Aquifer-Test Report for WW- 5C, Area 5, Nevada Test Site

By Steven Reiner, U.S. Geological Survey, Las Vegas, Nevada

INTRODUCTION

The U.S. Geological Survey (USGS) proposed to the U.S. Department of Energy (DOE) that an aquifer test be conducted using wells WW-5C and WW-5A (fig. 1). These wells produce water from the same alluvial aquifer and are about 4,800 feet apart. The transmissivity and storage of the alluvial aquifer were estimated to constrain hydraulic parameters used in ground-water models at the Nevada Test Site. The aquifer-test was analyzed with the Theis (1935) and Cooper-Jacob (1946) solutions.

TEST DESCRIPTION

The aquifer test started when well WW-5C began pumping at 09:16 Pacific Standard Time on January 3, 2003. Water levels in well WW-5A had recovered for about 94 hours prior to this test. An average of 180 gallons per minute was discharged from WW-5C for approximately 79 hours. No water was discharged from nearby production well WW-5B (fig.1) during either of these tests. Water levels were monitored at one-minute intervals in well WW-5A for the duration of both tests.

Water level change in well WW-5A was measured from 09/20/02 to 01/28/03 with pressure transducers. The manufacturer provided accuracy of these transducers was ±0.007 ft. The transducers were calibrated under laboratory and field conditions. Water temperature and barometric pressure were measured also at each well site. Discharge from well WW-5C was measured to within 10 gallons per minute (R.J. La Camera, written communication, 2002).

AQUIFER TEST SITE

Water Wells WW-5A, WW-5B, and WW-5C are located at 36◦46´35´´N.; 115 ◦57´32´´W., 36◦48´04´´N.; 115 ◦58´11´´, and W., 36◦47´20´´N.; 115 ◦ 57´52´´W., respectively, in Area 5 of the Nevada Test Site (fig. 1). WW-5A is approximately 4,800 feet southeast of WW-5C and WW-5C is approximately 4,800 feet southeast of WW-5B.

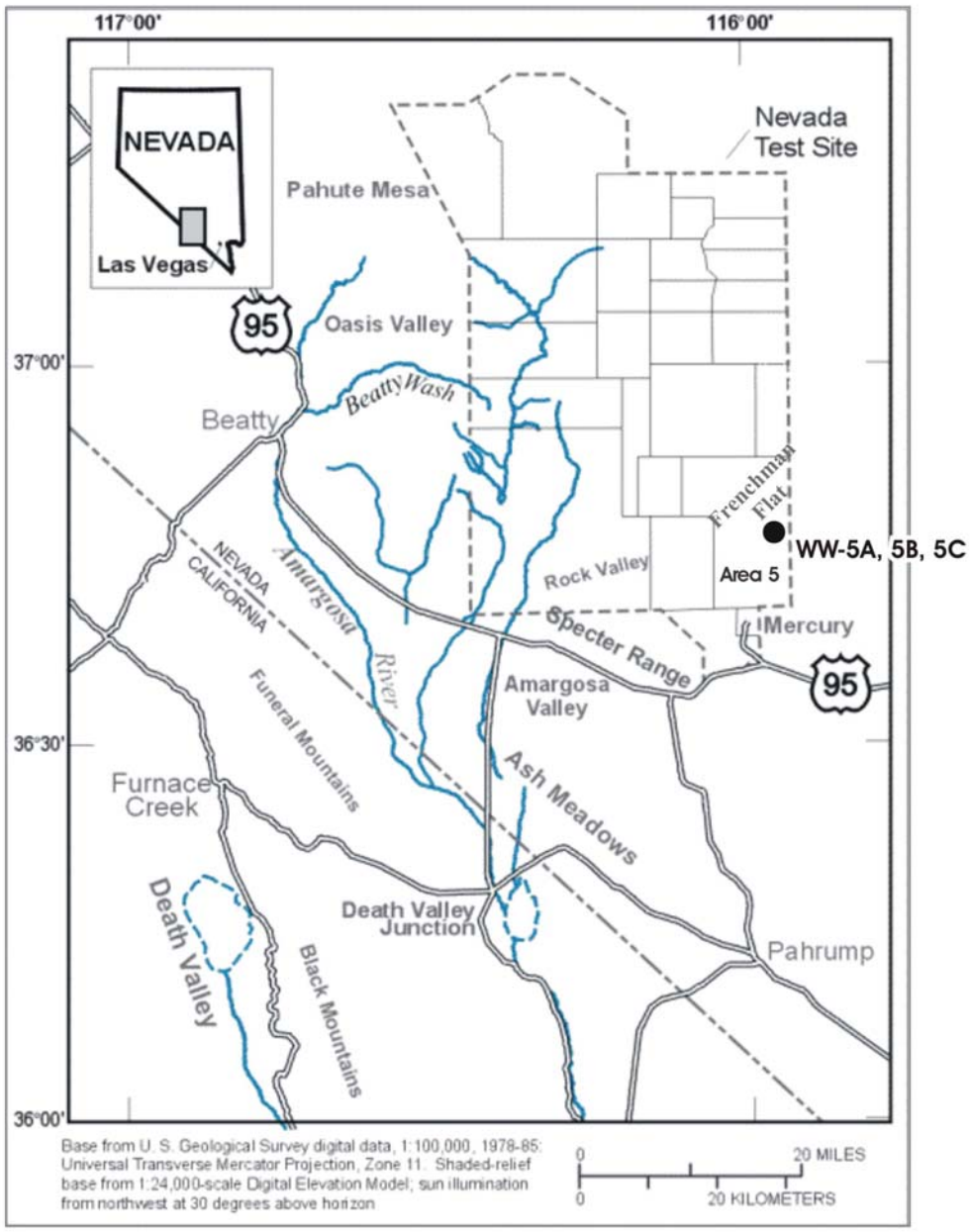

Figure 1. Location of wells WW-5A, WW-5B, and WW-5C on the Nevada Test Site.

CONSTRUCTION

Wells WW-5A, WW-5B, and WW-5C were drilled in the Frenchman Flat area as water-supply wells. Wells WW-5A, WW-5B, and WW-5C were completed, respectively, on March 23, 1951, May 7, 1951, and March 24, 1954. Figure 2 provides detailed information about well construction.

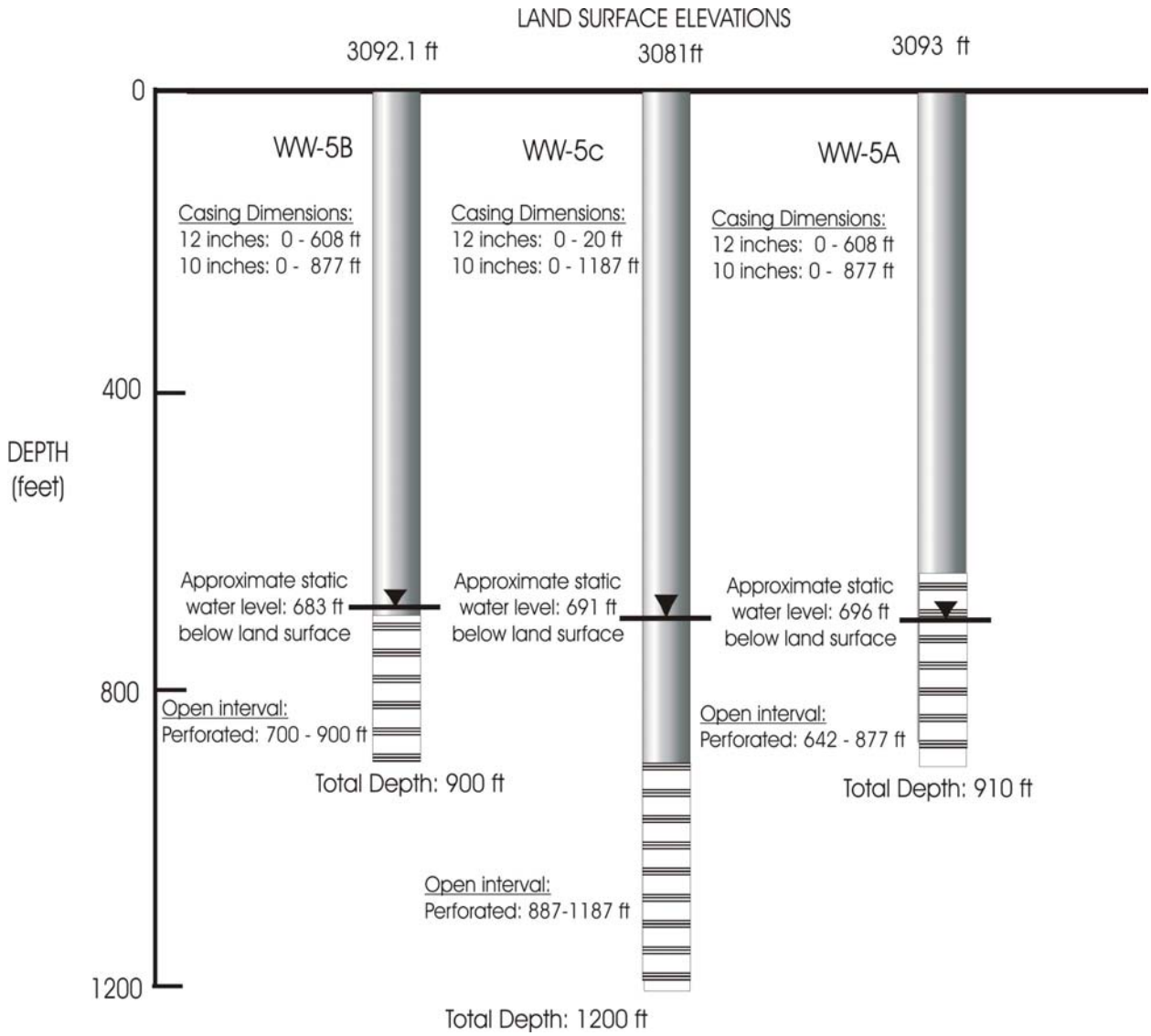

Figure 2. Construction of wells WW-5A, WW-5B, and WW-5C.

HYDROGEOLOGIC CHARACTERISTICS

Wells WW-5A, WW-5B, and WW-5C were completed in Tertiary and Quaternary valley-fill deposits (fig. 3). In central Frenchman Flat, these deposits, where saturated, form the valley-fill aquifer. The valley-fill aquifer in central Frenchman Flat is variably cemented and consists of moderately sorted deposits of gravel and sand. The aquifer has high interstitial porosity and permeability and transmits water efficiently. Less permeable siltstone and claystone deposits for the most part occur above the water table (Laczniak and others, 1996, p.26).

Lithologic well logs were used to determine the production zones of WW-5A, WW-5B, and WW-5C (Hood, 1961, p. 43-48). The production zone of these wells is a semi-confined sand and gravel unit with some silica cement. This zone is below gravel, sand, and clay zones that may be well cemented with calcium carbonate and, in WW-5A and possibly WW-5B, a transition zone of alluvium to fanglomerate deposits.

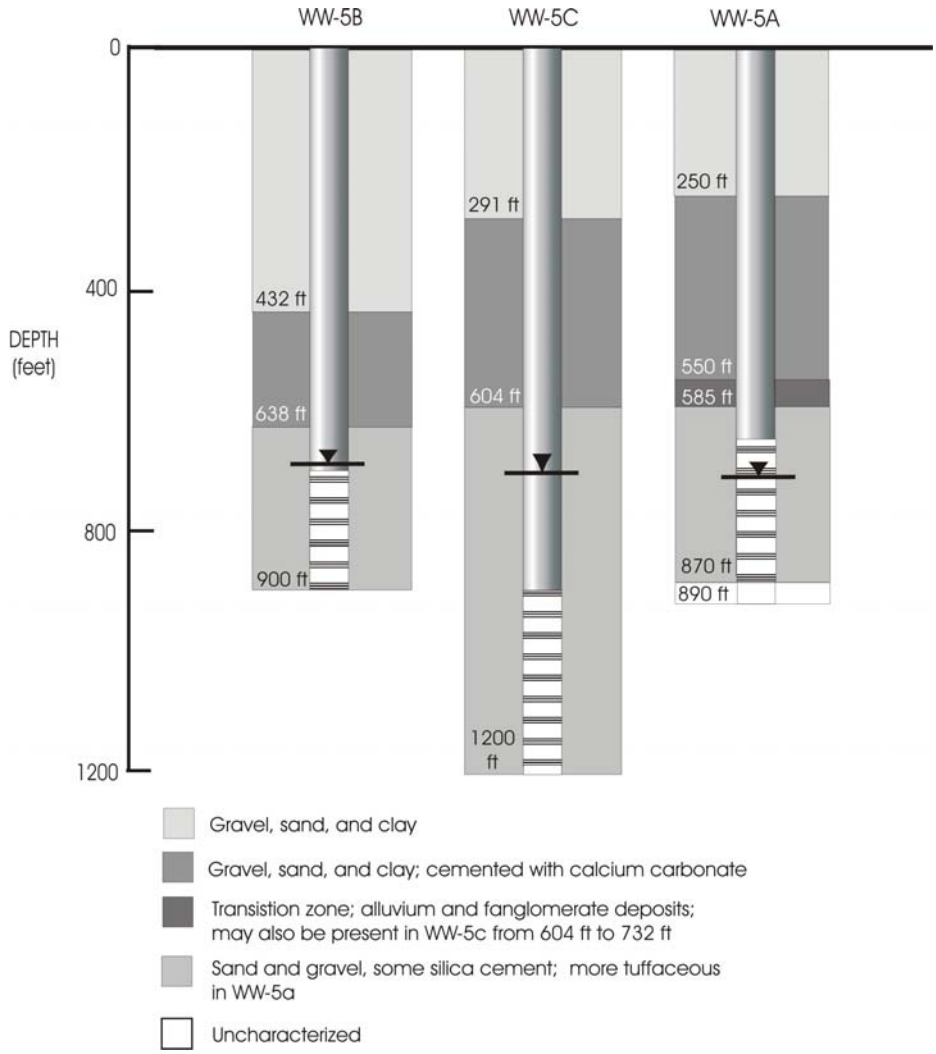

Figure 3. Well construction and hydrogeologic units at WW-5A, WW-5B, and WW-5C.

DRAWDOWN ESTIMATION

Drawdown in well WW-5A owing strictly to the pumping stress could not be computed by subtracting the water level at the start of pumping from measured water levels. Stresses other than pumping, such as barometric changes and earth tides, were known to have affected water levels. A general linear trend also existed prior to the pumping tests. The trend likely was continued recovery from prior pumping of wells WW-5C and WW-5B and was assumed to persist during the aquifer test.

Drawdowns in WW-5A were estimated by subtracting a surrogate for the unpumped water level from the measured water level (fig. 4). Surrogate water levels were estimated by fitting a summation of barometric, earth tide, and linear trends to antecedent water levels in well WW5A. Vertical offset, temporal slope, barometric amplitude, earth-tide amplitude, and earth-tide phase shift were adjusted to minimize the difference between surrogate and measured water levels. Shifting the phase of the barometric signal was found to be insignificant. The earth-tide amplitudes and phases were computed from a finite-serious Fourier regression of sines and cosines using the precise frequencies of the 6 principal earth tides (Galloway and Rojstaczer, 1989).

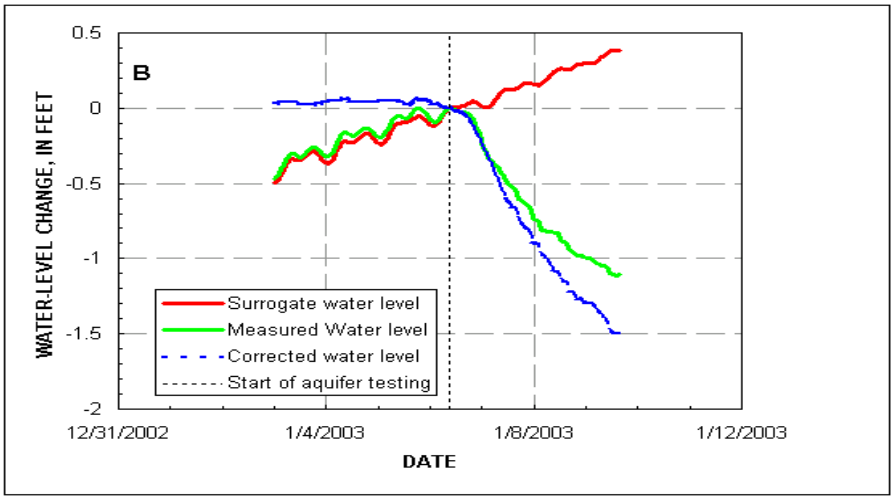

Figure 4. Surrogate, measured, and corrected water-level changes in well WW-5A between 1/3/2003 and 1/10/2003.

AQUIFER TEST ANALYSIS

The Theis solution for confined aquifers was used to analyze aquifer test data in well WW-5A. Production wells were assumed to be fully penetrating with horizontal flow. Analysis of the aquifer test results was performed with AQTESOLV software, version 3.01 (Duffield, 2000). Hydraulic properties were estimated by minimizing the sum-of-squares differences between simulated and measured (corrected) drawdowns. Simulated drawdowns matched measured drawdowns within about 0.1 ft (fig. 5). Recovery data was not used because the uncertainty of drawdown estimates was greater during this phase of the test than during the pumping phase of the test.

The best estimate of transmissivity and storage are considered to be 2,500 ft^2/d and 0.00025, respectively, as estimated with a Theis solution. Transmissivity estimates with the Cooper-Jacob approximation did not differ from the Theis solution (fig. 5).

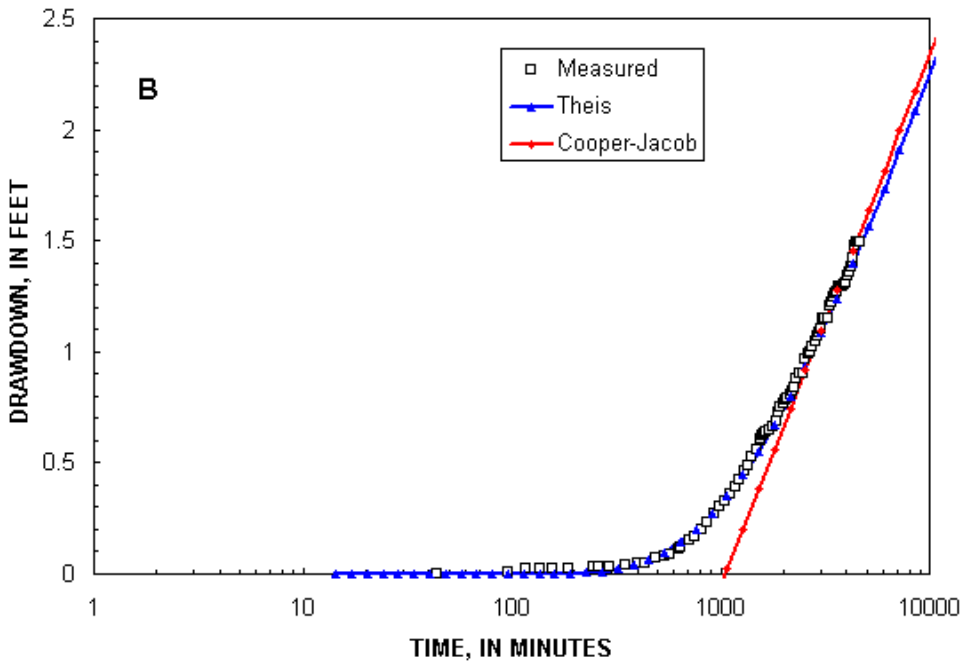

Figure 5. Measured and simulated drawdowns in well WW-5A during January 6-9, 2003.

REFERENCES

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APPENDIX A -DRAWDOWN RECORDS for well WW-5A

	DRAWDOWN, IN FEET			DRAWDOWN, IN FEET	
DATE-TIME	SIMPLE	CORRECTED	DATE-TIME	SIMPLE	CORRECTED
1/6/03 10:00	0.00	0.01	1/7/03 18:30	0.62	0.77
1/6/03 10:53	0.01	0.02	1/7/03 19:02	0.62	0.78
1/6/03 11:14	0.01	0.02	1/7/03 20:03	0.63	0.79
1/6/03 11:33	0.01	0.02	1/7/03 21:04	0.65	0.81
1/6/03 11:53	0.02	0.03	1/7/03 22:06	0.66	0.82
1/6/03 12:24	0.02	0.03	1/7/03 22:55	0.68	0.84
1/6/03 13:20	0.02	0.03	1/7/03 23:46	0.73	0.89
1/6/03 13:35	0.02	0.03	1/8/03 0:48	0.75	0.90
1/6/03 14:07	0.02	0.03	1/8/03 2:30	0.75	0.90
1/6/03 15:08	0.03	0.04	1/8/03 3:24	0.81	0.97
1/6/03 16:00	0.03	0.05	1/8/03 4:59	0.82	0.99
1/6/03 16:32	0.03	0.05	1/8/03 5:55	0.82	1.01
1/6/03 17:28	0.04	0.07	1/8/03 6:53	0.82	1.02
1/6/03 18:14	0.05	0.08	1/8/03 8:25	0.82	1.05
1/6/03 18:46	0.06	0.10	1/8/03 9:26	0.83	1.07
1/6/03 19:47	0.07	0.12	1/8/03 11:03	0.83	1.09
1/6/03 20:01	0.08	0.12	1/8/03 11:41	0.84	1.10
1/6/03 21:03	0.11	0.15	1/8/03 12:43	0.89	1.15
1/6/03 21:47	0.13	0.17	1/8/03 13:45	0.89	1.15
1/6/03 22:49	0.17	0.20	1/8/03 15:17	0.89	1.15
1/6/03 23:46	0.21	0.23	1/8/03 16:29	0.95	1.21
1/7/03 0:48	0.26	0.27	1/8/03 18:01	0.96	1.22
1/7/03 1:49	0.29	0.30	1/8/03 19:02	0.97	1.25
1/7/03 2:50	0.32	0.33	1/8/03 20:34	0.98	1.26
1/7/03 3:51	0.35	0.36	1/8/03 21:35	0.98	1.27
1/7/03 4:52	0.36	0.40	1/8/03 23:07	0.99	1.29
1/7/03 5:54	0.37	0.43	1/9/03 0:08	0.99	1.29
1/7/03 6:55	0.39	0.46	1/9/03 1:09	1.00	1.29
1/7/03 7:56	0.40	0.49	1/9/03 2:41	1.00	1.30
1/7/03 8:57	0.42	0.53	1/9/03 3:42	1.02	1.32
1/7/03 9:58	0.45	0.56	1/9/03 5:14	1.03	1.34
1/7/03 11:03	0.48	0.60	1/9/03 6:15	1.04	1.36
1/7/03 11:21	0.48	0.61	1/9/03 7:47	1.04	1.39
1/7/03 11:56	0.50	0.62	1/9/03 8:39	1.05	1.40
1/7/03 12:10	0.50	0.63	1/9/03 9:42	1.05	1.42
1/7/03 12:48	0.51	0.64	1/9/03 11:03	1.10	1.48
1/7/03 14:00	0.53	0.65	1/9/03 12:01	1.10	1.49
1/7/03 15:01	0.53	0.66	1/9/03 12:59	1.11	1.50
1/7/03 16:02	0.56	0.69	1/9/03 14:01	1.11	1.49
1/7/03 16:36	0.60	0.73	1/9/03 15:33	1.11	1.49
1/7/03 17:37	0.61	0.75			