Attachment 3. DOE/LANL has used improper fluid-assisted drilling methods that mask detection of groundwater contamination for the installation of the LANL characterization wells that are planned to be used as monitoring wells.

We disagree with DOE/LANL about the need to use fluid-assisted open-hole drilling methods for the installation of the LANL characterization wells that are intended to be used as monitoring wells for the next 50 to 100 years. For example, R-16, the sentry well for the Buckman Wellfield, which provides residents of the City of Santa Fe with over 40% of its drinking water, is a well that DOE/LANL found needed to be drilled with fluid-assisted open-hole drilling methods and with the mud-rotary drilling method. The result is a multi-million dollar well that requires replacement.

The casing advance drilling methods are commonly used in the monitoring well industry to prevent the drilling fluids from compromising the integrity of monitoring wells and to maintain a pristine environment in the aquifer strata that produce water to monitoring wells. Some monitoring wells installed at depths greater than 500 feet at Sandia National Laboratory in Albuquerque, New Mexico are examples of the proper application of the casing advance drilling methods.

DOE/LANL has a long history of making statements in reports and at meetings describing the casing advance drilling method as too risky and too costly for drilling in the complex geologic environment beneath the Pajarito Plateau. In fact, the well drilling industry created the casing advance drilling method for drilling in unstable geology. A well that is often used as an example of the failure of the casing advance drilling method is well R-16. It is located on the mesa east of White Rock, above the Rio Grande, and was installed as a sentry well for the City of Santa Fe's Buckman Wellfield.

However, the information in the LANL well R-16 Completion Report (LA-UR-03-1841, June 2003) is proof that the casing advance drilling method was not responsible for the abandonment of retractable drill casing in the well R-16 borehole. The borehole for well R-16 was first drilled with the open hole fluid-assisted air rotary drilling method to a depth of 729 feet below ground surface (bgs). Because of the difficult drilling with open hole methods, a decision was made to withdraw the open-hole drilling equipment and install cemented steel casing to stabilize the open borehole.

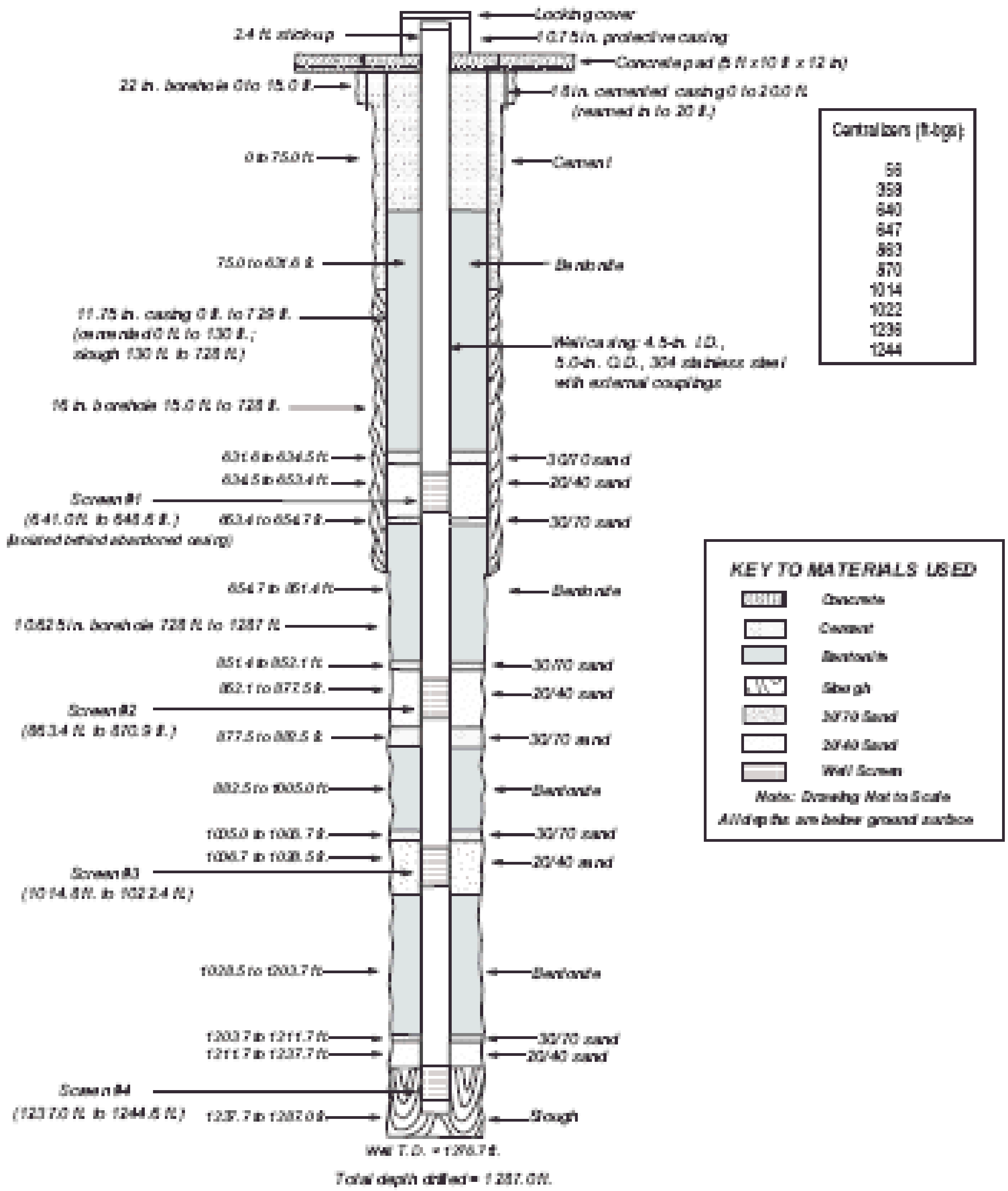
After the unstable strata collapsed into the open borehole and the casing could not be lowered into the borehole, a decision was made to use the casing advance drilling method to advance one dimension of retractable drill casing to a depth of 729 feet bgs. Because of the unstable strata, three strings of telescoped drill casing should have been used for drilling to the 729-foot depth. The three different diameters of drill casing were available for use, and the three strings would have greatly reduced the friction that resulted from drilling with one string.

The as-built schematic for well R-16 is shown below. The retractable drill casing that was abandoned in the borehole blocks off screen #1. Screen #4 does not produce representative groundwater samples because the screen is surrounded by bentonite clay slough sediments that were not cleaned from the borehole before the well was constructed. None of the well screens produce reliable and representative water samples because of the mud-rotary drilling method that invaded the screened intervals with organic and bentonite clay drilling fluids.

Further, the use of the no-purge Westbay^{R} water sampling equipment collects stagnant water samples from the screened intervals. The regulations require that a continuous flow of water is produced from the well to determine that representative samples are collected from the in-situ groundwater. The Westbay^{R} equipment does not allow for the purging of the large quantities of water that are required by the regulations.

An additional problem is that the Schlumberger^{R} borehole geophysics report, included as an appendix in the LANL Well R-16 Completion Report, shows that the well screens are not installed in the strata with highest permeability, the aquifer strata that are the fast pathways for contaminants to travel to the Buckman Wellfield. There are many factors that require replacement of Well R-16.

As-Built Schematic for LANL Characterization Well R-16



Source: LANL Well R-16 Completion Report, LA-UR-03-1841.

In fact, an important example of the justification by DOE/LANL of the essential need for the casing advance drilling method to install monitoring wells at LANL is that the casing advance drilling method was used for the installation of the single-screen well (Well R-16r) that was installed close to well R-16 to replace the blocked screen in well R-

16. Three strings of telescoped drill casing were used to drill the borehole for well R-16r. The three strings were retracted from the borehole during the construction of the well.

Unfortunately, organic drilling foam was allowed to invade the screened interval of the single-screen well R-16r and the well development activities were unsuccessful in removing the drilling foam and the drilling air trapped within the foam. The drilling foam plugged the aquifer strata resulting in an unreasonably low and spurious permeability value measured by a pumping test. Below is an excerpt from the pumping test report included as an appendix in the LANL Well R-16r Completion Report (Kleinfelder Project No. 49436, February 2006) –

> Test data were affected profoundly by air trapped or dissolved in the formation. During testing, the air was able to come out of solution and/or expand and contract in response to pumping and recovery. The air affected performance by clogging formation pores and entering the well and pump, resulting in very unusual data sets.

In addition, the new mineralogy formed by the organic drilling foam causes the well to produce unreliable water quality data for knowledge of the presence of the LANL contaminants. There is a need for additional development and performance of a new pumping test in well R-16r. After the redevelopment efforts, an extensive field test of the ability of the well to accurately detect LANL groundwater contamination is necessary. It may be necessary to replace well R-16r.

The casing advance drilling method that was used for the installation of well R-16r could have been used to prevent the invasion of the screened interval with the drilling additives. The correct drilling operations would have been to use fluid-assisted drilling with the two larger diameter drill casings to an appropriate location above the water table of the regional aquifer. The third string of telescoped drill casing should have been drilled with the dry air rotary drilling method in the unsaturated strata and with the water-only rotary method for drilling in the regional aquifer to the selected depth for installation of the screened interval in the regional aquifer. This drilling strategy would have prevented the screened interval from being invaded with the organic drilling fluids that cause the data from well R-16r to be unreliable.

Conclusion. Further, in Keating, Elizabeth, B.A. Robinson, and V.V. Vesselinov, 2005, "Development and Application of Numerical Models to Estimate Fluxes through the Regional Aquifer beneath the Pajarito Plateau," *Vadose Zone Journal,* Volume 4, August 2005, the authors state:

> Simulations suggest that flow beneath the Rio Grande (west to east) has been induced by production at the Buckman well Field. Our calculations show that this

flux may have increased from zero (pre-1980) to approximately 45 kg s^{-1} at present, or about 20% of the total annual production at Buckman. Page 658.

Travel times through the regional aquifer are poorly understood because of the lack of tracer tests and in situ measurements of effective porosity. Page 658.

Data concerning the spatial distribution of anthropogenic [LANL] contaminants in the regional aquifer has been inconclusive because of the exceptionally thick and complex vadose zone which makes it impossible to define the location and timing of contaminant entry to the regional aquifer. Page 658.

As shown in Table 3, a significant proportion of uncertainty in fluxes downgradient of LANL results from uncertainty in the permeability of the basalts. Basalt units are very important for potential contaminant transport because of their expected low effective porosity. Therefore, we can expect at least a factor of 3 uncertainty in the associated travel times resulting in uncertainty in the flow equation. Page 666.

The current understanding of hydrostratigraphy, as implemented in the numerical models, is sufficient to explain general trends in heads (spatial and temporal) but is lacking in a few key areas such as in the vicinity of R-9, R-12, R-22, and R-16. Detailed transport calculations in the vicinity of these wells would benefit from a refinement of the hydrostratigraphic framework model." Pages 667 to 668.

The implication of this work for contaminant transport issues is that because of parameter uncertainty, predicted fluxes and velocities are quite uncertain. Uncertainties in permeability and porosity values lead to additional model uncertainty." Page 668.

These uncertainties can be reduced meaningfully with more data collection, including multi-well pumping and tracer tests. Page 668.

The report by Keating et al. acknowledges the failure of LANL over the past ten years to acquire the knowledge that is necessary to protect the valuable groundwater resource from the LANL contaminants. Specifically, Keating et al. describe the poor knowledge of contaminant transport in the basalt strata beneath and away from Material Disposal Area (MDA) G to the property of the San Ildefonso Pueblo, the Rio Grande, and on to the Buckman Wellfield. There is a pressing need for the installation of a reliable network of monitoring wells to provide knowledge of groundwater contamination below and away from MDAs G, H, and L and to support the necessary field studies to address the contaminant transport issues.