

Review of Boise Front Low Temperature Geothermal Monitoring Data for Water Year 2016 (October 1, 2015 – September 30, 2016)

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EXECUTIVE SUMMARY

The total gross withdrawal from the four district heating systems in the Downtown Boise-East Boise area of the Boise Front Low Temperature Geothermal Resources Ground Water Management Area in Water Year 2016 (WY16) was 758.3 million gallons (mgal). This amount was 43.1 mgal less than the total gross withdrawal in Water Year 2015 (WY15). The net withdrawal for WY16 was 270.6 mgal, which was 26.4 mgal more than the net withdrawal in WY15. The Boise Warm Springs Water District and the State of Idaho Capitol Mall systems had increases in gross withdrawals in WY16, while the City of Boise and the Veterans Administration had decreases. About 64% of the water withdrawn in WY16 was re-injected, which is a decrease of about 6% from WY15.

Water level maximums and minimums decreased slightly in WY16. The maximum value for the BLM well decreased 0.9 foot, and the minimum value decreased 1.1 feet. The maximum and minimum values for the Kanta well decreased 1.0 feet and 1.6 feet, respectively, from WY15 to WY16. The changes in the maximum values for the three Boise Warm Springs Water District wells from WY15 to WY16 were as follows: East well – no change; West well – decrease of 5 feet; #3 well – no change. The minimum values for the East and West well were significantly lower in WY16, but these are undoubtedly reflective of pumping conditions at the time of the measurements. The minimum value for the #3 well was 3 feet lower in WY16.

The maximum water temperature for the State of Idaho Capitol Mall Production well, as determined on a monthly basis, was the same in WY16 as in WY15. However, the average of the monthly values for WY16 was 0.25 degrees Fahrenheit (°F) lower in WY16. The maximum temperature for BWSWD was about 1°F lower in WY16, while the minimum temperature was unchanged. The City of Boise's maximum water temperature was about 0.1°F lower in WY16.

The total withdrawal in Stewart Gulch Ground Water District 63-S (GWD63-S) in WY16 was 176.2 mgal, which was 14.0 mgal less than in WY15, which was a 7% decrease. The decrease was primarily attributable to the Terteling Ranch Windsock well. Ground water levels showed a decreasing trend in WY16. The maximum values for the Tiegs and Edwards wells declined 0.9 and 3.5 feet, respectively, and the minimum values declined 4.7 and 2.3 feet. The Quail Hollow minimum values decreased 6.1 feet in the Upper well and 4.5 feet in the Lower well. The maximum values were not recorded due to miscommunication during staff changes at the City of Boise. Water levels in GWD63-S declined despite a reduction in withdrawal in WY16. The reason for this unusual situation is probably because the water level decline in WY16 is actually reflective of a trend in increased withdrawals over the last four water years, which was 5% higher than the withdrawals in the previous four water years.

DOWNTOWN BOISE-EAST BOISE

Withdrawals and Re-Injection

In WY16, gross and net withdrawals from the four Downtown Boise-East Boise district heating systems were 758.3 mgal and 270.6 mgal, respectively (Table 1 and Figure 1). Gross withdrawal was 43.1 mgal less in WY16 than in the previous water year. Net withdrawal was 26.4 mgal more in WY16 than in WY15. Gross withdrawal was 5% less in WY16 and net withdrawal was 11% more in WY16, than their respective amounts in WY15. About 64% of the fluids were re-injected, which is 6% less than in WY15. The Boise Warm Springs Water District (BWSWD) and the State of Idaho Capitol Mall had increases in gross withdrawal, while the City of Boise and the Veterans Administration has decreases.

According to the City of Boise, the reasons for the increase in their net withdrawals in WY16 were: 1) system leaks, 2) unmetered discharge to the Cottonwood Ponds, 3) metered discharge to the Boise River, 4) utility maintenance, and 5) meter error.

Table 1. Withdrawals¹ from the four district geothermal heating systems in the Downtown Boise-East Boise areas for Water Year 2016 (October 1, 2015 through September 30, 2016).

System	Gross Withdrawals ¹ for WY16 (million gallons) and percent change from WY15 to WY16	Net Withdrawals ² for WY16 (million gallons) and percent change from WY15 to WY16
Boise Warm Springs Water District	244.3 (+6%)	244.3 (+6%)
State of Idaho Capitol Mall	89.5 (+3%)	0 (NC ³)
City of Boise	228.0 (-7%)	26.3 (+92%)
Veterans Administration	196.5 (-18%)	0 (NC ³)
Total	758.3 (-5%)	270.6 (+11%)

¹These numbers contain some degree of uncertainty which is typically associated with measurement equipment and methods. Therefore, the amounts are being reported in millions with one decimal place.

²Net Withdrawals equal Gross Withdrawals minus Injection amounts. ³NC = No change.

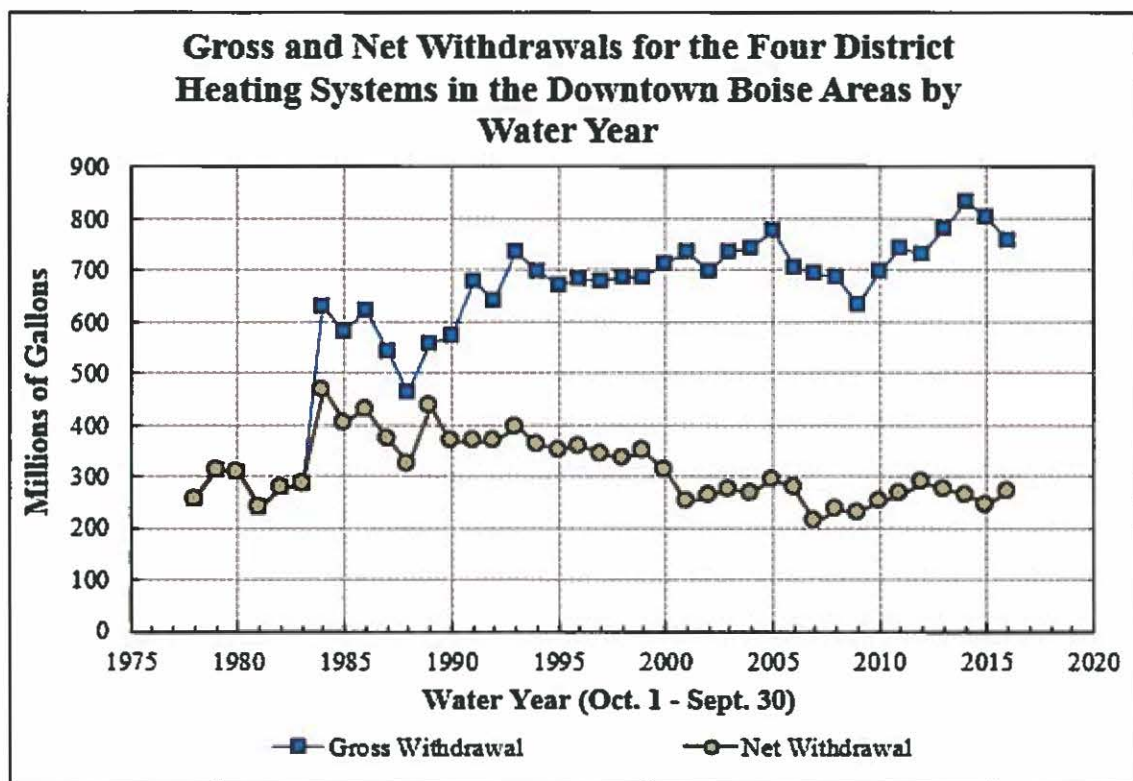


Figure 1. Gross and net withdrawals for the four district heating systems in the downtown Boise area for water years 1978 through 2016.

Water Levels in the BLM, Kanta, BWSWD, City of Boise, and Harris Ranch Wells

The BLM well, which is located near the City of Boise, Capitol Mall and VA wellfields, had a decrease of 0.9 feet in the maximum water level from WY15 to WY16, and a decrease of 1.1 feet in the minimum water level (Figure 2). The Kanta well showed similar trends (Figure 3). The BWSWD West well had a decrease of 5 feet in the maximum level, while the East and #3 wells had no change (Figures 4 and 5). The minimum values for the East and West well were significantly lower in WY16, but these are undoubtedly reflective of pumping conditions at the time of the measurements. The minimum value for the #3 well was 3 feet lower in WY16. The BGL #1 well had an unusual increasing trend in the hand measurement water levels (Figure 6); the City of Boise suspects the cause may be a bad pressure gauge, and they are investigating this situation. The Harris Ranch West and East wells had no significant change in WY16 (Figure 7).

Water Supply Temperatures for the Capitol Mall, BWSWD and City of Boise.

The maximum water temperature¹ for the State of Idaho Capitol Mall Production well was the same in WY16 as in WY15 (Figure 8). However, the average of the maximum monthly values in WY16 was about 0.25°F lower than in WY15 (Figure 9). The maximum temperature for BWSWD was about 1°F lower in WY16, while the minimum temperature was unchanged (Figure 10). The City of Boise's maximum water temperature was about 0.1°F lower in WY16 (Figure 11).

¹Readings that are preceded by 8 hours of discharge rates over 300 gallons per minute are valid for considering as maximum values. Analysis is done on a monthly basis.

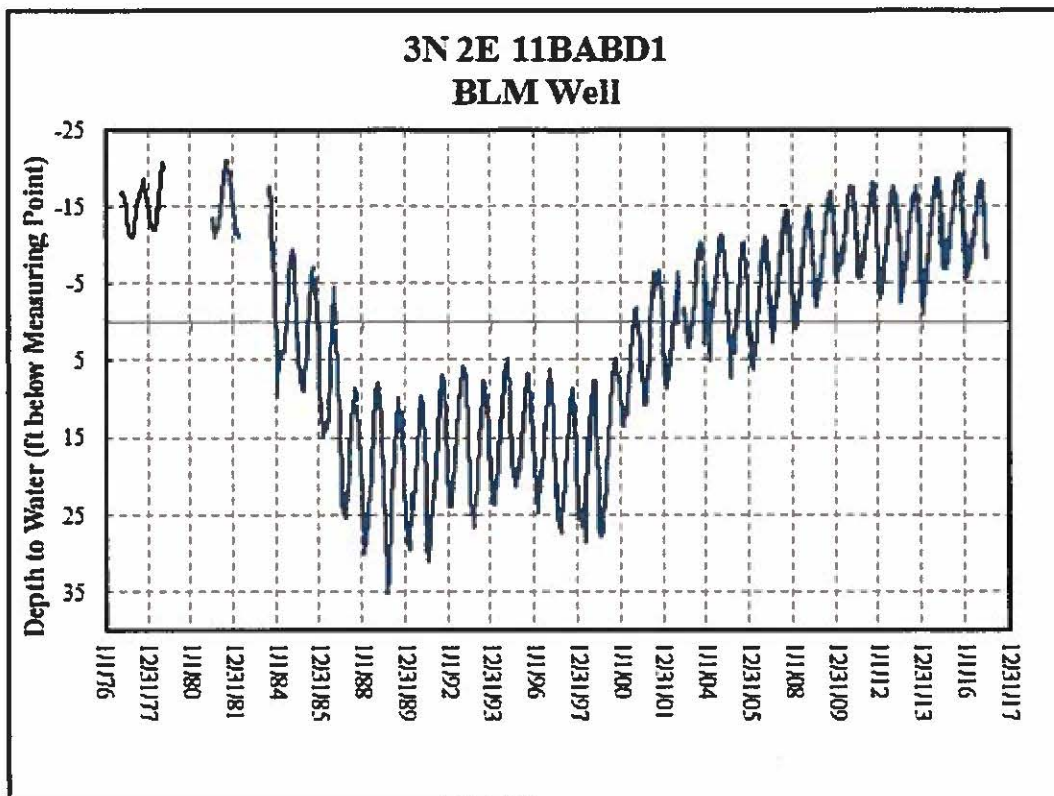


Figure 2. Water level hydrograph for the BLM well.

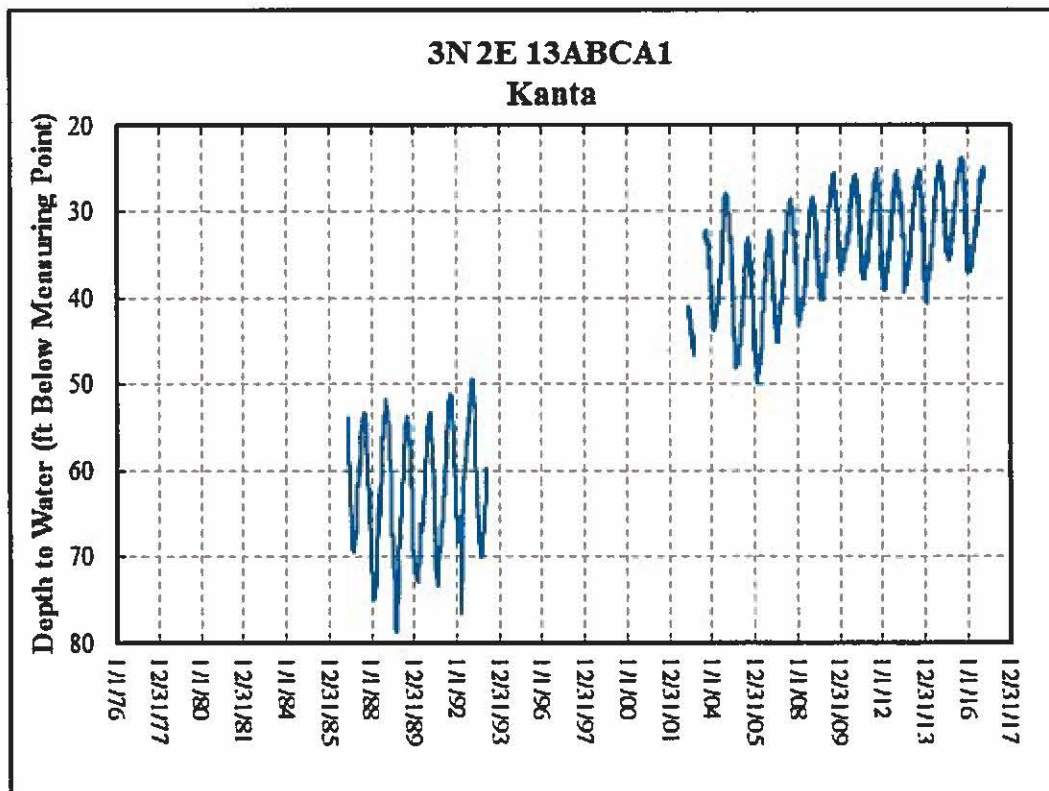


Figure 3. Water level hydrograph for the Kanta well.

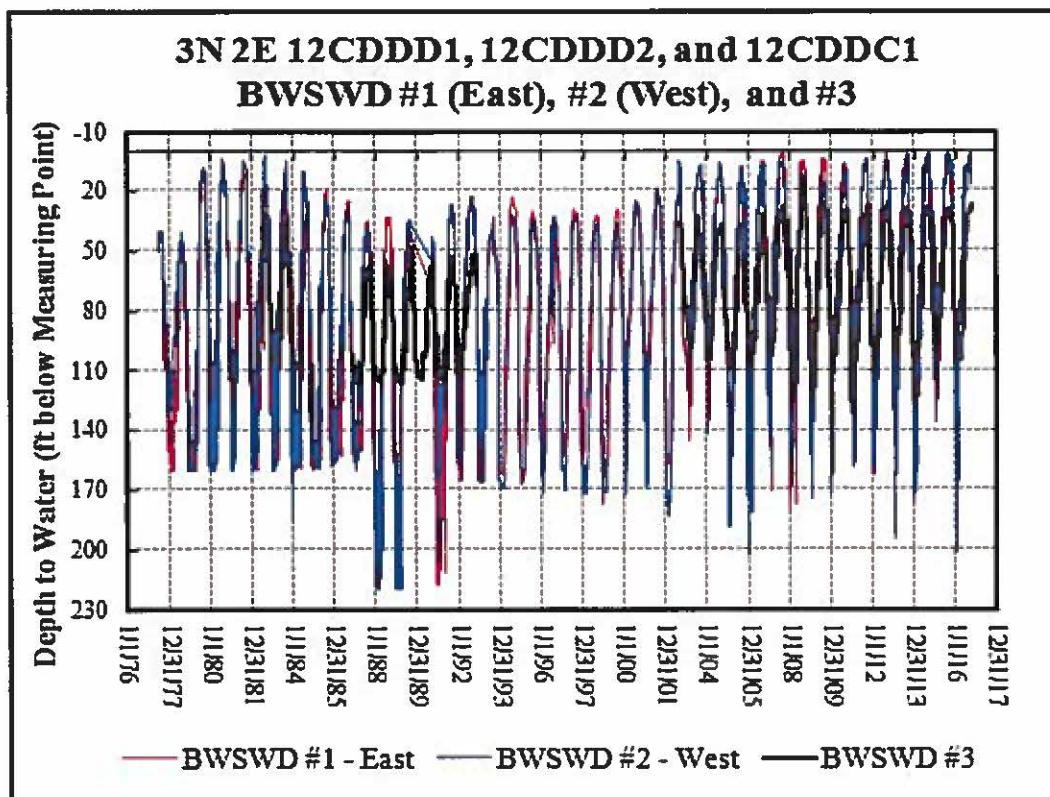


Figure 4. Water level hydrographs for the Boise Warm Springs Water District (BWSWD) wells.

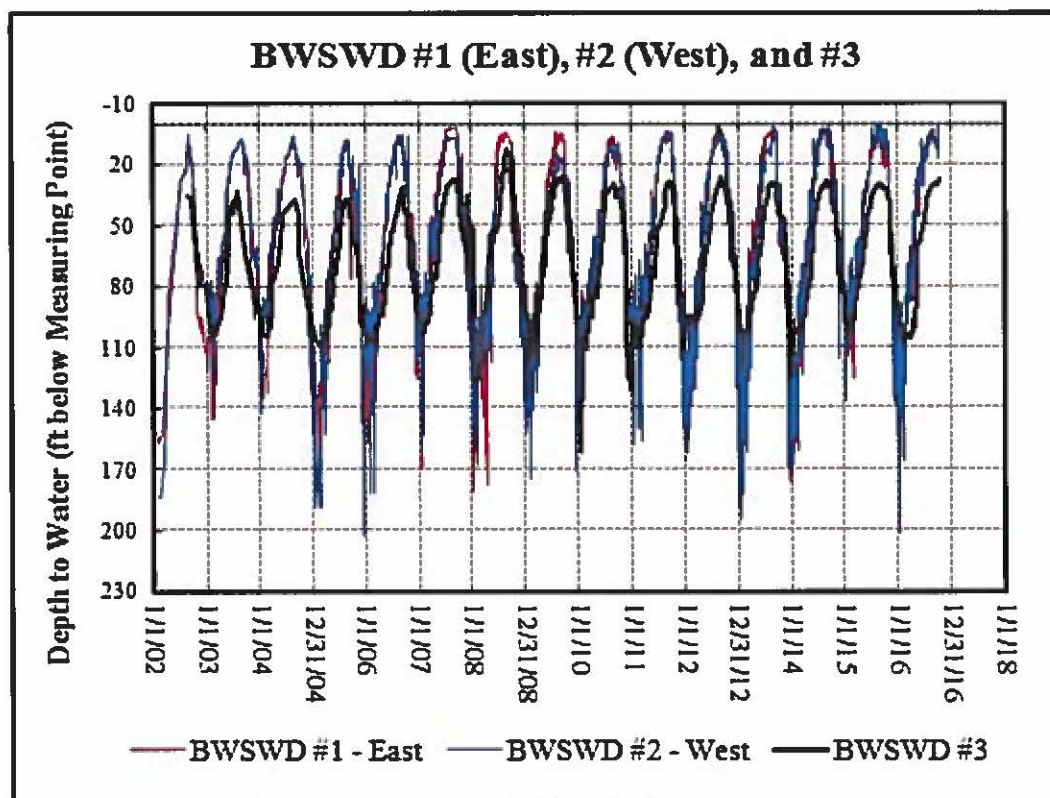


Figure 5. Water level hydrographs for the Boise Warm Springs Water District (BWSWD) wells, January 2002 to September 2016.

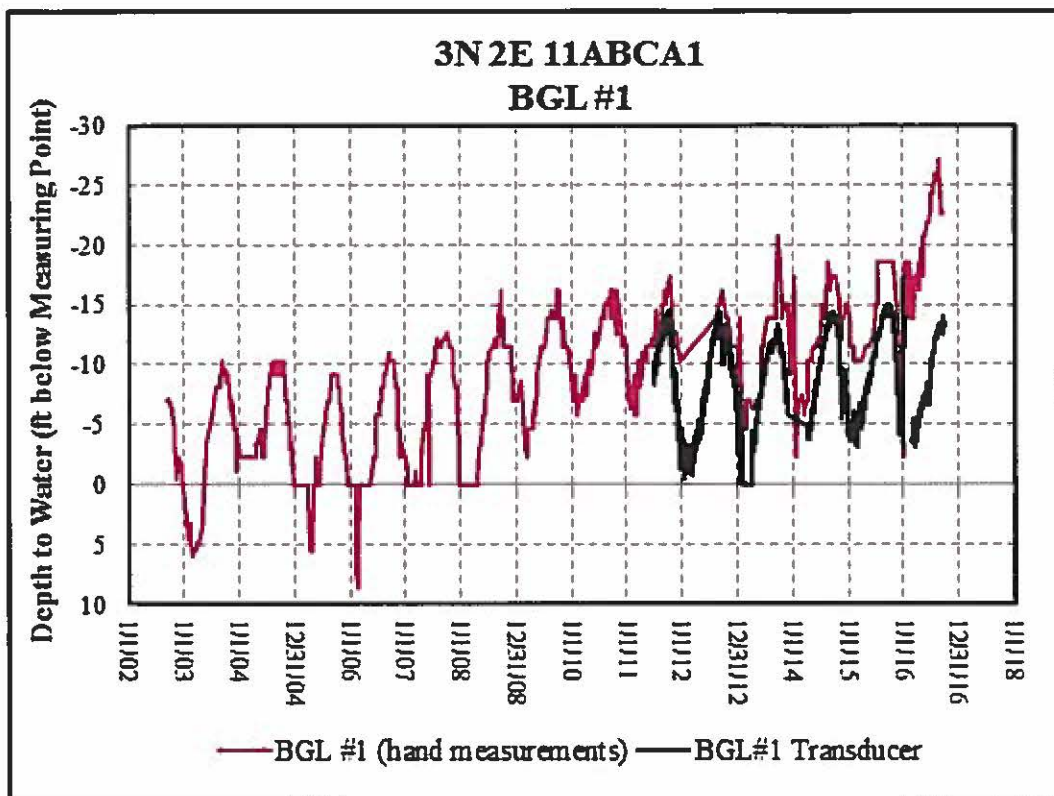


Figure 6. Water level hydrographs for the City of Boise's BGL #1 well.

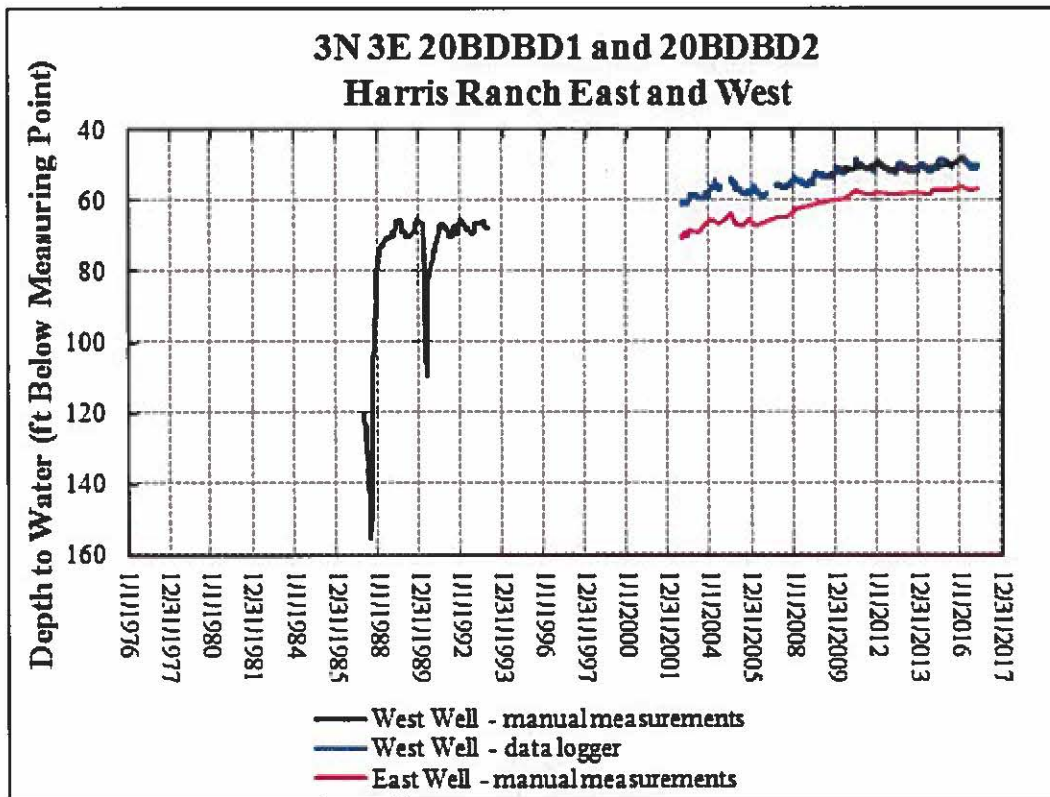


Figure 7. Water level hydrographs for the Harris Ranch wells.

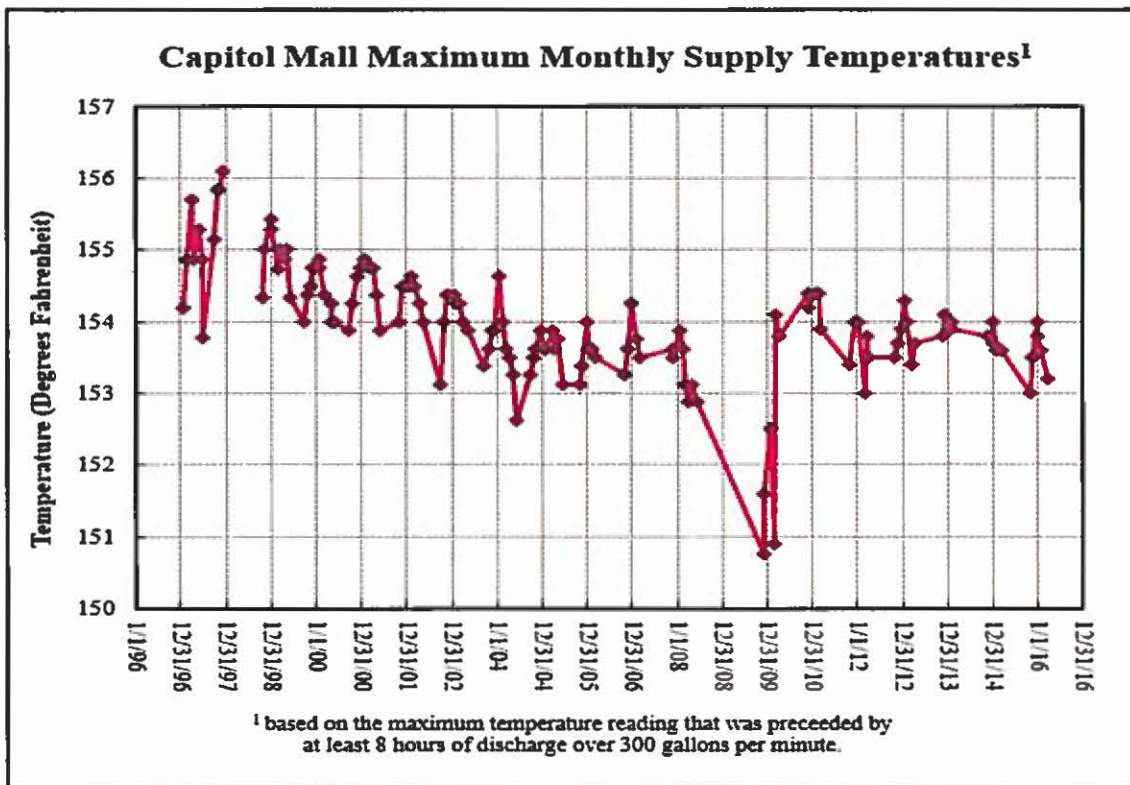


Figure 8. Monthly maximum supply water temperatures for the Capitol Mall geothermal system.

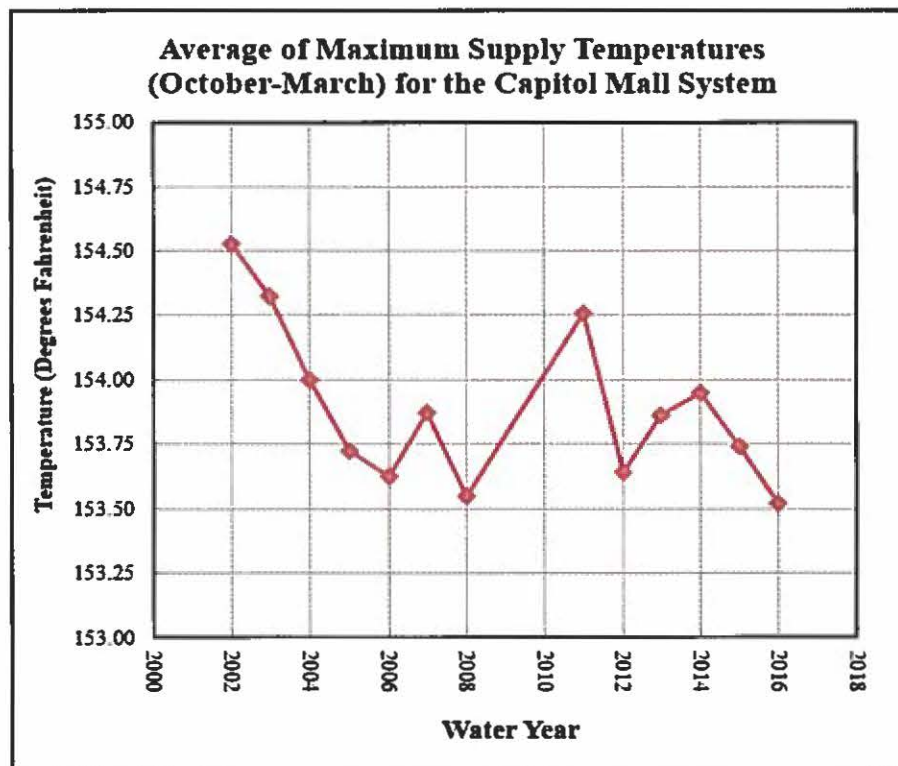


Figure 9. Average of the Capitol Mall maximum supply water temperatures for the November-March time periods for Water Years 2002 through 2016.

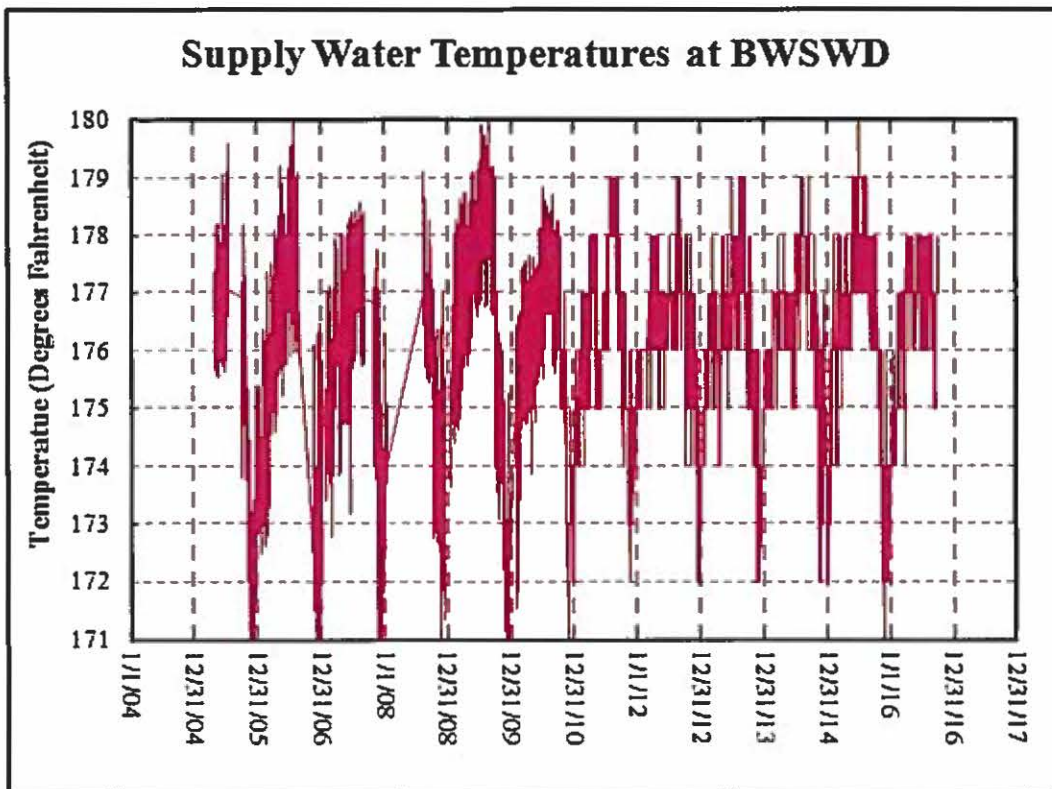


Figure 10. Supply water temperatures for the Boise Warm Springs Water District.

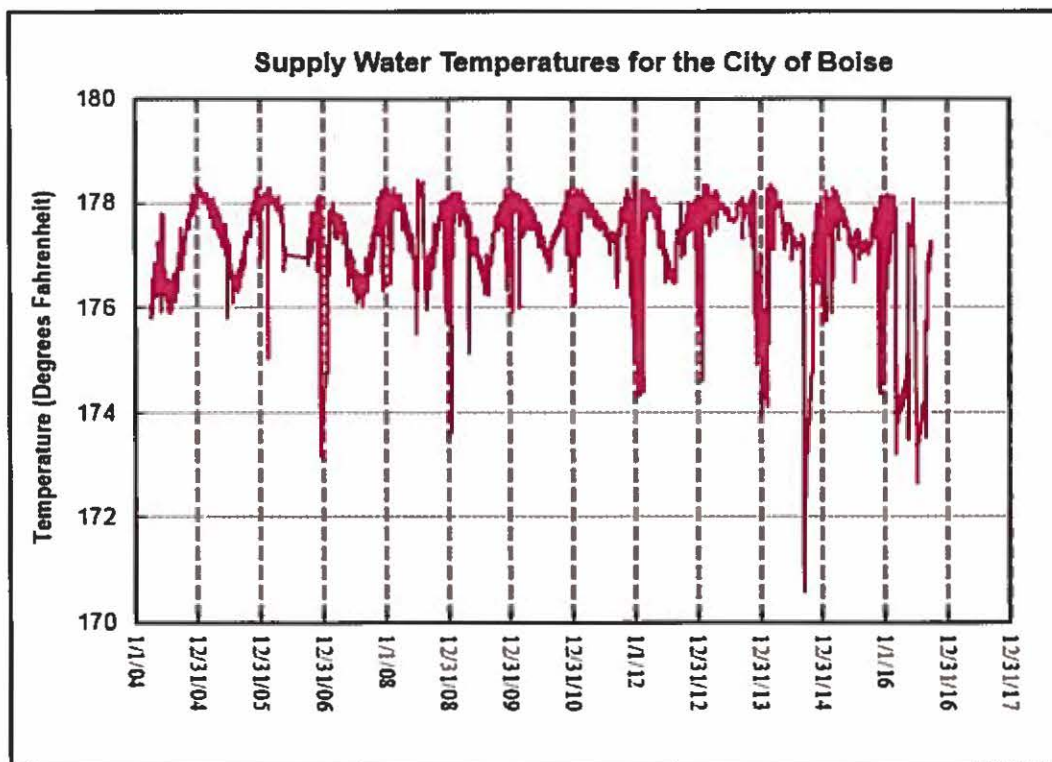


Figure 11. Supply water temperatures for the City of Boise's geothermal system. Readings less than 170 degrees Fahrenheit were removed from the dataset.

STEWART GULCH GROUND WATER DISTRICT 63-S

Withdrawals

The total withdrawal of low temperature geothermal water in GWD63-S in WY16 was 176.2 mgal (Figure 12). This amount is 14.0 mgal less than the withdrawal in WY15, which is a 7% decrease (Table 4).

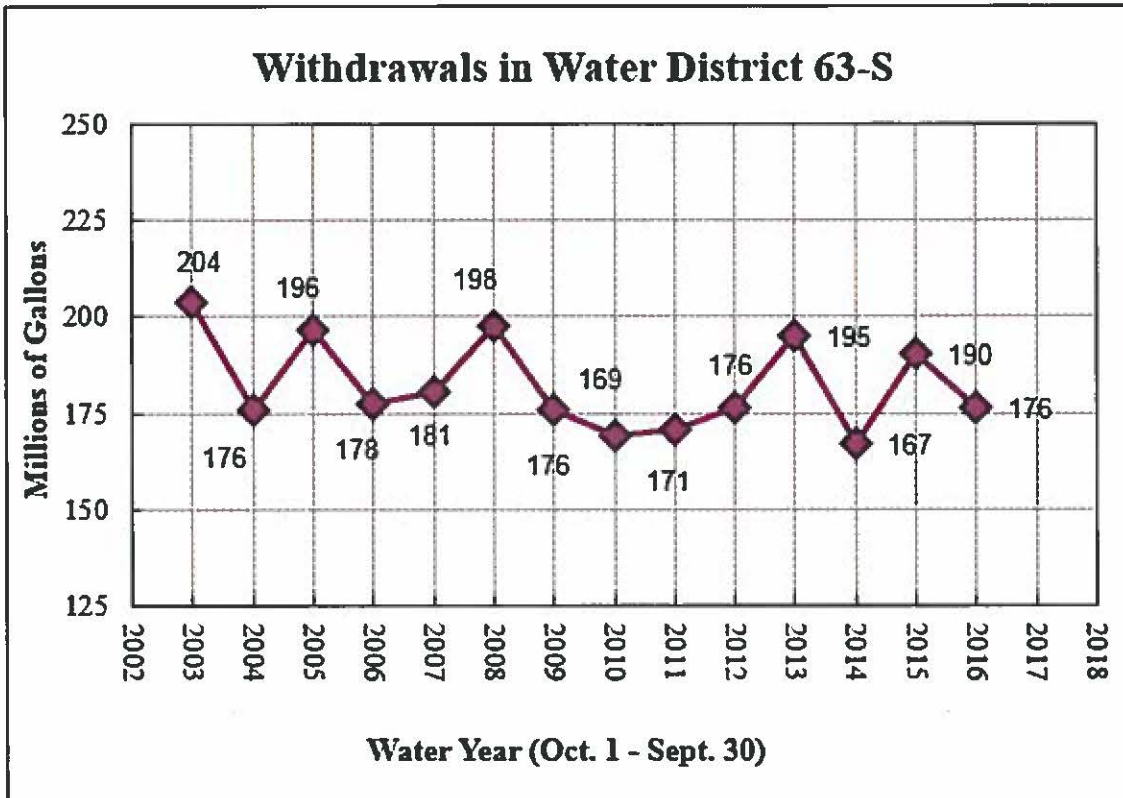


Figure 12. Geothermal withdrawals in Stewart Gulch Water District 63-S for Water Years 2003-2016.

Table 4. Withdrawals¹ from Stewart Gulch Ground Water District 63-S geothermal wells for Water Year 2016 (October 1, 2015 through September 30, 2016).

Well	Withdrawals in WY16 (millions of gallons)	Change from WY15 (millions of gallons)	Percent Change from WY15
TTCI Tieg's (Triangle)	0	0	0
TTCI Silkey (Shed)	17.1	-2.3	-12%
TTCI House (Office)	2.8	-0.3	-10%
Edwards Greenhouse	52.7	+4.2	+9%
Terteling Ranch Windsock	72.0	-18.4	-20%
Terteling Ranch Pool	25.3	+7.3	+41%
Quail Hollow (Tee Ltd) Upper	<0.1	<0.1	NC
Quail Hollow (Nibbler) Lower	1.3	-3.3	-71%
Niznik (Whitehead)	4.9	-1.2	-20%
Total	176.2	-14.0	-7%

¹These numbers contain some degree of uncertainty which is typically associated with measurement equipment and methods. Therefore, the amounts are being reported in millions with one decimal place. NC = Not Calculated because the number would be so large that it would not be of value to report.

The ownerships and locations of the wells allow them to be grouped into withdrawal centers, which is a useful approach for summarizing the withdrawals in these localized areas within the District. Table 5 shows the three centers and the changes in withdrawals.

Table 5. Three withdrawal centers in GWD63-S and changes from WY15 to WY16.

Withdrawal Center	Number of Wells	Numerical change from WY15 to WY16	Percentage change from WY15 to WY16
Edwards Greenhouse, Terteling Garden Center, Niznik	5 (4 in use; 1 unused)	0.3 mgal	<1%
Quail Hollow	2	-3.3 mgal	-71%
Terteling Ranch	2	-11.1 mgal	-10%

Water Levels

Overall, ground water levels in GWD63-S wells showed a decreasing trend in WY16. The Tieg's well had declines of 0.9 feet and 4.7 feet in the maximum and minimum values (Figure 13). The Edwards well had declines in the maximum and minimum water levels of 3.5 feet and 2.3 feet (Figure 14). The Quail Hollow wells were measured regularly by City of Boise staff until March 2016, at which time there was a change in staffing. No measurements were made the remainder of the year. The new City staff person is now aware of the requirements under the Boise Front monitoring plan. Fortunately, there were enough data points to evaluate the minimum values, which showed that the Upper well dropped 6.1 feet from WY15 to WY16, and the Lower well dropped 4.5 feet from WY15 to WY16 (Figure 15 and 16).

Analysis of Withdrawal and Water Levels

The decline in water levels in WY16 was unexpected, given that there was a substantial decrease in withdrawals in this water year. It was postulated that the water level decline in WY16 may be part of a multi-year trend. Therefore, data were analyzed using three four year time intervals beginning with Water Year 2005. Intervals of four year were selected based on the water level trends and the withdrawal histories that were observed over these time periods. The three intervals analyzed were: Interval A (WY05 – WY08); Interval B (WY09 – WY12); and Interval C (WY13 – WY16) (Figure 13). The withdrawals for each of these intervals, and the general water level trends, were:

Interval A: Total withdrawal = 753 mgal. Average annual withdrawal = 188 mgal/yr.

Overall water level trend was declining.

Interval B: Total withdrawal = 692 mgal. Average annual withdrawal = 173 mgal/yr,

Overall water level trend was increasing.

Interval C: Total withdrawal = 728 mgal. Average annual withdrawal = 182 mgal/yr,

Overall water level trend was declining.

There was a 5% increase in withdrawals in Interval C, compared to Interval B. Thus, the analysis indicates that the water level values in a specific water year may not be entirely the result of the withdrawal in that water year, but may reflect the withdrawal pattern over several years.

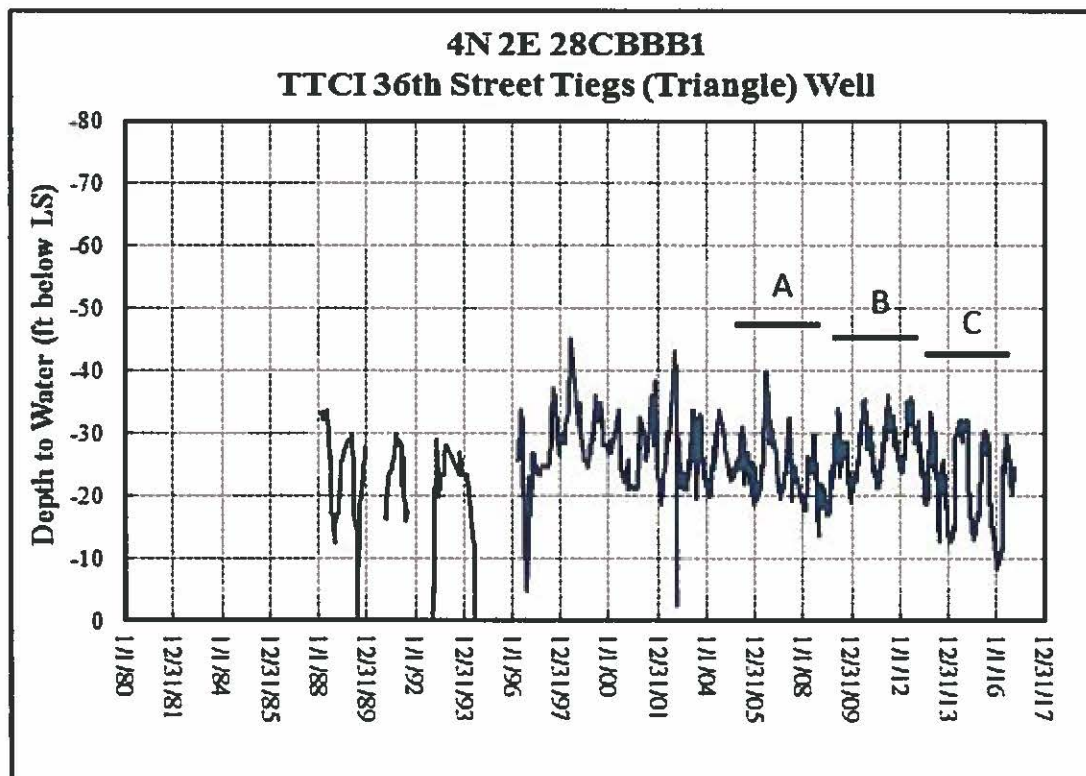


Figure 13. Water level hydrograph for the TTCI 36th Street Tiegs (Triangle) well.

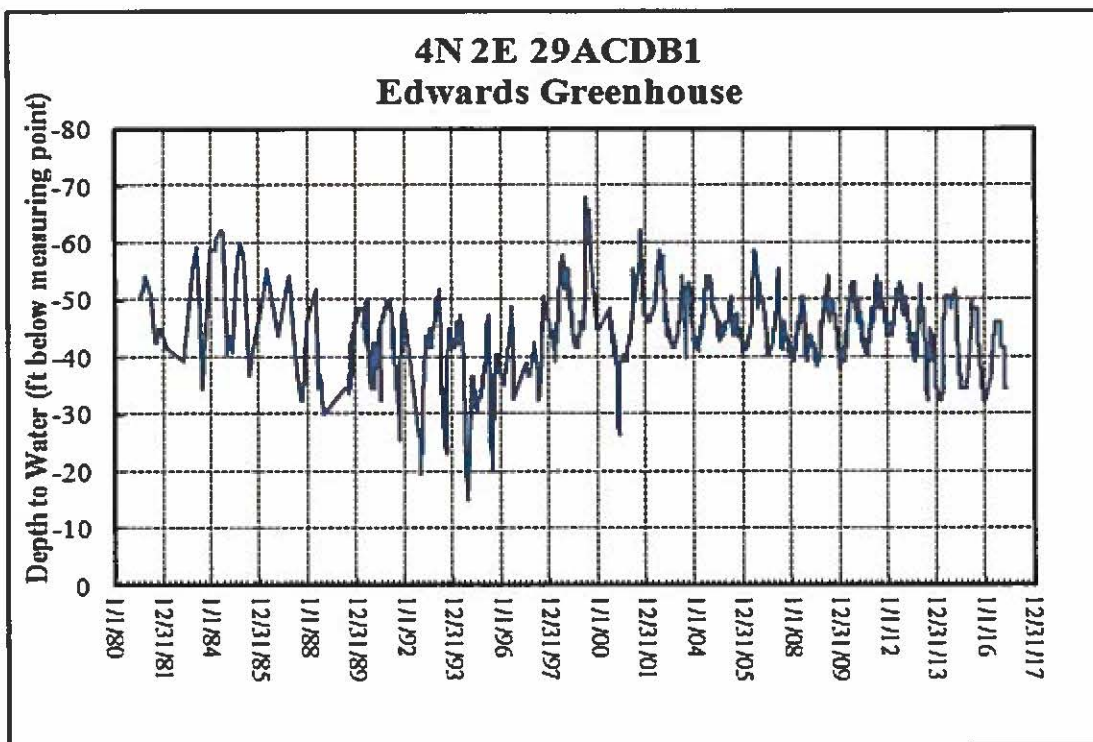


Figure 14. Water level hydrograph for the Edwards Greenhouse well.

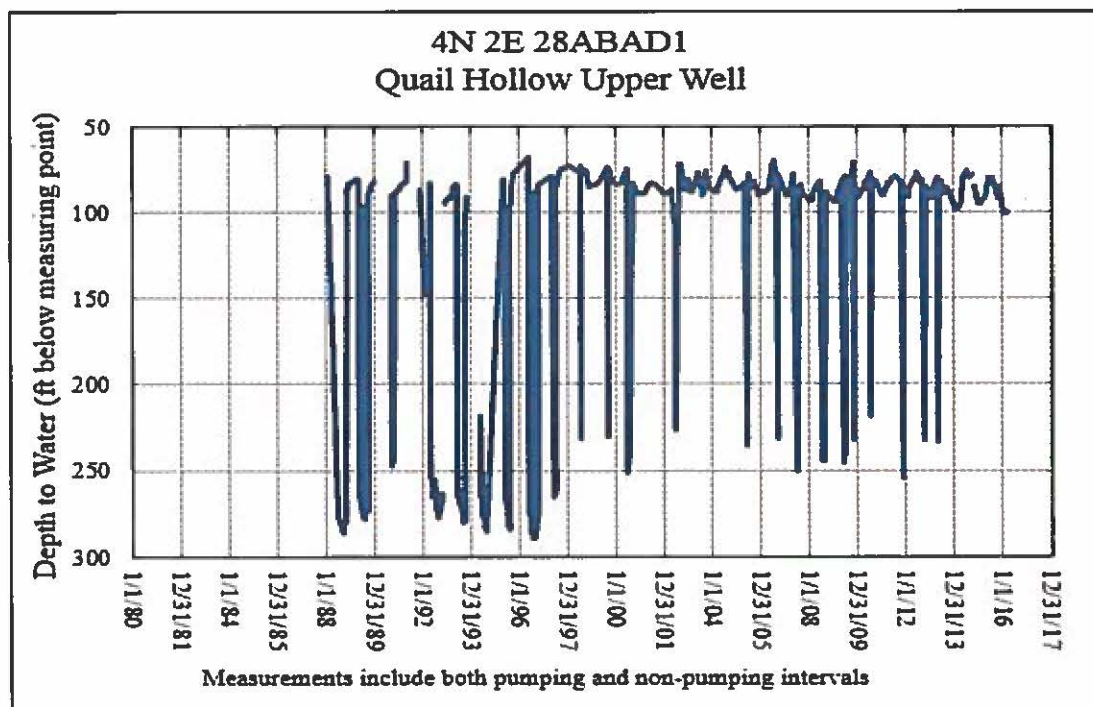


Figure 15. Water level hydrograph for the Quail Hollow Upper well.

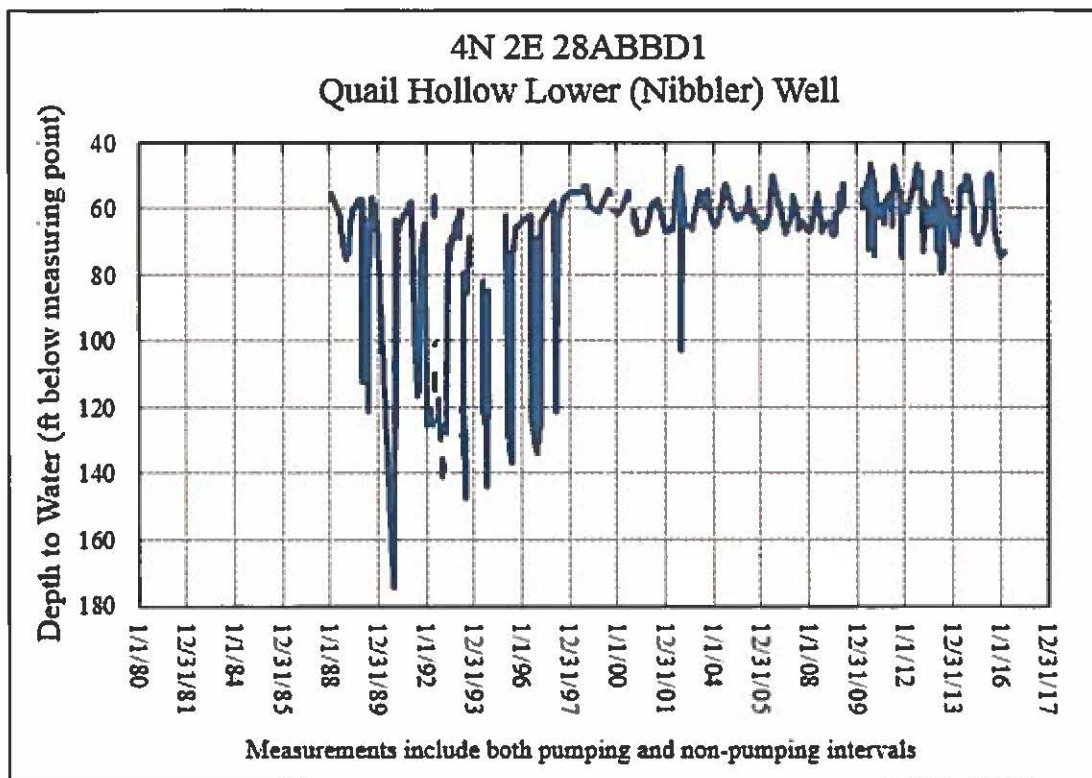


Figure 16. Water level hydrograph for the Quail Hollow Lower well.