Environmental Restoration Division
ORNL Environmental Restoration Program

**Groundwater Quality Monitoring Well Installation for
Waste Area Grouping 17 at Oak Ridge National
Laboratory, Oak Ridge, Tennessee**

**J. A. Mortimore
M. L. Ebers**

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Author Affiliations

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

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EXECUTIVE SUMMARY

This report documents the drilling and installation of groundwater quality monitoring (GQM) wells on the perimeter of Waste Area Grouping (WAG) 17. WAG 17 is composed of approximately 23 acres and is located in Bethel Valley about 3100 ft east of the Oak Ridge National Laboratory (ORNL) main plant area. The facilities in WAG 17 constitute the ORNL Services Area and include the shipping and receiving departments, machine shops, carpenter shops, paint shops, lead burning facilities, tritium facility, and the materials storage area. The wells at WAG 17 were drilled and developed between November 1989 and April 1990. These wells were installed to characterize and assess the WAG in accordance with applicable Department of Energy, state, and Environmental Protection Agency regulatory requirements.

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

The wells at WAG 17 were drilled with auger or air rotary rigs. Depending on the hydrogeologic conditions present at each proposed well location, one of four basic installation methods was utilized. Detailed procedures for well construction were specified by the Engineering Division to ensure that the wells would provide water samples representative of the aquifer. To ensure conformance with the specifications, Energy Systems Construction Engineering and ERCE provided continuous oversight of field activities.

The purpose of the well installation program was to install GQM wells for groundwater characterization at WAG 17. 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 17 characterization. The forms contained in the packages include predrilling and postdrilling checklists, drilling and construction logs, development and hydraulic conductivity records, and quality control-related documents.

1. INTRODUCTION

The purpose of this report is to document the drilling and installation of the groundwater quality monitoring (GQM) wells on the perimeter of Waste Area Grouping (WAG) 17. Installation of GQM wells was required at Oak Ridge National Laboratory (ORNL) for regulatory compliance. Data obtained from these wells will be used to characterize and assess groundwater quality at the perimeter of each WAG in accordance with applicable Department of Energy, state, and Environmental Protection Agency regulatory requirements. The wells in WAG 17 were drilled and developed from November 1989 to April 1990.

1.1 THE WAG CONCEPT

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

1.2 DESCRIPTION OF WAG 17

WAG 17 is composed of approximately 23 acres and is located in Bethel Valley about 3100 ft east of the ORNL main plant area [Fig. 1, map pocket (MMES map #C3E20004A124, Rev. 0)]. The facilities in WAG 17 constitute the ORNL Services Area and include the shipping and receiving departments, machine shops, carpenter shops, paint shops, lead burning facilities, tritium facility, and the materials storage area. Eight groundwater quality monitoring wells were installed along the perimeter of WAG 17 (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 were used at WAG 17. These types are described in Sects. 2.1 through 2.2. The specific details of each well installation are included in the monitoring well narratives (Appendix A). The specifications for drilling and well installation were provided in *Construction Specifications for Monitoring Wells Installation Construction Project*, K-4491G-G1.¹ The proposed well design criteria for the WAG 17 wells can be found in the report *Preliminary Geohydrologic Site Characterization and Proposed Water Quality Well Locations for WAG 17 and Lower WAG 2*, ORNL/RAP/Sub/87-SB189/2.² Actual completion data for WAG 17 are listed in Table 1.

2.1 TYPE A WELL

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

2.2 TYPE B WELL

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

2.3 TYPE D WELL

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

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

Table 1. Actual completion for WAG 17

Well	Depth clean to (ft) ^a	SST casing diam(in.)	Well type	Screened interval (ft)	Water level (ft) ^b
1196	18.3	2	D	8.0–18.0	–3.6
1197	48.8	4	B	33.6–48.6	–13.6
1198	43.0	2	D	27.8–42.8	–25.4
1199	72.8	4	B	52.6–72.6	–30.9
1200	40.0	2	D	29.8–39.8	–6.3
1201	47.8	4	B	37.6–47.6	–4.5
1202	20.3	4	B	10.1–20.1	–5.2
1203	17.8	2	D	7.6–17.6	–2.8

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

^bPredevelopment water level; depth measured from ground surface.
(Negative is below surface; positive, above surface.)

3. ENVIRONMENTAL, HEALTH, AND SAFETY REQUIREMENTS

All well drilling at WAG 17 was conducted in accordance with procedures outlined in *Health, Safety, and Environmental Protection Procedures for Excavating Operations*, ORNL/M-116/R1³. Among the procedures set forth by this document is a system for rating proposed well locations according to the degree of probability that contamination will be encountered. Ratings obtained by this system were used to determine the level of personnel training required and health and safety coverage to be used during drilling.

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

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

4. FIELD SUPPORT

The construction contractor Geotek Engineering Company, whose contract began in May 1989, installed the GQM wells in WAG 17. 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 GQM wells drilled in WAG 17. These data packages are presented in numerical order in Appendix A. All original records are retained in the Environmental Restoration (ER) Division Records Control Data Base. The forms included in each well data package are listed here in the order in which they appear in the package:

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

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

6. WELL DEVELOPMENT

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

Of the eight wells in WAG 17, six had turbidities less than or equal to 5 NTUs. The number of well volumes removed ranged from 3.3 to 43.8, with an average of 22.5 well volumes. The procedure for measuring turbidity described in ORNL/RAP/LTR-88/28⁴ was replaced with a more accurate method. While the previously used method depended on a visual comparison of the sample with prepared standards, the new method employs the Cole-Parmer turbidimeter, which measures NTUs by passing a lens-focused light beam through a test tube filled with a water sample. A photosensor detects the intensity of the exiting light beam, and an analog scale on the instrument displays the turbidity of the sample.

7. SAMPLING DURING INSTALLATION

The ERCE hydrogeologist took samples of soil, rock, and drilling water during well installation and submitted them to the ORNL Analytical Chemistry Division for chemical analyses. Soil and rock samples were taken from the unsaturated and saturated zones. Samples of drilling water were collected from the water pump discharge on the drill rig during air rotary drilling. All samples were transferred using chain-of-custody forms, which are included in the data packages. The sampling procedures are explained in ORNL/RAP/Ltr-88/28⁴. Soil samples were collected from each single well and from one well of each well pair. A drilling-water sample was collected from each air-rotary-drilled boring.

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

8. SPECIAL NOTES ON INSTALLATION AND DEVELOPMENT

Soil samples were collected from wells 1196, 1197, 1198 and 1199 by Bechtel National, Inc., the Remedial Investigation/Feasibility Study subcontractor. Analytical results for these soil samples can be obtained from Bechtel.

REFERENCES

1. Engineering Division, *Construction Specifications for Monitoring Wells Installation Construction Project*, K-4491G-G1 (Rev. 2), Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn. August 1988.
2. *Engineering, Design & 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 1196 is located in WAG 17. It is located in the northeast corner of WAG 17 approximately 120' northeast of Bldg. 7012. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 21,988.5166, E 37,553.8509 (X-10 grid) or latitude 35° - 56' - 11.32" and longitude 84° - 17' - 54.78". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 1196 was drilled by Geotek Engineering Company. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of George Akins with the assistance of Steve Kirk. Drilling commenced on 11/7/89 and was finished on 11/21/89. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

11-7-89: The Schramm was mobilized to the staked location and set up on plastic. Split spoon samples were taken from surface to 8.3'.

11-8-89: The boring was augered with a 6" auger to refusal at 10.8'. The boring was then augered with a 14" auger to 8.6 feet set 7.6 feet of 10 3/4" diverter casing and grouted it with 4 sacks of cement. The rig was moved off the hole.

11-20-89: The Schramm rig moved to location and set up on plastic. The boring was deepened to 15.0' using a 7 7/8 inch air rotary tri-cone bit.

11-21-89: The boring was deepened to 18.3'. 18.0' feet of 2 inch stainless steel casing was set and a sand pack was placed from 7.0 feet to 18.3 feet. A 2.1 feet bentonite seal was placed on the sand pack. The rig was moved off location. The annular space was grouted from the top of the bentonite seal to surface.

This well was logged by the EDGe Group of 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

WAG 17 encompasses approximately 23 acres in Bethel Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 17 is underlain by the Middle Ordovician Chickamauga Group consisting mainly of limestone and siltstone. The Chickamauga Group consists of eight units, designated by letters A through H (Stockdale, 1951). WAG 17 is underlain by units E, F, G and a portion of H. These units consist of thin bedded nodular limestone with clay and shale partings. Portions of units H and F consist of calcareous siltstone alternating with beds of olive gray to maroon shale. The regional strike is 56° northeast and has a moderate dip of 30° to 40° southeast.

2.3 Sample Collection

Soil samples were collected during drilling by Bechtel National, Inc., the Remedial Investigation/Feasibility

Study subcontractor. A drill water sample was collected from the water pump on the drill rig on 11-20-89. Analytical results for the soil samples described above can be obtained from Bechtel. The analytical results for the drill water sample 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 6.5 to 6.85 feet. The sample was measured and weighed, and a bulk density of 2.08 grams/cm³ was calculated.

The Schramm rig compressed air was sampled with a cloth filter inserted between drill rods on 11-20-89. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no evidence 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 from ground surface to auger refusal (10.8 feet). The air rotary method was required to complete the boring to the specified total well depth. Therefore, a 14-inch diameter boring was augered from ground surface to 7.6 feet and a 10 3/4-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 7.6 to 18.3 feet. A 2-inch diameter stainless steel screen with welded bottom cap was installed from 8.0 to 18.3 feet. A 2-inch diameter stainless steel casing was installed above the screen at

8.0 feet and extended 1.18 feet above ground surface. A sandpack was then tremied into the annular space from 7.0 to 18.3 feet, with a 2.1-foot bentonite pellet seal poured into the annular space above the sandpack from 4.9 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 1196 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 297 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 4-18-90 at a depth of 17.3 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1196 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 Model DPI-600 pressure transducer. The hydraulic conductivity value of 2.3×10^{-4} cm/sec (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

11-07-89

TDL

2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.

11-03-89

TDL

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

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

11-21-89

TDL

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

11-07-89

TDL

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

11-07-89

TDL

6. POLYETHYLENE COVER IN PLACE OVER HOLE.

11-07-89

TDL

7. AIR ROTARY COMPRESSED AIR SAMPLED.

11-21-89

TDL

RESULTS: No detectable hydrocarbons under ultra violet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

11-21-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1196

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

11-07-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1196

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG 17
 DRILLER: George Akins
 HELPER: Steve Kirk
 DRILL: Schramm

DATE: START: 11-07-89
 FINISH: 11-21-89
 LOGGED BY: Timothy A. Lee
 HEALTH PHYSICIST: Randy Summers

TYPE DRILLING: Split Spoon/Auger LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: * TYPE: _____

CONTAINMENT TYPE: Plastic, Auger pan and Containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 10.8'

DEPTH DRILLED IN ROCK: 7.2'

TOTAL DEPTH OF WELL: 18.0'

DRILLING FLUID SAMPLES:

TYPE: Drill Water DATE: 11-21-89

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	0.4		75%	Top soil and grass.
0.4	1.0		75%	Gravel fill? Reddish brown clay and yellowish brown clay.
1.0	2.0		75%	Clay, moderate yellowish brown, dense, damp, somewhat plastic.
2.0	3.0		85%	Clay, dark yellowish orange, damp, stiff, dense; streaks of dark iron stains, mottled with light yellowish gray clay.
3.0	3.5		85%	Clay, dark yellowish orange, slightly silty, mottled with dark brown iron stains, damp, stiff, dense.
3.5	4.0		85%	Clay, dark yellowish orange, slightly silty, damp, stiff, dense; mottled with light yellowish gray clay.
4.0	6.0		100%	Clay, dark yellowish orange, slightly silty, moist, dense, soft, mottled with light yellowish gray clay, scattered lenses of dark brown iron stains and scattered gravel sized unknown type rock.
6.0	7.9	Bulk density	100%	Clay, dark yellowish orange, slightly damp, dense, slightly silty, stiff bulk density
		@6.5'-6.85'

WELL No. 1196

ORNL MONITORING WELL LOG

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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

HELPER: Steve Kirk

EQUIPMENT

☐ 14 INCH AUGER 7.6 L.F.

☐ INCH AUGER L.F.

☐ 7 7/8 INCH ROTARY 10.7 L.F.

MATERIALS USED

EST. USED
VOL. VOL.

10.0 FEET OF 2 IN. S.S. SCREEN

9.2 FEET OF 2 IN. S.S. CASING

3 4.5 SACKS OF SAND

50 50 POUNDS OF BENTONITE PELLETS

2 2.0 SACKS OF CEMENT

10.0 POUNDS OF POWDERED BENTONITE

16 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Cavities 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 17.3 FEET.

CENTRALIZERS AT 8.0' FEET.

18.0' FEET.

FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT
TO 18.3 FEET

BOTTOM OF BOREHOLE
18.3 FEET

LOCATION WAG 17

ORNL GRID COORDINATES
N 21,988.5166

E 37,553.8509

ELEV. GROUND 856.60'

ELEV. TOP STAINLESS

STEEL CASING 857.78'

DRILLING DATES:

STARTED: 11-07-89

FINISHED: 11-21-89

LOCKING STEEL COVER

10 3/4 INCH DIAMETER

STEEL PROTECTIVE CASING

2.98 FT. ABOVE GROUND

TO 0.0 FT. BELOW

GROUND SURFACE

CONCRETE PAD

10 3/4 INCH DIVERTER

CASING 0.0 FT. ABOVE

GROUND SURFACE TO

7.6 FT. BELOW GROUND

SURFACE

14 INCH BOREHOLE

0.0 TO 8.6 FEET

GROUT SEAL 0.0 TO

4.9 FEET

7 7/8 INCH DIAMETER

BOREHOLE

2 INCH DIAMETER STAINLESS

STEEL CASING 1.18 FT. ABOVE

GROUND SURFACE TO 8.0 FT.

BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL

4.9 TO 7.0 FEET

SAND PACK

7.0 TO 18.3 FEET

2 INCH DIAMETER

STAINLESS STEEL 0.010

SLOTTED SCREEN

8.0 TO 18.0 FEET

2 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP

18.0 TO 18.3 FEET

TYPE D WELL

NOT TO SCALE

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	11-21-89	1
BENTONITE	11-21-89	1
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	11-21-89	2
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	11-21-89	2
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	11-21-89	2
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	11-21-89	2
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	4-18-90	5
GROUT	11-21-89	3
WELL COVERS		
SURFACE CASING Diverter Casing	11-07-89	2

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee

11-21-89

Timothy A. Lee

D. Charles Lytle

4-18-90

D. Charles Lytle

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>11-21-89</u>	<u>Tsk</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>11-21-89</u>	<u>Tsk</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>4-18-90</u>	<u>DCS</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>11-21-89</u>	<u>Tsk</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 11-21-89
Timothy A. Lee

D. Charles Lytle 4-18-89
D. Charles Lytle

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 3-28-90

TIME: _____

DEVELOPMENT
ENDING DATE: 4-18-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 6.8 GALLONS

TOTAL GALLONS PUMPED: 297 TOTAL WELL VOLUMES PUMPED: 43.8

INITIAL pH: 7.8 FINAL pH: 7.8

INITIAL CONDUCTIVITY (uS): 750 FINAL CONDUCTIVITY (uS): 830

DESCRIPTION OF INITIAL TURBIDITY: Very Cloudy

DESCRIPTION OF FINAL TURBIDITY: Semi 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: 3.6 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 4-18-90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUTR, VERSION 4.1, NOV. 1986

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

- (1) METHOD OF COOPER, PREDEHOFF 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 POWERS 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.: 1196

DATE OF TEST: 5/10/90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG 17

EDGE, INC. FIELD INVESTIGATOR: BRUCE MCMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 12.00 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 = 17

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

SUCCESSIVE COMPUTED VALUES FOR H0 (FEET)

2.8599
2.5389
2.3435
2.4047

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SECOND)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.930	2.930
20.00	3.420	2.420
30.00	3.080	2.080
40.00	2.920	1.920
50.00	2.800	1.800
60.00	2.790	1.790
75.00	2.190	1.190
90.00	2.010	1.010
105.00	1.870	.870
120.00	1.750	.750
150.00	1.600	.600
180.00	1.490	.490
240.00	1.360	.360
300.00	1.280	.280
360.00	1.160	.160
420.00	1.040	.040
480.00	1.010	.010

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $7.55E-06$ FT/SECOND = $2.30E-04$ CM/SEC

TRANSMISSIVITY = $7.55E-05$ FT**2/SECOND

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.08E-05$ FT/SECOND = $3.30E-04$ CM/SEC

TRANSMISSIVITY = $1.08E-04$ FT**2/SECOND

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

CHAIN OF CUSTODY RECORD

FOR

MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE
NUMBER

1196w01

WELL NO.

1196

LOCATION:

WAG 17

TYPE:

DRILL WATER

SAMPLER:

Smith Q 22

(SIGNATURE)

SAMPLE INTERVAL:

N/A

DATE:

11-20-89

TIME:

1625

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Smith Q 22

12/19/89

1245

EXC

JHS

12/19/82

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 1197 is located in WAG 17. It is along the east side of WAG 17 approximately 125 feet north of Bldg. 7033. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 21,732.6979, E 37,633.9438 (X-10 grid) or latitude 35°-56'-09.66" and longitude 84°-17'-52.24". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 1197 was drilled by Geotek Engineering Company. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of George Akins with the assistance of Steve Kirk and James Shelton. Drilling commenced on 11/7/89 and was finished on 11/28/89. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/ completion form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

11-7-89: The rig was moved to the staked location and set upon plastic. Split spoon samples were taken from the surface to refusal at 4.8 feet. The boring was reamed and 15 1/4 inch diverter casing was grouted in place at 3.5 feet. The rig was moved from the location.

11-21-89: The rig was mobilized to the location and set up on plastic. The boring was deepened from 4.8 feet to 10.9 feet with a 14 1/2 inch air rotary tricone bit using a containment box.

11-22-89: Set 10.9 feet of 10 3/4 inch decontaminated steel surface casing and grouted to surface with 4 sacks of cement.

11-27-89: The boring was deepened to 48.8 feet with a 7 7/8 inch air rotary tricone bit using the containment box.

11-28-89: Had 28.0 feet of water in hole. Installed 4" stainless steel casing and screen with sand pack and bentonite seal. Grouted annular space with 5 sacks cement.

This well was logged by the EDGE Group of 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

WAG 17 encompasses approximately 23 acres in Bethel Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 17 is underlain by the Middle Ordovician Chickamauga Group consisting mainly of limestone and siltstone. The Chickamauga Group consists of eight units, designated by letters A through H (Stockdale, 1951). WAG 17 is underlain by units E, F, G and a portion of H. These units consist of thin bedded nodular limestone with clay and shale partings. Portions of units H and F consist of calcareous siltstone alternating with beds of olive gray to maroon shale. The regional strike is 56° northeast and has a moderate dip of 30° to 40° southeast.

2.3 Sample Collection

Soil samples were collected during drilling by Bechtel National, Inc., the Remedial Investigation/Feasibility Study subcontractor. A drill water sample was collected

from the water pump on the drill rig on 11-27-89. Analytical results for the Schramm drill water sample can be obtained from the Remedial Action Program data base at ORNL. The analytical results for the soil samples can be obtained from Bechtel.

A bulk density soil sample was not collected.

The Schramm Rig compressed air was sampled with a cloth filter inserted between drill rods on 11-27-89. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no evidence 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 3.5 feet. A 15 1/4-inch diverter casing was installed from surface to 3.5 feet below ground surface and grouted in place. A 14 1/2-inch diameter boring was augered from 3.5 feet to 4.8 feet (auger refusal). The boring was then extended past the refusal depth with a 14 1/2-inch air rotary tricone roller bit from 4.8 feet to 10.9 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 10.9 feet, sealed with a 2.0-foot bentonite pellet layer from 8.9 feet to 10.9 feet, and tremie-grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. After the surface casing was installed, the air rotary method was used to drill an 8-inch diameter boring to a total depth of 49.0 feet. A 4-

inch diameter stainless steel screen with threaded bottom cap was installed from 48.8 feet to 33.6 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 33.6 feet and extended 2.13 feet above ground surface. A sandpack was then tremied into the annular space from 31.1 to 48.8 feet, with a 3.5-foot bentonite pellet seal poured into the annular space above the sandpack from 27.6 to 31.1 feet. The annular space from the top of the bentonite seal to the surface was tremie-grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 1197 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 147 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 3.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 4-2-90 at a depth of 45.4 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1197 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 Model DPI-600 pressure transducer. 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

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>11-07-89</u>	<u>CAB</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>11-03-89</u> <u>11-21-89</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> </u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>11-28-89</u>	<u>Tms</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>11-21-89</u> <u>11-07-89</u>	<u>CAB</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>11-21-89</u> <u>11-07-89</u>	<u>CAB</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>11-28-89</u>	<u>Tms</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>11-27-89</u>	<u>Tms</u>

RESULTS: _____

ADDITIONAL NOTES/OBSERVATIONS: _____

C. Allison Bailey 11-07-89
C. Allison Bailey
OBSERVER SIGNATURE/DATE Timothy A. Lee 11-21-89
Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1197

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

11/21/89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1197

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG-17
DRILLER: Larry Ledbetter/George Akins
HELPER: Fred Dixon/Steve Kirk/James
Shelton
DRILL: IR T-4/Schramm Rotadrill

DATE: START: 11-07-89
FINISH: 11-28-89
LOGGED BY: C. Allison Bailey/
Timothy A. Lee
HEALTH PHYSICIST: N/A

TYPE DRILLING: Splitspoon/Auger/Air Rotary LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: See samples taken by Bechtel TYPE: Soil

CONTAINMENT TYPE: Plastic, Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 4.8

DEPTH DRILLED IN ROCK: 44.2

TOTAL DEPTH OF WELL: 49.0

DRILLING FLUID SAMPLES:

TYPE: Water DATE: 11-27-89

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	.5		100%	Clay, moderate brown, top soil with grass.
.5	1.5		100%	Clay, moderate brown, firm clay - red root at 1.5' - Cedarroot.
1.5	2.0		100%	Clay, light olive gray and pale yellowish brown. Shaley, dry, with light brown clay lenses, dry, crumbly.
2.0	4.0		100%	Clay dark yellowish orange and light olive brown and dusty yellow. Moist will hold firm, slightly crumbly.
4.0	4.8		20%	Clay, mottled dusky yellowish brown, light brown and dark yellowish orange with lime- stone fragments. Auger refusal at 4.8' - limestone. Shaley limestone - pale olive and light olive brown - fizzes with acid crumbly dry limestone - medium light gray.
4.8	10.9		**	Limestone, hard.
10.9	16.0			Limestone, hard.
16.0	16.5			Limestone, shaley, soft.
16.5	17.0			Limestone, hard.
17.0	19.3			Limestone, shaley, soft.
19.3	40.9			Limestone, hard.

1921-COMC

PAGE 2 OF 2

PAGE 10 OF 20.

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: George Akins HELPER: Steve Kirk/James Shelton

DRILLING METHOD: ☒ 22 INCH AUGER 3.5 L.F.
☐ INCH AUGER L.F.
☒ 14 1/2 INCH ROTARY 7.4 L.F.
☒ 7 7/8 INCH ROTARY 38.1 L.F.

MATERIALS USED

EST. VOL.	USED VOL.	DESCRIPTION
50.0	50.0	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
10.9	10.9	FT. OF 10 3/4 IN. SURFACE CASING
3.5	4.0	SACKS OF CEMENT (SURFACE CASING)
30.0	30.0	POUNDS OF POWDERED BENTONITE (SURFACE CASING)
32.0	32.0	GALLONS OF WATER (SURFACE CASING)
35.7	35.7	FT. OF 4 IN. DIA. STAINLESS STEEL CASING
15.0	15.0	FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
4.3	5.0	SACKS OF SAND
50.0	50.0	POUNDS OF BENTONITE PELLETS
4.0	5.0	SACKS OF CEMENT (WELL CASING)
25	25	POUNDS OF POWDERED BENTONITE (WELL CASING)
40	40	GALLONS OF WATER (WELL CASING)
3.09	3.09	FT. OF 10 3/4 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and irregular boring diameters.

SURFACE CASING TREMIE GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ☒ NO ☐

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

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 45.4 FEET.

CENTRALIZERS AT 15 FEET.
34 FEET.
49 FEET.

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

TYPE B WELL

LOCATION WAG 17
ORNL GRID COORDINATES
N 21,732.6979
E 37,633.9438
ELEV. GROUND 868.67
ELEV. TOP STAINLESS
STEEL CASING 870.80
DRILLING DATES:
STARTED 11-07-89
FINISHED 11-28-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1197

DATE: 11-28-89

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	11-28-89	1
BENTONITE Pellets	11-21-89	1
Powder	11-28-89	3
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	11-28-89	2
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	11-28-89	2
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	11-28-89	2
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	11-28-89	2
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	4-02-90	5
GROUT Surface	11-21-89	3
SS Casing	11-28-89	3
WELL COVERS		
SURFACE CASING	11-21-89	3

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee
D. Charles Lytle
D. Charles Lytle

11-28-89

4-02-90

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>11-28-89</u>	<u>TJus</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>11-28-89</u>	<u>TJus</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>4-02-90</u>	<u>DCS</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>11-28-89</u>	<u>TJus</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 11-28-89
Timothy A. Lee

D. Charles Lytle 4-02-90
D. Charles Lytle

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 3/28/90

TIME: _____

DEVELOPMENT
ENDING DATE: 4/02/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 35.1 GALLONS

TOTAL GALLONS PUMPED: 147 TOTAL WELL VOLUMES PUMPED: 4.2

INITIAL pH: 7.6 FINAL pH: 7.3

INITIAL CONDUCTIVITY (uS): 781 FINAL CONDUCTIVITY (uS): 734

DESCRIPTION OF INITIAL TURBIDITY: Slightly Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 3.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR
OF WATER: None

WATER
DISCHARGED
TO:

☒ GROUND SURFACE
☐ STORM SEWERS
☐ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 13.6 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle

D. Charles Lytle 4/02/90

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM: ELEC-TEST, VER. 2.0, 11/10/83

THIS PROGRAM CALCULATED MEAN TESTED TEST DATA FROM
ELEC-TEST DATA SHEET ON TWO ANAL. DATA SHEETS:

- (1) METHOD OF COOPER, PRESTON, AND TAPPAWING, 1967
(ARTICLE IN JOURNAL, NO. 1 OF 1967)
"RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS
CHARGE OF WATER"
- (2) METHOD OF HOUWER AND FIDEL, 1974 (ARTICLE IN
JOURNAL, NO. 1 OF 1974)
"A NEW TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY
OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY
PENETRATING WELLS"

WELL NO.: 1197

DATE OF TEST: 1/5/84

PROJECT NO.: E221-01C

CLIENT: MMEC

SITE LOCATION: WAG 17

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 29.80 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 = 22

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

SUCCESSIVE COMPUTED
VALUES FOR H₀
(FEET)

2.4849
2.4891

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME SEC:MM	FEET TO WATER FEET	TIME FEET
20.00	2.520	2.520
25.00	2.520	2.520
30.00	2.520	2.540
40.00	2.500	2.510
50.00	2.500	2.500
60.00	2.500	2.500
75.00	2.470	2.470
90.00	2.450	2.450
105.00	2.430	2.420
120.00	2.420	2.420
150.00	2.450	2.450
180.00	2.420	2.420
240.00	2.390	2.390
300.00	2.360	2.360
360.00	2.330	2.330
420.00	2.320	2.320
480.00	2.290	2.290
540.00	2.270	2.270
600.00	2.230	2.230
720.00	2.160	2.160
840.00	2.160	2.160
960.00	2.130	2.130
1080.00	2.130	2.130
1200.00	2.070	2.070
1320.00	2.070	2.070
1440.00	2.040	2.040
1560.00	2.040	2.040
1680.00	2.980	1.980
1800.00	2.940	1.940
1920.00	2.940	1.940
2040.00	2.940	1.940
2160.00	2.930	1.930

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF SOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $4.17E-07$ FT/SECONDS = $1.27E-05$ CM/SEC

TRANSMISSIVITY = $2.25E-06$ FT**2/SECONDS

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $5.07E-07$ FT/SECONDS = $1.57E-05$ CM/SEC

TRANSMISSIVITY = $7.55E-06$ FT**2/SECONDS

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

CHAIN OF CUSTODY RECORD

FOR

MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE
NUMBER

1197W01

WELL NO.

1197

LOCATION:

WAG 17

TYPE:

DRILL WATER

SAMPLER:

Smith G. B. S.
(SIGNATURE)

SAMPLE INTERVAL:

17.0'

DATE:

11-27-89

TIME:

0930

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Smith G. B. S.

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 1198 is located in WAG 17. It is located in the southeast corner of WAG 17, approximately 250' southeast of Bldg. 7032. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 21,214.1516, E 37,984.9834 (X-10 grid) or latitude 35°-56'-07.33" and longitude 84°-17'-45.19". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 1198 was drilled by Geotek Engineering Company. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of George Akins with the assistance of Steve Kirk. Drilling commenced on 11-9-89 and was finished on 11-20-89. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

11-9-89: The Ingersoll Rand drill rig was moved to staked locations and set up on plastic. The boring was augered to 18.0' without refusal. Filled hole to 14.0 and set 14.0' of 10 3/4 inch diverter casing and grouted it into place with 4 sacks cement. The rig moved off hole.

11-17-89: A Schramm rig was moved to location and set up on plastic. The boring was deepened to 43.0 feet with a 7 7/8 inch air rotary tricone bit.

11-20-89: The boring was cleaned out and 45.2' of 2 inch stainless steel casing was set in place. A sand pack was placed from 25.5' to 43.3' and a 2.1 foot bentonite seal was placed above the sand pack.

This well was logged by the EDGE Group of 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

WAG 17 encompasses approximately 23 acres in Bethel Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 17 is underlain by the Middle Ordovician Chickamauga Group consisting mainly of limestone and siltstone. The Chickamauga Group consists of eight units, designated by letters A through H (Stockdale, 1951). WAG 17 is underlain by units E, F, G and a portion of H. These units consist of thin bedded nodular limestone with clay and shale partings. Portions of units H and F consist of calcareous siltstone alternating with beds of olive gray to maroon shale. The regional strike is 56° northeast and has a moderate dip of 30° to 40° southeast.

2.3 Sample Collection

No soil samples were collected during drilling. A drill water sample was collected from the water pump on the drill rig on 11-17-89. Analytical results for the water sample described above can be obtained from the Remedial Action Program data base at ORNL.

The Schramm Rig compressed air was sampled with a cloth filter inserted between drill rods on 11-17-89. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no evidence 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 (18.0 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 14.0 feet and a 10 3/4-inch diverter casing was installed and grouted. A 7 7/8-inch diameter boring was then drilled with an air rotary tricone roller bit from 14.0 to 43.3 feet. A 2-inch diameter stainless steel screen with bottom cap was installed from 27.8 to 43.0 feet. A 2-inch diameter stainless steel casing was installed above the screen at 27.8 feet and extended 43.0 feet above ground surface. A sandpack was then tremied into the annular space from 25.5 to 43.0 feet, with a 2.1-foot bentonite pellet seal poured into the annular space above the sandpack from 23.4 to 25.5 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 1198 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 36.8 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 4-19-90 at a depth of 40.3 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1198 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 Model DPI-600 pressure transducer. The hydraulic conductivity value of 8.66×10^{-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>11-09-89</u>	<u>CAB</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>11-09-89</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> </u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>11-20-89</u>	<u>TJ</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>11-09-89</u>	<u>CAB</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>11-09-89</u>	<u>CAB</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>11-17-89</u>	<u>TJ</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>11-17-89</u>	<u>TJ</u>

RESULTS: _____

ADDITIONAL NOTES/OBSERVATIONS: _____

C. Allison Bailey 11-09-89
G. Allison Bailey
OBSERVER SIGNATURE/DATE Timothy A. Lee 11-20-89
Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1198

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

11/17/89

ORNL MONITORING WELL LOG

PAGE 1 OF 1

DATE: START: 11-09-89

FINISH: 11-20-89

LOGGED BY: Timothy A. Lee

HEALTH PHYSICIST: N/A

LUBRICANT TYPE: Green stuff

TYPE: N/A

DRILLING FLUID SAMPLES:

TYPE: Water DATE: 11-17-89

PAGE 8 OF 17.

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

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

DRILLING COMPANY: Geotek

DRILLER: George Akins HELPER: Steve Kirk

EQUIPMENT ☒ 22 INCH AUGER 14.0 L.F.
☐ _____ INCH AUGER _____ L.F.
☒ 7 7/8 INCH ROTARY 29.3 L.F.

MATERIALS USED

EST. USED
VOL. VOL.

15.0 FEET OF 2 IN. S.S. SCREEN
29.7 FEET OF 2 IN. S.S. CASING
4.5 11.0 SACKS OF SAND
50 50 POUNDS OF BENTONITE PELLETS
4.0 7.0 SACKS OF CEMENT
35 POUNDS OF POWDERED BENTONITE
32 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Irregular well diameters and
fractures and cavities.

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

MONITORING WELL PUMP BASE SET AT 40.3 FEET.

CENTRALIZERS AT 8.0 FEET.
28.0 FEET.
43.0 FEET.

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

TYPE D WELL

HOLE CLEANED OUT
TO 43.0 FEET
BOTTOM OF BOREHOLE
43.3 FEET

NOT TO SCALE

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>			<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND			11-20-89	1
BENTONITE	Pellets		11-20-89	1
	Powder		11-20-89	1
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	11-20-89	3
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	11-20-89	2
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	11-20-89	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	11-20-89	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	4-19-90	5
GROUT			11-20-89	3
WELL COVERS				
SURFACE CASING				

COMMENTS:

OBSERVER SIGNATURE/DATE Timothy A. Lee 11-20-89

D. Charles Lytle
D. Charles Lytle

4-19-90

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>11/20/89</u>	<u>Tmg</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>11/20/89</u>	<u>Tmg</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>4/19/90</u>	<u>DCS</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>11/20/89</u>	<u>Tmg</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

11/20/89

Timothy A. Lee

D. Charles Lytle

4/19/90

D. Charles Lytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1198

LOCATION: WAG 17

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 3/28/90

TIME: _____

DEVELOPMENT
ENDING DATE: 4/19/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 9.8 GALLONS

TOTAL GALLONS PUMPED: 368 TOTAL WELL VOLUMES PUMPED: 37.5

INITIAL pH: 7.7 FINAL pH: 7.8

INITIAL CONDUCTIVITY (uS): 786 FINAL CONDUCTIVITY (uS): 720

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Muddy

FINAL MEASURED TURBIDITY: * greater than 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: 25.4 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/19/90
D. Charles Lytle

ONE WELL VOLUME = 9.8 GALLONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/19/90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT. REVISION 1.0 NOV. 1976

THIS PROGRAM CALCULATES MEAN $\frac{1}{2}$ ANNEMBEL LIES FROM
SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

- (1) METHOD OF COOPER, BREDEHOLT AND RABENOLD (ARTICLE IN VOL. 3, NO. 1 OF WRF ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")
- (2) METHOD OF BOUWER AND RICE (1976) (ARTICLE IN VOL. 10, NO. 3 OF WRF ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 1198

DATE OF TEST: 5/10/90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG 17

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 19.10 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .93 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING, "0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 11

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

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

3.1402
3.2931

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME SECONDS	DEF TEST	HEAD FEET
0.00	1.210	1.130
20.00	1.700	1.110
30.00	1.950	1.090
40.00	1.940	1.070
50.00	1.250	1.050
60.00	1.120	1.030
75.00	1.050	1.010
90.00	1.040	1.000
105.00	1.970	1.040
120.00	1.560	1.070
150.00	1.940	1.010

METHOD OF BOUWER AND PICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $2.84E-05$ FT/SECONDS = $8.66E-04$ CM/SEC

TRANSMISSIVITY = $4.26E-04$ FT**2/SECONDS

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $3.92E-05$ FT/SECONDS = $1.20E-03$ CM/SEC

TRANSMISSIVITY = $5.89E-04$ FT**2/SECONDS

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

178201

WELL NO.

1198

LOCATION:

WAG 17

TYPE:

DRILL WATER

SAMPLER:

Jimothy G. [Signature]

(SIGNATURE)

SAMPLE INTERVAL:

N/A

DATE:

11-17-89

TIME:

1510

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Jimothy G. [Signature]

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 1199 is located in WAG 17. It is in the southeast corner of WAG 17 approximately 300' southeast of Bldg. 7032. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,206.5665, E 37,967.5922 (X-10 grid) or latitude 35°-56'-07.17" and longitude 84°-17'-45.31". 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 1199 was drilled by Geotek Engineering Company. An Ingersoll Rand and a Schramm air rotary rig were used to drill this boring for monitor well installation under the operation of Larry Ledbetter and George Akins with the assistance of Fred Dixon and Steve Kirk. Drilling commenced on 11-7-89 and was finished on 11-15-89. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

- 11-7-89: The T-4 and equipment were decontaminated and mobilized to the site. Plastic was layed down and a six-inch boring was split spooned and augered to a refusal depth of 13.0'. Soil samples were taken by Bechtel. A bulk density sample was taken from 10.30 to 10.64 feet. A 22.0" boring was then augered to 7.0' and a 15 1/4" diverter casing set.
- 11-9-89: The T-4 and equipment were decontaminated, mobilized to the site and rigged up. A 14.0 inch boring was drilled to a depth of 18.0' with a tricone bit. A 10 inch surface casing was installed to 18.0', a bentonite seal poured and the annulus partially grouted.
- 11-10-89: The grouting was completed.
- 11-13-89: The Schramm and equipment were decontaminated, mobilized to the location and rigged up. An eight-inch boring was advanced to 23.9' with a tricone bit.
- 11-14-89: After reaching a depth of 55.0' the borehole was cleaned and after 1 hour 2.6' of water had accumulated in the borehole. Water and air samples were taken at 23.9'. The boring was advanced to 65.0' and after 1 hour of recharge, 7.2' of water was present. The decision was made by R. C. Williams to drill the well to 73.0' and set 20.0' of screen. The boring was advanced to 73.0' and after 1 hour of recharge 9.2' of water had accumulated.

11-15-89: The water level was checked in the morning and there was 41.2' of water in the borehole. The 4 inch stainless steel screen and casing were installed, sand was tremied and bentonited poured. The remaining annulus was grouted.

This well was logged by the EDGe Group of 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

WAG 17 encompasses approximately 23 acres in Bethel Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 17 is underlain by the Middle

Ordovician Chickamauga Group consisting mainly of limestone and siltstone. The Chickamauga Group consists of eight units, designated by letters A through H (Stockdale, 1951).

WAG 17 is underlain by units E, F, G and a portion of H. These units consist of thin bedded nodular limestone with clay and shale partings. Portions of units H and F consist of calcareous siltstone alternating with beds of olive gray to maroon shale. The regional strike is 56° northeast and has a moderate dip of 30° to 40° southeast.

2.3 Sample Collection

Soil samples were collected during drilling by Bechtel National, Inc., the Remedial Investigation/Feasibility Study constructor. A drill water sample was collected from the water pump on the drill rig on 11-14-89. Analytical results for the water sample can be obtained from the Remedial Action Program data base at ORNL. The analytical results for the soil samples can be obtained from Bechtel.

A bulk density soil sample was collected from the split spoon sample interval from 10.30 to 10.64 feet. The sample was measured and weighed, and a bulk density of 1.94 grams/cm³ was calculated.

The Schramm Air Rotary Rig's compressed air was sampled with a cloth filter inserted between drill rods on 11-14-89. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no evidence of hydrocarbons.

2.4 Installation and Development

2.4.1 Installation

This was a type B well. A 6-inch diameter boring was split spooned and augered from ground surface to a total depth of 13.0 feet. A 22.0-inch diameter boring was augered from ground surface to 7.0 feet. A 15 1/4-inch diverter casing was installed from surface to 7.0 feet below ground surface and grouted in place. The boring was then extended past the refusal depth with a 14.0-inch air rotary tricone roller bit from 7.0 feet to 18.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 18.0 feet, sealed with a 2.0-foot bentonite pellet layer from 16.0 feet to 18.0 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 73.0 feet. A 4-inch diameter stainless steel cap was installed from 72.8 feet to 72.6 feet. A 4-inch diameter stainless steel screen was installed from the top of the cap at 72.6 feet to 52.6 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 52.6 feet and extended 1.58 feet above ground surface. A sandpack was then tremied into the annular space from 72.8 to 47.8 feet, with a 3.1-foot bentonite pellet seal poured into the annular space above the sandpack from 47.8 to 44.7 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 1199 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 146 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 3-30-90 at a depth of 70.0 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1199 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 Model DPI-600 pressure transducer. The hydraulic conductivity

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Services Co.

MONITORING WELL PROGRAM
WELL DATA NARRATIVE
WELL No. 1199

value of 2.70×10^{-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>11-07-89</u>	<u>CAB</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>11-07-89</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> </u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>11-14-89</u>	<u>Tms</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>11-07-89</u>	<u>CAB</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>11-07-89</u>	<u>CAB</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>11-07-89</u>	<u>CAB</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>11-14-89</u>	<u>Tms</u>

RESULTS: No detectable hydrocarbons observed under ultra violet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

C. Allison Bailey 11-07-89
C. Allison Bailey

OBSERVER SIGNATURE/DATE Timothy A. Lee 11-14-89
Timothy A. Lee

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WELL No. 1199

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 11-07-89
C. Allison Bailey

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WELL No. 1199

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG 17
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersol Rand T-4

DATE: START: 11-07-89
FINISH: 11-15-89
LOGGED BY: C. Allison Bailey/
Timothy A. Lee
HEALTH PHYSICIST: N/A

TYPE DRILLING: Split spoon, Augering, Air rotary LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: See samples taken by Bechtel TYPE: Soil

CONTAINMENT TYPE: Plastic, Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 13.0'

DEPTH DRILLED IN ROCK: 56.0'

TOTAL DEPTH OF WELL: 73.0'

DRILLING FLUID SAMPLES:

TYPE: Drill Water DATE: 11-14-89

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	2.0		100%	Clay, light brown, firm - will hold form, moist - contains gravel fill material from 0.0' to 1.0'.
2.0	4.0		85%	Clay, mottled, light brown and pale yellowish brown, very hard; tight, damp to moist. Not plastic.
4.0	5.8		100%	Clay, slightly shaley, mottled, light brown and dark yellowish orange. Clay is layered, hard, firm; will hold form, moist. Slightly plastic.
5.8	6.0		100%	Clay, slightly shaley, mottled, light brown, and dark yellowish orange. Clay contains dusky yellowish brown to dusky yellow spots (Mn oxide mineral). Firm, will hold form.
6.0	7.0		100%	Clay, mottled, light reddish brown to light brown and dark yellowish orange. Firm. Moist to wet.
7.0	9.0		100%	Clay, mottled, light brown and moderate yellowish brown. Contains black mineral specks. Hard, firm, moist to wet.
9.0	10.5		100%	Clay, mottled, moderate yellowish brown and

1991-C-0186

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WELL No. 1199

ORNL MONITORING WELL LOG

PAGE 2 OF 2

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
9.0	10.5			(continued) light brown. Moist. Plastic.
10.5	11.0		100%	Clay, mottled, light olive gray and light
				brown. Dry to damp. Slightly crumbly. The
				bottom of the spoon contains calcareous silt-
				stone fragments. Bulk density taken from
				10.3' to 10.64' = 1.94 grams/cm ³ .
11.0	11.5		100%	Limestone, crushed fragments, light olive gray,
				fine grained, very hard with some calcite
				veins. Some edges ironstained. Rock is
				float material.
11.5	13.0		100%	Clay, mottled, light brown, dark yellowish
				orange and moderate greenish yellow. Firm,
				hard, plastic and moist.
	13.0			Auger and split spoon refusal.
13.0	18.2			*Limestone, hard drilling.
18.2	23.5			Limestone, hard.
23.5	24.0			Limestone, shaley, soft.
24.0	40.6			Limestone, hard.
40.6	50.0			Limestone, shaley, hard and soft.
50.0	55.0			Limestone, hard.
55.0	56.8			Limestone, hard.
56.8	57.3			Limestone, shaley, soft.
57.3	65.0			Limestone, hard.
65.0	73.0			Limestone, hard.
	73.0			Total Depth
				*No detailed lithologic log could be provided
				from 13.0' to 73.0' due to use of a contain-
				ment box.

4.0 IN. DIA. STAINLESS STEEL
- SIFT TRAP/CAP 72.6 TO
72.8 FEET

PAGE 12 OF 20

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WELL No. 1199

DATE: 11-15-89

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL	DATE USED	BATCH NUMBER
SAND	11-15-89	1
BENTONITE	11-09-89	1
	11-15-89	3
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	11-15-89	2
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	11-15-89	2
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	11-15-89	2
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	11-15-89	2
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	3-30-90	5
GROUT	11-09-89	2
	11-15-89	2
WELL COVERS	11-15-89	3
SURFACE CASING	11-09-89	3

COMMENTS:

D. Charles Lytle 3-30-90
D. Charles Lytle
OBSERVER SIGNATURE/DATE *C. Allison Bailey* 11-09-89
Timothy A. Lee 11-15-89

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>11-07-89</u>	<u>CAB</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>11-15-89</u>	<u>CAB</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>11-15-89</u>	<u>TJL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>11-15-89</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 11-07-89
C. Allison Bailey
Timothy A. Lee 11-15-89
Timothy A. Lee

ERC / EDGE
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and Energy
Services Co.

WELL No. 1199
LOCATION: WAG 17

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping.

DEVELOPMENT
BEGAN DATE: 3/28/90

TIME: _____

DEVELOPMENT
ENDING DATE: 3/30/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 44.5 GALLONS

TOTAL GALLONS PUMPED: 146 TOTAL WELL VOLUMES PUMPED: 3.3

INITIAL pH: 7.5 FINAL pH: 7.7

INITIAL CONDUCTIVITY (uS): 603 FINAL CONDUCTIVITY (uS): 588

DESCRIPTION OF INITIAL TURBIDITY: Slightly Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 4.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR
OF WATER: None

WATER
DISCHARGED
TO:

☒ GROUND SURFACE
☐ STORM SEWERS
☐ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 30.9 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle

D. Charles Lytle 3-30-90

ONE WELL VOLUME = 44.5 GALLONS

OBSERVER SIGNATURE/DATE D. Charles Lytle
D. Charles Lytle 3/30/90

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT VERSION 4.1 11/87

THIS PROGRAM CALCULATES MEAN TRANSMISSION COEFFICIENT
SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

- (1) METHOD OF COOPER, LEITCHHEAD AND PARADOLIS, 1967
ARTICLE 11 VOL. 7, NO. 1 OF WFF ENTITLED
"RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS
CHANGE OF WATER"
- (2) METHOD OF BOUMER AND RICE, 1976 ARTICLE 11
VOL. 12, NO. 3 OF WFF ENTITLED
"A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY
OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY
PENETRATING WELLS"

WELL NO.: 1199

DATE OF TEST: 4/8/77

PROJECT NO.: E221-002

CLIENT: MMEB

SITE LOCATION: WAG 17

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTEF

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 45.40 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .97 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING, "0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

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

SUCCESSIVE COMPUTED
VALUES FOR H₀
(FEET)

1.9989
2.0163

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME SEC	DEPTH OF WATER FEET	TIME SEC
10.00	2.250	1.15
20.00	2.200	1.40
30.00	2.150	1.50
40.00	2.100	1.70
50.00	2.050	1.85
60.00	2.000	1.95
75.00	1.950	2.10
90.00	1.900	2.20
105.00	1.850	2.25
120.00	1.820	2.30
150.00	1.790	2.50
180.00	1.750	2.60
240.00	1.650	2.80
300.00	1.550	2.90
360.00	1.470	2.90
420.00	1.420	2.450
480.00	1.390	2.420
540.00	1.370	2.400
600.00	1.340	2.370
720.00	1.300	2.330
840.00	1.230	2.260
960.00	1.220	2.250
1080.00	1.190	2.220
1200.00	1.180	2.210
1320.00	1.180	2.210
1440.00	1.190	2.220
1560.00	1.190	2.220
1680.00	1.150	2.180
1800.00	1.150	2.180
1920.00	1.160	2.190
2040.00	1.150	2.180
2160.00	1.150	2.180

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $8.87E-07$ FT/SECONDS = $2.70E-05$ CM/SEC

TRANSMISSIVITY = $1.77E-05$ FT**2/SECONDS

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.05E-06$ FT/SECONDS = $3.20E-05$ CM/SEC

TRANSMISSIVITY = $2.10E-05$ FT**2/SECONDS

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

CHAIN OF CUSTODY RECORD

FOR

MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE
NUMBER

1191W01

WELL NO.

1191

LOCATION:

WAG 17

TYPE:

DRILL WATER

SAMPLER:

Timothy C. Gier

(SIGNATURE)

SAMPLE INTERVAL:

26.0'

DATE:

11-14-81

TIME:

0800

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Timothy C. Gier

12/19/81

1245

ERC

JHS

12/19/82

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 1200 is located in WAG 17. It is located in the southwest corner of the parking lot, approximately 250' southwest of Bldg. 7013. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 21,339.1837, E 36,317.7933 (X-10 grid) or latitude 35°-55'-59.19" and longitude 84°-18'-02.88". 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 1200 was drilled by Geotek Engineering Company. A Schramm Air Rotary rig was used to drill this boring for monitor well installation under the operation of George Akins with the assistance of Steve Kirk. Drilling commenced on 11-8-89 and was finished on 11-13-89. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

11-8-89: The Schramm was mobilized to the staked location and set up on plastic. Split spoon samples were taken from the surface to 4.7 feet. The boring was augered with a 6" auger to refusal at 4.7 feet. The boring was then augered with a 14" auger to 3.3 feet. The rig was moved off the hole.

11-9-89: Set 3.3 feet of 10 3/4" diverter casing and grouted with 3 sacks cement.

11-10-89: Moved Schramm to location and drilled from 4.7' to 35.0' with 7 7/8" air rotary tri-cone using the containment box.

11-13-89: Continued drilling from 35.0' to 40.0' with a 7 7/8" air rotary tri-cone using the containment box. Had 4 feet of water in hole after 1 hour. Install-ed 2" casing, screen, sand pack and bentonite seal. Grouted annulus with 6 sacks of cement.

This well was logged by the EDGe Group of 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

WAG 17 encompasses approximately 23 acres in Bethel Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 17 is underlain by the middle Ordovician Chickamauga Group consisting mainly of limestone and siltstone. The Chickamauga Group consists of eight units, designated by letters A through H (Stockdale, 1951). WAG 17 is underlain by units E, F, G and a portion of H. These units consist of thin bedded nodular limestone with clay and shale partings. Portions of units H and F consist of calcareous siltstone alternating with beds of olive gray to maroon shale. The regional strike is 56° northeast and has a moderate dip of 30° to 40° 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 1200S01 was collected in the split spoon interval from 1.4' to 1.7' on 11-8-89.

A drill water sample was collected from the water pump on the drill rig on 11-10-89. Analytical results for the soil and water 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 1.4' to 1.7'. The sample was measured and weighed, and a bulk density of 2.18 grams/cm³ was calculated.

The Schramm air rotary rig's compressed air was sampled with a cloth filter inserted between drill rods on 11-13-89. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no evidence 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 from ground surface to refusal (4.7 feet). The air rotary method was required to complete the boring to the

specified total well depth. Therefore, a 14 inch diameter boring was augered from ground surface to 4.7 feet and a 10 3/4 inch diverter casing was installed and grouted. A 7 7/8-inch diameter boring was then drilled with an air rotary tricone roller bit from 4.7 to 40.0 feet. A 2-inch diameter stainless steel screen with a 0.2-foot bottom silt trap/cap was installed from 29.8 to 40.0 feet. A 2-inch diameter stainless steel casing was installed above the screen at 29.8 feet and extended 2.15 feet above ground surface. A sandpack was then tremied into the annular space from 28.1 to 40.0 feet, with a 1.6-foot bentonite pellet seal poured into the annular space above the sandpack from 26.6 to 28.1 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 1200 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 177 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 1.0 NTU. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 4-3-90 at a depth of 38.25 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 1200 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 Model DPI-600 pressure transducer. The hydraulic conductivity value of 2.25×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

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>11-08-89</u>	<u>TJm</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>11-08-89</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> </u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>11-13-89</u>	<u>TJm</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>11-08-89</u>	<u>TJm</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>11-08-89</u>	<u>TJm</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>11-08-89</u>	<u>TJm</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>11-13-89</u>	<u>TJm</u>

RESULTS: _____

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE Timothy A. Lee 11-13-89
Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1200

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

11/08/89

Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1200

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG 17
DRILLER: George Akins
HELPER: Steve Kirk
DRILL: Schramm

DATE: START: 11-08-89
FINISH: 11-13-89
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: N/A

TYPE DRILLING: Split spoon/Auger/Air rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: 1 (one) TYPE: Soil
CONTAINMENT TYPE: Plastic, Pan, Containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 4.7'
DEPTH DRILLED IN ROCK: 35.3
TOTAL DEPTH OF WELL: 40.0

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 11-10-89

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	0.7			Augered asphalt and gravel fill.
0.7	1.2		80%	Gravel fill and asphaltic clay mix.
1.2	2.0	1200S01	80%	Clay, dark yellowish orange, plastic, slightly
		@1.4'-1.7'		damp clay, mottled yellowish gray; dark iron
				streaks; scattered sandstone fragments, dark
				reddish brown, medium grained; bulk density.
				Sample taken 1.4' to 1.7';
				Bulk density = 2.18 g/cm ³
2.0	2.7		80%	Clay, dark yellowish orange, slightly silty,
				plastic, slightly damp; clay mottled yellowish
				gray; dark iron streaks; scattered sandstone
				fragments dark reddish brown, medium grained;
				scattered limestone fragments, olive gray,
				medium crystalline.
2.7	4.7		25%	*Limestone, shaley, moderate olive brown, hard.
	4.7			Split spoon refusal.
	4.7			6" auger refusal.
4.7	9.3			Limestone, hard drilling.
9.3	9.6			Limestone, shaley, soft.
9.6	20.0			Limestone, hard
20.0	25.0			Limestone, hard.

PAGE 2 OF 2

PAGE 10 OF 21.

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: George Akins HELPER: Steve Kirk

EQUIPMENT
☒ 14 INCH AUGER 4.7 L.F.
☐ INCH AUGER L.F.
☒ 7 7/8 INCH ROTARY 35.3 L.F.

MATERIALS USED

EST. USED VOL. VOL.
10.0 FEET OF 2 IN. S.S. SCREEN
32.0 FEET OF 2 IN. S.S. CASING
3.0 3.5 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
4.5 6.0 SACKS OF CEMENT
12 POUNDS OF POWDERED BENTONITE
43.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Due to irregular boring diameter and fractures.

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

MONITORING WELL PUMP BASE SET AT 38.25 FEET.

CENTRALIZERS AT FEET.
10 FEET.
30 FEET.

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

HOLE CLEANED OUT
TO 40.0 FEET
BOTTOM OF BOREHOLE
40.0 FEET

LOCATION WAG 17
ORNL GRID COORDINATES
N 21,339.1837
E 36,317.7933
ELEV. GROUND 835.77
ELEV. TOP STAINLESS
STEEL CASING 837.92
DRILLING DATES:
STARTED: 11-08-89
FINISHED: 11-13-89

TYPE D WELL

NOT TO SCALE

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	11-13-89	1
BENTONITE Pellets	11-13-89	1
Powder	11-13-89	3
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	11-13-89	2
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	11-13-89	2
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	11-13-89	2
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	11-13-89	2
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	4-03-90	5
GROUT	11-13-89	2
WELL COVERS		
SURFACE CASING	11-08-89	2

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee 11-13-89

Timothy A. Lee

D. Charles Lytle 4-03-90

D. Charles Lytle

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>11-08-89</u>	<u>TLg</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>11-08-89</u>	<u>TLg</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>4-04-90</u>	<u>DCS</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>11-13-89</u>	<u>TLg</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 11-13-89
Timothy A. Lee

D. Charles Lytle 4-03-90
D. Charles Lytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1200

LOCATION: WAG 17

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 3/28/90

TIME: _____

DEVELOPMENT
ENDING DATE: 4/03/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 10.0 GALLONS

TOTAL GALLONS PUMPED: 177 TOTAL WELL VOLUMES PUMPED: 17.7

INITIAL pH: 7.5 FINAL pH: 7.2

INITIAL CONDUCTIVITY (uS): 811 FINAL CONDUCTIVITY (uS): 772

DESCRIPTION OF INITIAL TURBIDITY: Slightly Cloudy

DESCRIPTION OF FINAL TURBIDITY: Crystal Clear

FINAL MEASURED TURBIDITY: 1.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR
OF WATER: None

WATER
DISCHARGED
TO:

☒ GROUND SURFACE
☐ STORM SEWERS
☐ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 6.3 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle

D. Charles Lytle 4/03/90

DATE: 3/28/90

ONE WELL VOLUME = 10.0 GALLONS

COMMENTS	Nice recharger and producer. Water cleared several cycles after surging.
	Well remained clear, passed and moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/03/90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROJECT NO.: E221-002 DATE OF TEST: 4-10-70

THIS PROGRAM CALCULATES HYDRAULIC CONDUCTIVITY FROM
SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

- 1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPOULOS, 1967
(ARTICLE IN VOL. 7, NO. 1 OF WPR ENTITLED
"RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS
CHANGE OF WATER")
- 2) METHOD OF LOMER AND RICE, 1972 (ARTICLE IN
VOL. 12, NO. 3 OF WPR ENTITLED
"A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY
OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY
PENETRATING WELLS")

WELL NO.: 1200

DATE OF TEST: 4-10-70

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAB 17

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 34.70 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 1.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING, "0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

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

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

3.8893
3.9267

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME SECONDS	DEPTH FEET	HEAD FEET
12.00	5.270	4.270
24.00	5.210	4.210
36.00	5.150	4.150
48.00	5.450	4.450
60.00	5.340	4.340
72.00	5.270	4.270
84.00	5.100	4.100
96.00	4.960	3.960
108.00	4.870	3.870
120.00	4.780	3.780
132.00	4.670	3.670
144.00	4.400	3.400
156.00	4.110	3.110
168.00	3.890	2.890
180.00	3.720	2.720
192.00	3.520	2.520
204.00	3.450	2.450
216.00	3.360	2.360
228.00	3.270	2.270
240.00	3.100	2.100
252.00	2.990	1.990
264.00	2.850	1.850
276.00	2.820	1.820
288.00	2.760	1.760
300.00	2.660	1.660
312.00	2.560	1.560
324.00	2.530	1.530
336.00	2.470	1.470
348.00	2.450	1.450
360.00	2.400	1.400
372.00	2.360	1.360
384.00	2.330	1.330

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF EDWARDS AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $7.37E-07$ FT/SECONDS = $2.25E-05$ CM/SEC

TRANSMISSIVITY = $7.37E-06$ FT**2/SECONDS

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $9.71E-07$ FT/SECONDS = $2.96E-05$ CM/SEC

TRANSMISSIVITY = $9.71E-06$ FT**2/SECONDS

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

1200501

WELL NO. 1200		LOCATION: WAG 17		TYPE: Soil			
SAMPLER: <i>Jeffrey A. Doss</i> (SIGNATURE)		SAMPLE INTERVAL: 1.4' to 1.7'		DATE: 11-8-89		TIME: 13.45	
RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<i>Jeffrey A. Doss</i>	12/19/89	1245	ERC	JHS	12/19/89	12:49	

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

1200.WC1

WELL NO.

1200

LOCATION:

WAG 17

TYPE:

DRILL WATER

SAMPLER:

Smith, Q. J.

SAMPLE INTERVAL:

12'

DATE:

11-10-89

TIME:

1100

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Smith, Q. J.

12/19/89

1245

EAC

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 1201 is located in WAG 17. It is located in the parking lot approximately 100 feet west of Bldg 7003. The location is shown on ORNL drawing number C3E20002A075. Survey coordinates for this well at N 21,566.8925, E 36,414.6397 (X-10 grid) or latitude 35°-56'-01.59" and longitude 84°-18'-03.44. 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 1201 was drilled by Geotek Engineering Company. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of George Akins with the assistance of James Shelton. Drilling commenced on 11-30-89 and was finished on 12-7-89. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

- 11-30-89: The rig was mobilized to the staked location and set up on a sheet of plastic. The boring was augered with a 20" auger to refusal at 3.4 feet. Set 3.4 feet of 15 3/4 inch decontaminated steel diverter casing and grouted it into place with 1 sack of cement. The rig was moved from the location.
- 12-4-89: The rig was mobilized to the location and set up on plastic. The boring was deepened from 3.4 feet to 24.8 feet using a 14 1/2 inch air rotary tricone bit into the containment box.
- 12-5-89: The boring was deepened from 24.8 feet to 30.0 feet. Set 30.0 feet of 10 3/4 inch decontaminated steel surface casing with Bentonite seal. The rig was moved from the location.
- 12-6-89: The surface casing was tremie grouted into place with 10 sacks cement.
- 12-7-89: The rig was mobilized to location and set up on plastic. The boring was deepened from 30.0 feet to 48.0 feet using a 7 7/8 inch air rotary tricone bit into a containment box. Estimated total depth was to be 65.0 feet, however, a large volume of water was encountered at 43.0 feet. Therefore, a decision was made to complete it at 48.0 feet. Stainless steel screen and casing were set with a sand pack and bentonite seal. The rig was moved from location.

12-8-89: The casing was tremie grouted into place with 9.0 sacks cement.

This well was logged by the EDGe Group of 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

WAG 17 encompasses approximately 23 acres in Bethel Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 17 is underlain by the Middle Ordovician Chickamauga Group consisting mainly of limestone and siltstone. The Chickamauga Group consists of eight units, designated by letters A through H (Stockdale, 1951). WAG 17 is underlain by units E, F, G and a portion of H. These units consist of thin bedded nodular limestone with clay and shale partings. Portions of units H and F consist of

calcareous siltstone alternating with beds of olive gray to maroon shale. The regional strike is 56° northeast and has a moderate dip of 30° to 40° southeast.

2.3 Sample Collection

No soil samples were collected during drilling.

A drill water sample was collected from the water pump on the drill rig on 12-7-89. Analytical results for the Schramm Rotadrill drill water samples described above can be obtained from the Remedial Action Program data base at ORNL.

The Schramm Rotadrill compressed air was sampled with a cloth filter inserted between drill rods on 12-7-89. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable hydrocarbons under ultraviolet light.

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 3.4 feet (auger refusal). A 15 1/4-inch diverter casing was installed from surface to 3.4 feet below ground surface and grouted in place. The boring was then extended past the refusal depth with a 14 1/2-inch air rotary tricone roller bit from 3.4 feet to 30.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 30.0 feet, sealed with a 1.1-foot bentonite pellet layer from 28.9 feet to 30.0 feet, and tremie-grouted in place. The surface casing minimizes potential cross contamination between the regolith

and bedrock water bearing zones. After the surface casing was installed, the air rotary method was used to drill an 8-inch diameter boring to a total depth of 48.0 feet. A 4-inch diameter stainless steel screen with bottom cap was installed from 37.6 feet to 47.8 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 37.6 feet and extended 2.0 feet above ground surface. A sandpack was then tremied into the annular space from 35.4 to 47.8 feet, with a 3.5-foot bentonite pellet seal poured into the annular space above the sandpack from 31.9 to 35.4 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 1201 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 315 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 4-2-90 at a depth of 46.8 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 1201 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 Model DPI-600 pressure transducer. The hydraulic conductivity value of 9.63×10^{-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>11-30-89</u>	<u>TJm</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>11-30-89</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></u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>12-07-89</u>	<u>TJm</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>11-30-89</u>	<u>TJm</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>11-30-89</u>	<u>TJm</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>11-30-89</u>	<u>TJm</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>12-07-89</u>	<u>TJm</u>

RESULTS: Showed no hydrocarbons under ultra violet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE Timothy A. Lee 11-30-89

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

11/30/89
12/04/89

ERC / EDGE
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Services Co.

WELL No. 1201

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG 17
DRILLER: George Akins
HELPER: James Shelton
DRILL: Schramm Rota drill

DATE: START: 11-30-89
FINISH: 12-08-89
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: N/A

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

THICKNESS OF SOIL (REFUSAL DEPTH): 3.4
DEPTH DRILLED IN ROCK: 44.6
TOTAL DEPTH OF WELL: 48.0

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 12-07-89

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	1.0		Augered	Asphalt and gravel.
1.0	3.4		Augered	Gravel and clay, dark yellowish orange, moist, dense, medium stiff.
	3.4			Auger refusal
3.4	25.0			**Limestone, hard.
25.0	27.0			Limestone, hard.
27.0	27.2			Limestone, shaley, soft.
27.2	30.0			Limestone, hard.
30.0	43.3			Limestone, hard.
43.3	43.7			Limestone, shaley, soft.
43.7	48.0			Limestone, hard.
	48.0			Total Depth
				**No detailed lithologic descriptions are available from 3.4' to 48.0' due to the use of containment box.

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: George Akins

HELPER: James Shelton

DRILLING METHOD: ☐ 22 INCH AUGER 3.4 L.F.
☐ INCH AUGER L.F.
☐ 14 1/2 INCH ROTARY 26.6 L.F.
☐ 7 7/8 INCH ROTARY 18.0 L.F.

MATERIALS USED

EST. VOL	USED VOL	
50.0	50.0	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
30.0	30.0	FT. OF 10 3/4 IN. SURFACE CASING
9.6	10.0	SACKS OF CEMENT (SURFACE CASING)
50.0	50.0	POUNDS OF POWDERED BENTONITE (SURFACE CASING)
80.0	80.0	GALLONS OF WATER (SURFACE CASING)
39.7	39.7	FT. OF 4 IN. DIA. STAINLESS STEEL CASING
10.0	10.0	FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
3.0	3.0	SACKS OF SAND
50.0	50.0	POUNDS OF BENTONITE PELLETS
4.8	9.0	SACKS OF CEMENT (WELL CASING)
45.0	45.0	POUNDS OF POWDERED BENTONITE (WELL CASING)
72.0	72.0	GALLONS OF WATER (WELL CASING)
3.07	3.07	FT. OF 10 3/4 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and irregular boring diameters.

SURFACE CASING TREME GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREME GROUTED YES ☒ NO ☐

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

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 46.8 FEET.

CENTRALIZERS AT 9.0 FEET.

29.0 FEET.

47.0 FEET.

NOTE:

ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

LOCATION WAG 17

ORNL GRID COORDINATES
N 21,566.8925

E 36,414.6397

ELEV. GROUND 835.85

ELEV. TOP STAINLESS

STEEL CASING 837.89

DRILLING DATES:

STARTED 11-30-89

FINISHED 12-07-89

TYPE B WELL

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		12-07-89	1
BENTONITE	Pellets	12-07-89	1
	Powder	12-07-89	3
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	12-07-89	2
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	12-07-89	2
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	12-07-89	2
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	12-07-89	2
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	4-02-90	5
GROUT	Surface	12-05-89	3
	Stainless	12-07-89	3
WELL COVERS			
SURFACE CASING		12-05-89	MMES Stores

COMMENTS:

OBSERVER SIGNATURE/DATE Timothy A. Lee 12-07-89
Timothy A. Lee

D. Charles Lytle 4-02-90
D. Charles Lytle

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>12-07-89</u>	<u>Touz</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>12-07-89</u>	<u>Touz</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>4-02-90</u>	<u>DCS</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>12-07-89</u>	<u>Touz</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 12-07-89
D. Charles Lytle 4-02-90
D. Charles Lytle

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WELL No. 1201
LOCATION: WAG 17

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 3/28/90

TIME: _____

DEVELOPMENT
ENDING DATE: 4/02/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 36.7 GALLONS

TOTAL GALLONS PUMPED: 315 TOTAL WELL VOLUMES PUMPED: 8.6

INITIAL pH: 7.7 FINAL pH: 7.6

INITIAL CONDUCTIVITY (US): 748 FINAL CONDUCTIVITY (US): 737

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR
OF WATER: None

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

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 4.5 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/02/90
D. Charles Lytle

WELL NO. 1201

LOCATION: WAG 17

DATE: 3/28/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 36.7 GALLONS

COMMENTS	Nice recharger and producer. Water cleared, passed and moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/02/90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

THIS PROGRAM CALCULATES HYDRAULIC CONDUCTIVITY FROM
SLUG-TEST DATA USING TWO AVAILABLE APPROACHES:
1. METHOD OF COOPER - INTERCEPT AND EXTRAPOLATION (1962)
(ARTICLE 11 VOL. 10 OF AFE ENTITLED
"DESIGN OF A PUMP-OUT DIAPHRAGM WELL TO AQUIFERS
CHARGE OF WATER")
2. METHOD OF EDGETT AND FITE, (1962) (ARTICLE 1
VOL. 10 OF AFE ENTITLED
"A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY
OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY
PENETRATING WELLS")

WELL NO.: 1201

DATE OF TEST: 4-10-82

PROJECT NO.: EEC1-001

CLIENT: MMCE

SITE LOCATION: WAG 17

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 45.00 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .91 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING, "0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 19

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

SUCCESSIVE COMPUTED
VALUES FOR H₀
(FEET)

1.6416
1.6043

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME SEC	DEPTH TO WATER FEET	SEAL FEET
10.00	1.130	1.00
20.00	1.120	1.00
30.00	1.100	1.00
40.00	1.100	1.00
50.00	1.110	1.10
60.00	1.110	1.10
75.00	1.120	1.10
90.00	1.180	1.10
105.00	1.160	1.10
120.00	1.440	1.10
150.00	1.160	1.10
160.00	1.140	1.10
240.00	1.150	1.10
300.00	1.170	1.10
360.00	1.080	1.10
420.00	1.040	1.10
480.00	.960	.050
540.00	.960	.050
600.00	.930	.020

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $3.16E-05$ FT/SECONDS = $9.63E-04$ CM/SEC

TRANSMISSIVITY = $3.16E-04$ FT**2/SECONDS

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $3.81E-05$ FT/SECONDS = $1.16E-03$ CM/SEC

TRANSMISSIVITY = $3.81E-04$ FT**2/SECONDS

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

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

SAMPLE
NUMBER

1201W01

WELL NO.

1201

LOCATION:

WAG 17

TYPE:

DRILL WATER

SAMPLER:

Justin G. Orr

(SIGNATURE)

SAMPLE INTERVAL:

44.0'

DATE:

12-7-89

TIME:

1050

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WTH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WTH:

Justin G. Orr

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 1202 is located in WAG 17. It is in the western portion of WAG 17, approximately 100' south of the west portal. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well at N 21,581.5347, E 36,414.7669 (X-10 grid) or latitude 35°-56'-01.71" and longitude 84°-18'-03.54". 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 1202 was drilled by Geotek Engineering Company. An Ingersoll Rand T-4 and a Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of Larry Ledbetter/George Akins with the assistance of Fred Dixon/Steve Kirk/James Shelton. Drilling commenced on 11-8-89 and was finished on 12-11-89. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

- 11-8-89: The Ingersoll Rand T-4 rig was moved to the well site and set up on plastic. The boring was augered from ground level to 0.8 feet with 8 inch auger and split spoon samples were taken from 0.8 feet to 3.6 feet (refusal). The boring was then augered from ground level to 3.5 feet to refusal with a 22 inch auger and 3.5 feet of decontaminated diverter casing was set and grouted into place.
- 11-16-89: A Schramm rig was set up on plastic and deepened the boring from 3.5 feet to 10.0 feet with a 14 inch air rotary tricone bit using the diverter and containment box. 10 3/4" decontaminated steel casing was set at 10.0 feet. The rig was moved from location.
- 11-17-89: The surface casing was grouted with 2.0 sacks cement.
- 11-29-90: The rig was moved to location. The boring was deepened from 10.0 feet to 50.0 feet using a 7 7/8 inch air rotary tricone bit. A large volume of water was encountered from 14.0 feet to 15.0 feet. Therefore it was decided to drill the offset well and plug this well back to 25.0 feet. The rig was moved from the location.
- 12-7-89: The boring was plugged back to 22.9 feet with 5.0 sacks cement.
- 12-11-89: Set 20.0 feet of stainless steel screen and casing with a sand pack and bentonite seal.

12-12-89: The casing was grouted into place with 1.5 sacks of cement.

This well was logged by the EDGe Group of 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

WAG 17 encompasses approximately 23 acres in Bethel Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 17 is underlain by the Middle Ordovician Chickamauga Group consisting mainly of limestone and siltstone. The Chickamauga Group consists of eight units, designated by letters A through H (Stockdale, 1951). WAG 17 is underlain by units E, F, G and a portion of H. These units consist of thin bedded nodular limestone with clay and

shale partings. Portions of units H and F consist of calcareous siltstone alternating with beds of olive gray to maroon shale. The regional strike is 56° northeast and has a moderate dip of 30° to 40° 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 soil sample is included with this data package. Soil sample 1202S01 was collected in the split spoon interval from 3.1' to 3.5' on 11-8-89.

A drill water sample was collected from the water pump on the drill rig on 11-29-89. Analytical results for the Schramm Rotadrill drill water sample 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 3.1' to 3.5'. The sample was measured and weighed, and a bulk density of 2.0 grams/cm³ was calculated.

The Schramm Rotadrill compressed air was sampled with a cloth filter inserted between drill rods on 11-29-89. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no evidence 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 3.5 feet. A 15 1/4-inch diverter casing was installed from surface to 3.5 feet below ground surface and grouted in place. A 6-inch diameter boring was augered from 0.0 feet to 3.6 feet (auger refusal). The boring was then extended past the refusal depth with a 14 1/2-inch air rotary tricone roller bit from 3.6 feet to 10.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 10.0 feet, sealed with a 2.7-foot bentonite pellet layer from 7.3 feet to 10.0 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 50.0 feet. The well has plugged back to 20.3 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 10.1 feet to 20.3 feet. A 2-inch diameter stainless steel casing was installed from the top of the screen at 10.1 feet and extended 2.10 feet above ground surface. A sandpack was then tremied into the annular space from 7.8 to 20.3 feet, with a 1.8-foot bentonite pellet seal poured into the annular space above the sandpack from 6.0 to 7.8 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 1202 was developed to remove drill cuttings, silt, and other fines. The monitoring was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 302 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 3-30-90 at a depth of 18.8 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1202 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 Model DPI-600 pressure transducer. The hydraulic conductivity (shown as permeability on the hydraulic conductivity calculations

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MONITORING WELL PROGRAM
WELL DATA NARRATIVE
WELL No. 1202

printout attached) value of 1.13×10^{-3} cm/second 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>11/07/89</u>	<u>MLE</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>11/07/89</u>	<u>MLE</u>
3a. SCREEN AND CASING HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	<u>N/A</u>	<u>N/A</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>12/11/89</u>	<u>CAH</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>11/07/89</u>	<u>MLE</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>11/07/89</u>	<u>MLE</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>11/07/89</u>	<u>MLE</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>11/16/89</u>	<u>CAH</u>

RESULTS: Sample showed no hydrocarbons under ultra violet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE C. Allison Hodges 12/11/89

OBSERVER SIGNATURE/DATE Michael L. Ebers 11/08/89
Michael L. Ebers

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

11/14/89

OBSERVER SIGNATURE/DATE

Michael L. Ebers

11/08/89

Michael L. Ebers

ERC / EDGE
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and Energy
Services Co.

WELL No. 1202

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG 17
DRILLER: Larry Ledbetter/George Akins
HELPER: Fred Dixon/Steve Kirk/James Shelton
DRILL: Ingersoll Rand T-4/Schramm Rotadrill

DATE: START: 11/08/89
FINISH: 12/12/89
LOGGED BY: Michael L. Ebers/
Timothy A. Lee
HEALTH PHYSICIST: N/A

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

No. SAMPLES TAKEN: One TYPE: Soil (1202S01)

CONTAINMENT TYPE: Pan and Plastic, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 3.6'

DEPTH DRILLED IN ROCK: 46.4

TOTAL DEPTH OF WELL: 50.0

DRILLING FLUID SAMPLES:

TYPE: Water DATE: 11-29-89

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	1.0		Augered	Asphalt and gravel.
1.0	3.0		10%	Gravel and clay, dark yellowish orange, moist, dense, medium stiff.
3.0	3.6	1202S01	100%	Clay, light brown, damp, dense, very stiff.
		@3.1'-3.5'		Bulk density (@ 3.1'-3.5') = 2.0 grams/cm ³ .
	3.6			Split spoon and auger refusal.
3.6	10.0			**Limestone, hard.
10.0	14.5			Limestone, hard.
14.5	14.8			Limestone, shaley, soft.
14.8	33.1			Limestone, hard.
33.1	50.0			Limestone, hard.
	50.0			Total Depth
				(Note: This well was plugged back to 22.9' on 12-07-89 with grout and filled up to 20.3' with bentonite.)
				**No detailed lithologic descriptions are available from 3.6' to 50.0' due to the use of the containment box.

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and Energy
Services Co.

WELL No. 1202

DATE: 12/11/89

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		12-11-89	1
BENTONITE	Pellets	12-11-89	1
	Powder	12-11-89	3
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	12-11-89	2
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	12-11-89	2
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	12-11-89	2
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	12-11-89	2
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	3-30-90	5
GROUT	Surface	12-11-89	3
	SS Casing	12-11-89	3
WELL COVERS		N/A	N/A
SURFACE CASING		11-16-89	3

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee

12-11-89

Timothy A. Lee

D. Charles Lytle

3-30-89

D. Charles Lytle

PAGE 12 OF 20

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>12-11-89</u>	<u>TAL</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>TAL</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>3-30-90</u>	<u>DCS</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>12-11-89</u>	<u>TAL</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 12-11-89
Timothy A. Lee

D. Charles Lytle 3-30-90
D. Charles Lytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1202
LOCATION: WAG 17

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 3/28/90

TIME: _____

DEVELOPMENT
ENDING DATE: 3/30/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 7.4 GALLONS

TOTAL GALLONS PUMPED: 302 TOTAL WELL VOLUMES PUMPED: 41.0

INITIAL pH: 7.9 FINAL pH: 7.6

INITIAL CONDUCTIVITY (uS): 546 FINAL CONDUCTIVITY (uS): 599

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Slightly Cloudy

FINAL MEASURED TURBIDITY: Greater than 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: 5.2 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 3-30-90
D. Charles Lytle

ONE WELL VOLUME = 7.4 GALLONS

COMMENTS	Fast recharger and nice producer. Had to pass, on account of the well
	volumes. Water remains slightly cloudy. Passed and moved to another
	hole.
	*Greater than 100 NTU's.

REFERENCES

HYDRAULIC CONDUCTIVITY CALCULATIONS

STANDARD SLUG TEST METHOD 4.11.10.1 FILE

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

- (1) METHOD OF COFFEY, BREDEHOEFT AND RABADOUZZO, 1967
(ARTICLE IN VOL. 3, NO. 1 OF WRF ENTITLED
"RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS
CHARGE OF WATER")
- (2) METHOD OF POWERS AND FICE, 1976 ARTICLE IN
VOL. 10, NO. 3 OF WRF ENTITLED
"A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY
OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY
PENETRATING WELLS")

WELL NO.: 1202

DATE OF TEST: 4/11/90

PROJECT NO.: E021-002

CLIENT: MMES

SITE LOCATION: WAG 17

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 16.70 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .90 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING, "0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 16

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

SUCCESSIVE COMPUTED VALUES FOR H0 (FEET)

7.3121
6.6465
6.6192

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME MIN	WATER LEVEL FEET	WATER LEVEL FEET
0.00	4.120	4.120
1.00	4.120	4.120
2.00	4.120	4.120
3.00	4.120	4.120
4.00	4.120	4.120
5.00	4.120	4.120
6.00	4.120	4.120
7.00	4.120	4.120
8.00	4.120	4.120
9.00	4.120	4.120
10.00	4.120	4.120
11.00	4.120	4.120
12.00	4.120	4.120
13.00	4.120	4.120
14.00	4.120	4.120
15.00	4.120	4.120
16.00	4.120	4.120

METHOD OF BOUWER AND FICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $3.72E-05$ FT/SECONDS = $1.13E-03$ CM/SEC

TRANSMISSIVITY = $3.72E-04$ FT**2/SECONDS

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $5.02E-05$ FT/SECONDS = $1.53E-03$ CM/SEC

TRANSMISSIVITY = $5.02E-04$ FT**2/SECONDS

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

1202 Soil

WELL NO. 1202 LOCATION: WAG 17 TYPE: Soil

SAMPLER: *Chick* (SIGNATURE) SAMPLE INTERVAL: 3.1' TO 3.5' DATE: 11/8/89 TIME: 0800

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<i>Chick</i>	11/16/89	1100		<i>J. P. W.</i>	11-16-89	1100	14/11/89

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

1202W01

WELL NO.

1202

LOCATION:

WAG 17

TYPE:

DRILL WATER

SAMPLER:

Samuel A. Dos

(SIGNATURE)

SAMPLE INTERVAL:

N/A

DATE:

11-29-89

TIME:

1410

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Samuel A. Dos

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: 110 samples were not acidified prior to receipt in 45018 JHS 12/19/89

1.0 General Information

1.1 Well Location

Monitoring well number 1203 is located in WAG 17. It is located approximately 150 feet due west of Building 7001. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well at N 21,916.3887, E 36,272.9661 (X-10 grid) or latitude 35°-56'-03.68" and longitude 84°-18'-07.24". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 1203 was drilled by Geotek Engineering Company. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of George Akins with the assistance of James Shelton. Drilling commenced on 1-2-90 and was finished on 1-4-90. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

- 1-2-90: The rig was mobilized to location and set up on plastic sheeting. Split spoon samples were taken from surface to refusal at 5.2 feet. A 6 inch auger was used to deepen the boring to 10.7 feet. A 14 inch auger was used to 4.0 feet and 10 3/4 inch decontaminated steel diverter casing was set at 4.0 feet. The rig was moved from the location.
- 1-3-90: The diverter casing was grouted into place with 2 sacks of cement.
- 1-4-90: The rig was moved to location. The boring was deepened to 18.0 feet using a 7 7/8 inch air rotary tricone bit into the containment box. Stainless steel 2 inch screen and casing was set with sand pack and bentonite seal.
- 1-5-90: The stainless steel casing was grouted into place using 1 sack cement.

This well was logged by the EDGe Group of 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

WAG 17 encompasses approximately 23 acres in Bethel Valley, which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 17 is underlain by the Middle Ordovician Chickamauga Group consisting mainly of limestone and siltstone. The Chickamauga Group consists of eight units, designated by letters A through H (Stockdale, 1951). WAG 17 is underlain by units E, F, G and a portion of H. These units consist of thin bedded nodular limestone with clay and shale partings. Portions of units H and F consist of calcareous siltstone alternating with beds of olive gray to maroon shale. The regional strike is 56° northeast and has a moderate dip of 30° to 40° 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 1203S01 was collected in the split spoon interval from 3.2 to 3.5 feet on 1-2-90.

A drill water sample was collected from the water pump on the drill rig on 1-4-90. Analytical results for the Schramm

Rotadrill drill water 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 3.2 to 3.5 feet. The sample was measured and weighed, and a bulk density of 2.22 gms/cm³ was calculated.

The Schramm Rotadrill compressed air was sampled with a cloth filter inserted between drill rods on 1-4-90. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no evidence 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 (5.2 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 4.0-feet and a 10 3/4-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 5.2 to 18.0 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 7.6 to 17.8 feet. A 2-inch diameter stainless steel casing was installed above the screen at 7.6 feet and extended 2.02 feet above ground surface. A sandpack was then tremied into the annular space from 5.6 to 17.8 feet, with a 1.6-foot bentonite pellet seal poured into the annular space above the sandpack from 4.0 to 5.6 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 1203 was developed to remove drill cuttings, silt, and other fines. The monitoring was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 174 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 4-3-90 at a depth of 16.5 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1203 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 Model DPI-600 pressure transducer. The hydraulic conductivity value of

ERC / EDGE
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and Energy
Services Co.

MONITORING WELL PROGRAM
WELL DATA NARRATIVE
WELL No. 1203

1.97x10⁻⁴ cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>1-02-90</u>	<u>TJm</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>1-02-90</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>_____</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>1-04-90</u>	<u>TJm</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>1-04-90</u>	<u>TJm</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>1-04-90</u>	<u>TJm</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>1-04-90</u>	<u>TJm</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>1-04-90</u>	<u>TJm</u>

RESULTS: No detectable hydrocarbons were detected under ultra violet
light.

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

1-04-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1203

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

1/04/90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1203

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG 17
DRILLER: George Akins
HELPER: James Shelton
DRILL: Schramm Rota drill

DATE: START: 1-02-90
FINISH: 1-04-90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: N/A

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): 10.7
DEPTH DRILLED IN ROCK: 7.3
TOTAL DEPTH OF WELL: 18.0

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 1-04-90

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	0.6		50	Gravel fill and vegetation.
0.6	2.0		50	Clay, moderate yellowish brown, dry, slightly silty, plastic; mottled with clay, dark yellowish orange; scattered fragments of gravel limestone from above.
2.0	2.6		75	Clay, moderate yellowish brown, dry, slightly silty, plastic; mottled with clay, dark yellowish orange; scattered fragments of sandstone, grayish orange, medium grained.
2.6	4.0	1203S01	75	Clay, dark yellowish brown, dry, slightly silty; mottled with clay, dark yellowish orange; scattered fragments of sandstone, grayish orange to dusky red, medium grained; bulk density from 3.2' to 3.5' is 2.22 g/cm ³ .
		3.2'-3.5'		
4.0	5.2		20	Clay, dark yellowish brown, dry, slightly silty; and fragments of chert.
	5.2			First split spoon refusal.
5.2	7.5		Augered	
7.5	8.5		60	Shale, light olive gray, limey, damp.
8.5	10.7		Augered	Shale, light olive gray, limey.
	10.7			Auger refusal.

WELL No. 1203

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 10 OF 20

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: George Akins

HELPER: James Shelton

LOCATION WAG 17

ORNL GRID COORDINATES
N 21,916,3887

E 36,272,9661

ELEV. GROUND 824.56

ELEV. TOP STAINLESS

STEEL CASING 826.58

DRILLING DATES:

STARTED: 1-02-90

FINISHED: 1-04-90

EQUIPMENT ☒ 6 INCH AUGER 10.7 L.F.

☐ INCH AUGER L.F.

☒ 7 7/8 INCH ROTARY 7.3 L.F.

MATERIALS USED

EST. USED
VOL. VOL.

10.0 FEET OF 2 IN. S.S. SCREEN

9.6 FEET OF 2 IN. S.S. CASING

3.0 5.0 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

0.5 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 16.5 FEET.

CENTRALIZERS AT 9.0 FEET.

17.0 FEET.

FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT

TO 17.8 FEET

BOTTOM OF BOREHOLE

18.0 FEET

LOCKING STEEL COVER

10 3/4 INCH DIAMETER

STEEL PROTECTIVE CASING

2.90 FT. ABOVE GROUND

TO 0.0 FT. BELOW

GROUND SURFACE

CONCRETE PAD

10 3/4 INCH DIVERTER

CASING 0.0 FT. ABOVE

GROUND SURFACE TO

4.0 FT. BELOW GROUND

SURFACE

14 INCH BOREHOLE

0.0 TO 4.0 FEET

GROUT SEAL 0.0 TO

4.0 FEET

7 7/8 INCH DIAMETER

BOREHOLE

2 INCH DIAMETER STAINLESS

STEEL CASING 2.02 FT. ABOVE

GROUND SURFACE TO 7.6 FT.

BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL

4.0 TO 5.6 FEET

SAND PACK

5.6 TO 17.8 FEET

2 INCH DIAMETER

STAINLESS STEEL 0.010

SLOTTED SCREEN

7.6 TO 17.6 FEET

2 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP

17.6 TO 17.8 FEET

TYPE D WELL

NOT TO SCALE

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>			<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND				
			1-04-90	2
BENTONITE				
		Pellets	1-04-90	1
		Powder	1-05-90	4
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	1-04-90	2
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	1-04-90	2
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	1-04-90	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	1-04-90	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	4-03-90	5
GROUT				
			1-05-90	4
WELL COVERS				
SURFACE CASING			N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee 1-04-90
Timothy A. Lee

D. Charles Lytle 4-03-90
D. Charles Lytle

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>1-04-90</u>	<u>Tbz</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>1-04-90</u>	<u>Tbz</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>4-03-90</u>	<u>DCS</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>1-04-90</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 1-04-90
D. Charles Lytle 4-03-90
D. Charles Lytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1203

LOCATION: WAG 17

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 3/28/90

TIME: _____

DEVELOPMENT
ENDING DATE: 4/03/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 7.3 GALLONS

TOTAL GALLONS PUMPED: 174 TOTAL WELL VOLUMES PUMPED: 24.0

INITIAL pH: 7.4 FINAL pH: 7.4

INITIAL CONDUCTIVITY (uS): 729 FINAL CONDUCTIVITY (uS): 707

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR
OF WATER: None

WATER
DISCHARGED
TO:

☒ GROUND SURFACE
☐ STORM SEWERS
☐ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER _____

INITIAL PRE-DEVELOPMENT

WATER DEPTH: 2.8 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/03/90
D. Charles Lytle

DATE: 3-28-90

ONE WELL VOLUME = 7.3 GALLONS

COMMENTS	Decent recharger and producer. Water cleared to 2.0 NTU.
	Passed and moved off hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 4-03-90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SUBJECT: VERSION 1.0, 12/1/80

THIS PROGRAM CALCULATES HEAD TRANSIENTS FROM
SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

- 1) METHOD OF COOPER, IDEE-DEPT AND PARALFOLDS, 1947
ARTICLE IN VOL. 1, NO. 1 OF JEE ENTITLED
"RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS
CHARGE OF WATER"
- 2) METHOD OF SOWER AND RICE, 1976 ARTICLE IN
VOL. 12, NO. 3 OF JEE ENTITLED
"A SLUG TEST FOR DETERMINING HEAD-UP TO CONDUCTIVITY
OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY
PENETRATING WELLS"

WELL NO.: 1203

DATE OF TEST: 4/10/90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG 17

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 16.60 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .85 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING, "0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 20

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

SUCCESSIVE COMPUTED VALUES FOR HO (FEET)

2.4841
2.2803
2.3591

HYDRAULIC CONDUCTIVITY CALCULATIONS

DEPTH FEET	DEPTH FEET	DEPTH FEET
10.00	1.10	1.780
20.00	1.720	1.570
30.00	2.300	1.450
40.00	2.860	1.310
50.00	3.400	1.150
60.00	3.900	1.060
70.00	4.340	1.090
80.00	4.740	1.100
100.00	5.380	1.070
120.00	5.730	1.030
150.00	6.500	1.030
180.00	7.390	1.040
240.00	9.180	1.040
300.00	11.170	1.020
360.00	13.110	1.060
420.00	15.030	1.080
480.00	16.930	1.140
540.00	18.800	1.110
600.00	20.640	1.090
720.00	28.600	1.010

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $6.48\text{E-}06$ FT/SECONDS = $1.97\text{E-}04$ CM/SEC

TRANSMISSIVITY = $6.48\text{E-}05$ FT**2/SECONDS

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $8.75\text{E-}06$ FT/SECONDS = $2.67\text{E-}04$ CM/SEC

TRANSMISSIVITY = $8.75\text{E-}05$ FT**2/SECONDS

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

CHAIN OF CUSTODY RECORD

FOR

MARTIN MARIETTA ENERGY SYSTEMS

OAK RIDGE NATIONAL LABORATORY

SAMPLE
NUMBER

1203401

WELL NO.

1203

LOCATION:

WAS 17

TYPE:

DRILL WATER

SAMPLER:

James G. ...

(SIGNATURE)

SAMPLE INTERVAL:

N/A

DATE:

1-4-90

TIME:

1105

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

James G. ...

1-3-90

1500

ERC

Redman

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:

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

1203501

WELL NO.

1203

LOCATION:

WAG 17

TYPE:

Soil

SAMPLER:

James G. P. Jr.

(SIGNATURE)

SAMPLE INTERVAL:

3.2' to 3.5'

DATE:

1-2-90

TIME:

1116

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

James G. P. Jr.

1-31-90

1500

ERC

NE Owen

4/31/90

1500

ORNL

TYPE OF SAMPLE: ☒ SPLIT SPOON CORES-SOIL

☐ AUGER CUTTINGS-SOIL

☐ AUGER CUTTINGS-ROCK

☐ AIR ROTARY CUTTINGS-ROCK

☐ DRILL WATER (NO AIR IN SAMPLE)

☐ OTHER _____

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

REMARKS:

Appendix B

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

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

**Prepared by
J. A. Greene**

PROCEDURE REVIEW AND APPROVAL Form

Environmental and Health Protection Division

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

Procedure No. _____ Rev. No. 0 Date _____

Author _____

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

Approved by: _____ Date _____
Manager, Implementing Unit

Reviewed by: Bene J. Bowles Date 1/16/90
Higher Level Manager
Quality Assurance

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

R/A		Name	Date
R	Facility Manager ^{MSB} Engineering	J.R. Lawson	11/4/89
	Environmental Protection Officer		
R	Safety Officer		
	Office of Operational Safety		
A	Health Physics	J.L. Gray	08-31-89
R	Industrial Hygiene	B.R. Lankford	9/15/89
	Division Director		
	Associate Division Director		
	Section Head		
A	Other Project Manager	J.A. GREENE	11/14/89
A	Other Environmental Compliance	C.E. Nix	10/5/89
R	Other Waste Management	C.B. Scott	11/1/89

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

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

Next review dates: 2 yrs.

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

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

1.0 PURPOSE

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

2.0 SCOPE

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

3.0 REFERENCE

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

4.0 DEFINITIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

5.0 RESPONSIBILITIES

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

6.0 PROCEDURE

6.1 EXPLANATION OF THE WELL RATING SYSTEM

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

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

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

6.2 CATEGORY 1 WELLS (RP OR IH)

6.2.1 Category 1 Drilling

6.2.1.1 Category 1 Auger Cuttings

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

6.2.1.2 Category 1 Air Rotary Drilling

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

(2) disposal at the containment box holding pit.

6.2.2 Category 1 Well Development

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

6.3 CATEGORY 2 WELLS (RP AND IH)

6.3.1 Category 2 Drilling

6.3.1.1 Category 2 Auger Cuttings

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

6.3.1.2 Category 2 Air Rotary Drilling

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

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

6.3.2 Category 2 Development

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

6.4 CATEGORY 3 WELLS (RP AND IH)

6.4.1 Category 3 Drilling

6.4.1.1 Category 3 Augering

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

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

6.4.1.2 Category 3 Air Rotary Drilling

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

6.4.2 Category 3 Development

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

6.5 BOREHOLE CLEANING

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

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

*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.

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

WAG 17 GROUNDWATER QUALITY MONITORING WELLS AS-BUILT COORDINATES

WELL #	NORTHING	EASTING
1196	21,988.52	37,553.85
1197	21,732.70	37,533.94
1198	21,214.15	37,584.98
1199	21,206.57	37,967.59
1200	21,339.18	36,317.79
1201	21,566.89	36,414.64
1202	21,581.53	36,414.77
1203	21,916.39	36,272.97

NO REPRESENTATION OR WARRANTY, EXPRESSED OR IMPLIED, IS MADE AS TO THE ACCURACY, COMPLETENESS OR USEFULNESS OF THE INFORMATION OR STATEMENTS CONTAINED IN THESE DRAWINGS, OR THAT THE USE OR DISCLOSURE OF ANY INFORMATION, APPARATUS, METHOD OR PROCESS DISCLOSED IN THESE DRAWINGS MAY NOT INFRINGE PRIVATE RIGHTS OF OTHERS. NO LIABILITY IS ASSUMED WITH RESPECT TO THE USE OF, OR FOR DAMAGES RESULTING FROM THE USE OF ANY INFORMATION, APPARATUS, METHOD OR PROCESS DISCLOSED IN THESE DRAWINGS. DRAWINGS MADE AVAILABLE FOR INFORMATION TO BIDDERS ARE NOT TO BE USED FOR OTHER PURPOSES, AND ARE TO BE RETURNED UPON REQUEST OF THE FORWARDING CONTRACTOR.

REV	DESCRIPTION	LGW	CHK	SECT	DEPT	DATE	PE	REQ	DATE	MMES	DATE	DOE	DATE	CA	EC	EE	EM	IE	M	PD	SE	XAD	DOE	DATE
0	ISSUED APPROVED					8-15-91																		

REVISION APPROVALS

ADAMS CRAFT HERZ WALKER A-E

MM-ES

DOE

DRAWING APPROVALS

DATE

DES L.G. WILLIAMS 4-1-91

DRW L.G. WILLIAMS 4-1-91

CHK *Chm. Hdd* 8/22/91

SECT *C.D. W. L.* 8/22/91

DEPT & PLANT *C.D. W. L.* 8/22/91

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

GROUNDWATER QUALITY MONITORING WELLS WAG 17 LOCATION MAP

WAG 17 MON WELL LOC MAP

TYPE	M
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