

Review of Boise Front Geothermal Monitoring Data for Water Year 2006 (October 1, 2005 – September 30, 2006)

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1. EXECUTIVE SUMMARY

Monitoring results for Water Year 2006 (WY06) showed that the total net withdrawal from the four downtown Boise geothermal district heating systems was 276.2 million gallons (mgal), which was about 6% less than the net withdrawal in Water Year 2005 (WY05). About 61% of the geothermal water withdrawn was re-injected. Overall, water levels¹ in the downtown area of the Boise Front geothermal system were higher in 2006 from the previous year. Maximum and minimum water levels increased 0.7 feet and 1.2 feet, respectively, in the BLM well, which is the primary monitoring well for the Boise Front Geothermal System. Maximum water levels also increased in the Boise Warm Spring Water District (BWSWD) #1 and #2 wells. However, the changes in the minimum values were mixed with BWSWD #1 increasing 5 feet, but BWSWD #2 decreasing 14 feet. Changes in water levels from 2005 to 2006 for BWSWD #3 were +5.8 feet for the maximum values, and +0.7 feet for the minimum values. Overall, the maximum monthly water temperatures continued to decline slightly in the State of Idaho Capitol Mall production well.

For Stewart Gulch Ground Water District 63S (WD63S), the total geothermal ground water withdrawal was 177.5 mgal, which was about 10% less than the total withdrawal in WY05. The main reason for the reduction in total withdrawal is because the Flora Silkey (Shed) well has been shut-in since April 2006 and, consequently, it produced 22.4 million gallons less in WY06 than in the previous water year. The Flora House (Office) well has also been shut-in since April. As a result of the decrease in withdrawals beginning in April, 2006, water levels responded as would be expected in a system with high transmissivity. Maximum values (which generally occur in the summer months) increased 2.6 to 8.2 feet for the District wells from 2005 to 2006. This change reflects the recovery that the geothermal system experienced after the two Flora wells were shut-in. Conversely, the minimum water levels (which generally occur in late Fall to early Winter) decreased 1.8 to 5 feet in the District wells from late 2004 to late 2005; these water level responses were a reflection of withdrawal rates before the two Flora wells were shut-in.

¹For flowing wells, pressure readings were converted to the equivalent feet below measuring points.

2. DOWNTOWN BOISE/HARRIS RANCH

Withdrawals and Re-Injection

In WY06, gross and net withdrawals from the four downtown Boise district heating systems were 702.6 and 276.2 mgal, respectively (Table 1). The gross withdrawal was about 8% less in WY06 than in the previous water year, and the net withdrawal was about 6% less. About 61 percent of the fluids were re-injected, which is a decrease of approximately 1% from the previous year. After dropping sharply in Water Year 2001 (WY01), net withdrawals rose steadily through WY05 before dropping slightly in WY06 (Figure 1). The net withdrawal is expected to decrease significantly in Water Year 2007 because the City of Boise completed its collection loop in January 2007, and now re-injects 100% of its spent geothermal fluids.

BLM Well Water Levels

Maximum and minimum water levels increased 0.7 feet and 1.2 feet, respectively, in the BLM well from WY05 to WY06 (Figure 2). The BLM well is the primary monitoring well for the Boise Front Geothermal System.

BWSWD West, East and #3 Wells Water Levels

Maximum water levels for all three BWSWD increased from WY05 to WY06 (Figure 3): Well #1 (East) was up 3 feet; Well #2 (West) was up 2 feet; Well #3 was up 5.8 feet (Figure 4). However, the changes in the minimum values were mixed with Well #1 showing an increase of 5 feet, Well #3 showing an increase of 0.7 feet, and Well #2 having a decrease of 14 feet.

Kanta, BGL, Old Penitentiary, and Harris Ranch Wells Water Levels

The minimum water level in the Kanta well was 1.5 feet lower in WY06, while the maximum water level was 0.8 feet higher (Figure 5). The BGL #1 well showed the most change of the City of Boise's production field wells with the minimum value being 3.2 feet lower than the previous year, and the maximum value being 1.7 feet higher than in WY05. Water levels for the BGL #2 and #4 wells in WY06 were very similar to the water levels in WY05 (Figure 6). Water levels in the Old Penitentiary well showed slight changes in WY06 with the maximum value being 2 feet higher and the minimum value being 2 feet lower than in WY05 (Figure 7). The maximum water level in the Harris Ranch West well decreased about 2.2 feet according to the logger data (Figure 8). Manual measurements in the Harris East and West wells showed decreases in the maximum water levels of 3.6 feet and 2.2 feet, respectively.

Capitol Mall Water Supply Temperatures

The maximum monthly water supply temperatures in the Capitol Mall Production well for WY06 were slightly lower than the values for WY05 (Figure 9). An additional analysis compared the changes in the water temperatures between successive water years. To create this graph, the maximum monthly water temperatures (based on readings that were preceded by at least 8 hours of discharge exceeding 300 gallons per minute) from

one water year were paired against the maximum monthly readings from the succeeding water year. For some comparisons, there were 9 months with readings in both years; for other comparisons, there were fewer months with readings in both years. The temperatures for each of the two years were summed, the difference between the sums was calculated, and the difference was divided by the number of months with paired data. The result was an average monthly change between the two water years. Figure 10 shows that the changes in successive years have been variable, but the overall trend is one of continuing declines in water temperature. Fortunately, the amount of temperature decline has been less in the last couple years than in most of the preceding years.

Table 1. Production from the four district geothermal heating systems in the downtown Boise area for Water Year 2006 (October 1, 2005 through September 30, 2006).

System	Gross Withdrawals for WY06 (gallons) and percent change from WY05 to WY06	Net Withdrawals¹ for WY06 (gallons) and percent change from WY05 to WY06
Boise Warm Springs Water District	225,310,463 (-9%)	225,310,463 (-9%)
Capitol Mall	114,219,494 (-15%)	0 (NC ²)
City of Boise	186,703,790 (-4%)	50,906,318 (+11%)
Veterans Administration	176,397,228 (-11%)	0 (NC)
Total	702,630,975 (-8%)	276,216,781 (-6%)

¹Net Withdrawals equal Gross Withdrawals minus Injection amounts.

²NC = No change.

Figure 1. Gross and net withdrawals for the four district heating systems in the downtown Boise area for water years 1978 through 2006.

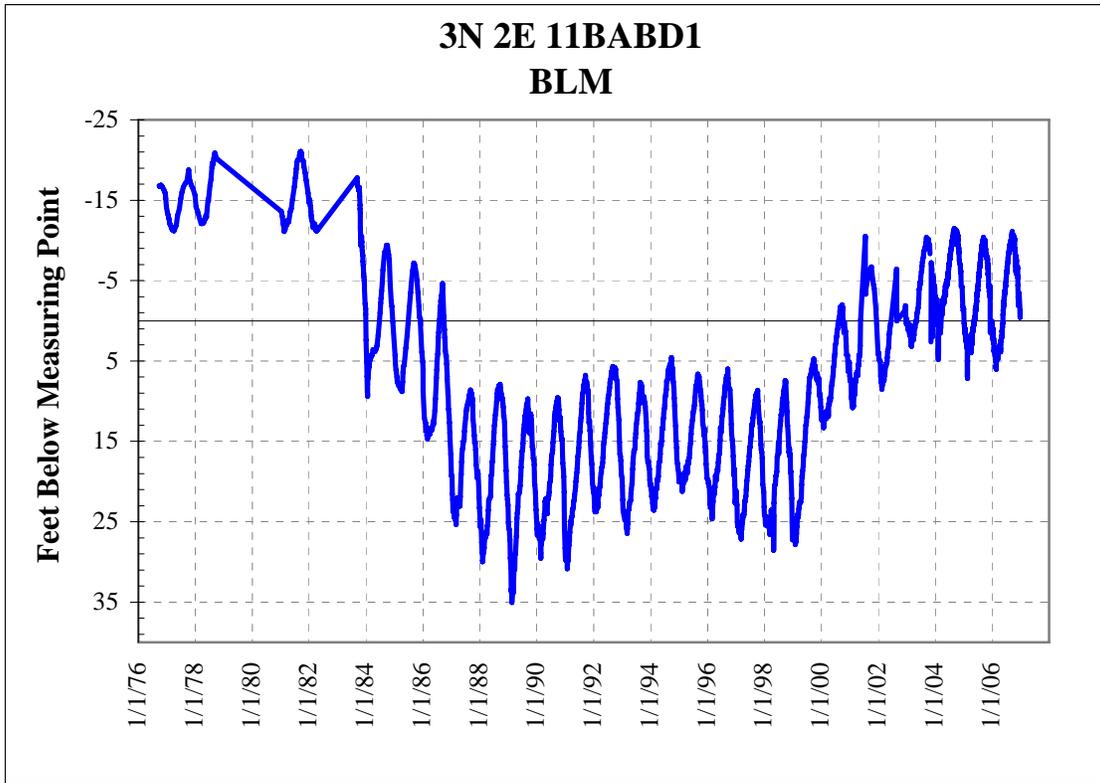


Figure 2. Water level hydrograph for the BLM well.

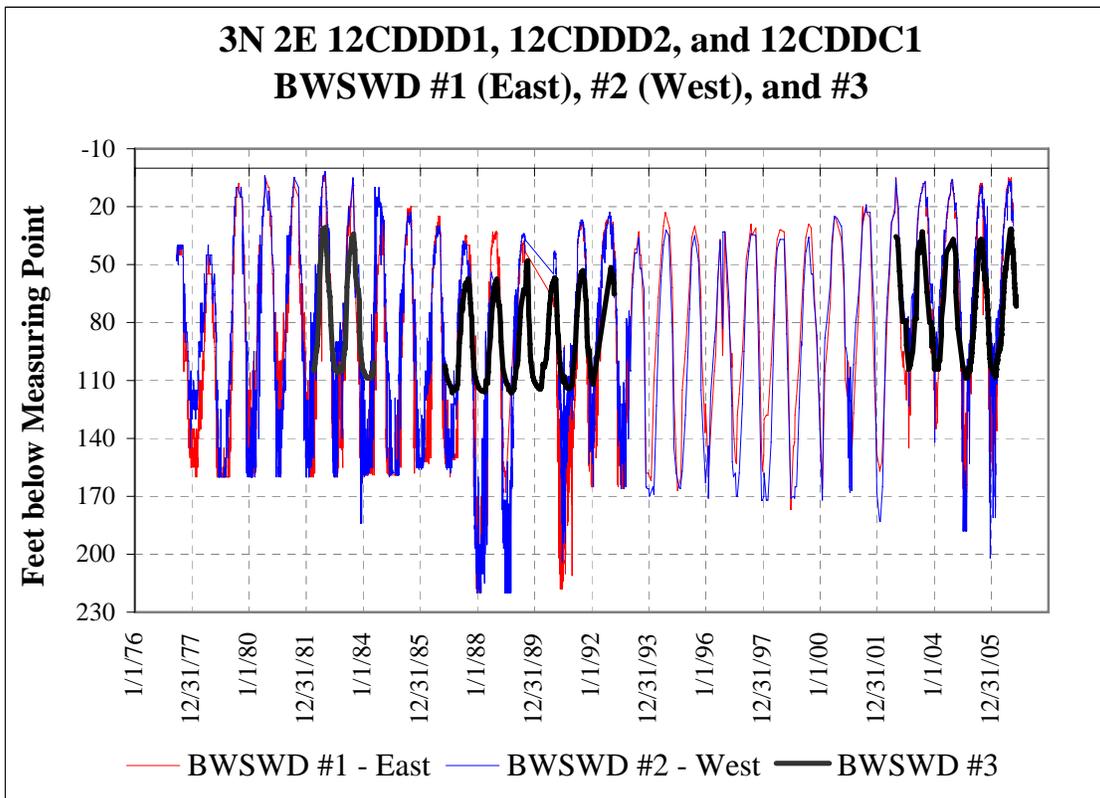


Figure 3. Water level hydrographs for the Boise Warm Springs Water District (BWSWD) wells.

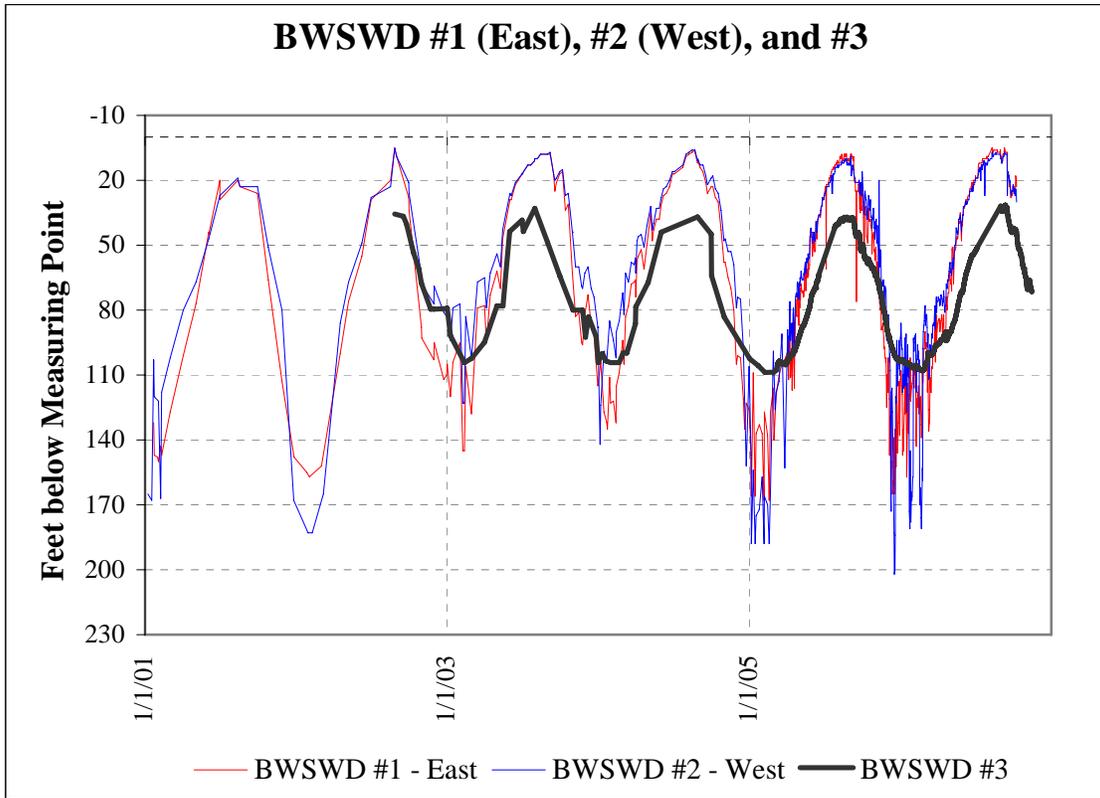


Figure 4. Water level hydrographs for the Boise Warm Springs Water District (BSWD) wells, January 2001 to November 2006.

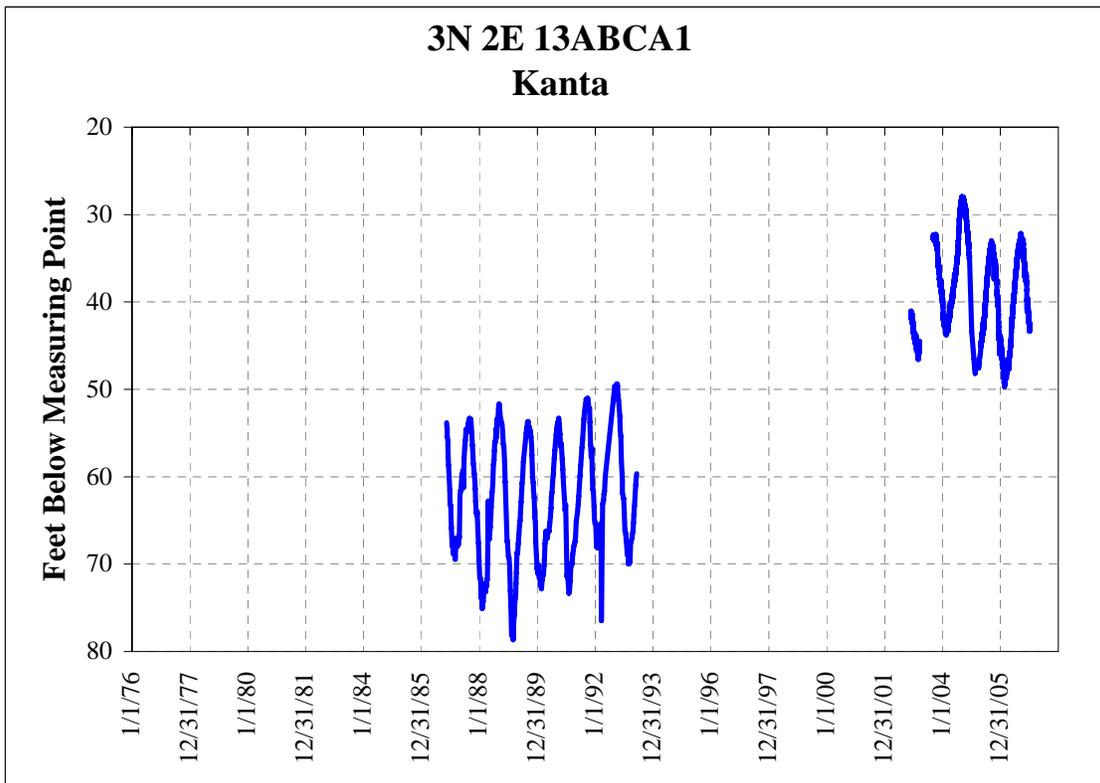


Figure 5. Water level hydrograph for the Kanta well.

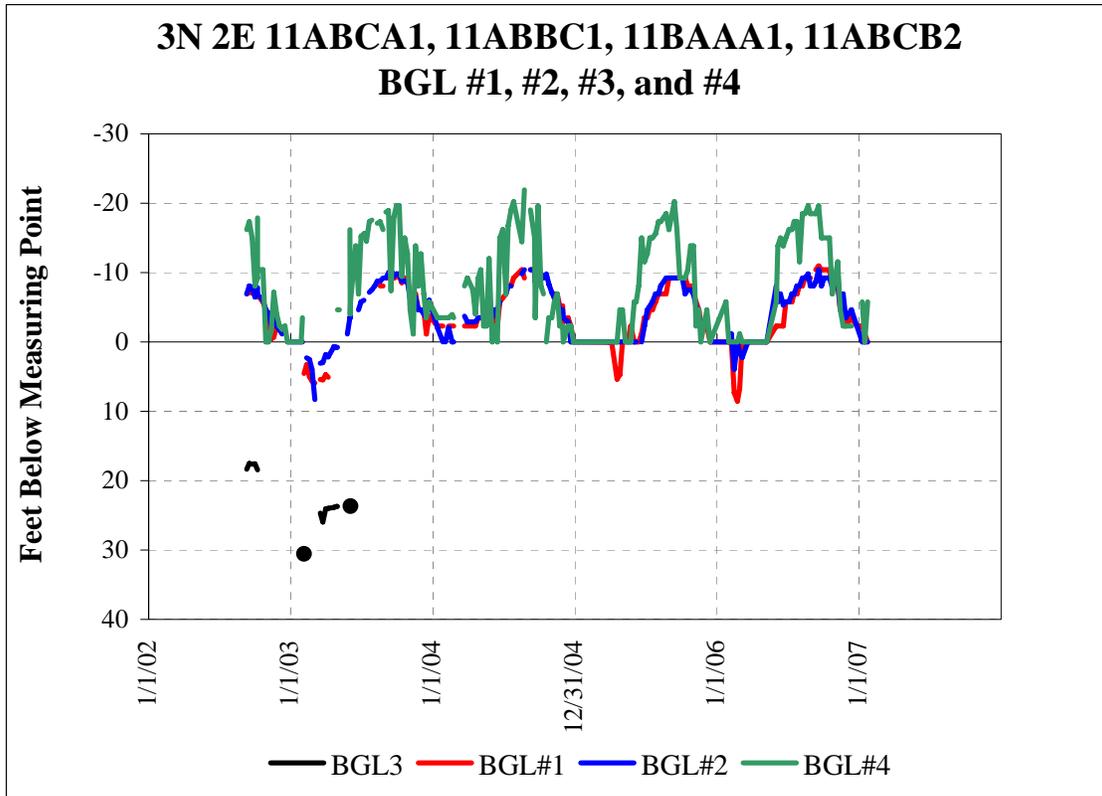


Figure 6. Water level hydrograph for the BGL #1, #2, #3, and #4 wells.

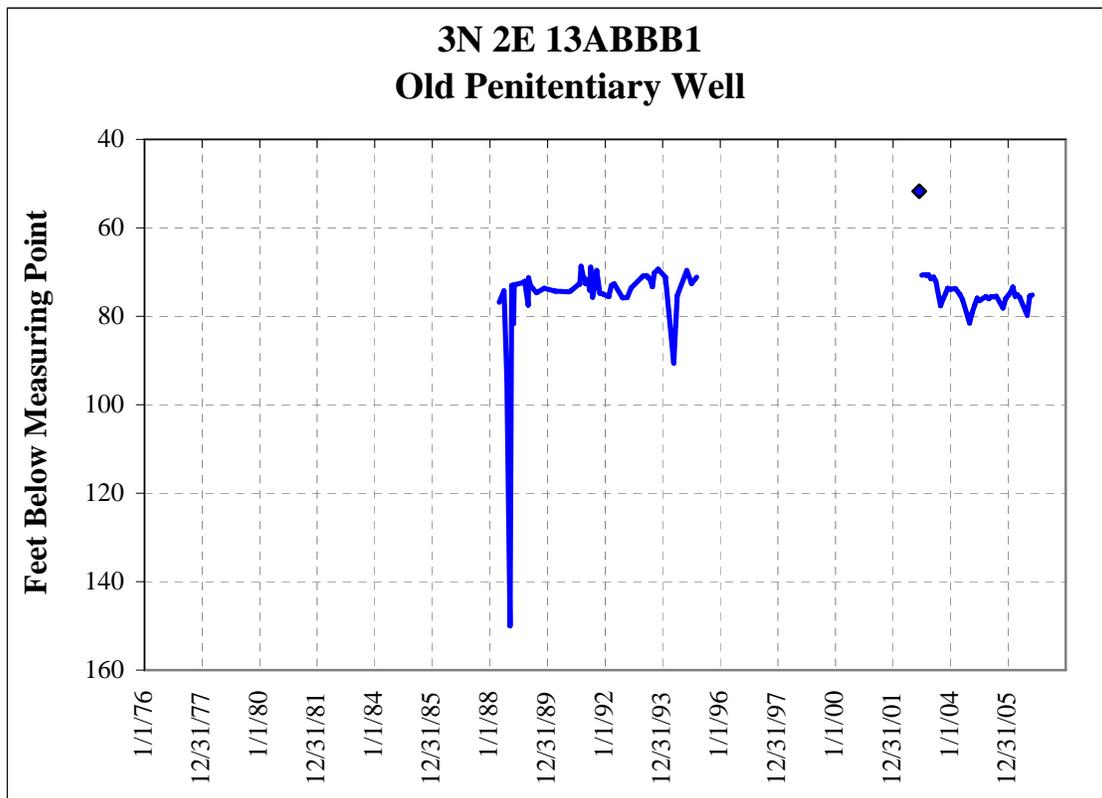


Figure 7. Water level hydrographs for the Old Penitentiary well.

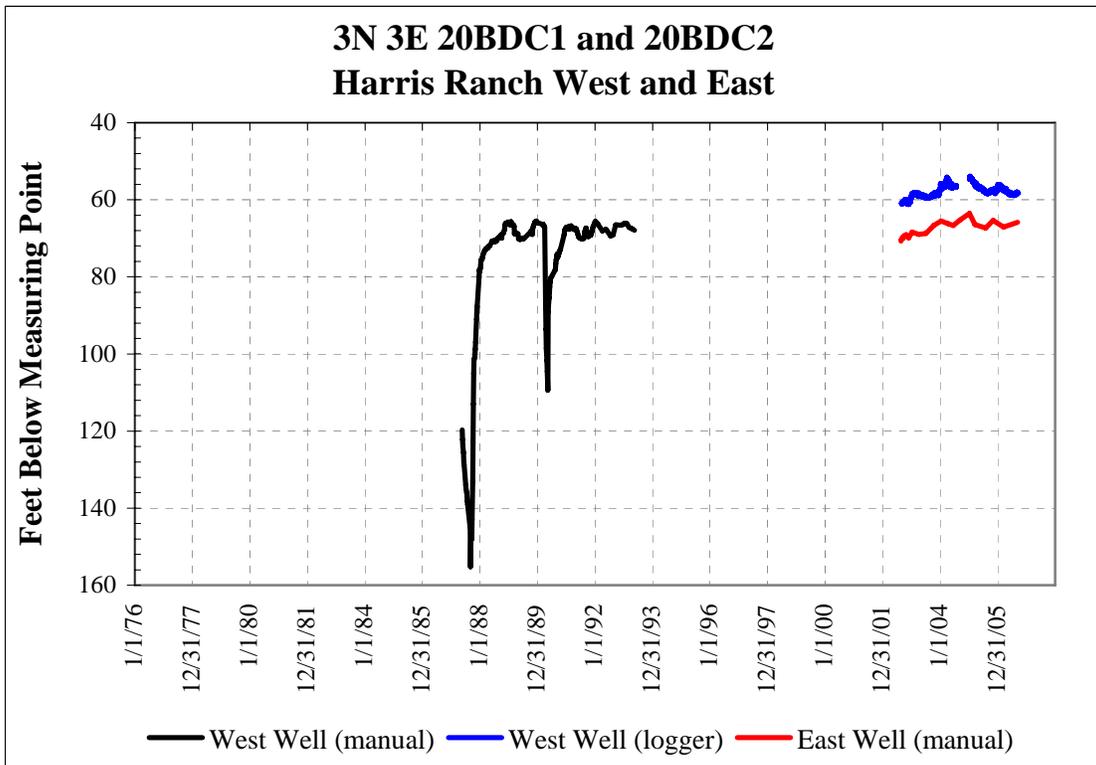


Figure 8. Water level hydrographs for the Harris Ranch wells.

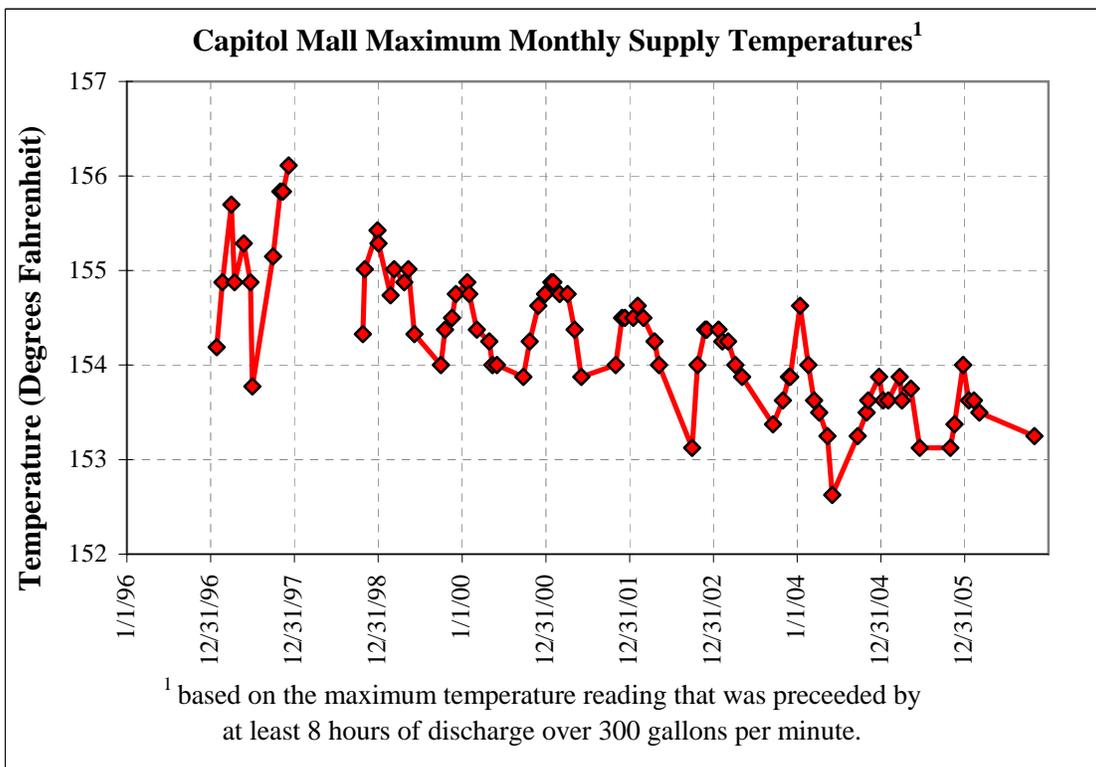


Figure 9. Maximum monthly water supply temperatures for the Capitol Mall geothermal system.

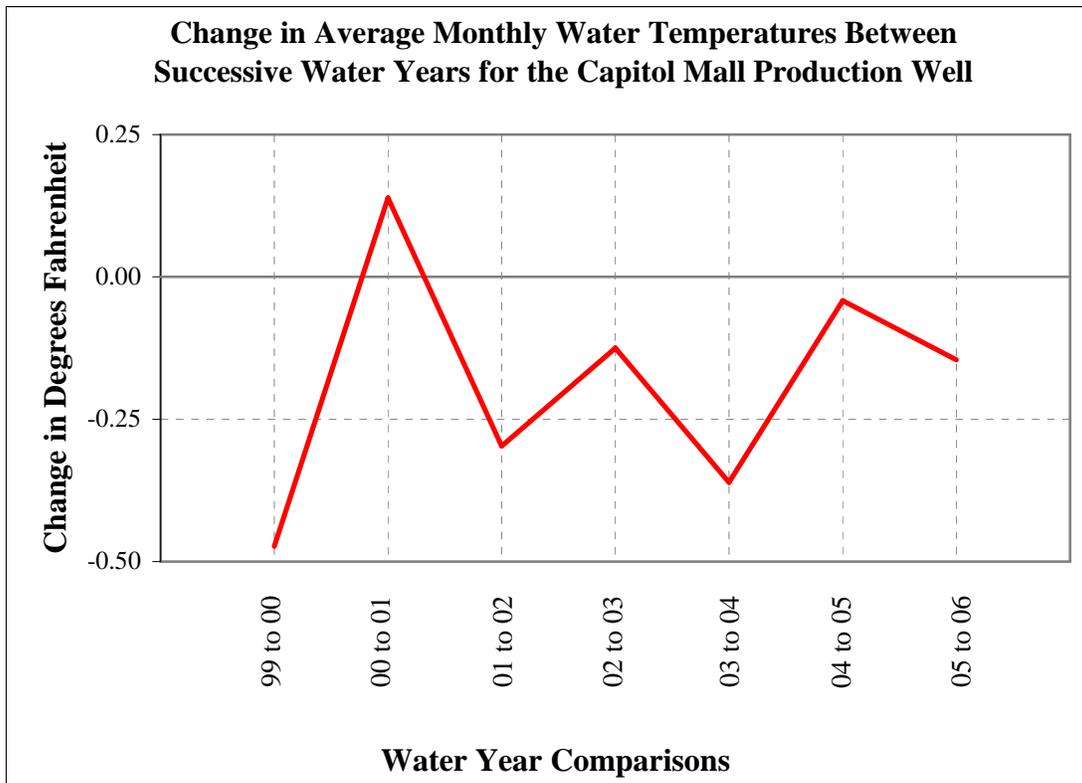


Figure 10. Changes in average monthly water temperatures between successive water years for the Capitol Mall production well.

3. STEWART GULCH GROUND WATER DISTRICT 63S

Withdrawals

The total geothermal withdrawal from WD63S wells for WY06 was 177.5 mgal (Figure 11), which was 19.4 million gallons less than in WY05...a change of about 10 percent (Table 2). The decrease in withdrawal was mainly the result of: 1) the Flora Silkey well being shut-in during construction at the Flora site, and 2) reduction in usage of the Quail Hollow Upper well (it was used more in 2005 when their cold water well was being serviced).

Water Levels

All of the wells in WD63S, with the exceptions of the Flora House and Silkey wells which did not have water level data for about six months due to a construction project, showed increases in the maximum water levels. Most of the wells showed decrease in the minimum values. This pattern was due to the responses of the water levels when the Flora House and Silkey wells were shut-in as of April 2006.

Edwards

The minimum value decreased 2.2 feet from January 2005 to December 2005 (Figure 12). However, the maximum value increased 7.7 feet from 2005 to 2006.

Whitehead

The minimum value decreased 3 feet, and the maximum value increased 8.2 feet (Figure 13).

Flora

The Tieg (Triangle) well had the most complete hydrograph record of the three Flora wells. This is because measurements had to be discontinued at the House (Office) and Silkey (Shed) wells for about one half year due to construction at the Flora site. The Tieg well showed a pattern very similar to the Edwards well (Figures 12 and 14); the maximum value increased 7.4 feet, and the minimum value decreased 3.8 feet. Because of the hiatus in measurements at the House and Silkey wells, only the minimum values can be evaluated; the House well was down 1.8 feet, and the Silkey well was down 4.3 feet (Figures 15 and 16).

Quail Hollow

Both Quail Hollow geothermal wells showed similar water level trends as the other wells in the District with the minimum readings decreasing and the maximum readings increasing. The Lower well's minimum reading decreased 3.2 feet and its maximum reading increased 3.5 feet (Figure 17). The Upper well's minimum reading decreased 2.6 feet and its maximum reading increased 8 feet (Figure 18).

Terteling Ranch

The maximum value for the Windsock well was up 6.2 feet, and the minimum value was up slightly in WY06 (Figure 19). The minimum value for the Pool well was down 3.2 feet and the maximum value was up 6.1 feet (Figure 20). The minimum value for the Motorcycle Club Hot well was down 5 feet and the maximum value was up 4.2 feet (Figure 21).

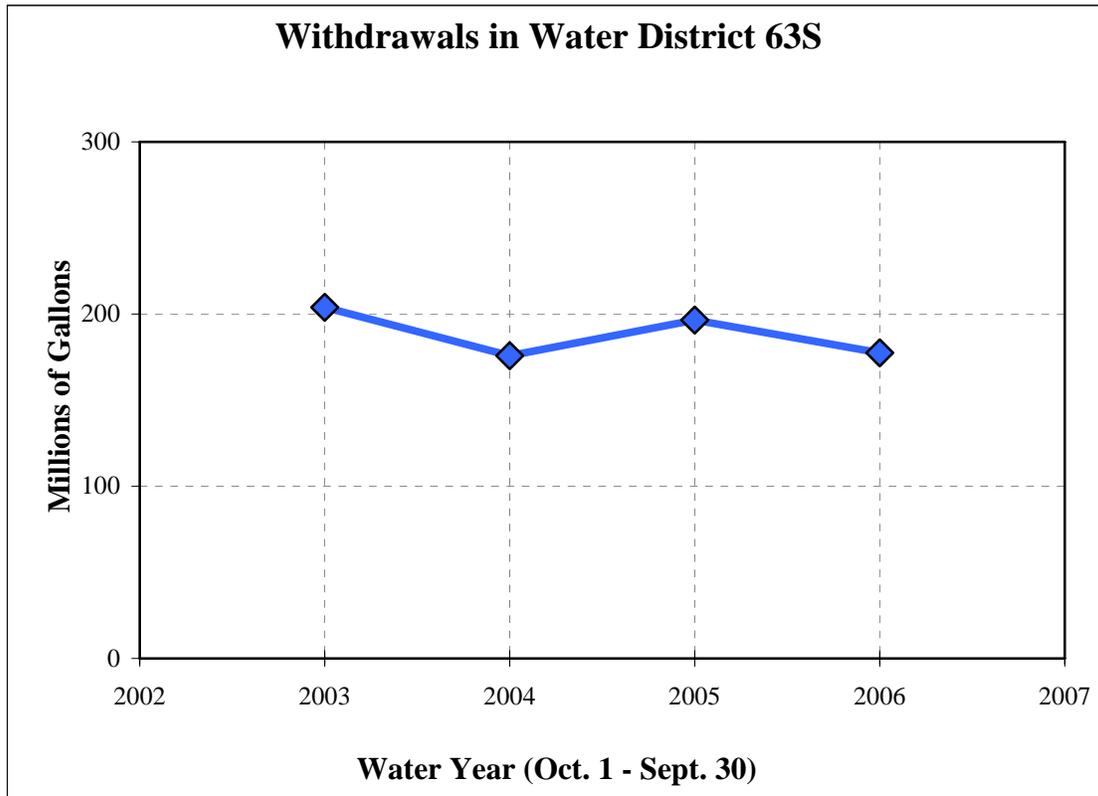


Figure 11. Geothermal withdrawals in Stewart Gulch Water District 63S for Water Years 2003-2006.

Table 2. Withdrawals from Stewart Gulch Water District 63S geothermal wells for Water Year 2006 (October 1, 2005 through September 30, 2006).

Well	Withdrawals in WY06 (gallons)	Change from WY05 (gallons)
Flora Company Tiegs (Triangle)	0	0
Flora Company Silkey (Shed)	11,286,667	-22,483,381
Flora Company House (Office)	2,760,933	-2,967,534
Edwards Greenhouse	43,927,688	+8,108,308
Terteling Ranch Windsock	88,822,555	+3,459,503
Terteling Ranch Pool	18,914,525	+1,658,305
Quail Hollow Golf Course Upper	6,917,200	-6,369,200
Quail Hollow Golf Course Lower	819,300	-159,400
Whitehead	4,052,645	-604,551
Total	177,501,513	-19,357,950

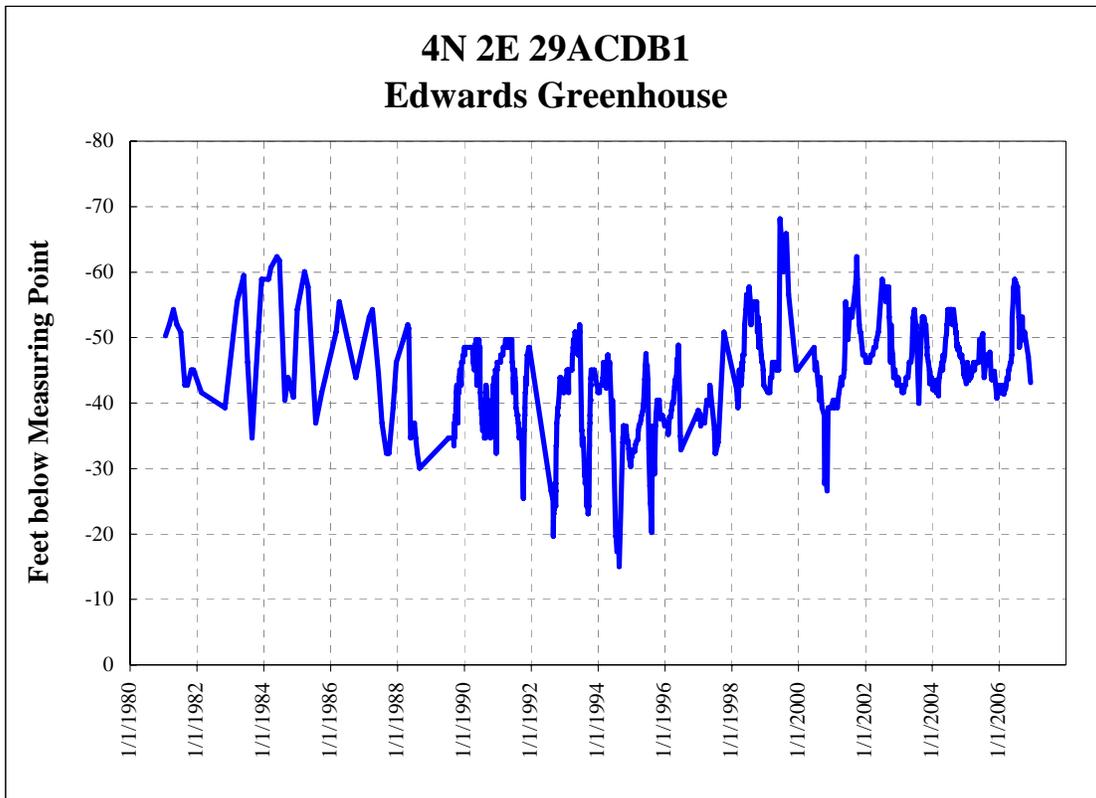


Figure 12. Water level hydrograph for the Edwards Greenhouse well.

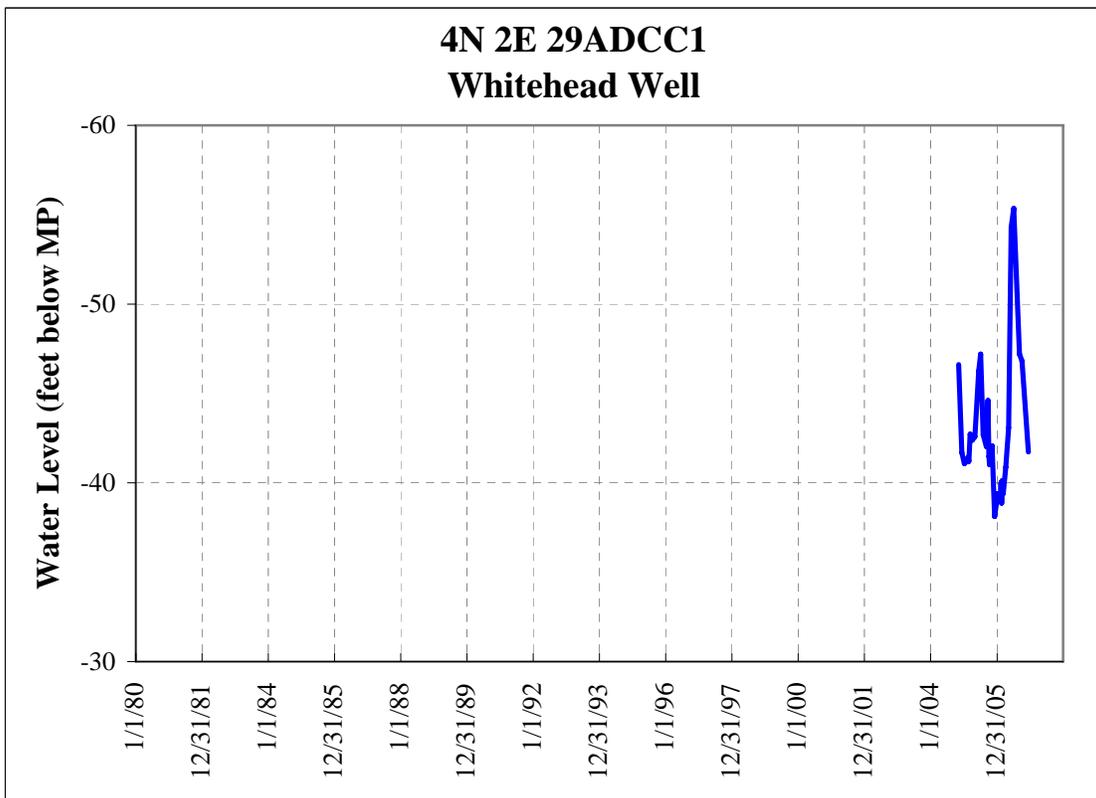


Figure 13. Water level hydrograph for the Whitehead well.

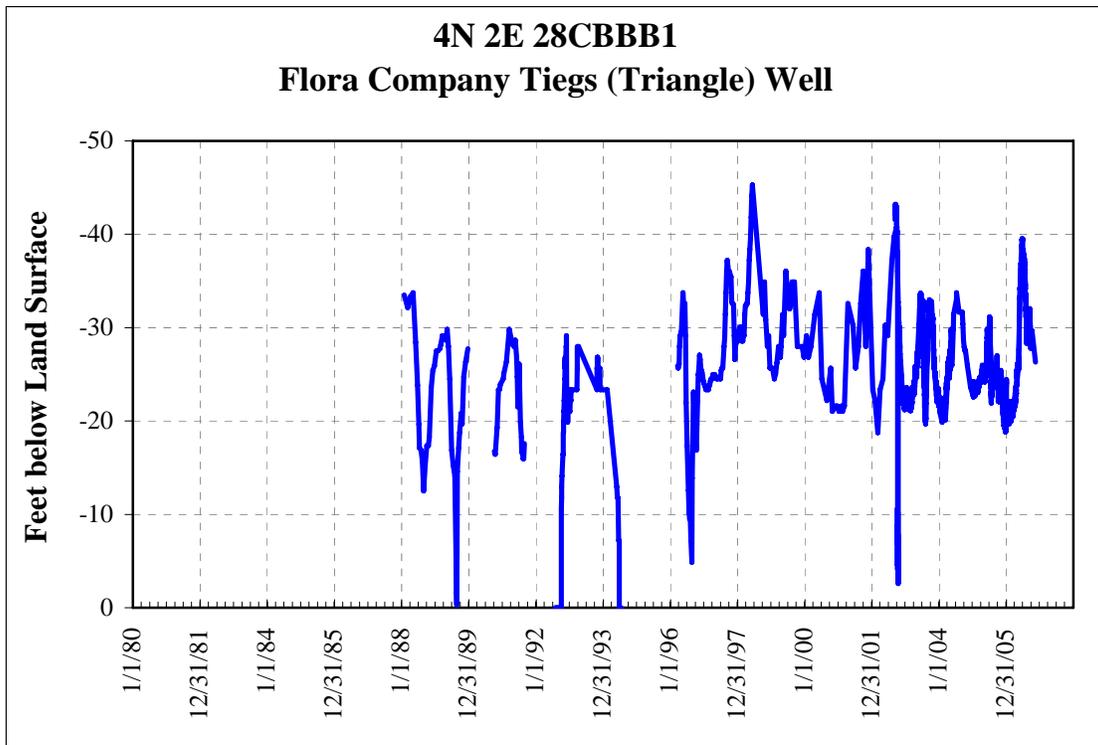


Figure 14. Water level hydrograph for the Flora Company Tieg (Triangle) well.

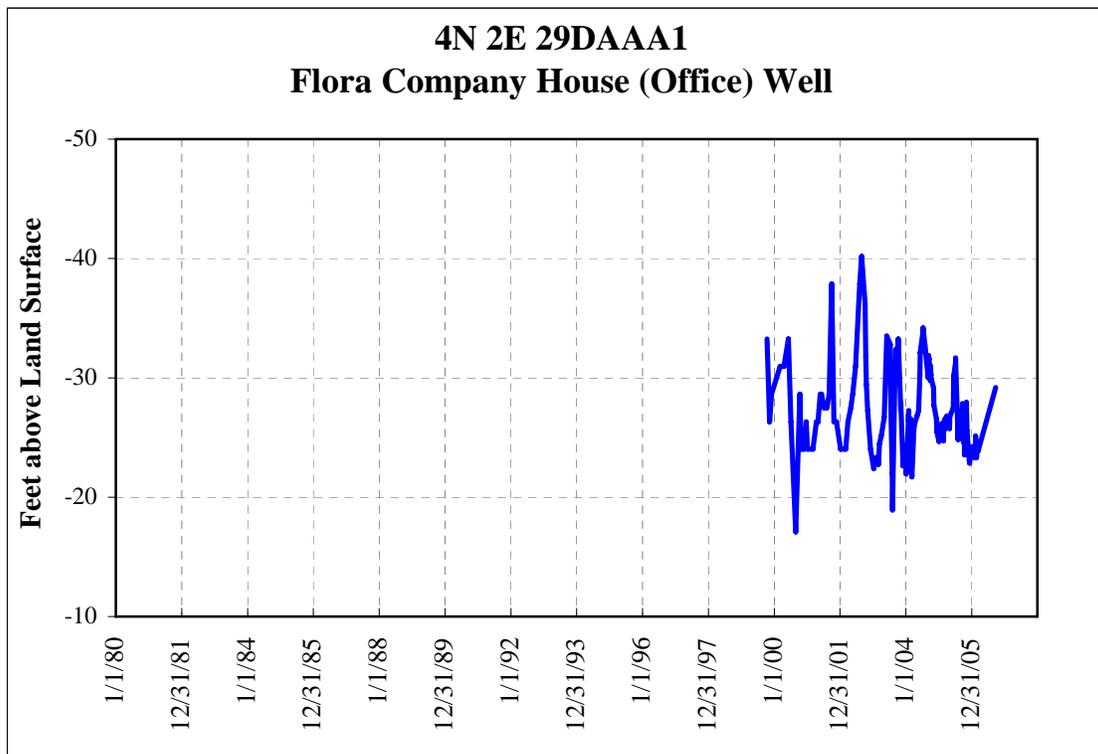


Figure 15. Water level hydrograph for the Flora Company House (Office) well.

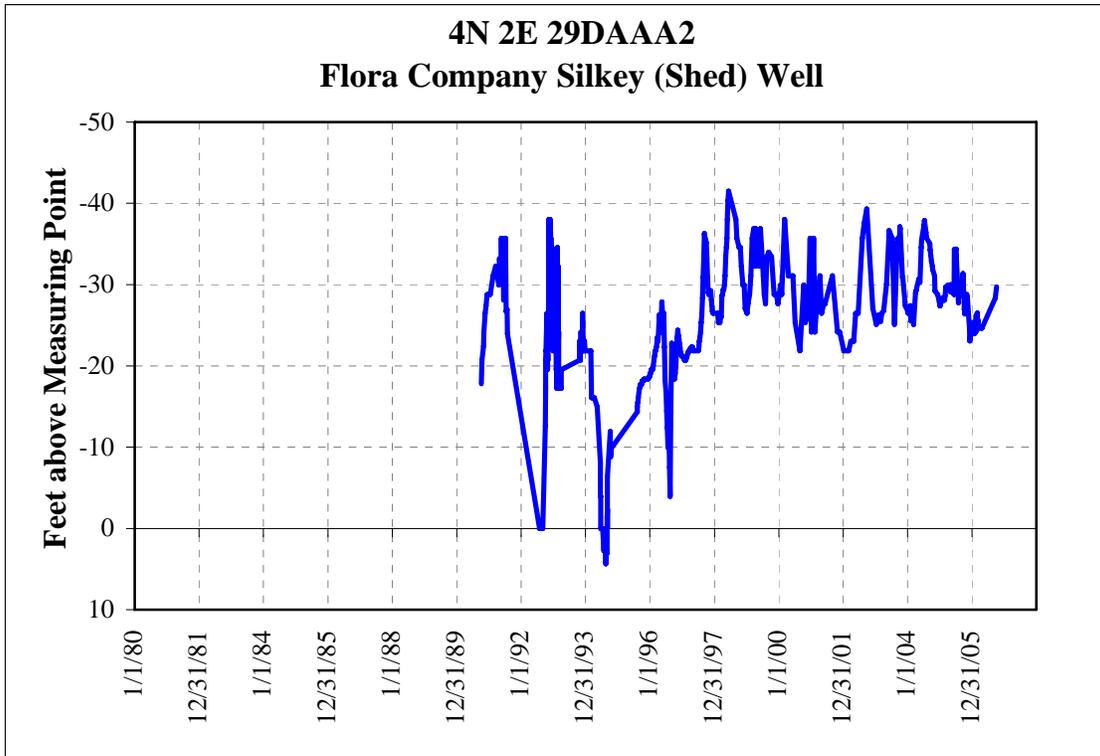


Figure 16. Water level hydrograph for the Flora Company Silkey (Shed) well.

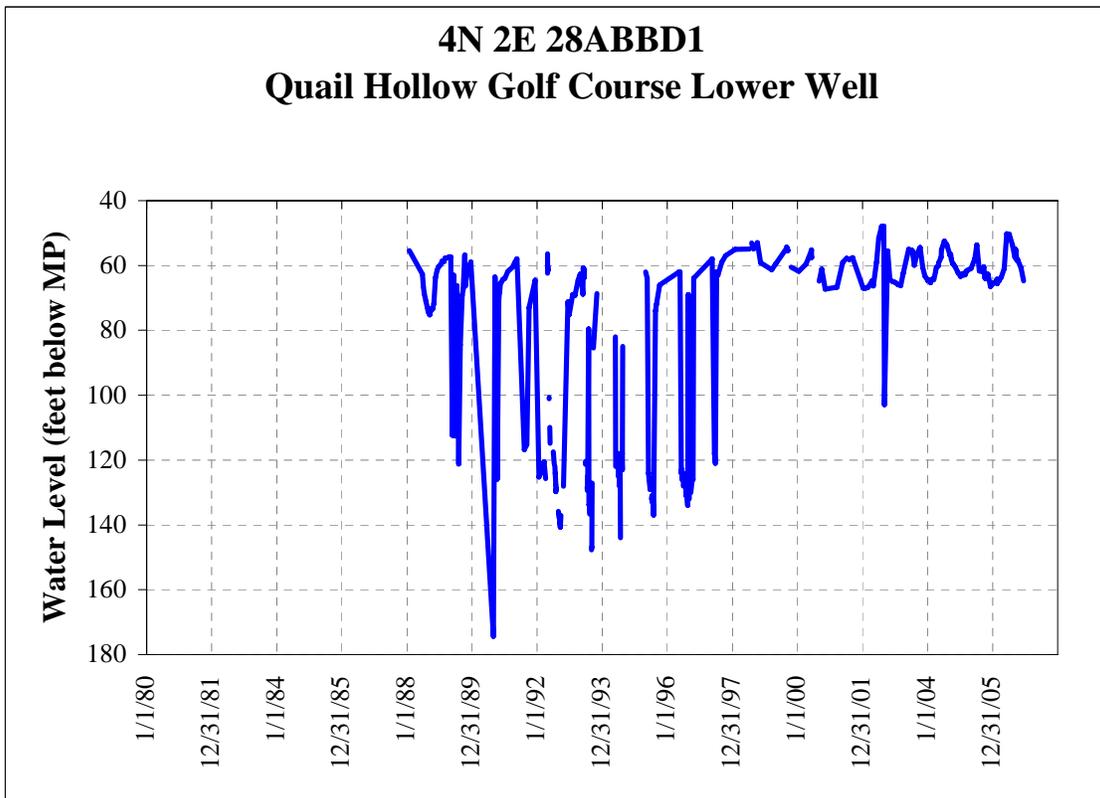


Figure 17. Water level hydrograph for the Quail Hollow Lower well.

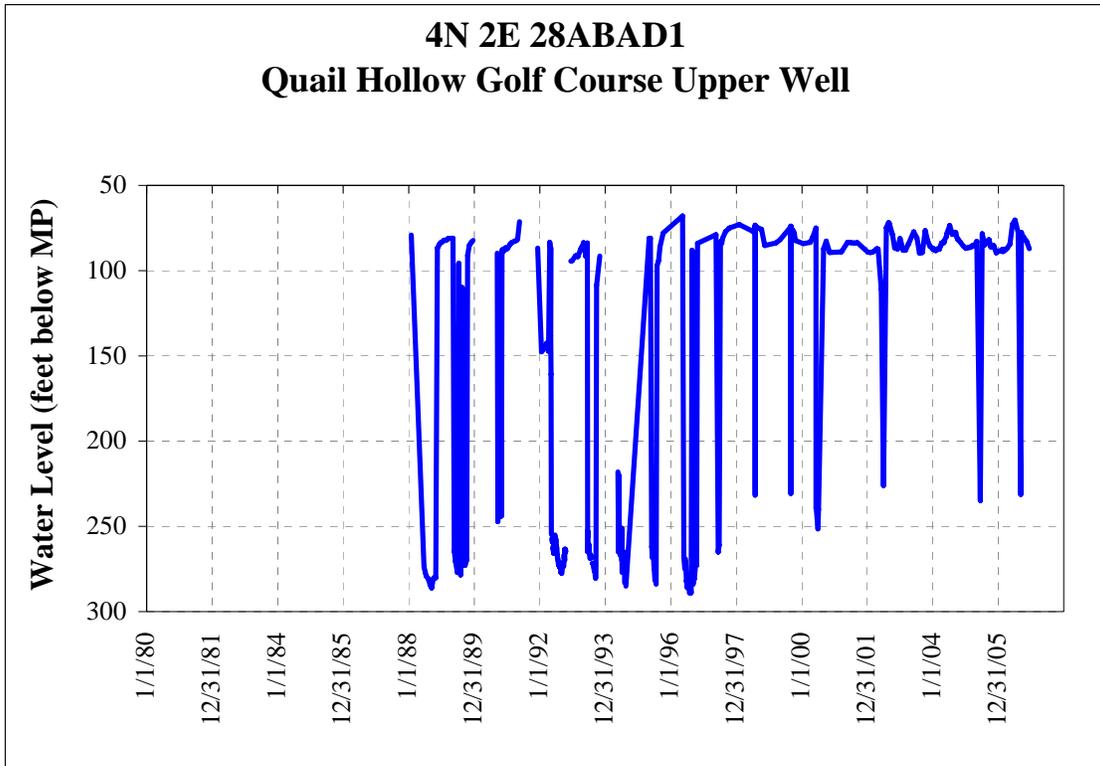


Figure 18. Water level hydrograph for the Quail Hollow Upper well.

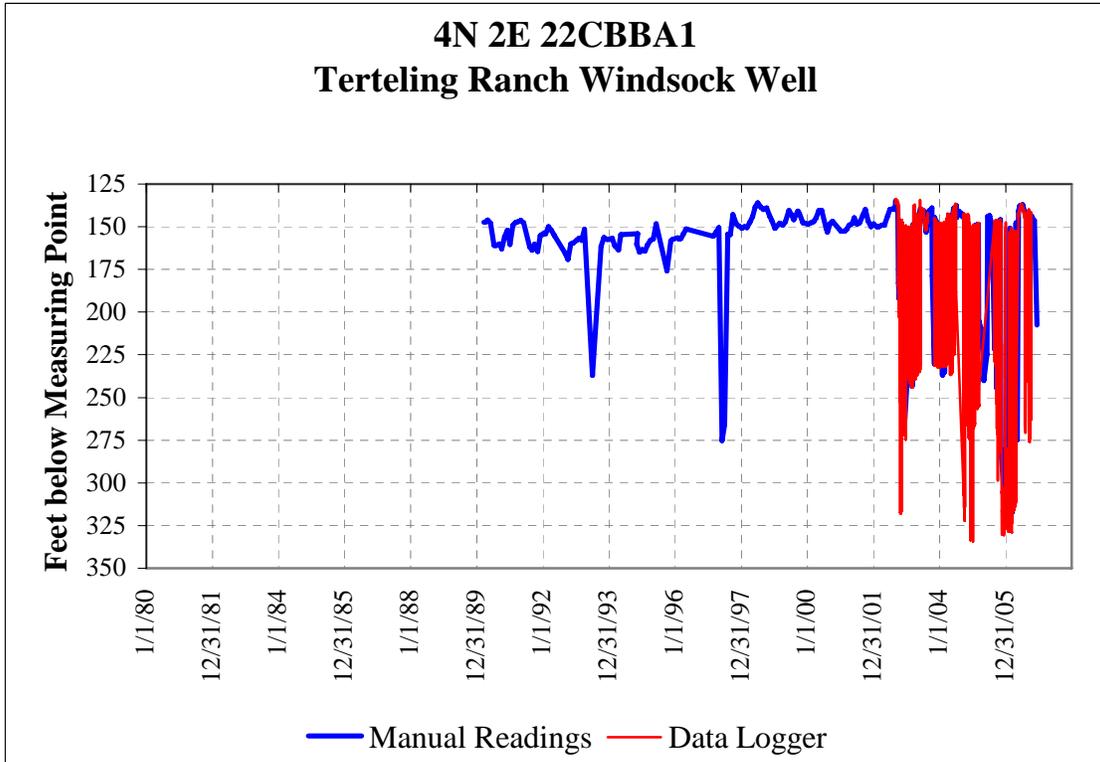


Figure 19. Water level hydrograph for the Terteling Ranch Windssock well.

Figure 20. Water level hydrograph for the Terteling Ranch Pool well.

Figure 21. Water level hydrograph for the Terteling Ranch Motorcycle Club Hot well.