TA-03

Department of Energy
National Nuclear Security Administration
Los Alamos Site Office
Los Alamos, New Mexico 87544

SEP 23 2004

Mr. John Young
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2905 Rodeo Park Drive East,
Building 1
Santa Fe, NM 87505-6303

Dear Mr. Young:

Subject: Drilling Plan for Alluvial Wells, Characterization and Res Boreholes, Mortandad Canyon

Enclosed is on copy of the subject drilling plan for your information. If you have any questions, I can be reached at (505) 665-5046 or Tom Whitacre at (505) 665-5042.

Sincerely,

Mat Johansen
Project Manager
Program Compliance Manager

EM:8TW-002

Enclosure

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DRILLING PLAN FOR ALLUVIAL WELLS, CHARACTERIZATION AND RES BOREHOLES MORTANDAD CANYON LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO PROJECT NO. 48335

PREPARED FOR:

THE UNITED STATES DEPARTMENT OF ENERGY AND THE NATIONAL NUCLEAR SECURITY ADMINISTRATION THROUGH THE UNITED STATES ARMY CORPS OF ENGINEERS SACRAMENTO DISTRICT

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1. INTRODUCTION

This Drill Plan (DP) provides guidance for site preparation, drilling, sampling, installation, testing, and site restoration activities associated with the shallow wells and boreholes to be advanced in Mortandad Canyon sites located at Los Alamos National Laboratory (LANL). The shallow wells and boreholes included in this DP consist of the following:

- RES Boreholes,
- Characterization Boreholes, and
- Alluvial Wells.

A map of the Los Alamos area showing the location of the wells and boreholes is presented in Figure 1. This plan has been prepared to comply with the scope of work set forth in U.S. Army Corps of Engineers (USACE) Delivery Order W91238-04-F-0096.

The following sections provide an overview of the program management and operations topics including project staff, health and safety, security, schedule, and permits, as well as plans for well installation and dust control.

2. PROGRAM MANAGEMENT AND OPERATIONS

Kleinfelder Inc.'s (Kleinfelder) proposed management personnel and their respective roles are detailed in Table 1 and in Kleinfelder's Project Management Plan (PMP). A list of Key Personnel involved in the project with roles and phone numbers is presented in Table 2. The overall project organization is shown schematically in Figure 2.

This project is being performed for the United States Department of Energy (USDOE) Project Manager with contractual assistance provided by the USACE. The end-users of the data collected from this project will be for the Remediation Services Project, USDOE, New Mexico Environment Department (NMED), and the general public. The LANL Field Operations Support Lead will assist with obtaining the necessary LANL-required permits and assist with scheduling and logistical issues.

2.1 PROJECT STAFF

2.1.1 PROJECT MANAGEMENT TEAM

The Kleinfelder Management Team consists of the Program Manager, Deputy Program Manager, Program Hydrogeologist, and Health and Safety Officer. The Management Team reviews all task order work plans, ensures compliance with environmental, safety, and health plans, and performs project audits of ongoing work. The Team ensures all work is planned, executed, and completed in the best and most compliant manner possible.

The Project Management Team will also provide technical assistance to the Field Team members in the form of the Program Hydrogeologist and the Health and Safety Officer. The Program Hydrologist will act as a technical resource for the entire Program Team as well as the client to

assist with "problem-solving" activities. He will provide technical guidance to the field and technical teams as well as quality control for well materials and field procedures.

The Health and Safety Officer will provide health and safety related technical assistance and senior review of all project-specific safety plans. He will conduct periodic job site safety inspections and oversee the Team's staff of safety professionals.

2.1.2 FIELD TEAM

The Field Team will consist of the Field Manager (FM) and Field Geologists (FGs). The FM will provide oversight and review ongoing operations as they relate to this DP and assist the FG and drillers with technical, operational, or other project related issues. A Field Geologist will be present during all field activities. The FG will:

- Provide guidance for site setup,
- Maintain geologic logs (to be performed out of the field),
- Package and document core and/or cuttings,
- Track drilling methodologies,
- Perform well development oversight, and
- Record general drill site activities.

Additional qualified and experienced staff (existing and new) may be added after submittal of this DP for performance of the work. These staff will be identified and their roles assigned prior to commencement of their services.

2.1.3 DRILLING SUBCONTRACTOR

Spectrum Exploration will be the drilling subcontractor for this portion of the project. The drilling subcontractor will be responsible for the timely completion of the work schedule, consistent and adequate core recovery, making sure that equipment is in proper working order and that personnel are properly trained in equipment use, and ensuring that daily driller's logs are maintained.

2.1.4 SITE PREPARATION/RESTORATION SUBCONTRACTOR

EnviroWorks, Inc. will be the subcontractor responsible for the timely preparation of each drill site. The site preparation/restoration subcontractor will assist the FG with the temporary installation of the best management practice (BMP) straw bales, perform minor leveling/grading of areas to assist with site access, and provide general labor and heavy equipment assistance to the project. In addition, the site preparation/restoration subcontractor will be responsible for moving waste containers and performing final site restoration activities (if necessary). The FM will coordinate assistance that is required from the site preparation/restoration subcontractor.

2.2 QUALITY PRACTICES

All staff will be trained to the PMP, Standard Operating Procedures (SOPs), the Contractor Quality Management Plan (CQMP), Work Instructions (WI), and quality procedures that are appropriate to their assigned roles. A listing of SOPs can be found in the CQMP.

A copy of this DP and the SOPs and WIs will be maintained at the site at all times. The FM will visit the sites regularly so that quality procedures and requirements are being met and to provide continuity amongst the field crews.

2.3 GENERAL HEALTH AND SAFETY

All staff will be trained to the Project Health and Safety Plan (HASP), the Site-Specific Health and Safety Plan (SSHASP), and health and safety practices that are appropriate to their assigned roles. Addenda to the SSHASP will address steep slopes, Radiological Work Permits (RWP), flash flooding, security issues, and other site-specific issues. The FM will visit the sites regularly so that the DP, HASP, SSHASP, and RWP requirements are being met and to provide continuity amongst the field crews.

All personnel are responsible for working safely. In support of this, the following safety related activities shall be conducted:

- A safety tailgate meeting will be conducted every shift. All site personnel are required to attend and sign the acknowledgement sheet. If not present during the meeting, personnel must review the tailgate meeting form and sign the acknowledgement sheet before entering the work zone.
- Heavy equipment inspections will be conducted and documented once per day.
- Site safety inspections will be conducted and documented once per day.
- A qualified safety professional will conduct and document weekly site walk-downs.
- Kleinfelder's corporate Health and Safety Officer will conduct site walk-downs monthly.

Material Safety Data Sheets (MSDSs) for all of the chemicals being used for this project can be found in the Appendix. A current physician's release and Health Insurance Portability & Accountability Act (HIPAA) Release Form for work for all field personnel will be in the project file.

2.4 RADIATION SURVEY

The following radiation survey procedures will be followed at each site:

- A Health, Safety, and Radiological Control (HSR)-1 Radiological Control Technician (RCT) will screen support and drilling equipment both before it enters Mortandad Canyon and before removal. Support and drilling equipment may also be screened between boreholes, as required by the RCT. In addition, all field samples will be screened before leaving a drill site. The FG will schedule screening through the LANL

Field Operations Support Lead at least 48 hours before removing equipment or samples (see Table 2, Key Personnel Phone List, for contact numbers).

- ARS (RADVAN samples) will screen core samples before the Sample Management Office (SMO) ships samples for analyses.
- A beta/gamma radiation meter will be available to screen personnel and borehole materials at each drill site.
- A HSR-1 RCT will perform screening of the drill site before any work is performed at the site and on an as needed basis.
- Onsite personnel will wear dosimeters to monitor for exposures to radiation.

See the Mortandad Canyon Site Specific Health and Safety Plan (SSHASP) for further details. All screening results will be maintained in the project files and recorded in the field logbook. In addition, the HSR-1 screening paperwork is required for submittal of core for final disposition to the Field Support Facility (FSF). If at any time the site-specific action levels are reached or exceeded, work will stop and a RCT will be contacted at 667-5185.

2.5 TRAINING

All staff will receive training to be provided by Kleinfelder or LANL that will be specific to the duties they will be performing. All training will be documented in the project file. Examples of specified training requirements are provided below.

2.5.1 KLEINFELDER (PROJECT) TRAINING

- Occupational Safety and Health Act (OSHA) 29 Code of Federal Regulations (CFR) 1910.120 40-hr HAZWOPER
- First Aid/CPR
- Documentation Training
- WI and SOP Training

2.5.2 LANL TRAINING

- General Employee Training (GET) – Training required for any individual that will be working at LANL for a period of time greater than 10 days in a year
- Radworker II – Training to satisfy the requirements of the RWP (necessary for work performed in Mortandad Canyon)
- Fire Watch – Training required for any individual that will be on a worksite that is considered to have fire risks or has the potential of using a fire extinguisher
- Fire Extinguisher – Training qualifying a worker to properly use an emergency fire extinguisher

2.6 SECURITY

No wells or boreholes are located within a high security area. All Kleinfelder personnel and subcontractors shall maintain current LANL badges and follow the directions of security personnel.

2.7 SCHEDULE

Shifts are planned to be 12 hours long. Drilling is scheduled to occur only during the day shift. The overall project schedule will be monitored and modified on a well-by-well basis by the Program Managers (PM), FM, and Technical Manager (TM). Drilling is anticipated to begin in September 2004.

See Tables 3A, 3B, and 3C, Borehole Sequence and Data Table, for the sequence of Alluvial Wells to be drilled and installed and for drilling of the characterization and RES Boreholes.

2.8 PERMITS

Environmental permits approved for this work include program 401/404 determinations and a National Pollutant Discharge Elimination System (NPDES) Storm Water Pollution Prevention Plan (SWPPP). Kleinfelder will obtain each of these permits. For each well, LANL excavation permits (obtained by the USDOE) have also been approved. Where necessary, spark/flame permits will be obtained. No work will begin before all necessary permits are obtained.

Due to the short drilling/well installation duration of each well/borehole and the minimal ground to be disturbed, permanent best management practices (BMPs) will not be installed. However, temporary BMPs will be put in place before the start of drilling. Temporary BMPs will consist of straw bales that will be placed between the borehole and any adjacent waterway. If the borehole is not located adjacent to a waterway, straw bales will be placed at the up-gradient side of the drill site (see the SWPPP for details).

In accordance with the requirements of the Construction General Permit (Subparts 3.10 and 9.C.1.c), the BMPs of each site containing drill cuttings will be inspected as follows.

- At least once every 14 calendar days; or
- Monthly during seasonal arid periods, during winter conditions when runoff is unlikely (e.g. when site is covered with snow, ice or the ground is frozen), and/or when the entire site is temporarily stabilized; or
- Within 24 hours of the end of a storm event of 0.5 inch or greater.

Inspections may be waived when land disturbance activities have ceased and frozen conditions are expected at the site for more than one month. In the Los Alamos area, frozen conditions typically exist from December through February. If waived, inspections will resume one month before thawing conditions are expected to result in a discharge. If repairs are required to the erosion control BMPs, the person performing the inspection will notify the FM.

3. DRILLING AND CORING

Drilling and coring will involve a number of tasks for each site. These tasks will include site preparations consisting of temporary BMP installation, temporary exclusion zone construction, and drill rig and equipment setup. Drilling and core collection will be accomplished with either direct-push technology (DPT), hollow stem auger (HSA) and/or a HQ-size GeoBarrel coring system. The type of drilling system used will depend on the type of geologic formation encountered and sample required.

Once drilling is completed, the locations and elevations of both the Boreholes and Alluvial Wells will be surveyed by a State of New Mexico licensed Professional Land Surveyor. Alluvial Wells will be properly developed. Finally, site restoration activities will include the disposal of site litter, backfilling of site excavations as appropriate, and site re-vegetation. The following sections detail activities for each boring.

3.1 SITE PREPARATION

It is anticipated that the drill rig will be able to access each drill site without the need for a road construction; however, the FM will coordinate heavy equipment support in the event an access road is required. Preparation of the site for drilling will consist of the following:

- Accessing the site with the necessary drilling equipment and vehicles,
- Providing temporary erosion control, and
- Establishing the exclusion zone.

Figure 3 provides a generalized diagram of the drill site layout. Upon arrival of equipment to the drill site, straw bales will be appropriately placed at the drill site. The straw bales will be placed to prevent the intrusion of drill cuttings into the waterway. In the event that the borehole is not located adjacent to a waterway, the straw bales will be placed along the up-gradient side of the drill site. In no case shall the placement of any drilling generated materials into a waterway be allowed.

The drill rig, equipment, and support vehicles will be placed at the drill site to minimize impacts to nearby vegetation. In the event that a tree must be removed or branches trimmed, the FM will be contacted to obtain the necessary approvals. In no case shall the removal of trees greater that 8 inches in diameter be allowed.

Drilling water will be obtained from a fire hydrant located in TA-52 along the access road into Mortandad Canyon. Contact the FM for the exact location of the hydrant.

3.2 DRILL AND INSTALL MONITOR WELLS

Field operations will be guided by the Mortandad Canyon Groundwater Work Plan Revision 1 dated January 2004 (LA-UR-0165, ER2004-0019). Drilling and well installation will be performed in accordance with:

- LANL ER-SOP-04.01, REV.2, Drilling Methods and Drill Site Management

- LANL ER-SOP-01.08, REV.1, Field Decontamination of Drilling and Sampling Equipment
- LANL ER-SOP-05.01, REV. 3 attachments, Well Construction
- American Society for Testing and Materials (ASTM) Guides D5092-02, D6282-98, D4044-96, 5299-92, and D1452-80.

Spectrum Exploration (Spectrum) will perform the drilling, soil coring, and well installation under the guidance of Kleinfelder. Spectrum Exploration will provide two separate drilling rigs. These drill rigs are:

- A CME–550 track-mounted drill rig capable of drilling with either DPT or HSA drilling, and
- A StrataStar SS-15 rubber tires-mounted drill rig capable of drilling with either HSA or HQ wire line coring.

The DPT system that is proposed for this project uses the AMS Power Probe Model 9630 drive hammer with 2.75-inch outside diameter (OD) dual tube drive rods. The dual tube system is capable of collecting a 2-inch diameter core sample within a lexan liner. Core samples can be collected in either 2-ft or 4-ft lengths.

A Kleinfelder geologist will be present during activities to collect, log, and package cores, oversee well installation and sampling, and generally manage site operations. The borings are presented below in the general order in which they will be drilled, but there may be some overlap or adjustments as two drill rigs may be operating simultaneously.

3.2.1 RESISTIVITY BOREHOLES

Three Resistivity Boreholes identified as RES-2, RES-3, and RES-4 are scheduled for drilling to depths of 200 feet (ft), 200 ft, and 225 ft respectively. See Table 4 for the RES Borehole data quality objectives (DQOs) and Table 3A for the drilling methods and proposed sequence. The Resistivity Boreholes will be drilled with the StrataStar SS-15 using HSA. A 5-ft-long sample barrel will be used to collect continuous core samples.

The HQ GeoBarrel system will be advanced in the event that refusal is encountered with HSA. The HQ GeoBarrel is a triple-tube coring system that uses a spring-loaded steel nipple to capture soft material. It is capable of recovering cores of 5-ft length. In softer material (e.g., Otowi Member of the Bandelier Tuff), a core catcher will be placed in the core barrel to improve sample recovery. The core barrel is lined with a reusable stainless steel liner. Coring will proceed without the addition of fluids other than air to the extent possible. In the event that fluids are necessary, the FM will be contacted before their use.

Samples for moisture/tritium will be collected in lexan liners every 10 ft of depth from the borehole. Before removal of the lexan liners from the sample barrel, the percent recovery of core will be noted. End caps will be placed on each end of the lexan liner and sealed with tape. Samples that do not require collection for moisture or tritium will be placed in lay-flat plastic tubing and both ends will be sealed. The core will be properly labeled and placed within a core

box. The core box will be properly labeled and transported to the FSF for geologic logging and sample collection.

Geophysical logging will be performed inside of the HSA in boreholes that will have instruments installed in them. The geophysical logging will be performed before installation of the instruments. However, the bottom of the HSA will be raised to the top of the Bandelier Tuff unit (bottom of alluvium) before performing induction logging. For boreholes that do not require instrumentation, geophysical logging will be performed after the HSA has been removed and before backfilling. See Table 3C for the appropriate geophysical logging suite.

3.2.2 CHARACTERIZATION BOREHOLES

Thirteen Characterization Boreholes (B-1, B-2, B-5, B-6, B-7, B-8, B-9, B-10, B-11, B-12, B-14, B-15, B-16) will be drilled. See Table 5 for the Characterization Borehole DQOs and Table 3A for the proposed sequence and drilling methods. The depth of the Characterization Boreholes is generally 100 ft except B-14, which is 350 ft. The Characterization Boreholes will be continuously cored with the CME-550 track rig using HSA. The 5-ft-long sample barrel will be used to collect continuous core samples as previously described in Section 3.2.1.

Samples for moisture/tritium will be collected from boreholes in lexan liners at every 10 ft. interval of depth. Before removal of the lexan liners from the sample barrel, the percent recovery of core will be noted. End caps will be placed on each end of the lexan liner and sealed with tape. Samples that do not require collection for moisture or tritium will be placed in lay-flat plastic tubing and both ends will be sealed. The core will be properly labeled and placed within a core box. The core box will be properly labeled and transported to the FSF for geologic logging and sample collection.

Geophysical logging will be performed inside of the HSA in boreholes that will have instruments installed in them. The geophysical logging will be performed before installation of the instruments. However, the bottom of the HSA will be raised to the top of the Bandelier Tuff unit (bottom of alluvium) before performing induction logging. For boreholes that do not require instrumentation, geophysical logging will be performed after the HSA has been removed and before backfilling. See Section 3.2.12 for further information and Table 3C for the appropriate geophysical logging suite.

3.2.3 ALLUVIAL WELLS

A total of 8 Alluvial Wells (A-1, 2, 4, 5, 6, 7, 8, 9) and up to 6 piezometers (A-3a through A-3f) will be drilled. See Table 6 for the Alluvial Well DQOs. The depths of the Alluvial Wells are generally 90 ft. Exceptions to this are A-1, A-4, and A-5, which will be installed to shallow depths (less than 15 ft bgs) and A-3a through A-3f, to be installed to depths of 60 ft bgs.

The Alluvial Well boreholes will be continuously cored with the CME-550 track rig using the DPT drive and sampling system. The sampler, a 4-ft-long sample barrel with clear lexan liners, will be used to collect continuous core samples. Table 3A lists the proposed sequence and drilling method for each Alluvial Well borehole.

Before removal of the lexan liners from the sample barrel, the percent recovery of core will be noted. End caps will be placed on each end of the lexan tube and sealed with tape. The core will

be properly labeled and placed within a core box. The core box will be properly labeled and transported to the SMO for geologic logging.

After coring is completed, the inner rods and sampling barrel will be removed. The outer rods will be left in place to facilitate construction of the Alluvial Well. As construction of the Alluvial Well progresses, the outer rods will be removed from the borehole.

Geophysical logging will be performed inside of the outer rods. However, the bottom of the outer rods will be raised to the top of the Bandelier Tuff unit (bottom of alluvium) before performing induction logging. The geophysical logging will be performed before installation of the Alluvial Well. See Section 3.2.12 for further information and Table 3C for the appropriate geophysical logging suite.

In the event that advancement of the borehole is unsuccessful using DPT, the borehole will be advanced using HSA and a 5-ft length continuous core barrel with clear lexan sleeves. Geophysical logging will be performed inside of the HSA prior to installation of the Alluvial Well. The Alluvial Well will also be constructed within the HSA.

3.2.4 DRILLING CONTINGENCIES

Kleinfelder will attempt to drill each borehole with the methods described above. However, drilling conditions may require the conversion to alternative drilling methods. In the event that refusal is encountered with DPT, the borehole may be advanced using HSA. Kleinfelder will consult with USDOE, USACE, and LANL before modifying the above referenced drilling techniques.

3.2.5 CORE HANDLING, SAMPLING, AND ANALYSES

Moisture and tritium samples will be collected from each borehole at every 10 ft. interval of depth. These samples will be collected within lexan tubes, capped, and properly marked. The lexan tubes will then be placed within moisture-protect plastic tubing, heat-sealed, and placed in standard core boxes. All remaining core that is collected in the field will be placed in lay-flat plastic tubing, labeled, and stored in standard core boxes. Sample collection and packaging will be performed in accordance with LANL ER-SOP-09.10, REV.0, Field Sampling of Core and Cuttings for Geological Analysis, and LANL ER-SOP-12.01, REV.4, Field Logging, Handling, and Documentation of Borehole Materials.

The core boxes will be labeled with the well name, box number, and the footage range for the box. Core will be screened by a LANL RCT for release from the drill site upon completion of drilling of each borehole. The core will be brought to the FSF for geologic logging, additional radiological screening for data collection purposes, analytical sample collection, and temporary storage. Samples collected in the field for laboratory analysis will be submitted to the SMO using the LANL ER Chain of Custody documentation.

With the exception of moisture and tritium samples, all core samples to be submitted for laboratory analyses will be collected by Kleinfelder at the direction of LANL staff. Table 3A lists the sampling depth, suite, and frequency for each borehole. Samples collected for moisture will be placed in pre-weighed amber jars. Samples collected for tritium will be placed in moisture-protection bags.

Upon completion of sample collection and logging, the core materials will be prepared for formal submittal to the FSF as per LANL ER-SOP-12.02, REV.4, Transportation and Admittance of Borehole Materials to the Field Support Facility.

3.2.6 Perched Water

Kleinfelder will attempt to identify the presence of perched water in all of the boreholes. In the event that perched water is determined, a static water level measurement will be attempted.

3.2.6.1 Perched Water Detection

The presence of perched water will be noted when observed in cores of borehole material or drill cuttings. The presence of perched water will also be checked before backfilling the borehole in accordance with LANL ER-SOP-07.02, REV.1, Water-Level Measurement. If the borehole is left overnight, it will be checked for the presence of perched water prior to beginning drilling operations. An electronic water level meter will be used to check for the presence of water. A static water level will be established by three consecutive water level readings (within 0.1 ft) measured 10 minutes apart.

The FM must be notified when a perched water layer is encountered in a Characterization Borehole, RES Borehole, or if multiple perched water layers are encountered in an Alluvial Well borehole. Kleinfelder will consult with LANL and USDOE to determine if a well should be installed in a Characterization Borehole or RES Borehole or if multiple screens will be installed in an Alluvial Well.

3.2.6.2 Perched Water Sampling

In the event that perched water is encountered, the depth to water will be logged in the permanent record and the FM will be notified. If significant perched water is encountered (enough to collect a sample), an attempt will be made to collect a groundwater sample through the HSA or outer rods using a disposable bailer. The collected groundwater will be placed in appropriate containers (see Table 7) and delivered to the SMO for preservation. Once the SMO generates the appropriate chain of custody documentation, the metals sample will be delivered to the EES-6 analytical laboratory.

3.2.7 RES and Characterization Borehole Abandonment

The boreholes will be plugged and abandoned by backfilling with hydrated bentonite chips. Above the standing water level, a minimum of 10 gallons of potable water will be added to the hole after each 10-ft lift of bentonite is placed. All materials will be allowed to free-fall into place. Where allowed, drill cuttings may be used for backfill.

Backfill materials will be allowed to free-fall into the borehole through the augers as they are removed. The abandoned hole will be marked for surveying using a pin flag or other type of marker.

3.2.8 Alluvial Well Installation and Completion

The Alluvial Wells shall be constructed using pre-packed 0.81-inch inside diameter (ID), flush-threaded screens constructed of polyvinyl chloride (PVC) and stainless steel. Screen lengths are

expected to be between 5 or 10 ft. See Figure 4, Typical Alluvial Well Construction Diagram. The bottom of the well will be completed using a PVC flush-threaded bottom cap of an appropriate size. The remainder of the well will be constructed of 1-inch ID PVC flush-threaded blank casing.

The annular space around the screen will be backfilled with 10/20-mesh silica sand to approximately 5 ft above the top of the screen. The remainder of the borehole annular space will be backfilled with 3/8-inch bentonite chips from above the silica sand to ground surface. In the event that groundwater is not found within an Alluvial Well borehole, the FM will be contacted. The FM, USDOE, and LANL will determine whether to abandon the borehole rather than complete it as a well.

All well materials and construction procedures are subject to the guidance documents and regulations of the State New Mexico. Well installation details will be recorded on a well installation record form.

3.2.9 Surface Completion

Each Alluvial Well will be completed with a lockable aboveground steel well vault. The aboveground surface completion will extend approximately 3 feet above the ground surface and two feet bgs. The top of the well casing will be no less than 6 inches lower than the top of the protective casing. The well completion will include a minimum 36" square concrete well pad that is a minimum 4" thick. Each corner of the well pad will be protected with a steel bollard. The bollards will be filled with concrete and extend a minimum of 18" below ground surface and 36" above ground surface. The bollards will be cemented in place.

3.2.10 Boring and Well Location Survey

Once drilling is completed, the location and elevation of both the abandoned boreholes and completed Alluvial Wells will be surveyed by a New Mexico licensed Professional Land Surveyor. Data provided by the surveyor will include NAD83 State Plane Coordinates, latitude and longitude, and elevation in relation to mean sea level (NGVD29). Survey data will be on file with Kleinfelder.

3.2.11 Well Development

Well development will consist of hand bailing, surging, and pumping in accordance with LANL ER-SOP-06.02, REV.2, Field Analytical Measurements of Groundwater and ASTM D5092-02 as applicable. Pumping will be performed using a dedicated bladder pump system (see Section 3.2.13). Well conditions (e.g., fluids used, initial turbidity, formation type) will dictate the duration and order in which the above methods are used. The criterion for satisfactory development is turbidity at or below 5 NTU (Nephelometric Turbidity Units). An alternative standard of three consecutive, repeated measurements (within 5% of the previous measurement) of temperature, conductivity, and pH may be used to determine sufficient development. Development water will be containerized and managed as described in Section 3.3, Investigation Derived Waste, below.

Groundwater samples will be collected following well development. See Table 7 for the proposed analytical suite, requested sample volumes, and sample containers. Samples will be

kept on ice and delivered to the SMO for processing. All samples must be transferred under chain-of-custody.

When samples are taken, notify Keith Greene at SMO (665-9966), Dale Counce at EES-6 analytical chemistry lab (667-1224), and Pat Longmire (665-1264) that sample(s) have been collected and will be submitted to SMO. If sampling occurs during non-working hours, call Keith Greene to schedule processing.

3.2.12 Hydrologic Testing

Once development of the Alluvial Wells is complete, an aquifer test will be designed with input from USDOE, LANL, and the NMED. Where applicable, ASTM 4044-96, LANL ER-SOP-07.03, REV.1, Slug Tests; and LANL ER-SOP-07.04, REV.2, Pumping Tests will be followed. Due to the small diameter of the wells, possible methods include injection or slug tests. The test method selection will be based upon well design, data needs, and productivity of the aquifer. For completely submerged screens, a vacuum method is preferred that raises the water level in the well, after which the declining head is monitored once the vacuum is released. Either test would consist of several short duration tests conducted over one day.

Regardless of test type, a transducer/data logger will be set and allowed to stabilize for approximately 24 hours before beginning the test. If multiple short duration tests are performed, the aquifer will be allowed to return to the static water level between each test. The static water level will be considered recovered when 95% of the initial static water level (+/- 5% of the originally measured depth from ground surface) has been obtained. The water level will be confirmed with an electronic water level meter before and after each test.

3.2.13 Sampling System Installation

A dedicated sampling system will be installed in each Alluvial Well. Kleinfelder will use a GeoProbe submersible pneumatic bladder pump. The system consists of a ½-inch OD stainless steel pump body with an internally placed Teflon bladder. Water is forced to the ground surface through tubing by the pneumatic contraction of the bladder. Check valves at the top and bottom of the pump regulate the flow of water into and out of the pump.

Concentric tubing is used to provide air to the pump while allowing for water to discharge to the surface. The inner tubing is constructed of Teflon. The outer tubing is constructed of polyethylene. Compressed air for the sampling system is provided using a small portable air compressor and is controlled using a pneumatic pump controller box. The pneumatic pump controller allows for control of the inlet/supply gas pressure with a regulator and a pressure gauge. The amount of water discharged from the pump can be adjusted by the amount of air pressure going into the pump and the duration of air cycles.

3.2.14 Geophysical Logging

Geophysical logs will be collected from selected boreholes. Geophysical logging will include gamma ray and induction and will be performed with LANL-supplied equipment. A trained Kleinfelder field staff member will perform the logging operations and process the geophysical logs. Copies of the geophysical logs will be provided to USDOE and LANL. Boreholes to be logged and the geophysical logs to be performed are listed in Table 3C.

3.3 INSTALLATION OF LANL-PROVIDED INSTRUMENTS

Instruments will be permanently placed in several of the boreholes to assist LANL scientists with collecting long-term data (see Table 3C). These instruments consist of a Vector Probe and a Water Content/Matric Potential Probe. A LANL representative will be present during the placement of the instruments and will provide all necessary instruments and materials. All instruments will be placed at the direction of the LANL representative. A diagram of the instrument placement will be made in the field. It will show, at a minimum, the depth the tool was placed.

3.3.1 Vector Probe Installation

Vector probes will be installed in boreholes B-5, B-8, B-10, B-12, and B-14, with the possibility of installing a probe in B-16. Installation of this probe will consist of backfilling the borehole to the bottom of observed perched water (this may be at or above the alluvium/Bandelier Tuff interface). The probe will be placed in the hole by lowering it down on 10-ft long flush mount, 2 ¼ inch diameter, schedule 40, PVC sections. When the auger bit has been raised to a depth above the probe, the drillers will reverse the HSA to place drill cuttings around the probe. In materials that will not readily collapse around the probe, ninety or sixty grade sand can be used to backfill around the probe. The bottom of the probe must be installed no closer than 1 ft above any bentonite seal at the bottom of the saturated section, and natural backfill or sand must extend at least six feet above the probe. The remainder of the borehole will be backfilled to the surface with bentonite.

3.3.2 Water Content/Matric Potential Probe Installation

Water Content/Matric Potential probes will be installed in RES-4 (or alternatively in B-6), B-2, B-7, B-9, and B-11, with the possibility of installing a probe in B-16. The probes will be mounted on 1" ID PVC. Each water content and matric potential sensor in a given pair will be two feet apart. The first pair of probes will be lowered 30 ft below saturation and into tuff (backfill of natural material, e.g., cuttings, may be necessary to fill the hole to this depth). The probes will be lowered using threaded sections of PVC, and 20/40 silica sand will be gently backfilled around it to a level 8 ft above the top sensor. At this level, the second set of probes will be installed as above. Once the hole is backfilled 8 ft above the top sensor in the second pair, the third pair can be installed with backfill extending 8 ft above the top sensor. The remainder of the hole will be backfilled with bentonite.

3.3.3 Instrumentation Surface Completion

After the borehole is backfilled, instrument cables that exit the ground surface will be protected within a surface completion. The surface completion will consist of a 4-in ID PVC pipe that will be placed vertically into the ground. The instrument cables will be placed within the pipe for protection. The PVC pipe will be centered within a 2-ft by 2-ft by 4 in-thick concrete pad that will be constructed flush with the ground surface. A brass survey marker will be placed within the concrete pad and stamped with the well number.

The top of the PVC pipe will be capped with a 4-in ID PVC slip cap. A hole will be drilled through the side of the PVC pipe to allow cables to penetrate the wall of the pipe. This will allow the cables to be connected to a data logger.

3.4 INVESTIGATION-DERIVED WASTE

Duratek will provide a Waste Management Plan (WMP) to handle the Investigation-Derived Waste (IDW) generated from the project. The anticipated IDW will include drill cuttings, contact wastes, decontamination water, and sample and development water. Duratek will review existing site-specific data and provide the Waste Characterization Strategy Form (WCSF) as a separate field document.

Field personnel should follow the WMP as the guideline for handling and storage of IDW. In general, storage of IDW will be centrally located at each site. Drill cuttings that cannot be used to backfill the borehole will be placed in either one cubic yard capacity recycled nylon sacks, previously containing bentonite chips, or 55-gallon drums and stored on pallets. Decontamination water and development water will be placed in 30 to 55-gallon drums, sealed, and labeled.

IDW produced during drilling, well development, and testing will be sampled and analyzed for the suite of constituents as agreed to between USDOE and NMED. The number of samples to be collected and the analytical suite will be provided in the WCSF and the WMP. Waste will be characterized based on borehole characterization analytical results and waste characterization analytical results and disposed of accordingly.

Drill cuttings that are approved for non-regulated disposal will be thin-spread at the location of the drill site. Contact wastes obtained from the same drill location as the drill cuttings will be disposed of at a sanitary landfill.

Drilling and development water approved for discharge will be applied to the land surface or used for dust suppression on access roads or the drill site in accordance with the terms and conditions of the original NOI (August 2, 2001).

Petroleum leaks, spills, etc. are considered New Mexico Special Waste and must be managed according to the regulations. These wastes will be stored in a secure, labeled drum. The drum will be placed on a pallet and labeled as New Mexico Special Waste. When assessing the site conditions, all drip pads, absorbents, and petroleum-contaminated soils will be stored according to New Mexico Special Waste guidelines. Non-contact waste, such as food containers, empty bentonite bags, etc. will be disposed of at a sanitary landfill.

3.5 SITE RESTORATION

Restoration of the site will be limited to removal of site litter, BMPs (unless instructed to leave in place), and reseeding of any disturbed areas. The drill cuttings (if any) and drummed water will be properly disposed of in agreement with DOE, NMED, USAC, and Kleinfelder procedures. Care will be taken to prevent drummed water from entering intermittent streams and dry arroyos.

4. DUST CONTROL

Spectrum and EnviroWorks will implement dust control procedures at drill sites and on roads throughout the project.

4.1 DRILL PADS AND ROADS

Dust suppression at the drill pads and on roads will be accomplished by application of water to areas where dust is created. USDOE will approve the applied water for use. Field personnel are to notify the FM when dust suppression is necessary.

4.2 DRILLING

Two of the proposed drilling methods (HSA and DPT) are not anticipated to create significant quantities of dust. However, during HQ coring and GeoBarrel operations, significant dust will be generated. The LANL Dust Suppression System will be employed to minimize dust emissions during coring operations. Cuttings from the dust suppression system will be properly disposed of in agreement with DOE, NMED, USAC, and Kleinfelder procedures.

5 REFERENCES

American Society for Testing and Materials (ASTM), 1980, 2000. Standard Practice for Soil Investigation and Sampling by Auger Borings. Designation: D 1452-80. West Conshohocken, Pa: ASTM Committee D18 and Subcommittee 18.02.

American Society for Testing and Materials (ASTM), 1997, 2002. Standard Test Method (Field procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers. Designation: D 4044-96. West Conshohocken, Pa: ASTM Committee D18 and Subcommittee 18.21.

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American Society for Testing and Materials (ASTM), 1993. Standard Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities. Designation: D 5299-92. Philadelphia, Pa: ASTM Committee D18 and Subcommittee 18.21.

American Society for Testing and Materials (ASTM), 1999. Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations. Designation: D 6282-98. West Conshohocken, Pa: ASTM Committee D18 and Subcommittee 18.21.

Kleinfelder, Inc., 2003. Project Management Plan for USDOE Monitoring Well Installation at Los Alamos National Laboratories, Contract Number 03-0029L-033-1009, Los Alamos, New Mexico, October 29, 2003.

Kleinfelder, Inc., 2003. Final – Contractor's Quality Management Program, Revision 1, Monitoring Well Installation, Los Alamos National Laboratory, Los Alamos, New Mexico, USACE Task Order DACW05-03-F-0090, Contract GS-10F-0029L, November 24, 2003.

Notice of Intent to Purchase No. W91238-04-N-0001 for Monitoring Well Installation, Los Alamos National Laboratory, Los Alamos, New Mexico

Mortandad Canyon Groundwater Work Plan Revision 1 dated January 2004 (LA-UR-0165, ER2004-0019).

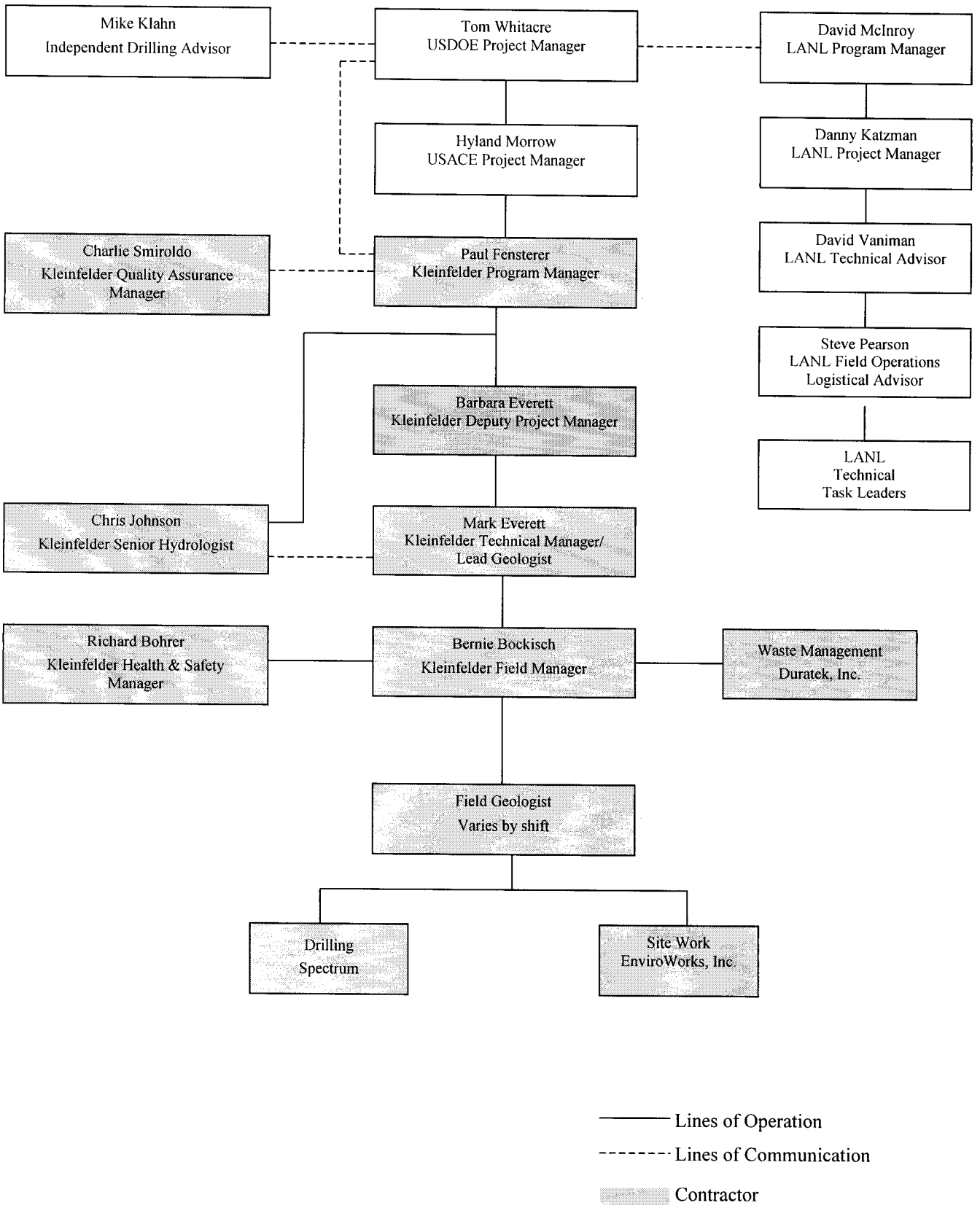
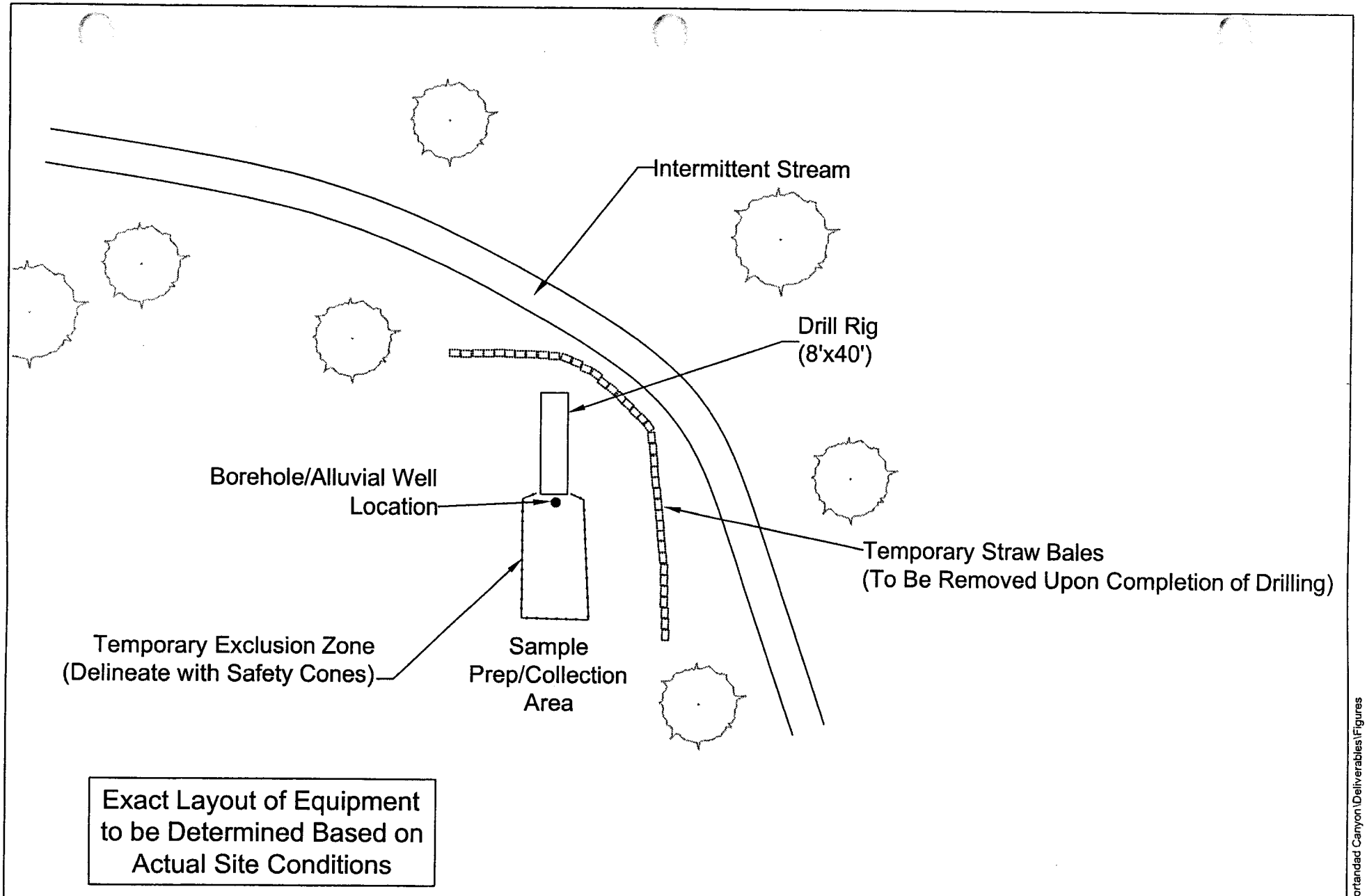


Figure 2. Project Organization Chart



40 0 20 40

SCALE: 1 inch =40 ft.
All Locations are Approximate

KLEINFELDER

Drawn By: C. London
Project No.: 48335

Date: September
Filename: Figure 3.dwg

Generalized Site Plan
Shallow Drilling Program
Mortandad Canyon
Los Alamos National Laboratory
Los Alamos, New Mexico

FIGURE
3

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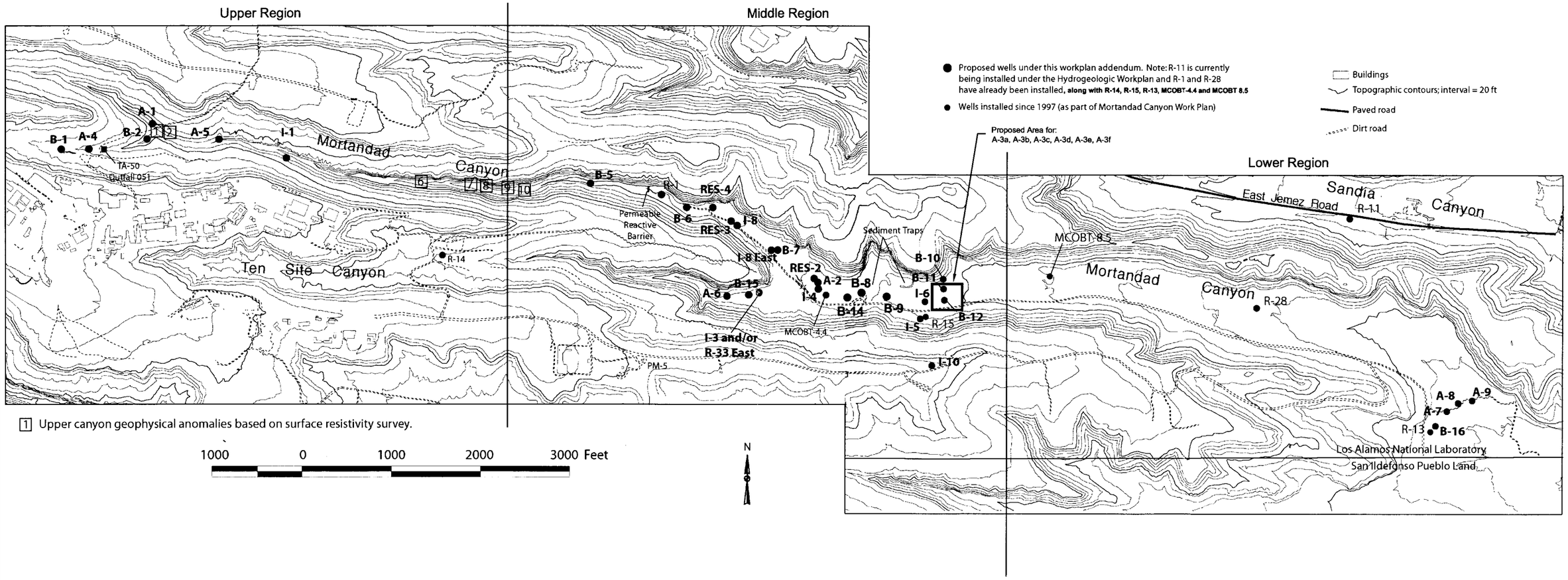

1 Upper canyon geophysical anomalies based on surface resistivity survey.

KLEINFELDER		Mortandad Canyon Well Location Map Mortandad Canyon Los Alamos National Laboratory Los Alamos, New Mexico	FIGURE 1
Drawn By: C. Landon	Date: September 2004		
Project No.: 48335	Revision: 1		

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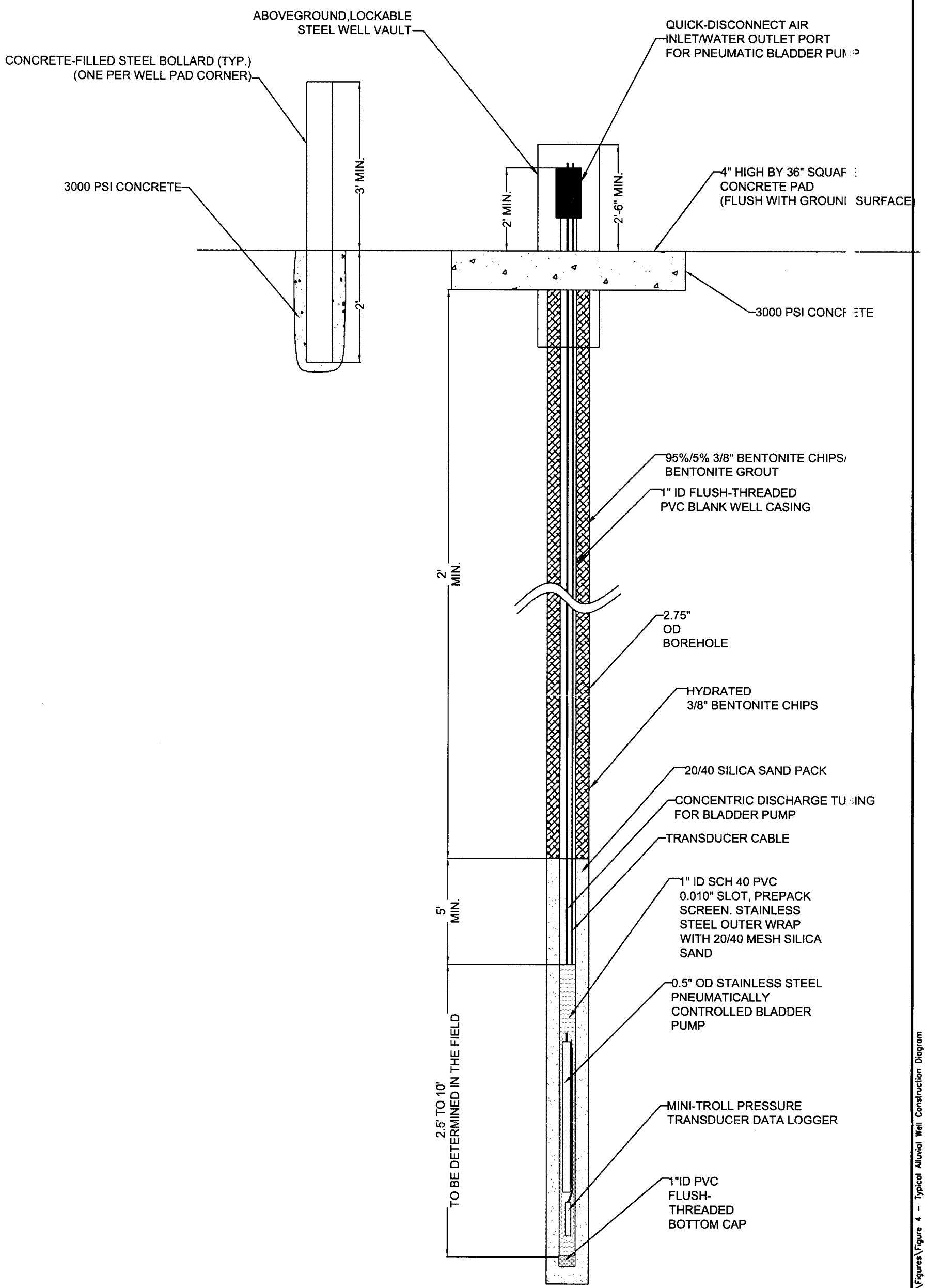

KLEINFELDER

Drawn By: B. Bockisch	Date: September 2004
Project No.: 48335	Revision: 1

Typical Alluvial Well Construction Diagram
Mortandad Canyon
Los Alamos National Laboratory
Los Alamos, New Mexico

FIGURE **4**

G:\Environ\48335 - DOE Mortandad Canyon\Figures\Figure 4 - Typical Alluvial Well Construction Diagram

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TABLES

Table 1
Roles and Responsibilities

Name	Role	Responsibility
Paul Fensterer	Program Manager	Project management, budget, resource commitments, USDOE/USACE interaction
Barbara Everett	Deputy Program Manager	Assist Program Manager in overall project management, budget, resource commitments, USDOE/USACE interaction, daily activity management
Christopher Johnson	Program Hydrogeologist	Technical hydrogeology oversight
Richard Bohrer	Health & Safety Officer	SSHASP and compliance
Charlie Smiroldo	Quality Assurance Director	Develop, implement, manage, and continuously improve the Quality Assurance Program
Bernie Bockisch	Field Manager	Daily logistics and site management, subcontractor coordination, SSHASP, security
Mark Everett	Technical Manager/ Lead Geologist	Schedule management, LANL interaction, technical training, CQMP, reports, geophysics
Robert Helton	Drilling Manager (Spectrum)	HSA drilling, coring management, and technical support
Marc Haes	Drilling Manager (Spectrum)	HAS and DPT drilling, Alluvial Well construction management, and technical support

Table 2
Key Personnel Phone List

Program Manager	Paul Fensterer	Kleinfelder	344-7373	
Deputy Program Manager	Barbara Everett	Kleinfelder	344-7373	328-4844
Project Manager	Mark Everett	Kleinfelder	344-7373	681-5333
Field Manager	Bernie Bockisch	Kleinfelder		401-1955
H&S Manager	Rich Bohrer	Kleinfelder	(916) 366-1701	
Chief Technical Lead	Chris Johnson	Kleinfelder	(559) 486-0750	(559) 779-4051
Spectrum Manager	Rob Helton	Spectrum	797-0803	681-6546
Spectrum Manager	Marc Haes	Spectrum	(719) 633-5790	(719) 499-1457
Spectrum General Manager	Jim Kleinfelder	Spectrum	(209) 465-8712	(209) 993-1207
Enviroworks Field Manager	Vern Cates	E-Works		362-0183
Enviroworks Manager	Sean Grossetete	E-Works	765-5887	362-1050
LANL Project Lead	Danny Katzman	LANL	667-6333	
LANL Geologist/Infiltration Investi.	Brent Newman	LANL	667-3021	
DOE Project Manager	Tom Whitacre	DOE/NNSA	665-5042	699-2308
DOE H&S Manager	David Barber	DOE/NNSA	667-3818	
Drilling Advisor	Mike Klahn	Independent		231-2409
LANL Field Ops Support	Steve Pearson	LANL	667-3005	699-3684
LANL Technical Lead	David Broxton	LANL	667-2492	699-0950
LANL Geochemistry Lead	Pat Longmire	LANL	665-1264	699-1987
LANL Geology Lead	David Vaniman	LANL	667-1863	699-1079
LANL Chemist	Dale Counce	LANL	667-1224	
SMO	Keith Greene	LANL	665-9966	
Core Submittal	Mike Clevenger	LANL	665-6809	
RCT Pool	Larry Pacheco	LANL	667-5185	
FMU 8 Contact	Charles Trujillo	LANL	667-0491	
Rad Source Control	Gilbert Estrada	LANL	665-5298	
Training Center	Staff	LANL	667-0059	
LANL Locator (operator)	Staff	LANL	667-5061	

TABLE 3A - BOREHOLE SEQUENCE and DATA TABLE - Drilling Methods, Depth, and Core Sampling

[1]Well/Borehole	Proposed Sequence	Est. Depth (ft)	Target Unit	Drilling Method	Core Depth (ft)	[2]Core Sampling Suite	Core Sampling Frequency
RES-4	1	225	30' alluv/195' tuff	HSA w/ continuous sample barrel	225	H	every 10 ft
RES-3	2	200	30' alluv/170' tuff	HSA w/ continuous sample barrel	200	H	every 10 ft
RES-2	3	200	60' alluv/140' tuff	HSA w/ continuous sample barrel	200	H	every 10 ft
B-14	4	350	60' alluv/40' CT/250' Qbo	[3]Auger	350	A & G/CDE & Kd	10 ft intervals/3 samples for each
B-16	5	100	40-100' alluv/60'-0' CT pr Qbo	[3]Auger	100	A & G	10 ft intervals
A-7	6	90	base of alluvium	Direct Push w/dual-tube sampling	[4]90	na	na
A-8	7	90	base of alluvium	Direct Push w/dual-tube sampling	90	CDE	3 samples
A-9	8	90	base of alluvium	Direct Push w/dual-tube sampling	[4]90	na	na
B-10	9	100	60' alluv/40' Qbo	[3]Direct Push w/dual-tube sampling. HSA w/ continuous sample barrel if borehole refusal occurs.	100	A & G/CDE	10 ft intervals/3 samples
B-11	10	100	60' alluv/40' Qbo	[3]Direct Push w/dual-tube sampling. HSA w/ continuous sample barrel if borehole refusal occurs.	100	A & G/CDE & Kd	10 ft intervals/3 samples for each
B-12	11	100	60' alluv/40' Qbo	[3]Direct Push w/dual-tube sampling. HSA w/ continuous sample barrel if borehole refusal occurs.	100	A & G/CDE	10 ft intervals/3 samples
[5]A-3a to A-3f	12	60	base of alluvium	Direct Push			
B-9	13	100	50' alluv/50' tuff	[3]Direct Push w/dual-tube sampling. HSA w/ continuous sample barrel if borehole refusal occurs.	100	A & G/CDE	10 ft intervals/3 samples
B-8	14	100	50' alluv/50'tuff	[3]Direct Push w/dual-tube sampling. HSA w/ continuous sample barrel if borehole refusal occurs.	100	A & G/CDE & Kd	10 ft intervals/3 samples for each
A-2	15	60	base of alluvium	Direct Push w/dual-tube sampling	[4]90	na	na
B-15	16	100	30' alluv/70' tuff	[3]Auger	100	A & G/CDE & Kd	10 ft intervals/3 samples for each
A-6	17	40	base of alluvium	Direct Push w/dual-tube sampling	[4]Core not required	na	na
B-7	18	100	30' alluv/70'tuff	[3]Direct Push w/dual-tube sampling. HSA w/ continuous sample barrel if borehole refusal occurs.	100	A & G/CDE	10 ft intervals/3 samples
B-6	19	100	30' alluv/70'tuff	[3]Direct Push w/dual-tube sampling. HSA w/ continuous sample barrel if borehole refusal occurs.	100	A & G/CDE & Kd	10 ft intervals/3 samples for each
B-5	20	100	15' alluv/85' tuff	[3]Direct Push w/dual-tube sampling. HSA w/ continuous sample barrel if borehole refusal occurs.	100	A & G/CDE	10 ft intervals/3 samples
B-1	21	100	100' Bandelier Tuff	[3]Direct Push w/dual-tube sampling. HSA w/ continuous sample barrel if borehole refusal occurs.	100	A & G/CDE & Kd	10 ft intervals/3 samples for each
A-4	22	<5	base of alluvium	Hand Auger	[4]Core not required	na	na
B-2	23	100	100' Bandelier Tuff	[3]Direct Push w/dual-tube sampling. HSA w/ continuous sample barrel if borehole refusal occurs.	100	A & G/CDE	10 ft intervals/3 samples
A-1	24	12	base of alluvium	Hand Auger	[4]Core not required	na	na
A-5	25	10	base of alluvium	Hand Auger	10	CDE	3 samples

[1] RES = Resistivity Boreholes. A = Alluvial Aquifer Boreholes and Wells. B = Characterization Boreholes.

[2] Core Sampling Suite:

A = Analysis of leachates for anions, cations, Al, Fe, and Mn by LANL; 3H by an external lab; analysis of core for moisture content by LANL and of radionuclides (isotopes of Am, Pu, U, Cs, and Sr) by an external lab.

B = Analysis of leachates from core as in A plus stable isotopes (H,O,N).

C = Petrographic analysis by LANL.

D = Quantitative X-ray diffraction (QXRD) by LANL.

[2] Core Sampling Suite continued:

E = Clay-mineral separation and analysis by LANL.

F = X-ray Fluorescence analysis by LANL.

G = Moisture analysis by LANL

H = Porosity, moisture content, grain-size distribution, and clay mineralogy

Kd = Radionulcide distribution coefficient

[3] Auger drilling preferred to obtain sufficient core volume for sampling suite.

[4] Core not required by Work Plan. If drilled by direct push, core will be obtained but not sampled.

[5] Two initial holes will be drilled to determine alluvium saturation. Depending on results, additional holes will be drilled.

TABLE 3B - BOREHOLE SEQUENCE and DATA TABLE - Water Sampling and Hydrologic Testing

[1]Well or Borehole	Proposed Sequence	Est. Depth (ft)	Ground Water Sampling	Hydrologic Testing
RES-4	1	225	No samples will be taken	None will be performed
RES-3	2	200	No samples will be taken	None will be performed
RES-2	3	200	No samples will be taken	None will be performed
B-14	4	350	No samples will be taken	None will be performed
B-16	5	100	No samples will be taken	None will be performed
A-7	6	90	[2]Water samples will be collected and sampled after well development using sand catcher or stainless steel disposable bailers, and Kemmerer Bottles.	slug tests
A-8	7	90	[2]Water samples will be collected and sampled after well development using sand catcher or stainless steel disposable bailers, and Kemmerer Bottles.	slug tests
A-9	8	90	[2]Water samples will be collected and sampled after well development using sand catcher or stainless steel disposable bailers, and Kemmerer Bottles.	slug tests
B-10	9	100	No samples will be taken	None will be performed
B-11	10	100	No samples will be taken	None will be performed
B-12	11	100	No samples will be taken	None will be performed
[3]A-3a to A-3f	12	60	[2]Water samples will be collected and sampled after well development using sand catcher or stainless steel disposable bailers, and Kemmerer Bottles.	None will be performed
B-9	13	100	No samples will be taken	None will be performed
B-8	14	100	No samples will be taken	None will be performed
A-2	15	60	[2]Water samples will be collected and sampled after well development using sand catcher or stainless steel disposable bailers, and Kemmerer Bottles.	slug tests
B-15	16	100	No samples will be taken	None will be performed
A-6	17	40	[2]Water samples will be collected and sampled after well development using sand catcher or stainless steel disposable bailers, and Kemmerer Bottles.	slug tests
B-7	18	100	No samples will be taken	None will be performed
B-6	19	100	No samples will be taken	None will be performed
B-5	20	100	No samples will be taken	None will be performed
B-1	21	100	No samples will be taken	None will be performed
A-4	22	<5	[2]Water samples will be collected and sampled after well development using sand catcher or stainless steel disposable bailers, and Kemmerer Bottles.	slug tests
B-2	23	100	No samples will be taken	None will be performed
A-1	24	12	[2]Water samples will be collected and sampled after well development using sand catcher or stainless steel disposable bailers, and Kemmerer Bottles.	slug tests
A-5	25	10	[2]Water samples will be collected and sampled after well development using sand catcher or stainless steel disposable bailers, and Kemmerer Bottles.	slug tests

[1] RES = Resistivity Boreholes. A = Alluvial Aquifer Boreholes and Wells. B = Characterization Boreholes.

[2]**Water Collection**: See Table 7 Sampling and Analysis of Shallow Aquifer Groundwater.

[3] Two initial holes will be drilled to determine alluvium saturation. Depending on results, additional holes will be drilled.

TABLE 3C - BOREHOLE and SEQUENCE DATA TABLE - Geophysical Logging, Screens, and Downhole Instruments

[1]Well or Borehole	Proposed Sequence	Est. Depth (ft)	Geophysical Logging	No. of Well Screens	Screen Interval Depth	[2]Downhole Instruments
RES-4	1	225	Gamma log and Induction	not applicable	not applicable	Water Content & Matric Potential (MP)
RES-3	2	200	Gamma log and Induction	not applicable	not applicable	
RES-2	3	200	Gamma log and Induction	not applicable	not applicable	Vector Probe (VP)
B-14	4	350	Gamma log and Induction	not applicable	not applicable	Vector Probe (VP)
B-16	5	100	Gamma log and Induction	not applicable	not applicable	Vector Probe, Water Content & Matric Potential (MP), contingency
A-7	6	90	Gamma log and Induction	1	Submerged in saturated zone depth per site conditions.	
A-8	7	90	Gamma log and Induction	1	Submerged in saturated zone depth per site conditions.	
A-9	8	90	Gamma log and Induction	1	Submerged in saturated zone depth per site conditions.	
B-10	9	100	Gamma log and Induction	not applicable	not applicable	Vector Probe (VP)
B-11	10	100	Gamma log and Induction	not applicable	not applicable	Water Content & Matric Potential (MP)
B-12	11	100	Gamma log and Induction	not applicable	not applicable	Vector Probe (VP)
[3]A-3a to A-3f	12	60				
B-9	13	100	Gamma log and Induction	not applicable	not applicable	Water Content & Matric Potential (MP)
B-8	14	100	Gamma log and Induction	not applicable	not applicable	Vector Probe (VP)
A-2	15	60	Gamma log and Induction	1	Submerged in saturated zone depth per site conditions.	
B-15	16	100	Gamma log and Induction	not applicable	not applicable	
A-6	17	40	Gamma log and Induction	1	Submerged in saturated zone depth per site conditions.	
B-7	18	100	Gamma log and Induction	not applicable	not applicable	Water Content & Matric Potential (MP)
B-6	19	100	Gamma log and Induction	not applicable	not applicable	
B-5	20	100	Gamma log and Induction	not applicable	not applicable	Vector Probe (VP)
B-1	21	100	not required	not applicable	not applicable	
A-4	22	<5	not applicable	1	Submerged in saturated zone depth per site conditions.	
B-2	23	100	not required	not applicable	not applicable	Water Content & Matric Potential (MP)
A-1	24	12	not applicable	1	Submerged in saturated zone depth per site conditions.	
A-5	25	10	not applicable	1	Submerged in saturated zone depth per site conditions.	

[1] RES = Resistivity Boreholes. A = Alluvial Aquifer Boreholes and Wells. B = Characterization Boreholes.

Note: Vector Probe will only be installed if saturation is observed. Vector Probe will be installed through the augers and backfilled by reversing the augers.

[2] Down the Hole instruments will be installed permanantly by LANL

[3] Two initial holes will be drilled to determine alluvium saturation. Depending on results, additional holes will be drilled.

Table 4
Data Quality Objectives for RES Borings in Mortandad Canyon

	RES-2	RES-3	RES-4
Conceptual Model Uncertainty	Verify DC Resisitvity survey data concerning potential moist and dry zones	Verify DC Resisitvity survey data concerning potential moist and dry zones	Verify DC Resisitvity survey data concerning potential moist and dry zones
Projected Depth	200ft penetrate through alluvium and into Bandelier Tuff. Plug and abandon boring when completed	200ft penetrate through alluvium and into Bandelier Tuff. Plug and abandon boring when completed	225ft penetrate through alluvium and into Bandelier Tuff. Plug and abandon boring when completed
Core Needs and Vadose zone sampling	Collect continuous core sample to Total Depth for moisture profile data. Submit samples to laboratory from every 10-foot interval to TD for analysis for anions, metals, radionuclides and stable isotopes.	Collect continuous core sample to Total Depth for moisture profile data. Submit samples to laboratory from every 10-foot interval to TD for analysis for anions, metals, radionuclides and stable isotopes.	Collect continuous core sample to Total Depth for moisture profile data. Submit samples to laboratory from every 10-foot interval to TD for analysis for anions, metals, radionuclides and stable isotopes.
Geophysics	Suite and timing of geophysical logging to depend on borehole Laboratory borehole video camera to be used when open-hole conditions in the vadose zone are favorable for logging.	Suite and timing of geophysical logging to depend on borehole Laboratory borehole video camera to be used when open-hole conditions in the vadose zone are favorable for logging.	Suite and timing of geophysical logging to depend on borehole Laboratory borehole video camera to be used when open-hole conditions in the vadose zone are favorable for logging.

Table 5
Data Quality Objectives for Characterization Boreholes in Mortandad Canyon

	Boreholes 1,2,5,6 (B-3,4 deleted)	Boreholes 7-9	Boreholes 10-12 (B-13 deleted)	Boreholes 14 and 15	Borehole 16
Conceptual Model Uncertainty	Reduce uncertainty in contaminant distributions, adsorption capacity, and infiltration in alluvium and upper Bandelier Tuff in Effluent Canyon and Upper Mortandad Canyon upstream (west) of TW-8 Constrain location of effluent infiltration	Reduce uncertainty in contaminant distributions, adsorption capacity, and infiltration in alluvium and upper Bandelier Tuff in Mortandad Canyon between MCO-6.6 and sediment trap #2 Constrain location of effluent infiltration	Reduce uncertainty in contaminant distributions, adsorption capacity, and infiltration in alluvium and upper Bandelier Tuff in Mortandad Canyon between MCO-7.2 and MCO-8.2 Constrain location of effluent infiltration	Reduce uncertainty in contaminant distributions, adsorption capacity, and infiltration in alluvium and upper Bandelier Tuff in Ten Site Canyon upstream of confluence with Mortandad Canyon Constrain location of effluent infiltration	Reduce uncertainty in anion/tritium distributions and infiltration near R-13 in upper 100 ft of alluvium and Bandelier Tuff
Projected Depth	100 ft	100 ft	100 ft	B-14 350 ft B-15 100 ft	100 ft
Geology	Determine thickness, reactive phases, and composition of alluvium/Bandelier Tuff in Effluent Canyon and upper Mortandad Canyon west and east of confluence with Effluent Canyon	Determine thickness, reactive phases, and composition of alluvium/Bandelier Tuff in Mortandad Canyon between MCO-6.6A and sediment trap #2	Determine thickness, reactive phases, and composition of alluvium/Bandelier Tuff in Mortandad Canyon between MCO-7.2 and MCO-8.2	Determine thickness, reactive phases, and composition of alluvium/Bandelier Tuff in Ten Site Canyon upstream of confluence with Mortandad Canyon	Determine thickness, and composition of alluvium/Bandelier Tuff near R-13
Hydrology	Determine moisture content in Bandelier Tuff	Determine moisture content in Bandelier Tuff	Determine moisture content in Bandelier Tuff	Determine moisture content in Bandelier Tuff	Determine moisture content in Bandelier Tuff
Geochemistry /Contaminant Chemistry	Determine contaminant profiles for radionuclides, anions, and metals. Measure effective Kd values for radionuclides in 3 boreholes at 3 depths/borehole	Determine contaminant profiles for radionuclides, anions, and metals. Measure effective Kd values for radionuclides in 1 borehole at 3 depths	Determine contaminant profiles for radionuclides, anions, and metals. Measure effective Kd values for radionuclides in 1 borehole at 3 depths	Determine contaminant profiles for radionuclides, anions, and metals. Measure effective Kd for radionuclides in 2 boreholes at 3 depths/borehole	Determine contaminant profiles for anions.
Core Needs	Obtain continuous core. Submit core samples (every 10 ft) from surface to total depth (100 ft) for radionuclide, metal, and anion analyses and moisture content.	Obtain continuous core. Submit core samples (every 10 ft) from surface to total depth (100 ft) for radionuclide, metal, and anion analyses and moisture content.	Obtain continuous core. Submit core samples (every 10ft) from surface to total depth (100 ft) for radionuclide, metal, and anion analyses and moisture content.	Obtain continuous core. Submit core samples (every 10ft) from surface to total depth (350 ft for B-14, 100 ft for B-15) for radionuclide, metal, and anion analyses and moisture content.	Obtain continuous core. Submit core samples (every10 ft) from surface to total depth (100 ft) for anions, tritium, and moisture content.

Table 6
Data Quality Objectives for Alluvial Wells in Mortandad Canyon

	Well A-1	Well A-2	Well A-3a–f (Reserved)	Wells A-4, A-5	Well A-6	Wells A-7, A-8, and A-9
Conceptual Model Uncertainty	A-1 will define the limits on baseline/contaminant content in alluvial groundwater upstream of confluence with Effluent Canyon. Constrain location and rate of effluent infiltration in the upper portion of Mortandad Canyon	A-2 will provide data on the alluvial system where moderately-adsorbing contaminants (e.g., Sr) are accumulated. Constrain location and rate of effluent infiltration in the middle portion of Mortandad Canyon and the extent of saturation in the alluvium between MCO-6 and MCO-7	Install piezometers to reduce uncertainty in hydraulic gradients. The A-3 series will provide data on alluvial hydrology for modeling contaminant transport. Constrain location and rate of effluent infiltration	A-4 will define location and rate of infiltration within Effluent Canyon and A-5 will define location and rate of infiltration in Mortandad Canyon just below the confluence with Effluent Canyon. Replace wells that are not usable: MCO-2 (A-4) and MCO-3 (A-5).	A-6 is located in an area that may be a "hydrological sink" or a zone of enhanced infiltration. A-6 will determine whether adsorptive contaminants released into Ten Site Canyon have accumulated in the alluvium and will help to constrain location and rate of effluent infiltration.	This series of alluvial wells across the eastern portion of Mortandad Canyon will provide a check on whether non adsorptive contaminants (e.g., ^{3}He, ClO_4) migrate over large distances in periodically saturated alluvium and help to constrain location and rate of effluent infiltration.
Projected Depth	12 ft; penetrate 5 ft into Bandelier Tuff	90 ft; penetrate 20 ft into Bandelier Tuff	45 ft; penetrate to base of alluvium	2-3 ft at A-4 and 10 ft at A-5; penetrate to base of alluvium	90 ft; penetrate to base of alluvium	90 ft for each well; penetrate to base of alluvium and/or colluvium
Geology	Determine thickness and composition of alluvium in upper Mortandad Canyon west of confluence with Effluent Canyon	Determine thickness, reactive phases, and composition of alluvium between MCO-6 and MCO-7.	Determine thickness and composition of alluvium and/or colluvium between MT-3 and MT-4	Determine thickness and composition of alluvium at MCO-2 and MCO-3	Determine thickness and composition of alluvium in Ten Site Canyon 1000 ft west of confluence with Mortandad Canyon	Determine thickness and composition of alluvium and/or colluvium near MCO-13
Hydrology	Determine hydraulic gradient, hydraulic conductivity, flow direction, and extent of saturation in alluvium	Determine hydraulic gradient, hydraulic conductivity, flow direction, and extent of saturation between MCO-6 and MCO-7	Determine vertical and horizontal gradients, hydraulic conductivity, flow direction, and extent of saturation between MT-3 and MT-4	Determine hydraulic gradient, hydraulic conductivity, flow direction, and extent of saturation at MCO-2 and MCO-3	Determine hydraulic gradient, hydraulic conductivity, flow direction, and extent of saturation 1000 ft west of confluence with Mortandad Canyon	Determine hydraulic gradient, flow direction, and extent of saturation in the alluvium and/or colluvium near MCO-13 Act as characterization wells, if saturation is encountered
Geochemistry /Contaminant Chemistry	Evaluate hydrochemistry of alluvium in upper Mortandad Canyon west of confluence with Effluent Canyon	Evaluate attenuation of strontium-90 between MCO-6 and MCO-7. Characterize mineralogy that controls migration of strontium-90 and other contaminants	None	Evaluate hydrochemistry of alluvium at MCO-2 and MCO-3	Evaluate hydrochemistry of alluvium in Ten Site Canyon	Evaluate hydrochemistry of alluvium and/or colluvium near MCO-13
Saturated Zone Sampling	Collect and analyze water samples after well development	Collect and analyze water samples after well development	None	Collect and analyze water samples after well development	Collect and analyze water samples after well development	Collect and analyze water samples after well development
Core Needs	None	Collect core samples from surface to total depth (90 ft) for radionuclide, metal, and anion analyses	None	None	None	None
Hydraulic Testing	Slug tests	Slug tests	Slug tests	Slug tests	Slug tests	Slug tests
Geophysical Testing	None	Gamma induction	Gamma induction	Gamma induction	Gamma induction	Gamma induction
Number of Well Screens	One	One	Install one per well (total 6); placed at different depths to determine vertical gradients	One per well	One	One per well

Table 7
Sampling and Analysis of Shallow Aquifer Groundwater

Estimated Number of Water Samples/ Borehole	Analysis	Container	Preservation	Filtered Through Acetate 0.45 Micrometer	Volume of Each Sample (L)	Collect Archival Sample	Archival Sample Volume (L)
1	Metals (dissolved)	100 ml plastic	HNO_3 to pH 2, 4°C	Yes	0.25	none	
1	Anions (dissolved)	100 ml plastic	No preservation	Yes	0.25	none	
1	γ spec, ^{241}Am, ^{137}Cs, $^{238,239,240}Pu$, $^{234,235,238}U$, ^{90}Sr	1 gal. plastic	HNO_3 to pH 2, 4°C	No	3.78	X	3.78
1	Stable isotopes ($^{18}O/^{16}O$, D/H)	30 ml glass w/ poly-seal cap	Ambient temperature	No	0.03	X	0.03
1	Stable isotopes ($^{15}N/^{14}N$)	1 gal. plastic	HCL or H_2SO_4 to pH 2, 4°C	No	3.78	X	3.78
1	Tritium[a]	500 ml poly	Ambient temperature	No	0.5	X	0.5
1	Tritium (low-level or direct-counting)[a]	500 ml poly	Ambient temperature	No	0.5	X	1
1	Gross α, ß ,γ (for off-site shipping)	500 ml poly	Ambient temperature	No	0.5	X	0.5
1	TKN	1 L poly	H_2SO_4 to pH 2, 4°C[b]	No	1	X	1
1	ClO_4	250 ml poly	Ambient temperature	Yes	0.25	X	0.25
				Total volume of each sample event: filtered and non-filtered	10.84		10.84
				Part of total volume to be filtered	0.75		

[a] Initially analyze tritium using liquid scintillation. If activity is less than 300 pCi/L, analyze archival sample using direct counting or electrolytic enrichment at University of Miami.

[b] No preservation for ClO_4^-, Br^-, Cl^-, F^-, NO_3^-, NO_2^-, SO_4^{2-}, and PO_4^{3-}

APPENDIX
MATERIAL SAFETY DATA SHEETS

HALLIBURTON

MATERIAL SAFETY DATA SHEET

Product Trade Name: **SAND - ARIZONA SILICA**

Revision Date: 11-Feb-2002

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: SAND - ARIZONA SILICA
Synonyms: None
Chemical Family: Sand
Application: Proppant

Manufacturer/Supplier
Halliburton Energy Services
P.O. Box 1431
Duncan, Oklahoma 73536-0431
Emergency Telephone: (800) 666-9260 or (713) 753-3000

Prepared By
Chemical Compliance
Telephone: 1-580-251-4335

2. COMPOSITION/INFORMATION ON INGREDIENTS

SUBSTANCE	CAS Number	PERCENT	ACGIH TLV-TWA	OSHA PEL-TWA
Crystalline silica, quartz	14808-60-7	60 - 100%	0.05 mg/m^3	10 mg/m^3 / %SiO2 + 2

More restrictive exposure limits may be enforced by some states, agencies, or other authorities.

3. HAZARDS IDENTIFICATION

Hazard Overview

CAUTION! - ACUTE HEALTH HAZARD
May cause eye and respiratory irritation.

DANGER! - CHRONIC HEALTH HAZARD
Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposures below recommended exposure limits. Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product. Review the Material Safety Data Sheet (MSDS) for this product, which has been provided to your employer.

4. FIRST AID MEASURES

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Skin	Wash with soap and water.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.
Notes to Physician	Not Applicable

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (F):	Not Determined
Autoignition Temperature (C):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media	None - does not burn.
Special Exposure Hazards	Not applicable.
Special Protective Equipment for Fire-Fighters	Not applicable.
NFPA Ratings:	Health 0, Flammability 0, Reactivity 0
HMIS Ratings:	Flammability 0, Reactivity 0, Health 0*

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures	Use appropriate protective equipment. Avoid creating and breathing dust.
Environmental Precautionary Measures	None known.
Procedure for Cleaning / Absorption	Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. HANDLING AND STORAGE

Handling Precautions	This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.
Storage Information	Store in a cool, dry location. Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Product has a shelf life of 36 months.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls	Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits listed in Section 2.
Respiratory Protection	Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product.

Hand Protection	Normal work gloves.
Skin Protection	Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid
Color:	Tan
Odor:	Odorless
pH:	Not Determined
Specific Gravity @ 20 C (Water=1):	2.65
Density @ 20 C (lbs./gallon):	Not Determined
Bulk Density @ 20 C (lbs/ft3):	100
Boiling Point/Range (F):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	0
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Insoluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistrokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	65

10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur
Conditions to Avoid	None known.
Incompatibility (Materials to Avoid)	Hydrofluoric acid.
Hazardous Decomposition Products	Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).
Additional Guidelines	Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure	Eye or skin contact, inhalation.

Inhalation

Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).

Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).

Skin Contact

None known.

Eye Contact

May cause mechanical irritation to eye.

Ingestion

None known

Aggravated Medical Conditions

Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.

Chronic Effects/Carcinogenicity

Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2).

There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

Other Information

For further information consult "Adverse Effects of Crystalline Silica Exposure" published by the American Thoracic Society Medical Section of the American Lung Association, American Journal of Respiratory and Critical Care Medicine, Volume 155, pages 761-768 (1997).

Toxicity Tests

Oral Toxicity:	Not determined
Dermal Toxicity:	Not determined
Inhalation Toxicity:	Not determined
Primary Irritation Effect:	Not determined
Carcinogenicity	Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997).
Genotoxicity:	Not determined

Reproductive / Developmental Toxicity: Not determined

12. ECOLOGICAL INFORMATION

Mobility (Water/Soil/Air) Not determined

Persistence/Degradability Not applicable

Bio-accumulation Not Determined

Ecotoxicological Information

Acute Fish Toxicity: Not determined
Acute Crustaceans Toxicity: Not determined
Acute Algae Toxicity: Not determined

Chemical Fate Information Not determined

Other Information Not applicable

13. DISPOSAL CONSIDERATIONS

Disposal Method Bury in a licensed landfill according to federal, state, and local regulations.

Contaminated Packaging Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

DOT
Not restricted

Canadian TDG
Not restricted

ADR Not restricted

Air Transportation

ICAO/IATA
Not restricted

Sea Transportation

IMDG
Not restricted

Other Shipping Information

Labels: None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory	All components listed on inventory.
EPA SARA Title III Extremely Hazardous Substances	Not applicable
EPA SARA (311,312) Hazard Class	Acute Health Hazard Chronic Health Hazard
EPA SARA (313) Chemicals	This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).
EPA CERCLA/Superfund Reportable Spill Quantity For This Product	Not applicable.
EPA RCRA Hazardous Waste Classification	If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.
California Proposition 65	The California Proposition 65 regulations apply to this product.
MA Right-to-Know Law	One or more components listed.
NJ Right-to-Know Law	One or more components listed.
PA Right-to-Know Law	One or more components listed.

Canadian Regulations

Canadian DSL Inventory	All components listed on inventory.
WHMIS Hazard Class	D2A Very Toxic Materials (Crystalline silica)

16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS
Not applicable

Additional Information	For additional information on the use of this product, contact your local Halliburton representative. For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.
Disclaimer Statement	This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

*****END OF MSDS*****

HALLIBURTON

MATERIAL SAFETY DATA SHEET

Product Trade Name: **SILICA FLOUR**

Revision Date: 19-Jun-2002

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: SILICA FLOUR
Synonyms: None
Chemical Family: Sand
Application: Proppant

Manufacturer/Supplier
Halliburton Energy Services
P.O. Box 1431
Duncan, Oklahoma 73536-0431
Emergency Telephone: (800) 666-9260 or (713) 753-3000

Prepared By
Chemical Compliance
Telephone: 1-580-251-4335

2. COMPOSITION/INFORMATION ON INGREDIENTS

SUBSTANCE	CAS Number	PERCENT	ACGIH TLV-TWA	OSHA PEL-TWA
Crystalline silica, quartz	14808-60-7	60 - 100%	0.05 mg/m^3	10 mg/m^3 %SiO2 + 2

More restrictive exposure limits may be enforced by some states, agencies, or other authorities.

3. HAZARDS IDENTIFICATION

Hazard Overview

CAUTION! - ACUTE HEALTH HAZARD
May cause eye and respiratory irritation.

DANGER! - CHRONIC HEALTH HAZARD
Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposures below recommended exposure limits. Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product. Review the Material Safety Data Sheet (MSDS) for this product, which has been provided to your employer.

4. FIRST AID MEASURES

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Skin	Wash with soap and water.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.
Notes to Physician	Not Applicable

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (F):	Not Determined
Autoignition Temperature (C):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media	None - does not burn.
Special Exposure Hazards	Not applicable.
Special Protective Equipment for Fire-Fighters	Not applicable.
NFPA Ratings:	Health 0, Flammability 0, Reactivity 0
HMIS Ratings:	Flammability 0, Reactivity 0, Health 0*

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures	Use appropriate protective equipment. Avoid creating and breathing dust.
Environmental Precautionary Measures	None known.
Procedure for Cleaning / Absorption	Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. HANDLING AND STORAGE

Handling Precautions	This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.
Storage Information	Store in a cool, dry location. Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Product has a shelf life of 36 months.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls	Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits listed in Section 2.
Respiratory Protection	Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product.

Hand Protection	Normal work gloves.
Skin Protection	Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid
Color:	White
Odor:	Odorless
pH:	Not Determined
Specific Gravity @ 20 C (Water=1):	2.63
Density @ 20 C (lbs./gallon):	Not Determined
Bulk Density @ 20 C (lbs/ft3):	70
Boiling Point/Range (F):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	0
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Insoluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistrokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	60.1

10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur
Conditions to Avoid	None known.
Incompatibility (Materials to Avoid)	Hydrofluoric acid.
Hazardous Decomposition Products	Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).
Additional Guidelines	Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure	Eye or skin contact, inhalation.

Inhalation

Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).

Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).

Skin Contact

None known.

Eye Contact

May cause mechanical irritation to eye.

Ingestion

None known

Aggravated Medical Conditions

Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.

Chronic Effects/Carcinogenicity

Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2).

There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

Other Information

For further information consult "Adverse Effects of Crystalline Silica Exposure" published by the American Thoracic Society Medical Section of the American Lung Association, American Journal of Respiratory and Critical Care Medicine, Volume 155, pages 761-768 (1997).

Toxicity Tests

Oral Toxicity: Not determined

Dermal Toxicity: Not determined

Inhalation Toxicity: Not determined

Primary Irritation Effect: Not determined

Carcinogenicity Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997).

Genotoxicity: Not determined

Reproductive / Developmental Toxicity: Not determined

12. ECOLOGICAL INFORMATION

Mobility (Water/Soil/Air) Not determined

Persistence/Degradability Not applicable

Bio-accumulation Not Determined

Ecotoxicological Information

Acute Fish Toxicity: Not determined
Acute Crustaceans Toxicity: Not determined
Acute Algae Toxicity: Not determined

Chemical Fate Information Not determined

Other Information Not applicable

13. DISPOSAL CONSIDERATIONS

Disposal Method Bury in a licensed landfill according to federal, state, and local regulations.

Contaminated Packaging Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

DOT
Not restricted

Canadian TDG
Not restricted

ADR Not restricted

Air Transportation

ICAO/IATA
Not restricted

Sea Transportation

IMDG
Not restricted

Other Shipping Information

Labels: None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory	All components listed on inventory.
EPA SARA Title III Extremely Hazardous Substances	Not applicable
EPA SARA (311,312) Hazard Class	Acute Health Hazard Chronic Health Hazard
EPA SARA (313) Chemicals	This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).
EPA CERCLA/Superfund Reportable Spill Quantity For This Product	Not applicable.
EPA RCRA Hazardous Waste Classification	If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.
California Proposition 65	The California Proposition 65 regulations apply to this product.
MA Right-to-Know Law	One or more components listed.
NJ Right-to-Know Law	One or more components listed.
PA Right-to-Know Law	One or more components listed.

Canadian Regulations

Canadian DSL Inventory	All components listed on inventory.
WHMIS Hazard Class	D2A Very Toxic Materials (Crystalline silica)

16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS
Not applicable

Additional Information	For additional information on the use of this product, contact your local Halliburton representative. For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.
Disclaimer Statement	This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

*****END OF MSDS*****

HALLIBURTON

MATERIAL SAFETY DATA SHEET

Product Trade Name: **MUD-GEL®**

Revision Date: 05/17/2002

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: MUD-GEL®
Synonyms: None
Chemical Family: Mineral
Application: Weight Additive

Manufacturer/Supplier

Baroid Drilling Fluids
a Product Service Line of Halliburton Energy Services, Inc.
P.O. Box 1675
Houston, TX 77251
Telephone: (281) 871-4000
Emergency Telephone: (800) 666-9260 or (713) 676-3000

Prepared By

Product Stewardship
Telephone: 1-580-251-4335

2. COMPOSITION/INFORMATION ON INGREDIENTS

SUBSTANCE	CAS Number	PERCENT	ACGIH TLV-TWA	OSHA PEL-TWA
Bentonite	1302-78-9	60 - 100%	Not applicable	Not applicable
Crystalline silica, quartz	14808-60-7	1 - 5%	0.05 mg/m^3	$\frac{10 \text{ mg/m}^3}{\%SiO2 + 2}$
Crystalline silica, cristobalite	14464-46-1	0 - 1%	0.05 mg/m^3	1/2 x $\frac{10 \text{ mg/m}^3}{\%SiO2 + 2}$
Crystalline silica, tridymite	15468-32-3	0 - 1%	0.05 mg/m^3	1/2 x $\frac{10 \text{ mg/m}^3}{\%SiO2 + 2}$

More restrictive exposure limits may be enforced by some states, agencies, or other authorities.

3. HAZARDS IDENTIFICATION

Hazard Overview	**CAUTION! - ACUTE HEALTH HAZARD** May cause eye and respiratory irritation. **DANGER! - CHRONIC HEALTH HAZARD** Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease. This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposures below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Review the Material Safety Data Sheet (MSDS) for this product, which has been provided to your employer.

4. FIRST AID MEASURES

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.
Notes to Physician	Treat symptomatically.

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (F):	Not Determined
Autoignition Temperature (C):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media	All standard firefighting media.
Special Exposure Hazards	Not applicable.
Special Protective Equipment for Fire-Fighters	Not applicable.
NFPA Ratings:	Health 0, Flammability 0, Reactivity 0
HMIS Ratings:	Flammability 0, Reactivity 0, Health 0*

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures	Use appropriate protective equipment. Avoid creating and breathing dust.
Environmental Precautionary Measures	None known.
Procedure for Cleaning/Absorption	Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. HANDLING AND STORAGE

Handling Precautions

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.

Storage Information

Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container. Product has a shelf life of 12 months.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits listed in Section 2.

Respiratory Protection

Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product.

Hand Protection

Normal work gloves.

Skin Protection

Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.

Eye Protection

Wear safety glasses or goggles to protect against exposure.

Other Precautions

None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Powder
Color:	Tan to Gray
Odor:	Mild earthy
pH:	8-10
Specific Gravity @ 20 C (Water=1):	2.6
Density @ 20 C (lbs./gallon):	Not Determined
Bulk Density @ 20 C (lbs/ft3):	50 (uncompacted); 73 (compacted)
Boiling Point/Range (F):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	Not Determined
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Insoluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistrokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined

10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur
Conditions to Avoid	None anticipated
Incompatibility (Materials to Avoid)	Hydrofluoric acid.
Hazardous Decomposition Products	Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).
Additional Guidelines	Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure	Eye or skin contact, inhalation.
Inhalation	Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A). Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).
Skin Contact	May cause mechanical skin irritation.
Eye Contact	May cause eye irritation.
Ingestion	None known
Aggravated Medical Conditions	Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.
Chronic Effects/Carcinogenicity	Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis. Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2). There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

ICAO/IATA
Not restricted

Sea Transportation

IMDG
Not restricted

Other Shipping Information

Labels:	None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory	All components listed on inventory.
EPA SARA Title III Extremely Hazardous Substances	Not applicable
EPA SARA (311,312) Hazard Class	Acute Health Hazard Chronic Health Hazard
EPA SARA (313) Chemicals	This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).
EPA CERCLA/Superfund Reportable Spill Quantity For This Product	Not applicable.
EPA RCRA Hazardous Waste Classification	If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.
California Proposition 65	The California Proposition 65 regulations apply to this product.
MA Right-to-Know Law	One or more components listed.
NJ Right-to-Know Law	One or more components listed.
PA Right-to-Know Law	One or more components listed.

Canadian Regulations

Canadian DSL Inventory	All components listed on inventory.
WHMIS Hazard Class	D2A Very Toxic Materials (Crystalline silica)

16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS
Not applicable

Additional Information	For additional information on the use of this product, contact your local Halliburton representative. For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Product Stewardship at 1-580-251-4335.

Disclaimer Statement

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

END OF MSDS

3. HAZARDS IDENTIFICATION

Hazard Overview

CAUTION! - ACUTE HEALTH HAZARD

May cause eye and respiratory irritation.

DANGER! - CHRONIC HEALTH HAZARD

Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposures below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Review the Material Safety Data Sheet (MSDS) for this product, which has been provided to your employer.

4. FIRST AID MEASURES

Inhalation
If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Skin
Wash with soap and water. Get medical attention if irritation persists.

Eyes
In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Ingestion
Under normal conditions, first aid procedures are not required.

Notes to Physician
Treat symptomatically.

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (F):	Not Determined
Autoignition Temperature (C):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media
All standard firefighting media.

Special Exposure Hazards
Not applicable.

Other Information

For further information consult "Adverse Effects of Crystalline Silica Exposure" published by the American Thoracic Society Medical Section of the American Lung Association, American Journal of Respiratory and Critical Care Medicine, Volume 155, pages 761-768 (1997).

Toxicity Tests

Oral Toxicity:	Not determined
Dermal Toxicity:	Not determined
Inhalation Toxicity:	Not determined
Primary Irritation Effect:	Not determined
Carcinogenicity	Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997).
Genotoxicity:	Not determined
Reproductive / Developmental Toxicity:	Not determined

12. ECOLOGICAL INFORMATION

Mobility (Water/Soil/Air)	Not determined
Persistence/Degradability	Not determined
Bio-accumulation	Not Determined

Ecotoxicological Information

Acute Fish Toxicity:	Not determined
Acute Crustaceans Toxicity:	Not determined
Acute Algae Toxicity:	Not determined
Chemical Fate Information	Not determined
Other Information	Not applicable

13. DISPOSAL CONSIDERATIONS

Disposal Method	Bury in a licensed landfill according to federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

DOT
Not restricted

Canadian TDG
Not restricted

ADR Not restricted

Air Transportation

HALLIBURTON

MATERIAL SAFETY DATA SHEET

BENTONITE PELLETS 3\{8 Inch

Revision Date: 02/25/2002

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: BENTONITE PELLETS 3\{8 Inch
Synonyms: None
Chemical Family: Mineral
Application: Weight Additive

Manufacturer/Supplier
Baroid Drilling Fluids
a Product Service Line of Halliburton Energy Services, Inc.
P.O. Box 1675
Houston, TX 77251

Telephone: (281) 871-4000
Emergency Telephone: (800) 666-9260 or (713) 676-3000

Prepared By
Product Stewardship
Telephone: 1-580-251-4335

2. COMPOSITION/INFORMATION ON INGREDIENTS

Substance	Weight Percent (%)	ACGIH TLV-TWA	OSHA PEL-TWA
Crystalline silica, cristobalite 14464-46-1	0 - 1%	0.05 mg/m3	1/2 x $\frac{10\ mg/m3}{\%SiO2 + 2}$
Crystalline silica, tridymite 15468-32-3	0 - 1%	0.05 mg/m3	1/2 x $\frac{10\ mg/m3}{\%SiO2 + 2}$
Bentonite 1302-78-9	60 - 100%	Not applicable	Not applicable
Crystalline silica, quartz 14808-60-7	1 - 5%	0.05 mg/m3	$\frac{10\ mg/m3}{\%SiO2 + 2}$

More restrictive exposure limits may be enforced by some states, agencies, or other authorities.

Special Protective Equipment for Fire-Fighters
Not applicable.

NFPA Ratings: Health 0, Flammability 0, Reactivity 0

HMIS Ratings: Flammability 0, Reactivity 0, Health 0*

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures
Use appropriate protective equipment. Avoid creating and breathing dust.

Environmental Precautionary Measures
None known.

Procedure for Cleaning/Absorption
Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. HANDLING AND STORAGE

Handling Precautions
This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.

Storage Information
Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls
Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits listed in Section 2.

Respiratory Protection
Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product.

Hand Protection
Normal work gloves.

Skin Protection
Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.

Eye Protection
Wear safety glasses or goggles to protect against exposure.

Other Precautions

None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid
Color:	Various
Odor:	Odorless
pH:	8-10
Specific Gravity @ 20 C (Water=1):	2.55
Density @ 20 C (lbs./gallon):	62
Bulk Density @ 20 C (lbs/ft3):	71
Boiling Point/Range (F):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	Not Determined
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Insoluble
Solubility in Solvents (g/100ml):	Not Determined
Solubility in Sea Water (g/100ml):	Insoluble Sinks
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistrokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined

10. STABILITY AND REACTIVITY

Stability Data: Stable

Hazardous Polymerization: Will Not Occur

Conditions to Avoid
None anticipated

Incompatibility (Materials to Avoid)
Hydrofluoric acid.

Hazardous Decomposition Products
Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).

Additional Guidelines
Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure
Eye or skin contact, inhalation.

Inhalation
Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).

Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).

Skin Contact
May cause mechanical skin irritation.

Eye Contact
May cause eye irritation.

Ingestion
None known

Aggravated Medical Conditions
Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.

Chronic Effects/Carcinogenicity
Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2).

There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

Other Information
For further information consult "Adverse Effects of Crystalline Silica Exposure" published by the American Thoracic Society Medical Section of the American Lung Association, American Journal of Respiratory and Critical Care Medicine, Volume 155, pages 761-768 (1997).

Toxicity Tests

Oral Toxicity:	Not determined
Dermal Toxicity:	Not determined
Inhalation Toxicity:	Not determined
Primary Irritation Effect:	Not determined

Carcinogenicity
Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997).

Genotoxicity: Not determined

Reproductive/Developmental Toxicity: Not determined

12. ECOLOGICAL INFORMATION

Mobility (Water/Soil/Air)
Not determined

Persistence/Degradability
Not determined

Bio-accumulation
Not Determined

Ecotoxicological Information
Acute Fish Toxicity:
Not determined
Acute Crustaceans Toxicity:
Not determined
Acute Algae Toxicity:
Not determined

Chemical Fate Information
Not determined

Other Information
Not applicable

13. DISPOSAL CONSIDERATIONS

Disposal Method
Bury in a licensed landfill according to federal, state, and local regulations.

Contaminated Packaging
Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

DOT

Not restricted

Canadian TDG

Not restricted

ADR

Not restricted

Air Transportation

ICAO/IATA

Not restricted

Sea Transportation

IMDG

Not restricted

Other Shipping Information

Labels: None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory
All components listed on inventory

EPA SARA Title III Extremely Hazardous Substances
Not applicable

EPA SARA (311,312) Hazard Class
Acute Health Hazard
Chronic Health Hazard

EPA SARA (313) Chemicals
This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).

EPA CERCLA/Superfund Reportable Spill Quantity For This Product
Not applicable.

EPA RCRA Hazardous Waste Classification
If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.

California Proposition 65
The California Proposition 65 regulations apply to this product.

MA Right-to-Know Law
One or more components listed.

NJ Right-to-Know Law
One or more components listed.

PA Right-to-Know Law
One or more components listed.

Canadian Regulations

Canadian DSL Inventory
All components listed on inventory.

WHMIS Hazard Class
D2A Very Toxic Materials
(Crystalline silica)

16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS
Not applicable

Additional Information
For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Product Stewardship at 1-580-251-4335.

Disclaimer Statement
This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

*****END OF MSDS*****

HALLIBURTON

MATERIAL SAFETY DATA SHEET

Product Trade Name: **HOLEPLUG® 3/8**

Revision Date: 25-Feb-2002

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: HOLEPLUG® 3/8
Synonyms: None
Chemical Family: Mineral
Application: Fluid Loss Additive

Manufacturer/Supplier
Baroid Drilling Fluids
a Product Service Line of Halliburton Energy Services, Inc.
P.O Box 1675
Houston, TX 77251
Telephone: (281) 871-4000
Emergency Telephone: (800) 666-9260 or (713) 676-3000

Prepared By
Chemical Compliance
Telephone: 1-580-251-4335

2. COMPOSITION/INFORMATION ON INGREDIENTS

SUBSTANCE	CAS Number	PERCENT	ACGIH TLV-TWA	OSHA PEL-TWA
Bentonite	1302-78-9	60 - 100%	Not applicable	Not applicable
Crystalline silica, quartz	14808-60-7	0 - 5%	0.05 mg/m³	$\frac{10\ mg/m^3}{\%SiO2 + 2}$
Crystalline silica, tridymite	15468-32-3	0 - 1%	0.05 mg/m³	$1/2 \times \frac{10\ mg/m^3}{\%SiO2 + 2}$
Crystalline silica, cristobalite	14464-46-1	0 - 1%	0.05 mg/m³	$1/2 \times \frac{10\ mg/m^3}{\%SiO2 + 2}$

More restrictive exposure limits may be enforced by some states, agencies, or other authorities.

3. HAZARDS IDENTIFICATION

Hazard Overview

CAUTION! - ACUTE HEALTH HAZARD
May cause eye and respiratory irritation.

DANGER! - CHRONIC HEALTH HAZARD
Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposures below recommended exposure limits. Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product Review the Material Safety Data Sheet (MSDS) for this product, which has been provided to your employer.

4. FIRST AID MEASURES

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Skin Wash with soap and water. Get medical attention if irritation persists.

Eyes In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Ingestion Under normal conditions, first aid procedures are not required.

Notes to Physician Treat symptomatically.

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (F):	Not Determined
Autoignition Temperature (C):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media All standard firefighting media.

Special Exposure Hazards Not applicable.

Special Protective Equipment for Fire-Fighters Not applicable.

NFPA Ratings: Health 0, Flammability 0, Reactivity 0
HMIS Ratings: Flammability 0, Reactivity 0, Health 0*

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures Use appropriate protective equipment. Avoid creating and breathing dust.

Environmental Precautionary Measures None known.

Procedure for Cleaning / Absorption Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. HANDLING AND STORAGE

Handling Precautions This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.

Storage Information Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits listed in Section 2.

Respiratory Protection Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product.

Hand Protection Normal work gloves.

Skin Protection Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.

Eye Protection Wear safety glasses or goggles to protect against exposure.

Other Precautions None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid
Color:	Various
Odor:	Odorless
pH:	8-10
Specific Gravity @ 20 C (Water=1):	2.12
Density @ 20 C (lbs./gallon):	Not Determined
Bulk Density @ 20 C (lbs/ft3):	51
Boiling Point/Range (F):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	Not Determined
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Insoluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistrokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined

10. STABILITY AND REACTIVITY

Stability Data: Stable

Hazardous Polymerization: Will Not Occur

Conditions to Avoid	None anticipated
Incompatibility (Materials to Avoid)	Hydrofluoric acid.
Hazardous Decomposition Products	Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).
Additional Guidelines	Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure	Eye or skin contact, inhalation.
Inhalation	Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A). Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).
Skin Contact	May cause mechanical skin irritation.
Eye Contact	May cause eye irritation.
Ingestion	None known
Aggravated Medical Conditions	Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.
Chronic Effects/Carcinogenicity	Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis. Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2). There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

Other Information For further information consult "Adverse Effects of Crystalline Silica Exposure" published by the American Thoracic Society Medical Section of the American Lung Association, American Journal of Respiratory and Critical Care Medicine, Volume 155, pages 761-768 (1997).

Toxicity Tests

Oral Toxicity:	Not determined
Dermal Toxicity:	Not determined
Inhalation Toxicity:	Not determined
Primary Irritation Effect:	Not determined
Carcinogenicity	Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997).
Genotoxicity:	Not determined
Reproductive / Developmental Toxicity:	Not determined

12. ECOLOGICAL INFORMATION

Mobility (Water/Soil/Air)	Not determined
Persistence/Degradability	Not determined
Bio-accumulation	Not Determined

Ecotoxicological Information

Acute Fish Toxicity:	Not determined
Acute Crustaceans Toxicity:	Not determined
Acute Algae Toxicity:	Not determined
Chemical Fate Information	Not determined
Other Information	Not applicable

13. DISPOSAL CONSIDERATIONS

Disposal Method	Bury in a licensed landfill according to federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

Land Transportation

DOT
Not restricted

Canadian TDG
Not restricted

ADR Not restricted

Air Transportation

ICAO/IATA
Not restricted

Sea Transportation

IMDG
Not restricted

Other Shipping Information

Labels: None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory	All components listed on inventory.
EPA SARA Title III Extremely Hazardous Substances	Not applicable
EPA SARA (311,312) Hazard Class	Acute Health Hazard Chronic Health Hazard
EPA SARA (313) Chemicals	This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).
EPA CERCLA/Superfund Reportable Spill Quantity For This Product	Not applicable.
EPA RCRA Hazardous Waste Classification	If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.
California Proposition 65	The California Proposition 65 regulations apply to this product.
MA Right-to-Know Law	One or more components listed.
NJ Right-to-Know Law	One or more components listed.
PA Right-to-Know Law	One or more components listed.

Canadian Regulations

Canadian DSL Inventory	All components listed on inventory.
WHMIS Hazard Class	D2A Very Toxic Materials (Crystalline silica)

16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS
Not applicable

Additional Information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335

Disclaimer Statement

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*****END OF MSDS*****