United States Department of the Interior

U. S. GEOLOGICAL SURVEY

2730 N. Deer Run Rd.
Carson City, NV 89701
Phone: 775-887-7614

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MEMORANDUM

To: Devin Galloway, WSFT-West Groundwater Specialist, Sacramento, CA

From: Keith J. Halford and Steve Reiner, Hydrologists, Nevada WSC, USGS

Subject: AQUIFER TEST—Analysis of *ER-EC-12 main lower*, single-well slug test of volcanic rocks, Pahute Mesa, Nevada National Security Site

A single-well aquifer test was conducted by Navarro-Intera, LLC (N-I) at Pahute Mesa on the Nevada National Security Site (NNSS) in southern Nevada (Figure 1). Hydraulic conductivity of rhyolitic lava-flow aquifers within the Topopah Spring aquifer were estimated. Well *ER-EC-12 main lower* was pumped intermittently between February 29, 2012 and March 19, 2012 (appendix A). Hydraulic conductivity was estimated from well *ER-EC-12 main lower* by interpreting recovery from the last pumping event as a slug test. This hydraulic property estimate can be used to constrain estimates of radionuclide transport through volcanic rocks beneath Pahute Mesa, NNSS.

Site and Geology

The aquifer test occurred beneath Pahute Mesa in the northwest corner of NNSS where transport of radionuclides is a concern (Laczniak and others, 1996). The monitored well is completed in Tertiary volcanic rocks beneath Pahute Mesa. These rocks are dominated by lavas and tuffs of rhyolitic composition (Laczniak and others, 1996). Geologic structures at Pahute Mesa include normal faults with surface exposure and buried structural zones and caldera margins (Figure 2). The alleged water-producing hydrostratigraphic unit is the Topopah Spring aquifer (TSA). Well ER-EC-12 is located in the Bench and west of the Boxcar fault (Figure 1). ER- EC-12 penetrates about 1,400 ft of unsaturated rock, and 2,300 ft of saturated rock.

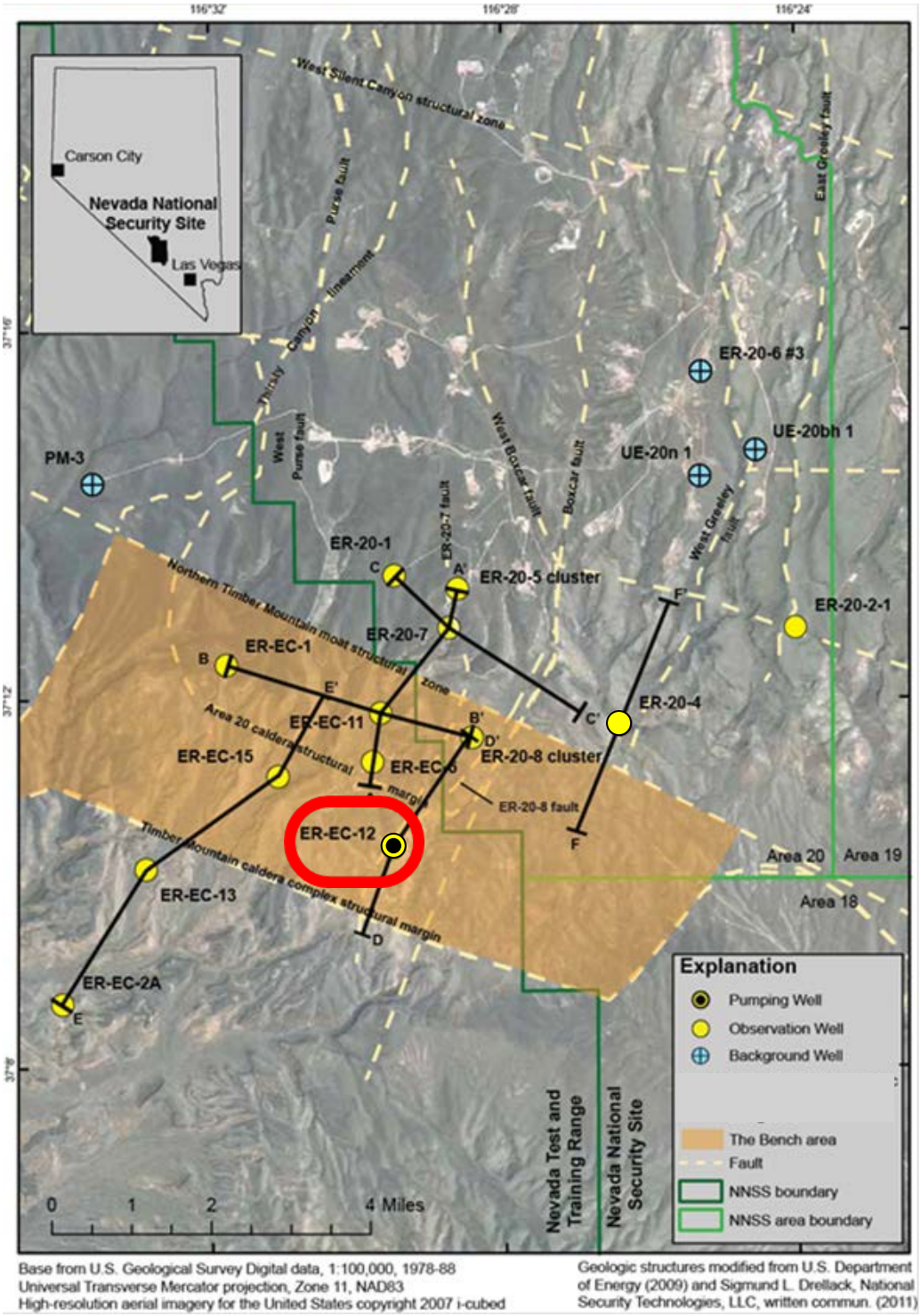

Figure 1.—Location of well ER-EC-12, Pahute Mesa, Nevada National Security Site and vicinity.

Table 1.—Well location and construction data for well ER-EC-12 main lower, Pahute Mesa, Nevada National Security Site.

[Latitude and longitude are in degrees, minutes, and seconds and referenced to North American Datum of 1927 (NAD 27); ft amsl, feet above North American Vertical Datum of 1929 (NAVD 29); ft bgs, feet below ground surface.]

Map Identifier	SITE IDENTIFIER	Latitude	Longitude	Ground surface elevation, ft amsl	Depth to Static Water Level, ft bgs	Diameter Screen, in inches	Top Screen, ft bgs	Bottom Screen, ft bgs
ER-EC-12 main lower	371024116293101	N37°10'24"	W116°29'31"	5,532	1,364	6 5/8	3,240	3,722
ER-EC-12 intermediate	371024116293103	N37°10'24"	W116°29'31"	5,532	1,364	2	3,188	3,770

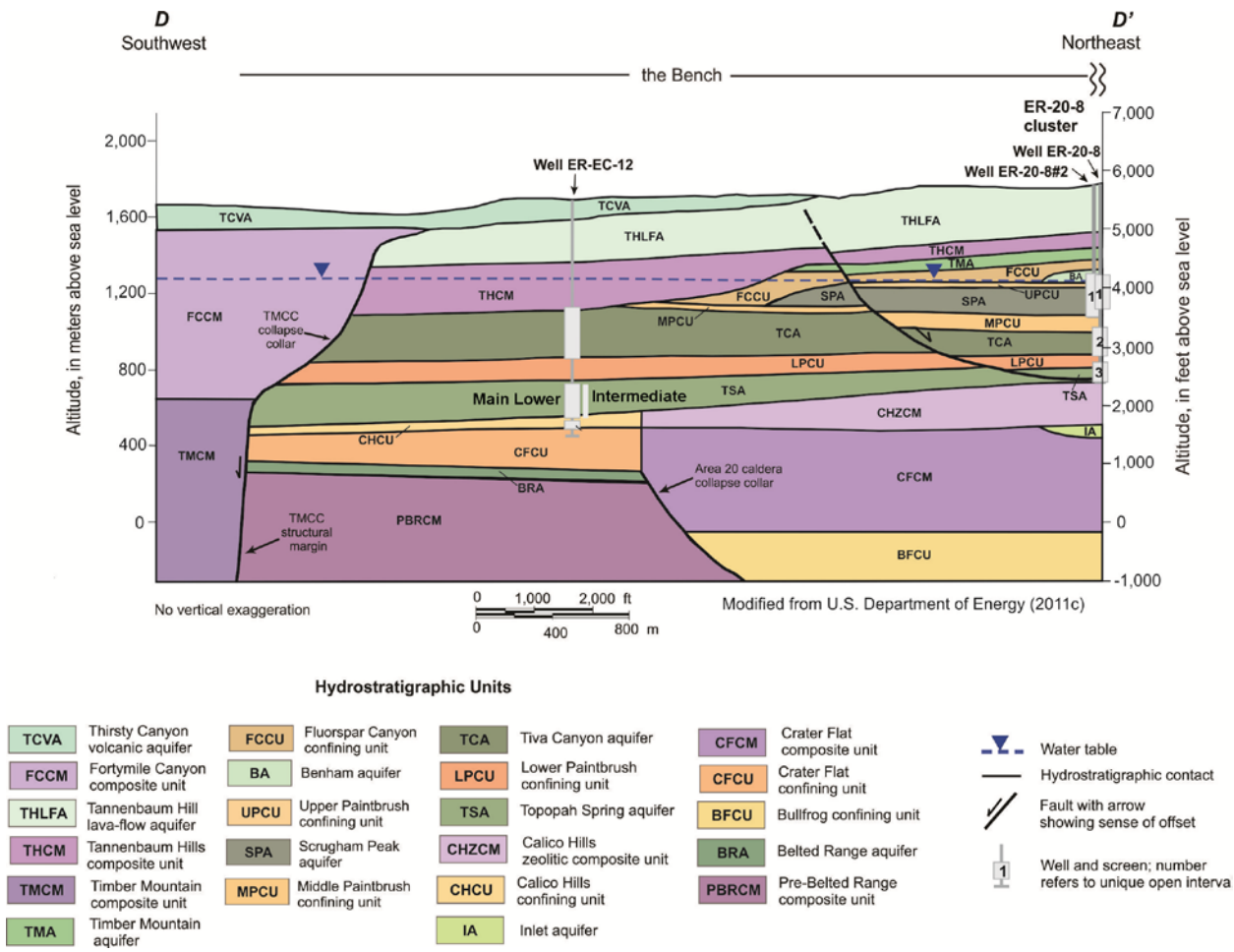

Figure 2.—Hydrostratigraphic section D-D' (includes well ER-EC-12), Pahute Mesa, Nevada National Security Site.

Pumping

The lower zone of well ER-EC-12 main could not sustain prolonged pumping because the specific capacity is less than 0.05 gal/min/ft (Figure 3). The lower zone of ER-EC-12 main was isolated from the upper zone with a straddle packer assembly (U.S. Department of Energy, 2011). Pumped water was removed from the main lower zone below the packer. The lower zone of well ER-EC-12 main is coincident with the open interval of well ER-EC-12 intermediate and produces water from the TSA. The well development and testing occurred intermittently from 3/1/2012 at 11:00 to 3/19/2012 at 11:04 (Figure 3). A volume of 640 gallons was produced 3/19/2012 during 64 minutes of pumping.

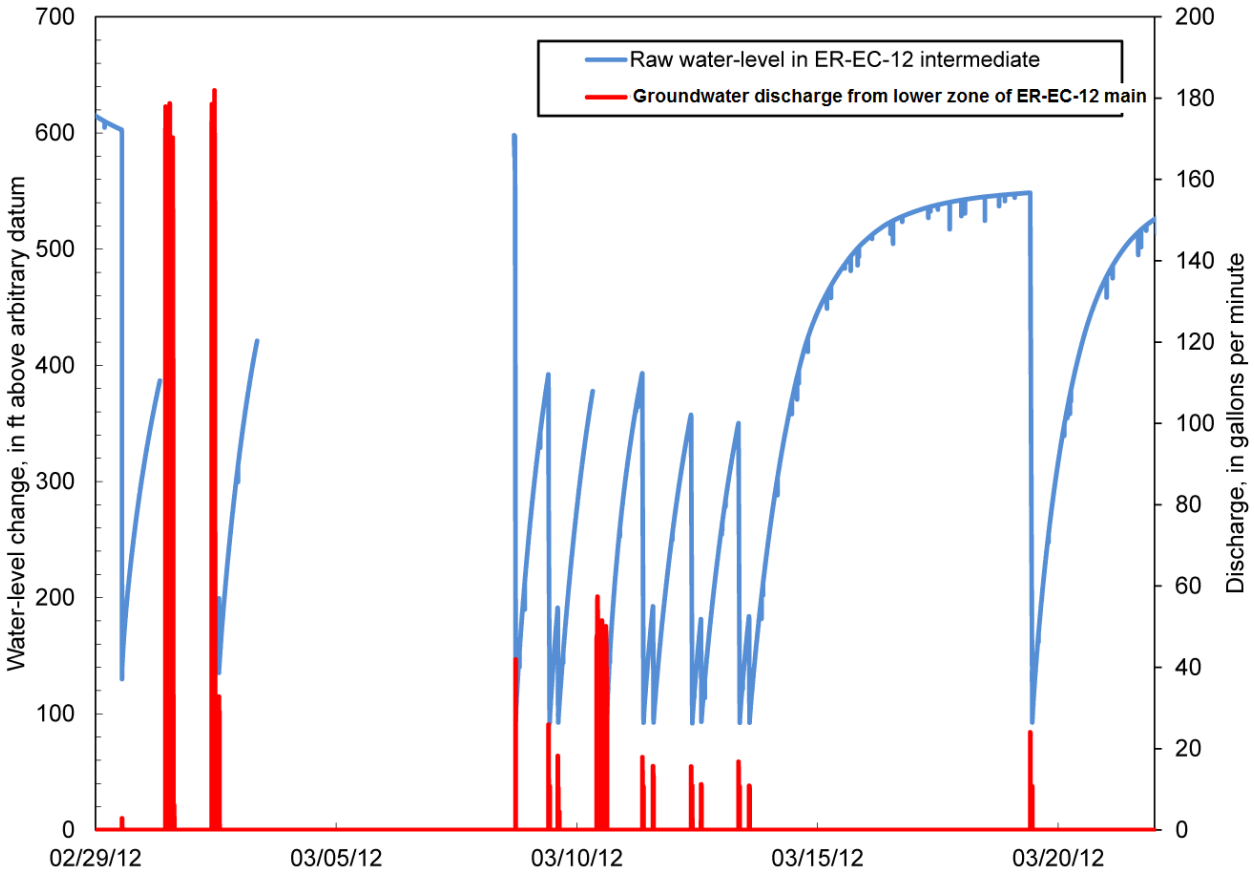

Figure 3.—Discharge from lower zone of ER-EC-12 main and water levels from ER EC-12 intermediate during well development and aquifer testing, March, 2012.

Analysis

A hydraulic conductivity of 0.0002 ft/d was estimated for the Topopah Spring aquifer that was penetrated by well ER-EC-12 main lower. The 460-ft recovery after 64 minutes of pumping was “instantaneous” relative to a 90-percent recovery period of 2.1 days. Water-level recovery was analyzed as a single-well, slug test (Bouwer and Rice, 1976) to estimate hydraulic conductivity (Figure 3). The application of the slug-test method assumes that the hydraulic stress from pumping was instantaneous relative to the recovery period. Prolonged recoveries in low permeability units have been previously analyzed as slug tests (Halford and others, 2005).

Slug tests were analyzed using analytical solutions coded in spreadsheet software (Halford and Kuniansky, 2002). Water levels recovered log-linearly during the 6-day period of analysis (Figure 4). An equivalent diameter of 3.7 in was used because recovery was affected by two free surfaces. Recovery occurred in the 3.2-inch inner diameter pump string that was seated in the packer between the upper and lower zones of ER-EC-12 main. Recovery also occurred in the 2-inch diameter ER-EC-12 intermediate well.

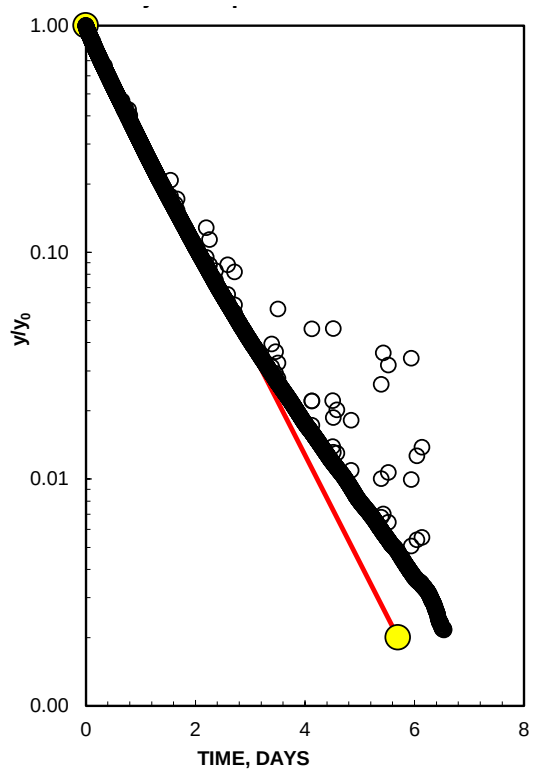

Figure 4.—Normalized water-level recovery in well ER EC-12 intermediate and estimated slope during recovery, which started 11:04, March 19, 2012.

References

Bouwer, Herman and Rice, R.C., 1976, A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells: Water Resources Research 12(3), p. 423–428.

Halford, K.J., and Kuniansky, E.L., 2002, Spreadsheets for the analysis of aquifer-test and slug-test data, version 1.1: U.S. Geological Survey Open-File Report 02-197, 51 p., http://water.usgs.gov/pubs/of/ofr02197/

Halford, K.J., Laczniak, R.J., and Galloway, D. L., 2005, Hydraulic Characterization of Overpressured Tuff in Central Yucca Flat, Nevada Test Site, Nevada, U.S. Geological Survey Scientific Investigation 2005-5211, 55p.

Laczniak, R.J., Cole, J.C., Sawyer, D.A., and Trudeau, D.A., 1996, Summary of hydrogeologic controls on ground-water flow at the Nevada Test Site: U.S. Geological Survey Water-Resources Investigations Report 96-4109, 59 p.

U.S. Department of Energy, 2011, Completion report for wells ER-EC-12, Corrective Action Units 101 and 102: Central and Western Pahute Mesa: U.S. Department of Energy Report DOE/NV--1446.

Appendix A. Construction diagram well cluster ER-EC-12

As-built diagram of the well completion for well cluster ER-EC-12 which includes wells *ER-EC-12 main* and *ER-EC-12 intermediate* (U.S. Department of Energy, 2011).

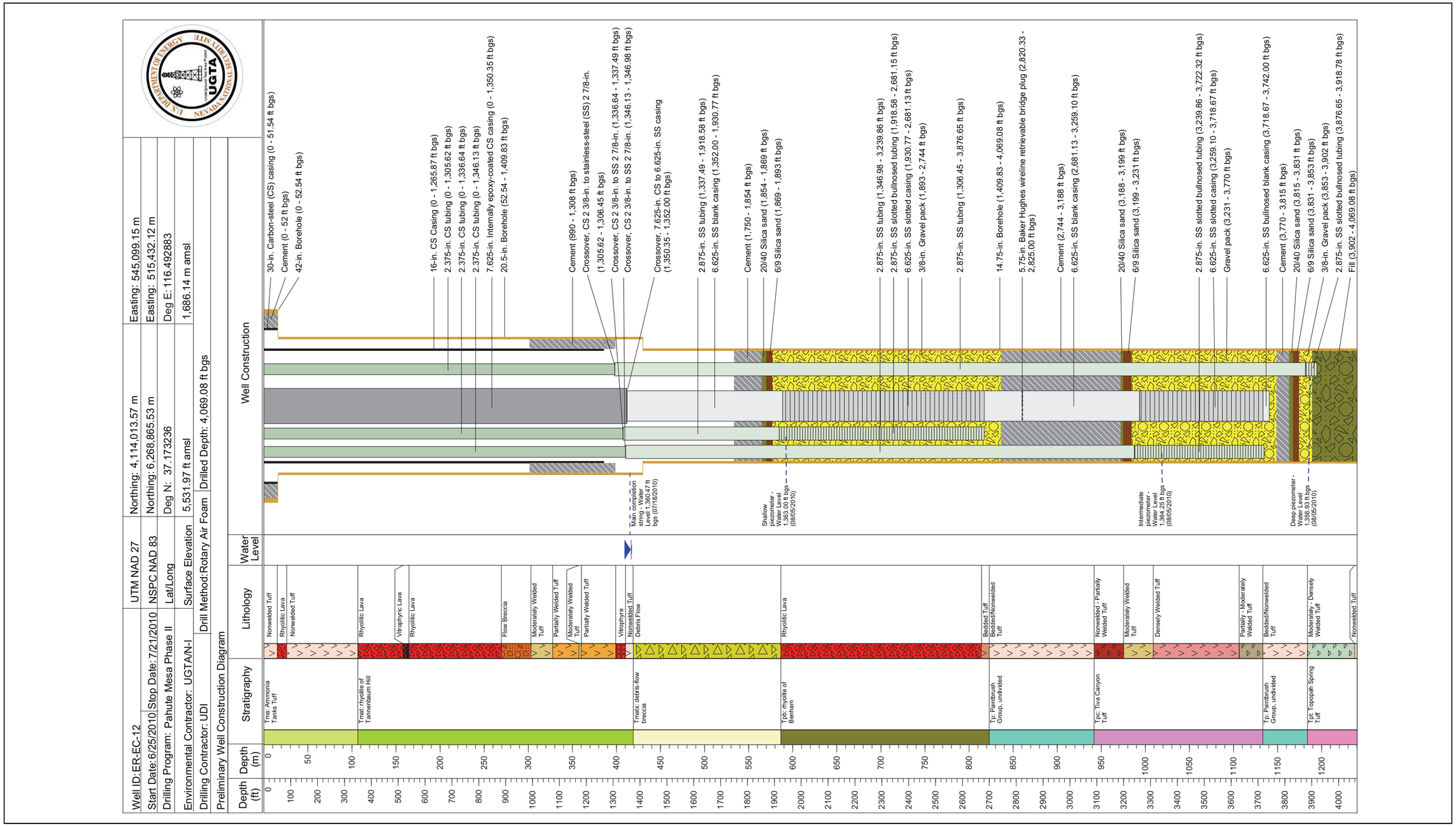

Figure 2-16
Well Completion Diagram for Well ER-EC-12