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FIELD IMPLEMENTATION PLAN FOR COMBINED REGIONAL AQUIFER WELL R-67 AND COREHOLE 6 (CrCH-6)

Los Alamos
NATIONAL LABORATORY
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Prepared by TPMC for the Environmental Programs Directorate

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ACRONYM LIST

APS	Accelerator Porosity Sonde
ASTM	American Society for Testing and Materials
bgs	Below ground surface
CD	Compact disc
CMR	Combinable Magnetic Resonance
CV	Casing volume
DOE	Department of Energy
DTH	down-the-hole
EES	Earth & Environment Science Division
EP (ADEP)	Environmental Programs Directorate
EP-WES	Environmental Programs Waste and Environmental Services
ES&H	Environment, Safety and Health
FMI	Formation Microimager
ft	Feet
FTL	Field Team Leader
FOD	Facility Operations Director
ID	Inside diameter
IDW	Investigation Derived Waste
in	inch
IWD	Integrated Work Document
LANL	Los Alamos National Laboratory
LANS	Los Alamos National Security
MOA	Memorandum of Agreement
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
NTU	Nephelometric turbidity units
OD	Outside diameter
PIC	Person in charge
PM	Project manager
ppm	Parts per million
PVC	Polyvinyl chloride
RLM	Responsible Line Manager
RP-1/ RP-3	Radiological protection group(s)
SMO	Sample management office
SOM	Shift Operations Manager
SOP	Standard Operating Procedure

SOW	Statement of Work
STR	Subcontract Technical Representative
TA	Technical Area
TD	Total Depth
TOC	Total organic carbon
TPMC	TerranearPMC
WCSF	Waste Characterization Strategy Form

1.0 INTRODUCTION

1.1 Background

TerranearPMC has been contracted to install a combined regional aquifer monitoring well and corehole by Los Alamos National Security (LANS) Environmental Programs (EP) Directorate. The combined regional aquifer well and corehole (designated as R-67 and CrCH-6) will be located within Los Alamos National Laboratory (LANL) Technical Area (TA) 61 in Los Alamos County, New Mexico (Figure 1). All work will be performed under the statement of work (SOW) and in accordance with the Compliance Order on Consent (March 2005, revised 2008) between the New Mexico Environment Department (NMED) and DOE/LANL, and the Drilling Work Plan for R-67 (LA-UR-15-20021).

Combined well R-67 and Chromium Corehole 6 (CrCH-6) will be installed as part of the Environmental Programs Chromium Investigation Monitoring Group. The R-67 well will be installed at a depth of approximately 1270 feet (ft) below ground surface (bgs). R-67 will be drilled deep enough to collect representative samples from the regional aquifer. Collection of core from CrCH-6 will be attempted in the Cerro Toledo Interval, Guaje Pumice Bed-Puye Formation contact, base of the Puye Formation, and the top of the regional aquifer in Miocene pumiceous sediments.

Well R-67 is tentatively designed with one well screen within Miocene pumiceous sediments. Final well design will be determined based on conditions found during drilling and geophysical logging and will incorporate discussions with NMED.

This Field Implementation Plan (FIP) provides guidance for drilling, coring, sampling, borehole geophysics, well installation, well development, aquifer testing, and sampling system installation. Project staff, health and safety, waste management, security, schedules, and required permits are also discussed in this document.

1.2 Objectives

The R-67 monitoring well is intended to provide hydrogeologic and groundwater quality data to achieve specific data quality objectives consistent with the Groundwater Protection Program for the Laboratory, the Compliance Order on Consent, and the NMED approved workplan. Specifically, R-67 is being installed to augment the existing network to better define chromium contamination flow paths above and within the regional aquifer. The primary purpose of R-67 is to delineate the nature and extent of the chromium plume and to provide groundwater monitoring for chromium and other potential contaminants within the regional aquifer as required by the NMED's Approval with Modifications of the Phase II Investigation Report for Sandia Canyon.

In addition, this location optimizes the objectives for CrCH-6, as stated in the July 2014 Drilling Work Plan for Chromium Project Coreholes (EP2015-0035), specifically to characterize the upgradient portion of the primary chromium plume. Data derived from CrCH-6 will be evaluated to determine the western extent of anthropogenic chromium in vadose zone pore water and core and within the regional aquifer. This location will also determine if chromium-contaminated surface water in the Sandia Canyon wetland is a potential source of recharges to the regional aquifer.

Secondary objectives are to collect drill-cutting samples for lithologic description and acquire borehole geophysical data.

The end-users of the data collected from this project will be LANL, DOE, NMED, and the general public.

2.0 ORGANIZATIONAL STRUCTURE

This project is being performed for LANS. The LANL Environmental Programs Drilling Subcontract Technical Representative (STR) will assist with obtaining the necessary LANL-required permits and assist with scheduling and logistical issues.

An organizational chart is presented in Table 1.

2.1 TerranearPMC Project Management Team

The TerranearPMC Management Team consists of the Program Manager, Project Manager (PM), Drilling Supervisor, Environment, Safety and Health (ES&H) Representative, and Quality Assurance (QA) Manager. The Management Team will review all task order work plans, ensure compliance with QA, ES&H plans, and perform project audits of ongoing work.

The Management Team will also provide technical assistance to the Field Team. In addition, they will provide health and safety oversight and quality control guidance for well-construction and procedure compliance.

The ES&H Representative will provide health and safety related technical assistance and senior review of all project specific safety plans. He will also conduct project site safety inspections. The TPMC and LANS Management Team key personnel and their respective roles are detailed in Table 2.

2.2 Field Team

TerranearPMC's field team personnel and their respective roles are shown in Table 2. Additional qualified staff may be added as necessary to ensure all project requirements are met. These staff will be identified and their roles assigned before work begins.

During the drilling operations, there will be one onsite TerranearPMC personnel per shift. One geologist will be onsite full time to act as the Field Team Leader (FTL)/Person in Charge (PIC) and lead site geologist. Other TerranearPMC team members will assist the FTL as needed. The lead field geologist will maintain field notes detailing daily site activities, compile and submit daily field reports, document down-hole tools and type/quantity of materials used during drilling and well construction, maintain and document pipe tallies, collect samples, conduct lithologic logging, document wastes generated, and conduct daily safety meetings and equipment inspections. The FTL/PIC will be the main point of contact at the site.

Field operations will run 24-hours a day, seven days per week with two shifts (12-hours per shift) throughout the duration of borehole drilling. After borehole drilling is finished, it is anticipated that work shifts will be 12-hour day shifts only for the remaining tasks (i.e. well construction, well development, aquifer testing, and sampling system installation). Shift timing is yet to be determined. TerranearPMC staff will rotate shifts on a regular basis. TerranearPMC field team members will be interchangeable and their exact scheduling is expected to be flexible.

2.3 Drilling Subcontractor

Boart Longyear will be the drilling subcontractor supporting the drilling, well installation, and development of R-67. The drilling subcontractor will be responsible for understanding and complying with Statement of Work and Drilling Work Plan requirements, such as hold points, use of additives, and maintaining records of daily drilling activities. The drilling subcontractor will also be responsible for site safety and consistent and adequate sample recovery, ensuring that equipment is appropriate for the goals of the drilling project and in proper working order.

3.0 FIELD ACTIVITIES

Field activities will include well drilling, sample collection, down-hole geophysical characterization, well installation, well development, aquifer testing, permanent sampling system installation, and surface completion. The Drilling Work Plan for Combined Groundwater Monitoring Well R-67 and CrCH-6 (LA-UR-15-21004) will be used to guide field operations and ensure all objectives are met.

3.1 Well Drilling

Drilling equipment and supplies for the completion of the project will be staged around the work site in an organized and secure manner. Surplus and/or inactive equipment and supplies may be stored at the LANL drilling project laydown yard located at the northwest corner of Pajarito Road and New Mexico State Road 4. Access to the laydown yard is through a locked gate.

3.1.1 Mobilization

Mobilization will consist of transporting and setting up equipment at the location. Mobilization will include the following:

- Mobilize drill rig, trailers, support vehicles, drilling tools and materials, and well construction materials to the drill site.
- Stage alternative drilling tools and construction materials at the laydown yard.
- Radiological screening of all equipment and tooling by RP-1 prior to arriving on site.
- Set up drill rig, trailers, support vehicles and tools at the location. Figure 2 presents a typical drilling site layout.
- Review scope of work and project-specific health and safety issues with crew.
- Complete all required training for all personnel.
- Obtain Facility Operations Director (FOD) Work Authorization, including rig inspection and Integrated Work Document (IWD) review.

The R-67 site will be accessed from south of E. Jemez Rd. All mobilization activities will be in accordance with the LANL provided traffic control plan. The water source for the project has been identified as a fire hydrant near the Eco Station on E. Jemez Rd.

3.1.2 Drilling Methods

The STR will be notified in writing approximately 24 hours prior to commencement of drilling activities. The R-67 borehole will be drilled with a Foremost DR-24HD drilling rig. Specifications for this machine may be found at Foremost's website (http://www.foremostmobile.com/index.php). At least two auxiliary air compressors will be utilized along with the rig's deck compressor. An LM-165 pump hoist will be used to build and develop the monitoring well. A Semco pump hoist will be used for sampling system installation.

The R-67 borehole will be initiated by setting a removable 16-inch conductor casing into competent tuff at an approximate depth of 250 ft bgs. Dual rotary methods will be used to set the conductor casing.

A 15-inch open hole will then be drilled through the tuff to the top of the Puye Formation, or as far as reliable open-hole drilling conditions will allow. If open-hole drilling cannot be sustained due to formation instability, a 12-inch casing will be advanced through this interval using dual rotary methods with an under-reaming bit to approximately 1000 ft bgs within Puye Formation sediments, or as far as drilling conditions will allow but no greater than 1175 ft bgs. Alternatively, loose zones will be cemented and redrilled. After landing the 12-inch casing a 10-inch casing will be advanced to the expected final total depth of 1324 ft bgs. The regional aquifer will be the target for the well screen interval and is expected to be encountered at 1224 ft bgs. The 10-inch casing will be advanced to a depth greater than the bottom of the well's filter sand interval so that the drive shoe can be cut off and isolated in bentonite during well construction.

The use of hammer oil when drilling with a down-the-hole (DTH) hammer bit will be stopped 100 ft above the regional aquifer beginning at 1124 ft bgs. Only potable municipal water will be used with DTH hammer bits if used during drilling below 1124 ft bgs.

Collection of core will be attempted at the approximate depths:

- 210 to 230 ft bgs, Cerro Toledo interval
- 565 to 595 ft bgs, Guaje Pumice Bed–Puye Formation contact
- 1150–1200 ft bgs, base of the Puye Formation
- 1235–1255 ft bgs, top of the regional aquifer within the Miocene pumiceous unit

Coring will be performed at the specified target intervals relying on a suite of different coring tools to maximize sample recovery and quality. Based upon knowledge and experience with coring in these lithologic units, core recovery may be highly variable. Additionally, water, and if necessary drilling foam, introduced to advance the borehole between core runs may complicate analysis of pore water, if present. Given the value of core collected at this location, the following pore water and solids analyses will be attempted, recognizing that some or all analyses may not be possible as a result of coring methods required at the target intervals.

- The softer, less consolidated units will be cored using a core barrel with a down hole hammer to drive samples into the barrel.
- Denser units will be cored using a PQ coring system with a variety of diamond bit options. When coring with the PQ system, an air/water mist will be used to cool the bit and facilitate cuttings removal.

- Core will be collected in 5-ft runs to optimize recovery. Core catchers will also be used to help retain core samples in loose units.
- The drilling approach for the coring intervals will be to core ahead of the drill casing, retrieve the core, and then advance the casing to the bottom of the core run. The next core run will then be made ahead of the casing. This process will be repeated until the target interval is completed. Longer or shorter core runs may be run depending on formation conditions and recovery.
- All core samples will be collected, handled and managed by the FTL/PIC in accordance with TPMC SOP-7006, SOP-7009, and SOP-7010.

A LANL supplied tracer (sodium 1, 5- naphthalene disulfonate) will be added to the drilling water used for advancing the borehole in subsequent coring runs in order to distinguish native water from introduced water. The tracer will be added to two 305gal poly tanks while filling the tanks with potable water (from a municipal source) to assist with mixing and dissolving the tracer. Each batch of mixed tracer will be sampled after the batch has been mixed and prior to emptying the tank. The samples will be collected in 60mL amber glass bottles, provided by LANL, labeled with date and time of collection, tank and batch number as well as beginning or end of batch, and kept in a dark place until LANL personnel retrieve the samples from the site. Each tank will be drained as completely as possible to avoid gradual buildup of tracer concentration within each batch. A starting depth and ending depth for each tank and batch will be logged.

The tracer and drill water mix will be used approximately 40-ft above a coring interval and while advancing the borehole during core runs. The tracer and drill water mix, and drilling foam above 1124 ft bgs, will be minimized to the extent possible 40-ft above and through the coring intervals. The tracer and drill water mix added to the borehole during drilling will not exceed 10,000gal without notification and approval from the LANL STR.

Figure 3 presents the anticipated geology, approximate core intervals, and predicted regional aquifer groundwater level.

3.1.3 Proposed Alternative Drilling Methods

Drilling conditions may require converting to alternative methods. Consultation with the LANL STR will precede any deviations from the above referenced drilling methods. Conventional dual-rotary, air rotary, and casing advance will be the primary drilling methods employed at the R-67 borehole.

3.1.4 Drilling Additives

Potable water from a municipal source will be used to cool the drilling tools, help evacuate cuttings from the borehole and suppress dust from the discharge of dry returns. Filtered compressed air will be the primary circulation 'fluid' for returning cuttings to the surface. Descriptions of potential drilling foaming agents are as follows.

- AQF-2®: Added at a rate of 0.5 to 2.0% by volume. AQF-2 is an anionic surfactant that is added to fresh water for air/foam, air/gel-foam, or mist drilling applications. AQF-2 is the newest foaming agent in the Baroid line and is the preferred foaming agent for environmental drilling applications.

- Quik Foam®: Added at a rate of 0.5 to 1.0% by volume. Quik Foam provides the surfactant necessary for foam formation.

Complete records will be maintained detailing the type, amount, and volume of drilling fluid used and the depths at which drilling fluid is added to the borehole. No drilling fluids, except potable municipal water, will be used within 100 ft of the regional aquifer at 1124 ft bgs. If the target aquifer cannot be reached without the addition of drilling fluids, the situation will be discussed with LANL and NMED.

Portland Type I/II cement with either no aggregate or a small amount of sand may be used for sealing perched groundwater intervals or managing unstable borehole conditions, if encountered. Hydrated bentonite chips may be used for sealing perched groundwater intervals. The LANL STR will be contacted for approval before any perched groundwater zone is sealed off.

3.1.5 Decontamination

Decontamination of the drill rig and tools will be performed by hot water/steam pressure washing before arriving onsite prior to the start of drilling activities and before leaving the site. Decontamination water will be containerized in 55-gallon drums, properly labeled and stored onsite. Decontamination of sample tools will be performed with a wire brush followed by spraying with Fantastik® and wiping clean with paper towels. Bailers will be washed with LiquiNox® detergent and potable water and rinsed prior to sample collection.

Decontamination will be conducted in accordance with TPMC SOP-7007.

A listing of relevant standard operating procedures (SOPs) for the R-67 field project is presented in Table 3.

3.1.6 Demobilization

Demobilization activities will include:

- Final decontamination and screening for radioactivity by RP-1 of the drill rig, tools, and support equipment.
- Loading and removal of the drilling tools, including alternative tools, from the site.
- Removal of the drill rig and support vehicles from the site.
- Staging and securing of investigation derived wastes (IDW) for future disposition.
- Removal of municipal waste (e.g. materials packaging).
- Final site cleanup.

The LANL STR will inspect the site prior to final demobilization of the drill crew. Final demobilization of the drill crew will not be permitted until the condition of the site is acceptable to the STR.

3.2 Groundwater Detection

Perched water is not expected at this location based on previous drilling observations and geophysical studies in the area. The STR will be notified within approximately 100 ft of the target aquifer depth of 1224 ft bgs. A review of fluids used to date and a check of systems for completing the remaining drilling to 1324 ft bgs will be conducted at the 1124 ft hold point.

The primary indicator for perched water will be driller's observations. If the driller notes any indication of groundwater, drilling will stop, the drilling tools will be removed from the borehole and the presence of water will be verified using a water level meter. Alternatively, if the drill tools employed allow, the presence of water may be verified through the tooling without removal from the borehole. If water exists in the borehole the tools will either be pulled from the borehole or remain out of the hole to allow the field team to check for accumulation of water in the borehole.

The LANL STR will be notified within four hours of perched groundwater detection or by 10 AM of the following day if the detection was made during the night shift.

Groundwater measurements will be conducted in accordance with TPMC SOP-7008.

3.3 Sample Collection Procedures

All samples will be collected by the TPMC field team and transported to the SMO and/or LANL Earth and Environmental Sciences Division (EES) Geomaterials and Geochemistry Research Laboratory (GGRL), as appropriate. A 'samples collected' table will be maintained electronically and submitted to the STR at the conclusion of each phase of the project.

Sample collection and handling will be conducted in accordance with TPMC SOP-7001, SOP-20235, and SOP-20236.

3.3.1 Groundwater Screening and Groundwater Characterization Sample Collection

Groundwater screening samples will be collected if significant perched groundwater is encountered. Screening samples will be analyzed for metals and anions by GGRL. The screening samples will be collected upon start-up of the following piece of casing advancement after establishing circulation and after unloading whatever column of water may exist in the bottom of the borehole. Groundwater screening samples will not be collected while drilling within the regional aquifer.

Attempts to collect any pore water will be made from each core run. The drilling team will use screens and funnels, provided by LANL, to drain any free moisture from the core tube/barrel into a large plastic bottle, also provided by LANL. The team will label each bottle with corehole name, depth, and date and time of collection. LANL will supply the coolers with ice for sample preservation. The water sample(s) will be kept cold until TPMC delivers them to LANL's SMO and/or GGRL. Sample filtration and preservation, and all additional pore sampling will be conducted by LANL EES staff. The FTL/PIC will log observations in the field notebook, including observations of moisture content of core regardless of presence or absence of free water.

Samples will be collected from the well screen interval during well development and aquifer pump testing. Development and aquifer pump test samples will be analyzed for metals, anions, and total organic carbon (TOC) by GGRL.

See Table 4 for analytical suites, container size, and preservation.

Groundwater sampling will be conducted in accordance with TPMC SOP-7014. Sample collection and handling will be conducted in accordance with SOP-7001, SOP- SOP-20235, and SOP-20236.

Groundwater characterization samples will be collected from the completed well between 10 and 60 days after well development in accordance with the Consent Order. This sampling event will be performed by others and is not a part of this field implementation plan.

3.3.2 Cuttings Samples

Cuttings will be collected from the discharge line at 5-ft intervals in portions of the borehole where core is not collected. The cuttings and core will be examined to determine lithologic characteristics and will be used to prepare lithologic logs. Portions of the cuttings will be wet sieved (using #10 and #35 mesh) and placed in chip trays along with unsieved cuttings. The sieved fractions in chip trays will be submitted to the LANL archive. Lost circulation zones with no cuttings returns will be indicated by empty chip trays and cuttings-loss markers (core boxes) labeled 'no returns'. The remaining bulk cuttings will be sealed in Ziploc® bags, labeled, and archived in core boxes.

A summary of cuttings sampling is presented in Table 5. The core boxes and chip trays containing cuttings samples will be delivered to the LANL archive at the conclusion of drilling activities.

During coring, core barrel liners (Lexan or brass) will be used where conditions permit. Lexan liners will be capped, and taped shut to preserve moisture. Driven samples where liners do not work will be packaged in CoreProtec core packaging sleeves. Where Lexan liners nor CoreProtec packaging sleeves work, driven samples will be extruded into lay-flat plastic sleeves or zip-top plastic bags. A summary of core sampling is presented in Table 5.

The drilling team will mark core with orientation stripes down the length of the packaging with red permanent marker on the right and blue permanent marker on the left from the top of the run (shallowest depth) to bottom of the run (deepest depth). Corehole number, run numbers, and footage intervals will be labeled on packaging with a black permanent marker. The samplers will tape the end caps on core tubes, place them in a core box, and store in a cool place (shady area or on-site trailer). If present, empty Lexan tube sections will be placed in the box with core. Any samples on site at the end of each shift will be picked up by LANL personnel and delivered to the refrigerated truck storage unit located at well R-28. A Field Container Summary and Transmittal Form (TPMC SOP-7010, Attachment 7.2) will be used to document drill-site to LANL transport and transfer of custody. A summary of cuttings sampling is presented in Table 5.

Cuttings and core sampling will be conducted in accordance with TPMC SOP-7006, SOP-7009, and SOP-7010.

3.4 Down-Hole Geophysics

The R-67 borehole may be logged with LANL-owned geophysical tools as requested during drilling. It is anticipated that LANL geophysical runs will be coordinated with specific drilling targets (e.g. upon reaching TD or before hanging a casing string in an open portion of the borehole). Additionally, the LANL-owned down-hole video camera may be used to evaluate and remedy adverse conditions.

Subcontract geophysical logging may be performed in the R-67 borehole by Schlumberger Water Services. If requested, Schlumberger will log the entire borehole after TD is reached. Alternatively, Schlumberger may be called to log the upper portion of the borehole if perched intermediate saturation is encountered. If requested, drill casing may be extracted in order to evaluate borehole stability. If the borehole is stable, an open hole logging suite will be collected.

The following cased-hole Schlumberger geophysical suite may be run in the R-67 borehole:

- Natural and Spectral Gamma Logs (HNGS)
- Array Induction (AIT)
- Accelerator Porosity Sonde (APS)
- Micro-Cylindrically Focused Log (MCFL)
- Litho Scanner

In the event that the borehole is open, the following open-hole Schlumberger geophysical suite will be performed:

- Natural and Spectral Gamma Logs (HNGS)
- Accelerator Porosity Sonde (APS)
- Micro-Cylindrically Focused Log (MCFL), with caliper; can only be operated below the water table
- Array Induction (AIT)
- Formation Micro-imager (FMI)
- MR Scanner or alternatively, Combinable Magnetic Resonance (CMR); depending on availability of MR Scanner

The logs will be used to characterize the hydraulic properties of saturated rocks within the aquifer and to help select the well screen interval. The geophysical logging operation will consist of one mobilization after reaching the total depth for R-67. Personnel from RP-3 will perform radiological screening and documentation of Schlumberger's down-hole radioactive source tool(s) upon arrival and prior to departure. If logging is conducted in an open hole, no radioactive sources will be used; however, RP-3 will be notified. A TPMC field crewmember will be present during logging operations to oversee logging runs and calibration checks.

Schlumberger will process the geophysical logs and provide a preliminary interpretation within 24 hours of completion. Five copies of the raw field geophysical logs and a compact disc (CD) containing the field logs (in .las format) will be provided to LANL immediately after completion of logging. Final logs, electronic files, and montages will be provided in the well completion report.

The drilling subcontractor shall assist in hanging a sheave from the rig mast or tophead for wireline access to the borehole during all geophysical logging operations.

Geophysical logging will be conducted in accordance with TPMC SOP-7011.

3.5 Well Installation and Completion

One well screen is tentatively designed to be placed between 1240 and 1260 ft bgs within Miocene pumiceous sediments. Data from screening samples and the lithologic, geophysical, and video logs will be used to determine the exact placement of the screened interval of the well. LANL will provide an approved well design to TPMC prior to the start of well installation. Final well design will be based on data review and discussions between TPMC, EP, DOE and NMED.

The total well screen length and well construction details will be based upon site-specific conditions and will be approved by the LANL STR in writing before the start of well construction. NMED will approve the design prior to well construction.

3.5.1 Well Construction

The well will be constructed of 5-in. inside diameter (ID)/ 5 9/16-in. outside diameter (OD), type A304, passivated stainless steel beveled casing fabricated to ASTM A312 standards provided by LANS. The screened interval of the well will consist of nominal 11-ft length(s) of 5 7/8-in. OD, 0.040-in. slot, rod-based wire wrapped well screen. Each well screen segment has an effective screen length of 10 ft. Stainless-steel casing will be installed below the bottom-most well screen to provide up to a 10 ft sump with an end cap. The beveled casing and screen joints will be flush welded together during installation. All well screen and casing will be thoroughly washed/ decontaminated before use and wrapped in plastic if staged after washing. Centralizers will be placed 2-ft above and below the well screen. A secure cap will be welded or threaded onto the top of the well casing to prevent backfill materials from entering the well during construction.

A tremie pipe will be used during well construction to gravity feed the annular fill materials. The bottom of the borehole will be tagged at the beginning of well installation and bentonite chips will be placed from the bottom of the borehole to within 5 ft of the bottom of the screened interval. The well shall be supported from the top at all times during construction. Drill casing will be extracted with hydraulic casing jacks and rings/slips. The drill casing will be removed in 20 ft sections and staged onsite for removal after well construction is completed.

The primary filter pack of the screened interval will consist of 10/20 sand and will be placed approximately 5 ft above and below the screened interval. The primary filter pack material and interval will be based on site-specific data. After placement, the screened interval will be swabbed to promote settling and compaction of the primary filter pack. A two to five foot thick collar of finer-grained (20/40) sand will be placed above the primary filter pack.

A bentonite seal consisting of 100 percent bentonite chips or uncoated pellets will be placed above the fine sand collar. Potable water will be used to transport the materials down-hole.

Backfill material will consist of bentonite chips to fill the borehole annulus to within 60 ft of the ground surface. Neat cement, or other approved mix, will be used to fill the remainder of the borehole annulus. The depth to annular material will be measured periodically to determine that the materials are settling properly.

The STR will be notified approximately 24 hours prior to well casing installation and backfilling of borehole/annulus.

Well construction will be conducted in accordance with TPMC SOP-7012.

3.5.2 Well Development

Development of R-67 will begin no sooner than 24-hrs after the well has been cemented to approximately 3-ft bgs. The primary objective of well development is to develop the filter pack and remove suspended sediment from the well until water quality parameters are stable, turbidity is less than 5 nephelometric turbidity units (NTUs) for three consecutive samples collected at 30-minute intervals, and twice (200%) the volume of water introduced into the aquifer during drilling, construction, and development is removed. Additional water quality parameters to be measured during development include pH, temperature, specific conductance, dissolved oxygen, and total organic carbon (TOC). If the turbidity standard is not attainable, an alternate standard of stabilization of pH, temperature, conductivity, dissolved oxygen, and a TOC level of less than 2.0 parts per million (ppm) must be achieved before termination of development procedures. Water will be collected daily in 40-ml septum vials and transferred to the LANL EES-14 laboratory for TOC analysis. Samples will be submitted unfiltered and without preservatives.

Development of the well will begin by bailing and swabbing the screened intervals and sump to remove any backfill and/or formation materials that have been introduced into the well during drilling and well construction and clean the filter pack. Bailing will continue until water clarity visibly improves.

The screened interval will be swabbed using a weighted surge block to enhance filter pack development. The surge block will consist of a 4.75-in. OD, 1-in. thick nylon (or similar) disc attached to a weighted static rod operated on a wireline. The swabbing tool will be lowered into the well and drawn repeatedly across the screened interval for approximately 1 hour. Water turbidity will not be measured during the bailing and swabbing process.

A 4-in. diameter submersible pump with an appropriately sized pump motor will be used for the final stage of the well development. The submersible pump used during development will be a larger unit, capable of moving larger volumes than the pump to be installed for the dedicated sampling system. The pump intake will be set at multiple depths within the screened intervals and in the sump to remove as much suspended sediment as possible until the desired results (parameters) are achieved.

The use of other mechanical methods (i.e. jetting) and/or chemical well development may be discussed with LANL and NMED if water quality parameters cannot be achieved. No chemicals will be added without LANL and NMED's approval.

The STR will be notified approximately 24 hours prior to the completion of well development.

Well development will be conducted in accordance with TPMC SOP-7013 and SOP-7014.

3.5.3 Aquifer Testing

Aquifer pump testing will be considered at R-67 if a sufficiently robust zone is encountered. The most likely test will be a 24hr constant-rate pumping test. The aquifer test will be designed and implemented at the direction of David Schafer and Associates.

Two metals and anions screening samples will be collected during the aquifer test. One sample will be collected after 3 casing volumes (CV) have been pumped. The second sample will be collected at the end of the aquifer test with the addition of TOC screening samples.

Aquifer testing will be conducted in accordance with TPMC SOP-7015.

3.5.4 Sampling System Installation

A dedicated sampling system consisting of an environmentally retrofitted 4-in., Grundfos® submersible pump with a 4-in., 3-phase, 460-volt, Viton fitted Franklin® submersible motor will be installed in the well. The pump size (horsepower) will be specified after well screen interval specific capacity observations are made during well development and aquifer testing.

All materials that contact the groundwater will be constructed of stainless steel, Teflon, Viton, or polyvinyl chloride (PVC). All components of the pump column will be new. The pump column will be constructed of 1-in. schedule 80 threaded/coupled passivated stainless steel pipe. The exact composition and pedigree of the 1-in. stainless pump column will be documented in the field logbook, in the sample system receipt inspection, and in the final well completion report. A weep hole or weep valve will be installed at the bottom of the uppermost pipe joint to protect the pump column from freezing. To measure water levels in the well, two 1-in. ID, flush-threaded, schedule 80 PVC tubes will be installed to sufficient depth to set a dedicated transducer and to collect manual water levels. The PVC transducer tubes will be equipped with 9-in sections of 0.010 in. slot screen with threaded end caps at the bottom of the tubes. A vented In-Situ® Level Troll 500 transducer will be set in one of the PVC tubes. A LANL-standardized weather-resistant pump control box will be installed next to the wellhead.

Prior to sample system installation, equipment blanks (EQBs) will be collected from the 1-in. stainless steel drop pipe, 1-in. schedule 80 PVC tubes, pump and motor, and pump wire. After installation the pump will be operated for approximately 10min to verify performance and to collect an EQB of the first water pumped through the discharge column. See Table 4 for analytical suites, container size, and preservation.

The sampling system will conform to the specifications found in the LANL ADEP E&T Wells Update and the Surface Completion Details for Intermediate and Regional Wells drawing package issued within the Task Order.

The STR will be notified approximately 24 hours prior to sampling system installation.

3.5.5 Surface Completion

The wellhead surface completion will include a 16-in. steel outer protective casing to protect the stainless steel monitoring well. The protective casing will extend to approximately 3-ft bgs. The wellhead completion will be a 'stick-up' with an overall height of the protective casing, including riser cap, of 3-ft, 6-in. (42-in. above concrete pad surface). The stainless steel well casing will have an overall height of 2-ft, 6-in. (30-in. above concrete pad surface). A weep hole will be installed to prevent water build-up inside the protective casing. The top of the protective casing will be fitted with a LANL supplied tamper-proof well cover plate and will be set in a 10-ft by 10-ft by 9-in.-thick reinforced concrete pad. A 10 ft long x 0.75 in. copper clad steel grounding rod will be installed in the concrete pad. A brass survey monument, imprinted with well identification information, will be placed in the northwest corner of the pad. A total of four bollards, painted yellow for visibility, will be set at the outside edges of the pad to protect the well from traffic. All four bollards will be designed for easy removal to allow access to the well.

The surface completion will conform to the specifications found in the LANL ADEP E&T Wells Update and the Surface Completion Details for Intermediate and Regional Wells drawing package issued within the Task Order.

Southwest Mountain Surveys, a New Mexico licensed professional land surveyor, will survey the well location and elevation. Survey points will include: ground surface elevation near the concrete pad, the top of the brass pin in the concrete pad, the top of the well casing, and the top of the protective casing. The accuracy of the survey data will be in accordance with NMED Regulations and LANL procedure. Survey data will be supplied to the LANL STR and will also be provided in the completion report.

3.6 Investigation Derived Waste

All IDW generated during implementation of this work plan will be managed in accordance with applicable Environmental Programs–Waste and Environmental Services (EP-WES) and Environmental Protection Water Quality and Resource Conservation Recovery Group (ENV-RCRA) SOPs. These SOPs incorporate the requirements of all applicable U.S. Environmental Protection Agency (EPA) and NMED regulations, DOE orders, and Laboratory requirements. Documents applicable to the characterization and management of IDW are the following:

- SOP-10021, Characterization and Management of Environmental Program Waste (http://int.lanl.gov/environment/all/docs/qa/ep_qa/ SOP-5238.pdf);
- the NMED-approved Notice of Intent (NOI) Decision Tree for Drilling, Development, Rehabilitation, and Sampling Purge Water; and
- the NMED-approved NOI decision Tree for IDW Solids from Construction of Wells and Boreholes.

A Waste Characterization Strategy Form (WCSF) will be prepared by LANS in accordance with SOP-7016 and will provide more detailed information on waste descriptions, quantities, handling, and disposition. All wastes generated during the R-67 project will be managed according to the WCSF.

Table 1
R-67 Project Organizational Chart

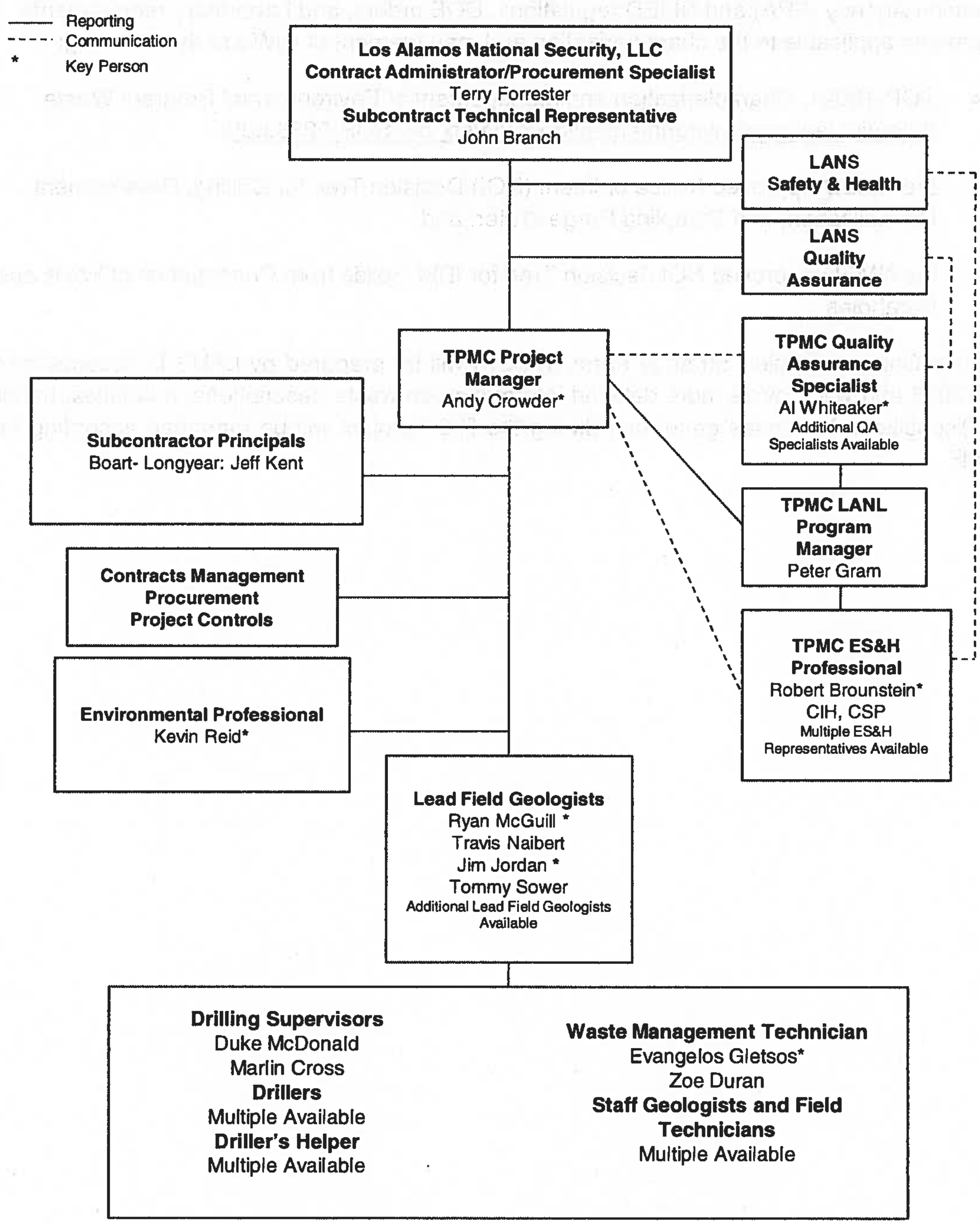

Table 2
Key Team Personnel Roles and Responsibilities

Name	Role	Responsibilities
Andy Crowder	Project Manager, Alternate Person in Charge (PIC)	Project management, budget, resource commitments, and LANS interaction
Ryan McGuill	Drilling Supervisor, Principal Field Team Leader (FTL), Alternate PIC	Project and field management, LANS interaction, geology, and subcontractor coordination
Robert Brounstein	ES&H Professional	IWD and Health and Safety compliance
Al Whiteaker	Quality Assurance Manager	Quality assurance management oversight
Kevin Reid	Environmental Professional	Regulatory compliance
Jim Jordan	Field Geologist, FTL/ Alternate PIC	Field management, geology, and subcontractor coordination
Thomas Sower	Field Geologist, FTL/ Alternate PIC	Field management, geology, and subcontractor coordination
Travis Naibert	Field Geologist, FTL/ Alternate PIC	Field management, geology, and subcontractor coordination
Zoe Duran	Waste Team Leader	Supervise field waste personnel
Jeff Kent	Boart Longyear Drilling Supervisor	Project and technical management oversight of drilling operations
Marlen Cross	Boart Longyear Tool Pusher	Project and technical management oversight of drilling operations

Table 2 (Continued)
Key Team Personnel Roles and Responsibilities

Name	Role	Responsibilities
Stephani Swickley	Program Director	Responsible to the Associate Director for the successful execution of the project.
Ted Ball	Project Leader	Responsible to the Program Director for the successful execution of the project.
Mike Alexander	Facility Ops Director (FOD)	Facility Operations and Security Management/Coordination; When delegated authorizes and approves project work
Mark Everett	Drilling Project Technical Lead	Project leadership for overall drilling projects planning, coordination, oversight, execution and closeout for this project
Terry Forrester	Procurement Specialist, (PS)	Responsible for solicitation, negotiation, award, and administration of subcontracts and has overall commercial responsibility for respective subcontracts; designated authority to direct subcontractor
John Branch	Primary Point-of-Contact (POC), Subcontract Technical Representative (STR)	Responsible to the Project Manager for monitoring and documenting the subcontractor's day-to-day performance, providing day-to-day oversight, assuring work is performed in a safe manner. STR is the single Point-of-Contact for interaction between LANS and Subcontractor.

Table 3
TPMC Project Specific Standard Operating Procedures (SOPs)

TPMC SOP	Title
SOP-7001	Sample Control and Field Documentation
SOP-20235	Sample Containers, Preservation, and Field Quality Control Samples
SOP-20236	Handling, Packaging, and Transporting Field Samples
SOP-7006	Field Logging, Handling, and Documentation of Borehole Materials
SOP-7007	Field Decontamination of Equipment
SOP-7008	Manual Groundwater Level Measurements
SOP-7009	Field Sampling of Core and Cuttings for Geological Analysis
SOP-7010	Transportation and Admittance of Borehole Materials to the Field Support Facility
SOP-7011	Contract Geophysical Logging
SOP-7012	Well Construction
SOP-7013	Well Development
SOP-7014	Field Water Quality Analysis
SOP-7015	Pump Testing
SOP-7016	Characterization and Management of Environmental Program Waste
SOP-5181	Notebook and Logbook Documentation for Environmental Directorate Technical and Field Activities

Table 4
Analytical Suites, Sample Containers, Sample Volume, and Preferred Laboratories for Groundwater Collection from Well R-67

Analytical Suite	Sample Container	Sample Volume	Preferred Laboratory
Perched Intermediate Water			
Metals/cations (dissolved and total)	poly	125mL	EES-14*
Anions (dissolved, (including perchlorate), alkalinity/pH	poly	125mL	EES-14
Well Development (sample at the end of each day)			
Total Organic Carbon (TOC)	Amber glass	40 ml	EES-14
Aquifer Testing (sample at 3 CV)			
Metals/cations (dissolved and total)	poly	125mL	EES-14
Anions (dissolved, (including perchlorate), alkalinity/pH	poly	125mL	EES-14
Aquifer Testing (sample at end of test)			
Metals/cations (dissolved and total)	poly	125mL	EES-14
Anions (dissolved, (including perchlorate), alkalinity/pH	poly	125mL	EES-14
Total Organic Carbon (TOC)	Amber glass	40 ml	EES-14
Sampling System EQB**			
VOCs***	Amber glass	40 ml	TBD*****
SVOCs****	Amber glass	1.0 L	TBD*****

Notes:
* EES-14: LANL Earth and Environmental Sciences-Hydrology, Geochemistry and Geology Group.
** EQB: equipment blank.
*** VOC: volatile organic compound(s).
**** SVOC: semivolatile organic compound(s)
***** TBD: Laboratory to be determined by LANL's Sample Management Office (SMO)

Table 5
R-67 Sample Collection Activities for Drill Cuttings and Core

Sample Description	Test	Sample Size	Container	Sample Frequency
Cuttings	Bulk cuttings systematically collected for archival purposes and for supplemental sample needs	500-700 ml	Plastic Ziploc™ bags	One sample every 5-ft.
Cuttings	Sieved cuttings for lithologic description and binocular microscope examination	Enough to partly fill trays	Plastic chip trays	One sample every cutting run (nominally every 5-ft.) Normally, an unseived sample, >10 mesh sample, and a >35 mesh sample every cuttings run.
Core	Core collected for supplemental sample needs, lithologic description, and archival purposes	Dependant on down-hole tool assembly	Preference order for core preservation: 1) Lexan liners with taped plastic caps 2) Heat sealed CoreProtec core packaging sleeves 3) Lay-flat plastic sleeves 4) Zip-top plastic bags	Every 5-ft. at the approximate* core depths: • 210 to 230 ft bgs • 565 to 595 ft bgs • 1150–1200 ft bgs • 1235–1255 ft bgs

* Core interval locations are based on predicted geology and therefore are approximate; the top of core intervals will be adjusted based on field identification of geologic unit contacts during drilling.

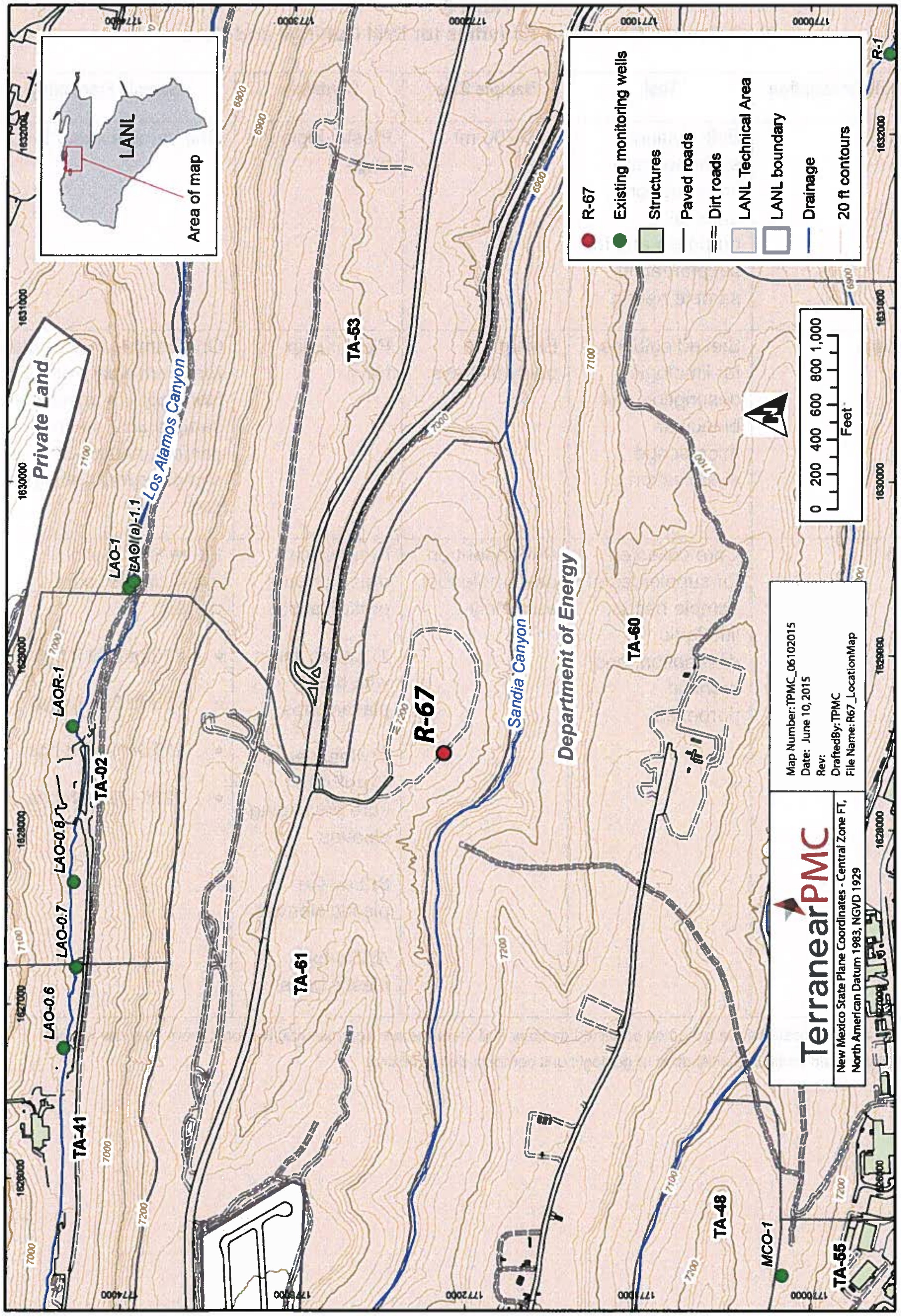

Figure 1 Proposed location of Regional Monitoring Well R-67

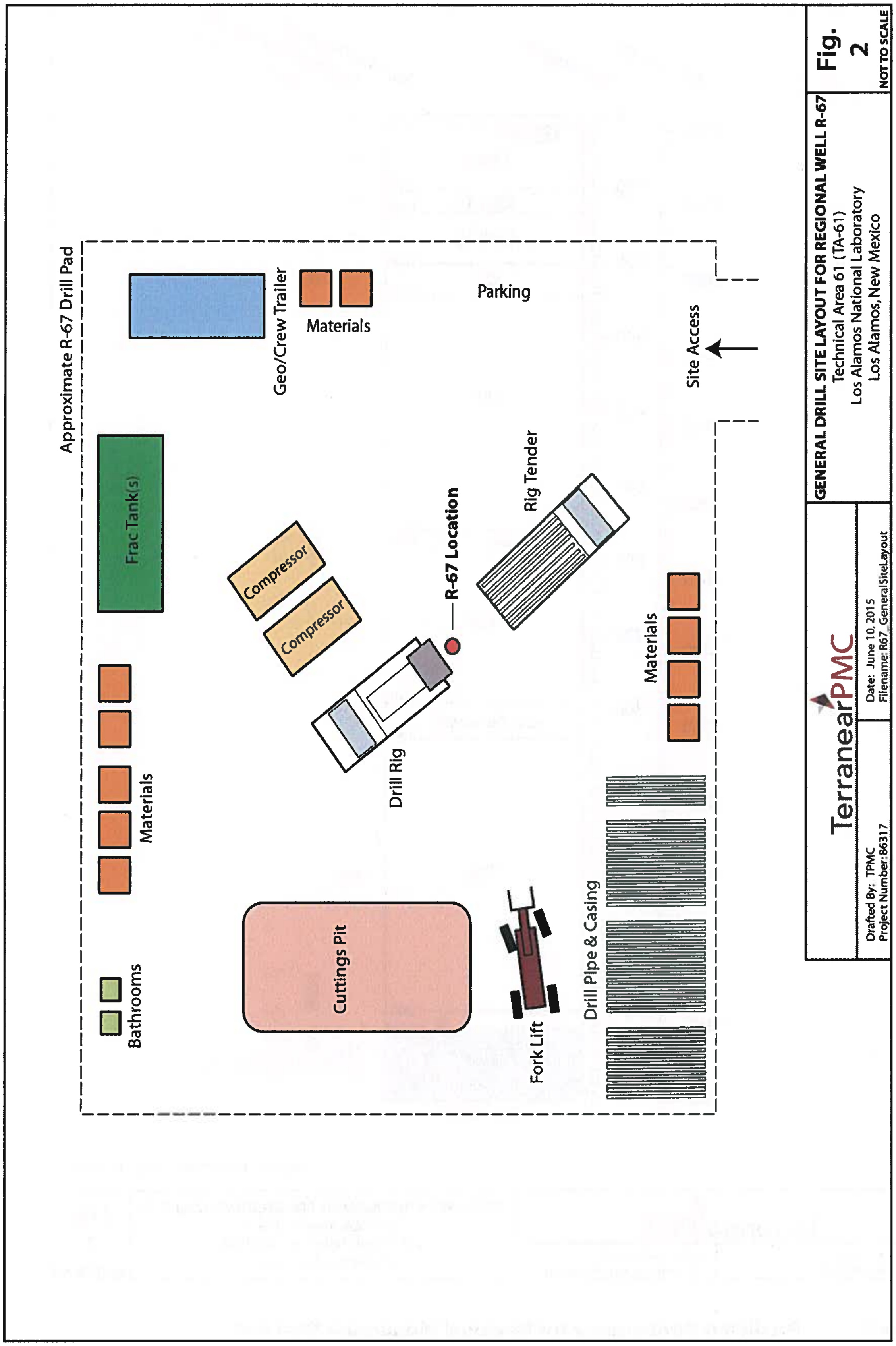

Figure 2 General Drill Site Layout for Regional Monitoring Well R-67

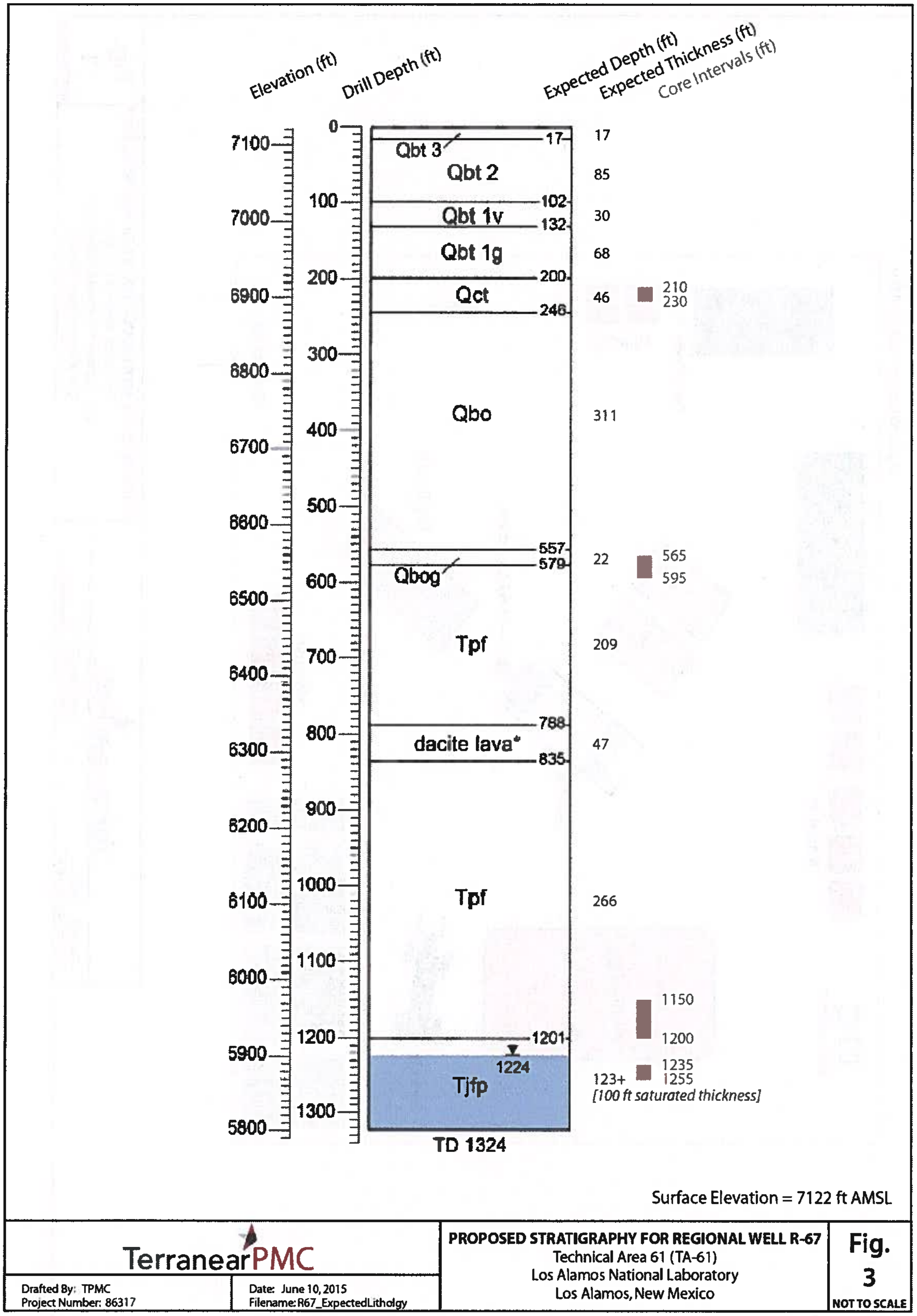

Figure 3 Predicted Stratigraphy for Regional Monitoring Well R-67