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GE Corporate
Environmental Programs

Roy S. Blickwedel, PG
Remedial Project Manager

General Electric Company
640 Freedom Business Center
King of Prussia, PA 19406
*610 992-7935, Dial Comm: 8*566-7935*
Fax: 610 992-7898
roy.blickwedel@corporate.ge.com

May 21, 2003

Mark Purcell
U.S. Environmental Protection Agency
1445 Ross Avenue, (6SF-LP)
Dallas, TX 75202-2733

Subject: Proposed Hydraulic Fracture Testing for Zone 3

Dear Mark:

Please find attached a technical memorandum from MACTEC to conduct the subject pilot test. As we discussed, UNC is prepared to begin drilling a test well for the pilot project in the next two weeks, and would greatly appreciate your review as soon as possible.

As of September 1997 United Nuclear Corporation became a wholly-owned, indirect subsidiary of General Electric Company. GE Corporate Environmental Programs has been retained through a separate administrative services agreement to assist United Nuclear both technically and administratively with environmental issues at the Church Rock site. Please contact me if you have any questions.

Sincerely,

Roy S. Blickwedel
Remedial Project Manager

Cc: Pat Pontoriero, MACTEC
Larry Bush, UNC
Bill Killoran, GE
Bill von Till, NRC
Robin Brown, NMED
Dianne Malone, NNEPA

NM8501

MACTEC

MEMORANDUM

DATE: May 19, 2003
TO: Roy Blickwedel
FROM: Pat Pontoriero
SUBJECT: Pilot Test Procedures, Stimulation of Vertical Wells, Church Rock NM Site

Background and Problem Statement: The declining performance of the Zone 3 pump back wells has been recognized for the past several years. Both USEPA (Five-Year Review Report, 1998) and UNC (License Amendment Request dated May 19, 2000) recommended discontinuation of pumping. The system had become ineffective, and it further appeared to be detrimental because seepage-impacted groundwater was being drawn more rapidly downgradient into unimpacted portions of the saturated zone than would occur naturally.

The NRC approved the termination of Zone 3 pumping in a December 29, 2000 license amendment. The amendment also provided for the installation of a sentinel monitoring well, which was completed as well NBL-01, and it directed UNC to explore other alternatives to meet groundwater cleanup goals.

UNC is currently exploring several options, and has conducted groundwater modeling exercises to evaluate the alternatives. There are two factors that stand out as limiting the feasibility of meeting Zone 3 cleanup goals in a reasonable period of time. The first is the recognition that the primary source of recharge to Zone 3, which is recharge via the Pipeline Arroyo Alluvium, should be cut-off. This may be accomplished by dewatering that part of the saturated alluvium that contacts Zone 3. The second is that Zone 3 dewaters very slowly, especially as the saturated thickness is reduced, because of delayed yield and a hydraulic conductivity that is approximately an order-of-magnitude less than previously thought. Unless the hydraulic conductivity can be improved, simulations show that greater than a decade would be needed to significantly de-saturate the seepage-impacted area even with the installation and pumping of up to 140 extraction wells.

Purpose and Method: Hydraulic fracturing will be tested in an un-impacted part of Zone 3 to test its effectiveness at increasing the hydraulic conductivity of the formation. The testing will include:

- The use of hydraulic fracturing and geophysical methods to evaluate the extent and magnitude of permeability enhancements for use in full-scale design.
- The identification of undesirable "permeability excursions" which might limit the application of fracturing techniques to Zone 3.

Hydraulic fracturing is a technology that has been widely used to increase production in oil and gas wells since the early 1950's. The technology has also been used to increase production in water supply wells and to provide a means for enhancing capture in environmental extraction wells. The objective of hydraulic fracturing is to increase well productivity by creating a highly conductive path some distance away from the wellbore into the formation. A hydraulic fracture is accomplished by pumping a suitable fluid (usually water) into the formation at a rate faster than the fluid can leak off into the rock. Fluid pressure (or stress) is built up sufficient to overcome the earth's compressive stress holding the rock material together. The rock then parts or fractures along a plane perpendicular to the minimum compressive stress in the formation matrix. The conductivity is maintained by propping with sand to hold the fracture faces apart.

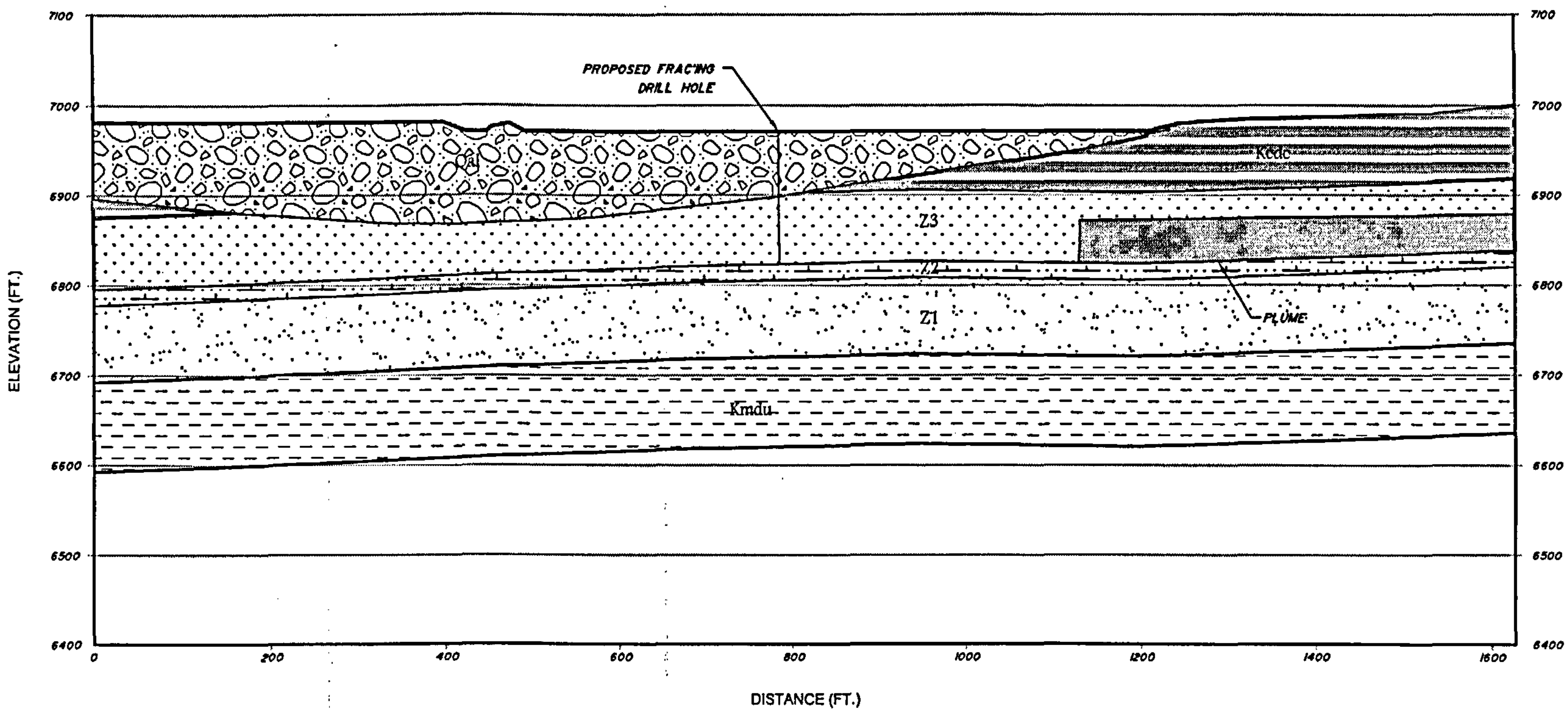
Rock mechanics greatly influences the propagation and resulting geometry of the induced fracture. In general, hydraulic fracturing at shallow depth (less than 2,000 feet) usually results in the propagation of fractures with more of a horizontal component, while fractures induced in deeper zones usually have more of a vertical

component. Because the Z-3 is present at depths less than 200 feet, we expect the induced fracture to propagate horizontally. However, because we realize that it important to minimize the vertical component of an induced fracture (to avoid cross contamination of aquifers) we have decided to complete the pilot test in an area where groundwater in the Z-3 is not impacted. Water will be used for fracturing operations (instead of another more aggressive fluid such as liquid nitrogen) and the injection program will be designed Halliburton to achieve control of the induced fracture. Fracturing operations will be monitored with surface tilt-meters by Pinnacle Technologies, a company specializing in induced fracture diagnostics, so that the geometry of the resulting induced fracture can be mapped.

Procedures: An approach was developed to test the effectiveness of 1) open hole and 2) cased and perforated completions using method that are commonly used in the area. An open hole completion was thought to give the best chance for evaluating the true potential for enhanced water production (as opposed to water production through perforated casing), since it is possible that casing and perforating operations can cause formation damage that could impede water production. However, if results are just as good for cased and perforated completions, future wells would be easier to install and multiple zone stimulations would be easily accomplished if needed.

The test well will be located approximately ½ way between monitoring wells 405 and 637B, in an area of the site that is not thought to have impacted groundwater. Following is a general summary of the proposed approach:

- Install a test boring and core the Z-3 to obtain an accurate record of stratigraphy and depth to various units. One goal is to determine the depth and thickness of the coal seam that underlies the Z-3. The core will extend approximately 3 feet into the aquitard beneath the Z-3 to allow observation and future core testing (if necessary) of that unit.
- Install a water production well approximately 20 feet from the pilot core boring using an 8 ¾ inch bit to a depth of approximately 5 feet above the anticipated base of the Z-3 (based on information from the pilot core boring).
- Set and cement 7 inch K or J rated casing (20 pound). The goal is to get a good cement job with observed returns to surface. Allow cement to cure.
- Continue drilling to a depth of approximately 1 foot above the base of the Gallup (another 4 feet). The goal is to advance the boring as close as possible to the base of the Z-3 without encountering the coal. Encountering the coal could cause the fracture to preferentially propagate through the coal seem instead of the Z-3. Finish the well with an 8-inch round collar.
- Conduct a 24-48 hour pumping test of the production well, using the pilot boring as an observation well.
- Cement the pilot boring to avoid "leak-off" issues during hydraulic fracturing operations of the pilot well.
- Set up an array of surface tilt meters to monitor the growth and coverage of the induced hydraulic fracture. This work will be conducted by Pinnacle Technologies, a company specializing in induced fracture diagnostics.
- Conduct hydraulic fracturing operations on the lower portion of the Z-3 (through the non-cased portion of well).
- Conduct a 2 hour aquifer test on the lower portion of the Z-3 to determine if hydraulic fracturing operations have improved flow. If no improvement is noted, the pilot test will be stopped until a further evaluation of the data can be conducted. If improvement in pumping rate is noted, the pilot test will proceed.
- Set a plug at the bottom of 7-inch casing to isolate the open hole portion of the well from the cased portion. Perforate the casing.
- Conduct a 2 hour aquifer test on the cased portion of the Z-3.
- Conduct hydraulic fracturing operations on the cased portion of the Z-3.
- Conduct a 2 hour aquifer test on the fractured, cased portion of the Z-3 to determine if hydraulic fracturing operations have improved flow.
- Install a new test boring to act as an observation well for a second pumping test.
- Drill out the plug and repeat the 24-48 hour pumping test (combined zones).
- Reduce the tiltmeter data and aquifer test data.
- Use all gathered data to gage the success or lack thereof of hydraulic fracturing operations. If successful, this data will be used to refine and optimize future hydraulic fracturing operations.



LEGEND

- UNIT KCDC
- UNIT KMDU
- Qal - ALLUVIUM
- UNIT Z-1
- UNIT Z-2
- UNIT Z-3

HORIZONTAL SCALE 0 60' 120'

VERTICAL SCALE 0 60' 120'

UNITED NUCLEAR CORPORATION

PROJECT: **CHURCH ROCK**

DRAWING TITLE: **PROPOSED FRAC' DRILL HOLE CROSS-SECTION**

MWH