

The Ingersoll-Rand T-4 air rotary rig's compressed air was sampled with a cloth filter inserted between drill rods on February 5, 1990. 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 4.0 feet. A 15 1/4-inch

diverter casing was installed from surface to 8.0 feet below ground surface and grouted in place. A 14.5-inch diameter boring was augered from 8.0 feet to 31.8 feet (auger refusal). A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 31.8 feet, sealed with a 1.5 foot bentonite pellet layer from 30.3 feet to 31.8 feet, and tremie grouted in place. The boring was then extended past the refusal depth with a 9.5-inch air rotary tricone roller bit from 31.8 feet to 50.9 feet. A 7.0-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 50.6 feet and tremie grouted into 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 6 1/2-inch diameter boring to a total depth of 97.5 feet. A 2-inch diameter stainless steel screen with welded bottom cap was installed from 77.1 feet to 97.3 feet. A 2-inch diameter stainless steel casing was installed from the top of the screen at 77.1 feet and extended 2.9 feet above ground surface. A sandpack was then tremied into the annular space from 73.8 to 97.3 feet, with a 1.6-foot bentonite pellet seal poured into the annular space above the sandpack from 72.2 to 73.8 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 1194 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 2165 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 9/28/90 at a depth of 94.66 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 1194 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 5.29×10^{-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>12-15-89</u>	<u>TBL</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>12-15-89</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>N/A</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>2-12-90</u>	<u>TBL</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>12-15-89</u>	<u>TBL</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>12-15-89</u>	<u>TBL</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>12-15-89</u>	<u>TBL</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>2-5-90</u>	<u>TBL</u>

RESULTS: There were no detectable signs of hydrocarbons under
ultraviolet light

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 2-12-90
Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1194

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

2-12-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1194

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: Lower WAG-2
DRILLER: George Akins/Larry Ledbetter
HELPER: James Shelton/Fred Dixon
DRILL: Schramm Rotadrill/Ingersoll Rand

DATE: START: 12-15-89
FINISH: 2-12-90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: Bill Shinpaugh

TYPE DRILLING: Split spoon, auger, air rotary LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: Three (1194S01, 1194S02 TYPE: Soil

1194S03)
CONTAINMENT TYPE: Plastic, pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 31.5'

DEPTH DRILLED IN ROCK: 66.0'

TOTAL DEPTH OF WELL: 97.5'

DRILLING FLUID SAMPLES:

TYPE: Water DATE: 2-5-90

#1194W01

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	2.0		Augered	Gravel fill
2.0	4.0		100%	Clay, some sand, moderate yellowish brown, dry, loose
4.0	6.0		100%	Clay, some sand, moderate yellowish brown, moist, loose
6.0	8.0		100%	Clay, some sand, moderate yellowish brown, dry loose
8.0	10.0		100%	Clay, some sand, moderate yellowish brown, moist, loose, plastic. Bulk density taken from 9.0' to 9.3'. Bulk density is 2.31g/cm ³
10.0	12.0		100%	Clay, some sand, moderate yellowish brown, moist, plastic
12.0	14.0	1194S01 13.0' to 13.5'	100%	Clay, some sand, moderate yellowish brown, very wet from 13.0' to 13.8', plastic
14.0	16.0		75%	Clay, some sand, moderate yellowish brown, moist, plastic
16.0	18.0		85%	Clay, some sand, moderate yellowish brown, moist to wet (gushy)
18.0	19.0		100%	Clay, some sand, moderate yellowish brown, very wet, very soft

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 10 OF 26

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: George Akins/
Larry Ledbetter

HELPER: James Shelton/Fred Dixon

DRILLING METHOD: ☒ 22.0 INCH AUGER 8.0 L.F.
☒ 14.5 INCH AUGER 24.2 L.F.
☒ 9.5 INCH ROTARY 19.1 L.F.
☒ 6.5 INCH ROTARY 46.6 L.F.

MATERIALS USED

EST. USED
VOL. VOL.
50.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
31.8 FT. OF 3/4 IN. SURFACE CASING
10.0 11.0 SACKS OF CEMENT (SURFACE CASING)
55.0 POUNDS OF POWERED BENTONITE (SURFACE CASING)
88.0 GALLONS OF WATER (SURFACE CASING)
50.6 FT. OF 7.0 IN. SURFACE CASING
7.0 8.0 SACKS OF CEMENT (SURFACE CASING)
40.0 POUNDS OF POWERED BENTONITE (SURFACE CASING)
64.0 GALLONS OF WATER (SURFACE CASING)
77.1 FT. OF 2 IN. DIA. STAINLESS STEEL CASING
20.0 FT. OF 2 IN. DIA. STAINLESS STEEL SCREEN
3.5 5.0 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
10.0 12.0 SACKS OF CEMENT (WELL CASING)
60.0 POUNDS OF POWERED BENTONITE (WELL CASING)
96.0 GALLONS OF WATER (WELL CASING)
3.08 FT. OF 10 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 94.66 FEET.

CENTRALIZERS AT 15.0 FEET.

35.0 FEET
55.0 FEET
75.0 FEET

95.0 FEET.

HOLE CLEANED OUT
TO 97.3 FEET

BOTTOM OF BORE
HOLE 97.5 FEET

TYPE B WELL

LOCATION Lower WAG-2
ORNL GRID COORDINATES
N 15,736.1075

E 21,046.7681

ELEV. GROUND 757.10

ELEV. TOP STAINLESS

STEEL CASING 759.44

DRILLING DATES:

STARTED: 12-15-89

FINISHED: 2-12-90

NOTE:
ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No1194

DATE: 2-12-90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			2-12-90	2
BENTONITE Powder Pellets			2-13-90	5
			2-12-90	1
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	2-12-90	3
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	2-12-90	3
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	2-12-90	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	2-12-90	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO		7
GROUT 7" surface casing S.S. well casing			1-11-90	5
			2-13-90	6
WELL COVERS				
SURFACE CASING 7" casing			1-11-90	MMES Stores

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

2-12-90

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>2-12-90</u>	<u>Tbz</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>2-12-90</u>	<u>Tbz</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>9-28-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>2-12-90</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

2-12-90

Timothy A. Lee

D. Charles Lytle

9-28-90

D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1194

LOCATION: LWAG 2

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 06-27-90

TIME: _____

DEVELOPMENT
ENDING DATE: 09-28-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 72.4 GALLONS

TOTAL GALLONS PUMPED: 2165 TOTAL WELL VOLUMES PUMPED: 30.0

INITIAL pH: 9.9 FINAL pH: 10.1

INITIAL CONDUCTIVITY ($\mu\text{S}/\text{cm}$): 553 FINAL CONDUCTIVITY ($\mu\text{S}/\text{cm}$): 825

DESCRIPTION OF INITIAL TURBIDITY: Very Cloudy

DESCRIPTION OF FINAL TURBIDITY: Very Cloudy

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: 10.9 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 09-28-90

D. Charles Lytle

DATE

ERCE
Environmental
and Energy
Services Co.

WELL NO. 1194

LOCATION: LWAG 2

DATE: 06-27-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 72.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
06-27-90	1130	20	Very Cloudy	---	9.9	553	20		
06-28-90	1300	35	"	---	10.0	553	55		
06-29-90	0930	13	"	---	9.5	916	68		
07-02-90	0830	10	"	---	9.7	871	78	1.1	
07-02-90	1300	30	"	---	9.7	935	108	1.5	
07-09-90	1030	13	"	---	9.9	937	121	1.7	
07-09-90	1300	7	"	---	9.9	940	128	1.8	
07-09-90	1400	12	"	---	9.8	984	140	1.9	
07-10-90	1100	40	"	---	9.8	982	180	2.5	
07-10-90	1400	20	"	---	9.8	946	200	2.8	
07-12-90	0900	12	"	---	10.1	952	212	2.9	
07-12-90	1100	24	"	---	9.5	890	236	3.3	
07-12-90	1330	16	"	---	9.5	904	252	3.5	
07-13-90	0830	55	"	---	9.6	872	307	4.2	
07-13-90	1300	28	"	---	9.7	840	335	4.6	
07-13-90	1400	32	"	---	9.9	849	367	5.1	
07-16-90	1000	53	"	---	9.8	911	420	5.8	
RESULTS AT END OF DEVELOPMENT									

COMMENTS

OBSERVER SIGNATURE/DATE

M:\FORMS.DWG

ERCE
Environmental
and Energy
Services Co.

WELL NO. 1194

LOCATION: LWAG 2

DATE: 06-27-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 72.4 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
07-16-90	1430	35	Very Cloudy	---	9.8	935	455	6.3	
07-17-90	1100	40	"	---	9.9	933	495	6.8	
07-18-90	0900	35	"	---	9.9	918	530	7.3	
07-18-90	1415	50	"	---	9.9	897	580	8.0	
07-23-90	1300	61	"	---	9.8	975	641	8.8	
07-24-90	1430	30	"	---	9.8	941	671	9.2	
07-26-90	1400	43	"	---	9.9	893	714	9.9	
08-01-90	1030	107	"	---	9.9	---	821	11.3	
08-01-90	1400	42	"	---	9.9	---	863	11.9	
08-02-90	1330	86	"	---	9.8	790	949	13.1	
08-03-90	1330	60	"	---	9.8	828	1009	14.0	
08-06-90	1315	260	"	---	10.0	846	1269	17.5	
08-09-90	1100	40	"	---	9.9	842	1309	18.1	
08-10-90	1400	60	"	---	9.9	789	1369	19.0	
09-04-90	1430	174	"	---	9.9	---	1543	21.3	
09-05-90	0800	40	"	---	10.0	946	1583	21.9	
09-05-90	0930	20	"	---	10.3	838	1603	22.1	
RESULTS AT END OF DEVELOPMENT									

COMMENTS

OBSERVER SIGNATURE/DATE

HWFORM06.DWG

ERCE
Environmental
and Energy
Services Co.

WELL NO. 1194

LOCATION: INAG 2

DATE: 06-27-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 72.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
09-06-90	1000	24	Very Cloudy	---	10.1	784	1627	22.5	
09-07-90	1300	10	"	---	10.1	879	1637	22.6	
09-07-90	1400	10	"	---	10.3	426	1647	22.7	
09-10-90	1030	18	"	---	10.2	835	1665	23.0	
09-10-90	1430	13	"	---	10.1	828	1678	23.1	
09-12-90	1430	30	"	---	10.0	895	1708	23.6	
09-13-90	1000	20	"	---	10.1	833	1728	23.9	
09-14-90	1400	30	"	---	10.1	898	1758	24.3	
09-17-90	0800	10	"	---	10.3	792	1768	24.4	
09-17-90	1000	22	"	---	10.1	810	1790	24.7	
09-17-90	1300	10	"	---	10.1	807	1800	24.8	
09-18-90	1300	20	"	---	10.2	847	1820	25.1	
09-19-90	1300	30	"	---	10.1	822	1850	25.6	
09-19-90	1400	10	"	---	10.1	792	1860	25.7	
09-20-90	1300	12	"	---	10.2	847	1872	25.8	
09-21-90	1400	28	"	---	10.2	845	1900	26.2	
09-24-90	1300	37	"	---	10.3	812	1937	26.8	
RESULTS AT END OF DEVELOPMENT									

COMMENTS

OBSERVER SIGNATURE/DATE

INFORMOS.DWG

DATE: 06-27-90

ONE WELL VOLUME = 72.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (U.S./cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
09-24-90	1400	37	Very Cloudy	---	10.1	857	1974	27.3	
09-25-90	1400	26	"	---	10.1	885	2000	27.6	
09-26-90	1000	10	"	---	10.2	780	2010	27.8	
09-26-90	1400	40	"	---	10.1	844	2050	28.3	
09-27-90	1400	55	"	---	10.1	898	2105	29.1	
09-28-90	0800	60	"	---	10.1	825	2164	30.0	
RESULTS AT END OF DEVELOPMENT			Very Cloudy	>100NTU's	10.1	825	2164	30.0	

COMMENTS Good recharger and producer. Water will not clear up. We tried washing well but it did not work. Pumped well until 30.0 well volumes produced. Passed and moved off of hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 09-28-90
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.: 1194

DATE OF TEST: 10-1-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: LOWER WAG-2

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 = 6.50 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 83.68 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 1.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING, "0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

5.3038
5.3109

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	6.400	5.400
20.00	6.380	5.380
30.00	6.360	5.360
40.00	6.340	5.340
50.00	6.310	5.310
60.00	6.300	5.300
75.00	6.280	5.280
90.00	6.250	5.250
105.00	6.220	5.220
120.00	6.180	5.180
150.00	6.140	5.140
180.00	6.100	5.100
240.00	5.990	4.990
300.00	5.890	4.890
360.00	5.840	4.840
420.00	5.750	4.750
480.00	5.660	4.660
540.00	5.600	4.600
600.00	5.510	4.510
720.00	5.360	4.360
840.00	5.240	4.240
960.00	5.130	4.130
1080.00	5.010	4.010
1200.00	4.910	3.910
1320.00	4.830	3.830
1440.00	4.750	3.750
1560.00	4.680	3.680
1680.00	4.600	3.600
1800.00	4.520	3.520
1920.00	4.430	3.430
2040.00	4.370	3.370
2160.00	4.290	3.290

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.74\text{E-}07$ FT/SEC = $5.29\text{E-}06$ CM/SEC

TRANSMISSIVITY = $3.47\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $2.17\text{E-}07$ FT/SEC = $6.61\text{E-}06$ CM/SEC

TRANSMISSIVITY = $4.34\text{E-}06$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

ED|Ge

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

1194501

WELL NO. 1194		LOCATION: LOWER WAG 2		TYPE: SOIL			
SAMPLER: <i>Smith G. Orr</i> (SIGNATURE)		SAMPLE INTERVAL: 13.0' to 13.5'		DATE: 12-15-89		TIME: 1145	
RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<i>Smith G. Orr</i>	12/19/89	1245	ERC	JHS	12/19/89	12:44	

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: _____

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

1194502

WELL NO.

1194

LOCATION:

Lower WAG 2

TYPE:

Soil

SAMPLER:

Jim O'Neil

(SIGNATURE)

SAMPLE INTERVAL:

23.0' to 23.5'

DATE:

12-15-89

TIME:

1205

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Jim O'Neil

12/19/89

1245

ERC

JNS

12/19/89

12:44

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 Mississippi Parkway
P.O. Box 23010 Knoxville, TN 37933-1010

MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

CHAIN OF CUSTODY RECORD

FOR

SAMPLE NUMBER

1194503

WELL NO.

1194

LOCATION:

WAG 2

TYPE:

Soil

SAMPLER:

James G. Jr.

SAMPLE INTERVAL:

29.5' to 30.0'

DATE:

12-15-89

TIME:

1325

RELINQUISHED BY:

James G. Jr.

DATE:

12/19/90

TIME:

1500

WITH:

ERC

RECEIVED BY:

James G. Jr.

DATE:

12/19/90

TIME:

1500

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

REMARKS:

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

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

1194w01

WELL NO. 1194 LOCATION: LOWER WAS 2 TYPE: DRILL WATER

SAMPLER: *Timothy A. Smith* (SIGNATURE) SAMPLE INTERVAL: N/A DATE: 2-5-90 TIME: 1450

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<i>Timothy A. Smith</i>			ERC				

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 1195 is located in Lower WAG 2. It is located 100' north of the confluence of White Oak Creek and the Clinch River. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N15716.8821, E21043.6320 (X-10 grid) or latitude 35°-53'-48.97" and longitude 84°-19'-59.17". 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 1195 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4 air rotary rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter with the assistance of Fred Dixon. Drilling commenced and was finished on February 6, 1990. 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.

02-06-90 The rig was mobilized to location and set up on plastic sheeting. The boring was augered to 32.0 feet with a 6 inch auger. Stainless steel well casing and screen was set with sandpack and bentonite seal. The rig was moved from location.

02-07-90 The well casing was grouted 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

Lower WAG 2 includes White Oak Creek, White Oak Lake and one of its feeder streams, the embayment between White Oak Dam and the Clinch River, and all adjacent floodplains. Lower WAG 2 is located in Melton Valley which is in the Valley and Ridge

Physiographic Province of East Tennessee. Lower WAG 2 is underlain by two members of the Conasauga Group. These members are the Maryville Limestone and the Nolichucky Shale. The Maryville Limestone consists of intraclastic limestone conglomerate interbedded with calcareous mudstone, siltstone, and coarse grained limestone. The Nolichucky Shale is composed of coarse grained limestone, mudstone, siltstone, and shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The average strikes and dips appears to be consistent with the regional strike of 56° northeast and dips of about 30° to the southeast.

2.3 Sample Collection

No samples were collected during drilling.

2.4 Installation and Development

2.4.1 Installation

This was a Type A well. A 6-inch diameter boring was augered from ground surface to a total depth of 32.0 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 16.2 feet to 31.4 feet. A 2-inch diameter stainless steel casing was installed above the screen from 16.2 feet to 2.2 feet above ground surface. A sandpack was then tremied into the annular space from 12.9 to 31.4 feet, with a 1.2-foot bentonite pellet seal poured into the annular space above the sandpack from 11.7 to 12.9 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 1195 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 657 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 July 24, 1990, at a depth of 29.34 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 1195 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 2.51×10^{-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

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

RESULTS: N/A

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 2-6-90
Timothy A. Lee

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Timothy A. Lee 2-6-90
Timothy A. Lee

PAGE 1 OF 1

DATE: START: 2-6-90
FINISH: 2-6-90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: Carl Stooksbury

THICKNESS OF SOIL (REFUSAL DEPTH): 32.0'

DEPTH DRILLED IN ROCK: 0.0'

TOTAL DEPTH OF WELL: 32.0'

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

PAGE 8 OF 18

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No 1195

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 32.0 L.F.

☐ _____ INCH AUGER _____ L.F.

MATERIALS USED

EST. USED
VOL. VOL.

15.0 FEET OF 2 IN. S.S. SCREEN

16.2 FEET OF 2 IN. S.S. CASING

2.5 9.5 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

1.0 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 29.34 FEET.

CENTRALIZERS AT 15.0 FEET.

31.0 FEET.

_____ FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

MOLE CLEANED OUT
TO 31.4 FEET

BOTTOM OF BOREHOLE
32.0 FEET

LOCATION Lower WAG-2

ORNL GRID COORDINATES

N 15,716.8821

E 21,043.6320

ELEV. GROUND 756.95

ELEV. TOP STAINLESS

STEEL CASING 758.61

DRILLING DATES:

STARTED: 2-6-90

FINISHED: 2-6-90

LOCKING STEEL COVER

8 INCH DIAMETER

STEEL PROTECTIVE CASING

3.19 FT. ABOVE GROUND

TO 2.0 FT. BELOW

GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO

11.7 FEET

TYPE A WELL

NOT TO SCALE

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			N/A	N/A
			2-5-90	2
BENTONITE	Pellets		2-5-90	1
	Powder		2-6-90	4
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	2-5-90	2&3
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	2-5-90	3
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	2-5-90	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	2-5-90	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	7-24-90	7
GROUT			2-6-90	5
			N/A	N/A
WELL COVERS				
SURFACE CASING			N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee

2-6-90

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>2-6-90</u>	<u>Tms</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>2-6-90</u>	<u>Tms</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>7-24-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>2-6-90</u>	<u>Tms</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 2-6-90
Timothy A. Lee

D. Charles Lytle 7-24-90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1195
Lower
LOCATION: WAG-2

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 7/2/90

TIME: _____

DEVELOPMENT
ENDING DATE: 7/24/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 22.0 GALLONS

TOTAL GALLONS PUMPED: 675 TOTAL WELL VOLUMES PUMPED: 30.0

INITIAL pH: 9.2 FINAL pH: 8.5

INITIAL CONDUCTIVITY ($\mu S/cm$): 366 FINAL CONDUCTIVITY ($\mu S/cm$): 373

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Cloudy

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: 12.2 feet below ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 7-24-90

D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL NO. 1195
Lower
LOCATION: WAG-2
DATE: 7-2-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 22.0 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
7-2-90	0830	4	Muddy	--	9.2	366	4		
7-2-90	1300	26	Cloudy	--	8.7	378	30	1.3	
7-9-90	0900	13	Cloudy	--	8.6	343	43	2.0	
7-9-90	1030	29	Cloudy	--	8.5	348	72	3.1	
7-9-90	1300	33	Muddy	--	8.1	349	105	4.8	
7-9-90	1430	19	Muddy	--	8.1	389	124	5.6	
7-10-90	0930	7	Muddy	--	8.0	326	131	6.0	
7-10-90	1100	10	Milky	--	8.2	349	141	6.4	
7-10-90	1300	20	Cloudy	--	8.1	348	161	7.3	
7-12-90	0900	6	Milky	--	8.4	339	167	7.6	
7-12-90	1100	16	Milky	--	8.5	317	183	8.3	
7-12-90	1330	18	Milky	--	8.6	341	201	9.1	
7-13-90	0830	45	Milky	--	8.2	317	246	11.2	
7-13-90	1300	34	Milky	--	8.1	326	280	12.7	
7-13-90	1400	52	Milky	--	8.0	304	332	15.1	
7-16-90	1430	55	Milky	--	8.3	369	387	17.6	
7-17-90	1100	40	Cloudy	--	8.0	347	427	19.4	
RESULTS AT END OF DEVELOPMENT									

COMMENTS

OBSERVER SIGNATURE/DATE D. Charles Lytle 7-24-90
D. Charles Lytle

MMFORMOS.DWG

LOCATION: ^{Lower}WAG-2

DATE: 7-12-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 22.0 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
7-18-90	0900	35	Cloudy	--	8.2	349	462	21.0	
7-18-90	1415	35	Cloudy	--	8.3	340	497	22.6	
7-23-90	1300	65	Cloudy	--	9.2	370	562	25.5	
7-24-90	1430	95	Cloudy	*	8.5	373	657	30.0	
RESULTS AT END OF DEVELOPMENT			Cloudy	*	8.5	373	657	30.0	

COMMENTS

COMMENTS Good producer. Water came out clean but changed to cloudy by the time

I got it back for testing. Had to pass with 30.0 well volumes

OBSERVER SIGNATURE/DATE D. Charles Lytle 7-24-90
D. Charles Lytle

MWFORM03.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.: 1195

DATE OF TEST: 9-27-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: LOWER WAG-2

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 = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 19.45 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 9.45 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)

1.2963
1.3282

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	7.440	2.010
20.00	7.500	1.950
30.00	7.610	1.840
40.00	7.690	1.760
50.00	7.760	1.690
60.00	7.810	1.640
75.00	7.920	1.530
90.00	7.990	1.460
105.00	8.070	1.380
120.00	8.140	1.310
150.00	8.260	1.190
180.00	8.360	1.090
240.00	8.540	.910
300.00	8.660	.790
360.00	8.780	.670
420.00	8.860	.590
480.00	8.940	.510
540.00	8.990	.460
600.00	9.000	.450
720.00	9.060	.390
840.00	9.080	.370
960.00	9.110	.340
1080.00	9.140	.310
1200.00	9.150	.300
1320.00	9.190	.260
1440.00	9.200	.250
1560.00	9.200	.250
1680.00	9.230	.220
1800.00	9.230	.220
1920.00	9.150	.300
2040.00	9.150	.300
2160.00	9.200	.250

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $8.25\text{E-}07$ FT/SEC = $2.51\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.24\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.05\text{E-}06$ FT/SEC = $3.21\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.58\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

Appendix B

Operating Instructions for Handling Water and Cuttings from Well Drilling and Development of Groundwater Quality Monitoring Wells

**OPERATING INSTRUCTIONS FOR HANDLING CUTTINGS AND WATER FROM
FROM WELL DRILLING AND DEVELOPMENT OF THE
GROUNDWATER QUALITY MONITORING WELLS**

Prepared by
J. A. Greene

PROCEDURE REVIEW AND APPROVAL Form

Environmental and Health Protection Division

Operating Instructions for Handling Cuttings and Water from
 Procedure Title Well Drilling and Development of the Groundwater Quality
Monitoring Wells
 Procedure No. _____ Rev. No. 0 Date _____

Author _____

REVIEW AND APPROVAL At a minimum, procedures are approved by the manager of the implementing unit and the next higher level manager. SOPs must be reviewed by QA staff to assure that QA requirements are met and to verify that applicable standards are specified. Signatures of the approvers MUST appear on the first page of each approved procedure. The required approvers and the QA reviewer must sign below.

Approved by: _____ Date _____
 Manager, Implementing Unit
 _____ Date _____
 Higher Level Manager
 Reviewed by: Bene J. Bowles Date 11/16/90
 Quality Assurance

In the spaces below indicate additional reviews (R) or approvals (A). All reviewers and approvers must sign and date this form before the procedure can be finally approved. If more than one procedure is being reviewed, attach list.

R/A	Name	Date
R Facility Manager ^{MS Engineering}	J.R. Lawson	11/4/89
_____	Environmental Protection Officer	_____
R	Safety Officer	_____
_____	Office of Operational Safety	_____
A	Health Physics	J.L. Gray Jerry L. Gray 08-31-89
R	Industrial Hygiene	B.R. Lankford B.R. Lankford 9/15/89
_____	Division Director	_____
_____	Associate Division Director	_____
_____	Section Head	_____
A	Other Project Manager	J.A. GREENE J.A. Greene 11/19/89
A	Other Environmental Compliance	C.E. Nix C.E. Nix 10/5/89
R	Other Waste Management	C.B. Scott C.B. Scott 11/1/89

Is revision of the SAR/OSR required? — YES ☒ NO
 If yes, by whom: _____

Signature Mark S. Baldwin Date 8-30-89
 Procedure Review Officer

Next review dates: 2 yrs.

Forward a completed copy of this form to the division QA Office, 4500N, MS-6186.

OPERATING INSTRUCTIONS FOR HANDLING CUTTINGS AND WATER FROM
FROM WELL DRILLING AND DEVELOPMENT OF THE
GROUNDWATER QUALITY MONITORING WELLS

1.0 PURPOSE

The purpose of this document is to cite the steps that are followed to handle water and soil produced during the installation and development of wells.

2.0 SCOPE

This document applies to well drilling and development associated with the Groundwater Quality Monitoring Wells Installation Program at Oak Ridge National Laboratory.

3.0 REFERENCE

Health, Safety, and Environmental Protection Procedures for Excavating Operations, ORNL/M-116/R1, Oak Ridge National Laboratory, March 3, 1988.

4.0 DEFINITIONS

Well Ratings. Ratings assigned during the excavation permit cycle by Radiation Protection (RP) and Industrial Hygiene (IH) to indicate the probability of encountering radioactive and chemical contamination, respectively. These ratings are based on historical information or from previous drilling or excavation activity. The ratings are marked on the excavation permits. (RP ratings on permits may sometimes be called 'HP' for 'Health Physics.' The two designations are interchangeable.) Protective measures required for the three categories are stated in Table 1, 'Excavation-classification categories,' in ORNL/M-116/R1. The categories for soil handling are stated in Appendix B, 'Radiological Soil Handling Criteria,' in ORNL/M-116/R1.

RP Category 1. A rating assigned by RP which indicates that the probability of encountering radioactive contamination is low and that intermittent monitoring is required by RP.

IH Category 1. A rating assigned by IH which indicates that the probability of encountering chemical contamination (i.e., organics) is low and that monitoring is not required by IH. An IH and/or Environmental Monitoring and Compliance (EM&C) representative will be called in any time chemical or hazardous contamination is suspected.

RP Category 2. A rating assigned by RP which indicates that the probability of encountering radioactive contamination is moderate and that continuous monitoring is required. The RP representative will determine the necessary level of protective clothing to be worn.

IH Category 2. A rating assigned by IH which indicates that the probability of encountering chemical contamination is moderate and that respirators must be on-site and ready for use by the workers when

indicated by the IH or RP representative on-site. Location will be checked periodically with an IH field instrument, such as a Photovac or Organic Vapor Organizer (OVA).

RP Category 3. A rating assigned by RP which indicates that there is a high probability of encountering radioactive contamination. Therefore, continuous monitoring by an RP representative is required, and protective clothing must be worn. In addition to the training listed above, workers must have successfully completed the Category 3 Driller Training course that is administered by Environmental and Health Protection Division (E&HP) personnel.

IH Category 3. A rating assigned by IH which requires the workers to wear respirators as a minimum. Additional protection deemed appropriate by IH will be designated for each location. Continuous monitoring by IH personnel is required.

Training Requirements. Training requirements for workers include the Basic Radiation Training administered by E&HP personnel and the 40 h of training required by the Superfund Amendment Reauthorization Act (SARA) through a company-approved course. There is an additional training course required for Category 3 drilling.

Air rotary containment box. A box specially designed to contain the cuttings and water that are blown from the borehole during air rotary drilling. The box is equipped with a high-efficiency particulate air (HEPA) filter to prevent particles that possibly contain contaminants from being dispersed into the air. Air rotary drilling is generally used only for drilling into bedrock.

Auger pan. A metal catch pan with a hole cut in the middle. The pan surrounds the borehole and contains soil cuttings as they are augered up.

Proper On-Site Disposal. Disposal of noncontaminated soil and water produced from work on a well at a location near the well that is not openly visible to the public and has no risk of causing erosion or direct discharge into a stream. The construction engineer (CE) will indicate to the drillers which areas are acceptable for on-site disposal. The pH will have been checked and adjusted to the 5-to-9 range before releasing. This precise definition is intended wherever this term is used in this procedure.

Proper Contaminated Waste Disposal. Generally, radioactively contaminated soil will be packaged in drums and tagged by the RP representative for disposal by ORNL Waste Operations. However, Category-2-level soil may be used on site as backfill in remote areas when covered by 1 ft of noncontaminated soil as stipulated in ORNL/M-116/R1. The CE will specify to the drillers when a well location has been approved by EM&C for on-site disposal of contaminated soil. This definition is intended wherever this term is used in this procedure.

Temporary Drilling Equipment Cleaning Facility. An outdoor area located in Melton Valley for steam cleaning of drill rigs and associated equipment, referred to as the steam cleaning area.

Containment Box Holding Pit. A lined pit at the Temporary Drilling Equipment Cleaning Facility. The contents of the pit will be sampled and tested for gross alpha, gross beta, pH, and tritium*, before being released through a silt fence. Contents that have a potential for containing hazardous materials (i.e., IH Category 2 and 3 locations) will have been checked with an IH field instrument before being released into the pit.)

Steam Cleaning Pits. Two lined pits at the Temporary Drilling Equipment Cleaning Facility that collect runoff from the steam cleaning operations. The contents of the pits will be sampled and tested for gross alpha, gross beta, pH, and tritium*, before being released through a silt fence. Contents that have a potential for containing hazardous materials (i.e., IH Category 2 and 3 locations) will have been checked with an IH field instrument before being released into the pit.)

5.0 RESPONSIBILITIES

- 5.1 Radiation Protection Personnel monitor and determine the presence of detectable radioactive contamination in drill cuttings during well-drilling activities. They provide guidance to ensure that exposures to the workers, public, and environment are kept as low as reasonably achievable. They also provide radiation monitoring during the precursory cleaning by the drillers.
- 5.2 Well-Drilling Personnel perform well drilling and completion activities. They package soil and water in appropriate containers and transport it, if necessary; perform precursory cleaning of low-level contaminated equipment; and perform cleaning of equipment between the drilling of each well.
- 5.3 EDGE Hydrogeologists observe all crucial well installation activities and record data for all boreholes drilled. They do a visual inspection of the cuttings produced during augering and note any unusual occurrences and obvious deleterious material encountered during the drilling process. They check the cuttings and water with a Photovac or OVA or similar instrument and check pH of water when necessary.
- 5.4 Construction Engineer serves as the field contact and provides guidance to the drillers during field activities.

6.0 PROCEDURE

6.1 EXPLANATION OF THE WELL RATING SYSTEM

Each well is assigned a rating by RP and IH before drilling begins. Because additional information is gained during drilling,

well ratings may be changed by RP and IH as the work progresses. A lower RP Category rating will be changed to a Category 3 rating upon encountering radioactive contamination within the Category 3 range defined in ORNL/M-116/R1. Likewise, an IH Category 3 may result if chemical contamination is detected in a well with a lower rating. The RP and/or IH representative on site will notify the on-site personnel when conditions warrant a rating change. Any additional actions or modifications in protective clothing required by the rating change will be executed at that time. The change will be documented immediately by the on-site hydrogeologist in the well data package and as soon as possible by the RP and/or IH representative by a signed written statement stating the well number, the old and new ratings, and the rationale supporting the change. The statement will be sent by the RP and/or IH representative to the Construction Engineer (CE) for filing with the original excavation permit. A copy will be sent to the RAP Well Installation Manager by the CE.

A well category also may be changed from a higher rating to a lower rating. For example, if no contamination is encountered while drilling a Category 2 or 3 well, it may be changed to a lower rating after drilling to a certain depth or for development purposes, depending on the history of the area. The documentation procedure stated above for an increase in rating must also be followed for a decrease in rating.

6.2 CATEGORY 1 WELLS (RP OR IH)

6.2.1 Category 1 Drilling

6.2.1.1 Category 1 Auger Cuttings

- a. Auger cuttings will be collected in a catch pan.
- b. An RP representative will scan the cuttings intermittently to check for radioactive contamination. Cuttings will be inspected for any unusual discoloration or odor by the hydrogeologist.
- c. If there is no contamination detected, proper on-site disposal or disposal at the steam cleaning area will be done.

6.2.1.2 Category 1 Air Rotary Drilling

- a. Cuttings will be collected in a containment box.
- b. When the containment box is full, one of the following will be done to empty cuttings and/or decant water from the containment box:
 - (1) proper on-site disposal.

(2) disposal at the containment box holding pit.

6.2.2 Category 1 Well Development

- 6.2.2.1 Water removed from the well will be contained in drums.
- 6.2.2.2 The pH of the water will be measured and will be adjusted to be between 5 and 9 by the CE if it is above or below that range.
- 6.2.2.3 Drums of water will be discarded by proper on-site disposal or disposal at the steam cleaning area will be done.

6.3 CATEGORY 2 WELLS (RP AND IH)

6.3.1 Category 2 Drilling

6.3.1.1 Category 2 Auger Cuttings

- a. Auger cuttings will be collected in a catch pan.
- b. An RP representative will scan the cuttings continuously to check for radioactive contamination. Cuttings will be inspected for any unusual discoloration or odor and tested with a Photovac or OVA by the hydrogeologist for presence of RCRA materials.
- c. If there is no contamination detected, proper on-site disposal or disposal at the steam cleaning area will be done.
- d. Cuttings will be contained in drums if contamination is detected. Proper disposal will be arranged by Martin Marietta Energy Systems through Waste Operations.

6.3.1.2 Category 2 Air Rotary Drilling

- a. Rock cuttings and drill water will be collected in a containment box.
- b. When the containment box becomes full, the RP representative will perform a wet towel smear to detect the presence of radioactive contamination. An inspection for unusual discoloration or odor and tests with an OVA will be conducted for the presence of RCRA materials by the hydrogeologist.

- c. If no contamination is detected, one of the following will be done to empty cuttings and/or decant water from the containment box:
 - (1) proper on-site disposal.
 - (2) disposal at the containment box holding pit.
- d. If contamination is detected by the tests, arrangements will be made by Martin Marietta Energy Systems through Waste Operations to properly dispose of the water. Further laboratory testing of the box contents may be done.

6.3.2 Category 2 Development

- 6.3.2.1 Water removed from the well will be contained in drums.
- 6.3.2.2 When the drums are ready to be emptied, the RP representative will perform a wet towel smear to detect the presence of radioactive contamination. An inspection for unusual discoloration or odor and tests with an OVA will be conducted for presence of RCRA materials by the hydrogeologist. The pH will be adjusted if necessary.
- 6.3.2.3 If no contamination is detected, the water will be discarded by proper on-site disposal or disposal at the steam cleaning area will be done.
- 6.3.2.4 If contamination is detected by the tests, arrangements will be made by Martin Marietta Energy Systems to properly dispose of the water. Further laboratory testing may be done.

6.4 CATEGORY 3 WELLS (RP AND IH)

6.4.1 Category 3 Drilling

6.4.1.1 Category 3 Augering

- a. When a well is classified as an RP Category 3 or an IH Category 3, continuous monitoring will be required by RP and IH. Wearing of respirators will be required. Cuttings will be inspected for any unusual discoloration or odor. Tests for chemical contamination (i.e., organics) will be performed with IH field instruments by an IH representative for IH Category 3 wells. Specially trained personnel will be required to do the drilling.

- b. If no contamination is detected by RP or IH while augering through soil to bedrock, a rating may be changed by RP or IH to a Category 2 depending on the depth, the type of contamination expected, and the history of the area.
- c. If contamination is detected during augering, cuttings will be drummed. Proper disposal of all cuttings and water will be arranged by Martin Marietta Energy Systems.

6.4.1.2 Category 3 Air Rotary Drilling

- a. Rock cuttings and drill water will be collected in a containment box.
- b. When the containment box becomes filled with water and/or cuttings, a sample will be collected by EM&C and will be tested by the Analytical Chemistry Division for gross alpha, gross beta, tritium*, for an RP Category 3. If it is an IH Category 3, the IH representative on-site will determine which (if any) laboratory testing is necessary for chemical contaminants.
- c. Proper disposition of the containment box contents will be decided by consensus of E&HP, the IH or RP representative, EM&C, and the CE, based on the results from Analytical Chemistry Division of the above tests.

6.4.2 Category 3 Development

- 6.4.2.1 Water pumped from Category 3 wells will be contained in drums. Samples will be collected by EM&C and will be tested by Analytical Chemistry Division for gross alpha, gross beta, tritium*, and pH. It will be tested with IH field instruments by IH representatives for the presence of RCRA materials.
- 6.4.2.2 A decision based on the test results will be made between E&HP and Engineering whether to continue development.

6.5 BOREHOLE CLEANING

When sludge and water have accumulated in the bottoms of boreholes drilled in soil, the boreholes must be cleaned out prior to setting casings. A decision based on the location of the borehole and its rating will be made between the RP and/or IH representatives whether the sludge and water from the borehole must be contained in a drum. Water and sludge from a Category 2 well will be drummed, and a wet towel smear will be done by RP to

determine proper disposal of the drum contents. Laboratory testing of the drum contents for gross alpha, gross beta, tritium*, and pH will be done if recommended by the RP or IH representative. Water and sludge removed from an RP Category 3 well will be drummed, and laboratory testing will be done for gross alpha, gross beta, tritium*, and pH. EM&C will be consulted to determine proper disposal based on the test results. Further laboratory testing to determine actual contaminants will be done if recommended by EM&C.

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

7

6

7

EASTERN LIMIT OF
LOWER WAG 2

UPPER WAG 2
(SEE C3E020004 A121)

746X0

750

1186

1185

757X0

775

800

800

825

825

850

875

900

925

950

975

1000

850

875

900

925

950

975

E

D

**LOWER WAG 2 GROUNDWATER QUALITY MONITORING
WELLS AS-BUILT COORDINATES**

<u>WELL#</u>	<u>NORTHING</u>	<u>EASTING</u>
1185	16,343.85	26,464.80
1186	16,346.39	26,443.78
1187	15,183.27	24,285.13
1188	15,170.51	24,267.22
1189	15,146.78	23,280.95
1190	15,358.22	23,384.36
1191	15,373.83	23,387.98
1192	15,542.38	23,358.39
1193	15,021.21	21,225.91
1194	15,736.11	21,046.77
1195	15,716.88	21,043.63

WILLIAMS	4-1-91
WILLIAMS	4-1-91
vs. Fadden	8/22/91
A. Wy l.	8/22/91
PLANT	8/22/91
Wy l.	

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**GROUNDWATER QUALITY MONITORING WELLS
LOWER WAG 2 LOCATION MAP**

LOWER WAG 2 MON WELL LOC MP										TYP
1	48	49	50	PLANT	BLDG	FL	SHEET	OF	CLAS	M
3	C	M	T	X-10	—	—	1	1	U

BUILDING
SECONDARY ROAD
STREAM
SECURITY FENCE
POWER POLE
CONTOUR INTERVALS 5 FEET
AS-BUILT WATER QUALITY
WELL LOCATIONS

[illegible]

C

B

(DASHED CONTOURS ARE APPROX. DUE TO HEAVY FOLIAGE)

A

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