Wood River Groundwater Level Synoptic Fall 2018

by Alex Moody

Introduction

Water levels in 103 groundwater wells were measured between October 22, 2018 and October 26, 2018 across the Wood River Valley (figure 1). The work was a collaborative effort between the Idaho Department of Water Resources (IDWR) and the U.S. Geological Survey (USGS). The measurement, known as the groundwater level synoptic, is a continuation of a periodic six-year synoptic schedule. Previous synoptic measurements were conducted in 2006 and 2012 at the end of October. The timing of the synoptic attempts to capture the lowest intra-annual state of the aquifer after the cessation of irrigation and prior to recharge from spring runoff. These are summarized in Bartolino (2014) and Skinner et al. (2007). Large-scale repeated measurements improve our understanding of the aquifer and provide calibration data for Wood River Groundwater Flow Model (Bartolino, 2014).

Of the 103 wells measured, 97 are completed in the upper alluvial unconfined aquifer. The six remaining wells are completed in the deeper confined aquifer that exists in the southern extent of the valley. Using the unconfined well levels, we can make an estimate of the water table surface elevation within the aquifer.

This report does not present differences between synoptic years 2012 and 2018 due to the variability of aquifer

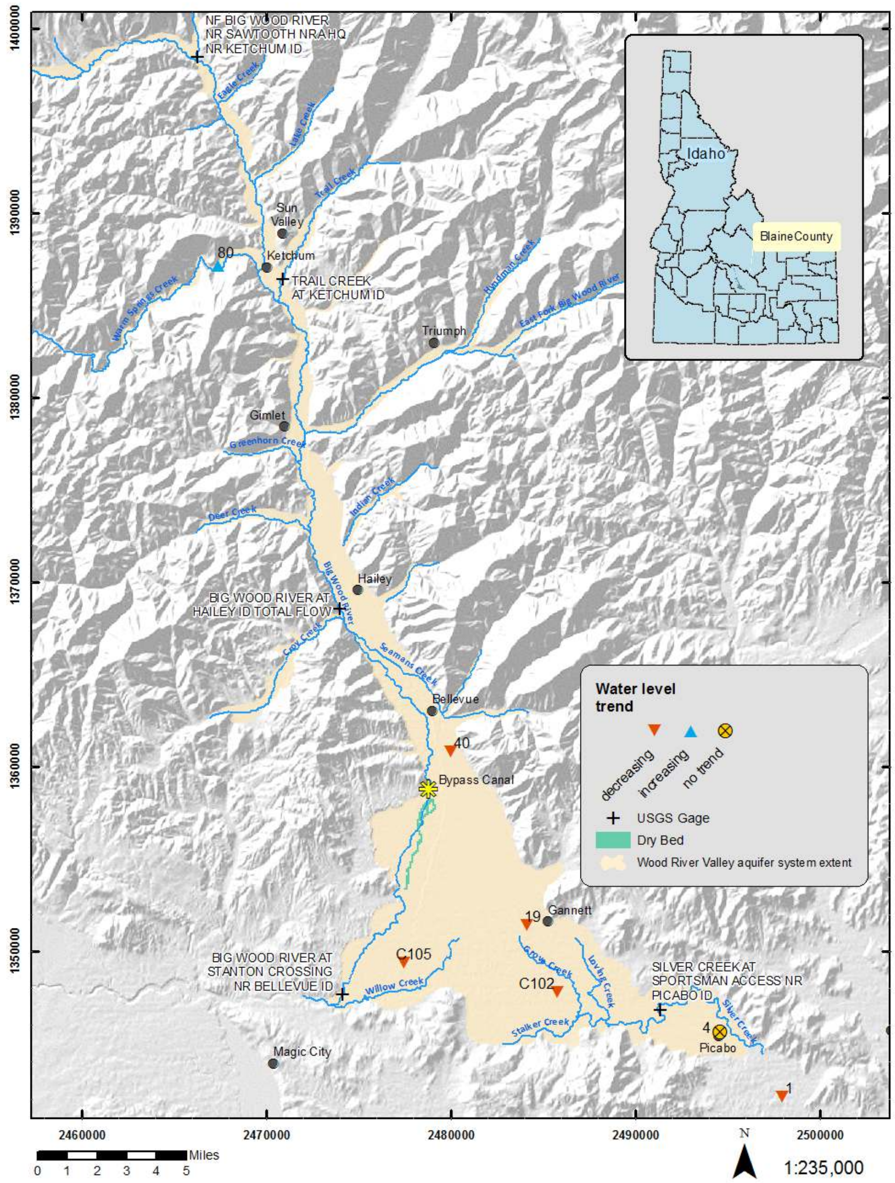


Figure 1: Regional map of the Wood River Valley in Blaine County, Idaho, showing well locations for water-level trends, select USGS gages, and a perennially dry section of the Big Wood River.

levels caused by the previous year's precipitation and snow pack volumes. Inter-annual change analysis is possible using the Fall measurement of IDWR's groundwater monitoring network in the Wood River, which is measured in late October or early November. IDWR's network has less than half the number of wells measured compared to the USGS Synoptic.

Water Level Maps

Two methods were used to produce models of water table elevation in the Wood River Valley. One approach was the "Splines with Barriers" interpolation tool in the spatial analyst toolbox of ArcMap 10.6. Both the groundwater altitude and groundwater depth-to-water values were interpolated, though not used for all maps. The depth-to-water map was subtracted from a modified 30 meter, low-pass filtered digital elevation model (DEM) to obtain groundwater altitude. DEM modification was done to remove contour artifacts introduced by the steep slopes at the edge of the valleys. After contouring the final raster, some contours were removed or edited in areas where we felt there was not enough data to support interpolation. The second approach was to use ordinary kriging to predict water level altitudes and was implemented in the python package PyKrige (PyKrige, 2017). All maps are presented in appendix A.

Results

Water Levels in October 2018

The water table was 33 feet below land surface on average and 50% of the measured levels were between 9.75 feet and 48.93 feet during the 2018 synoptic measurement. The deepest well is located near Picabo at the interface of the Wood River aquifer with the Eastern Snake Plain aquifer where the hydraulic gradient steepens significantly. Figure 2 shows the depth to water measurements from the 2018 synoptic, which can also be referenced in table B.1.

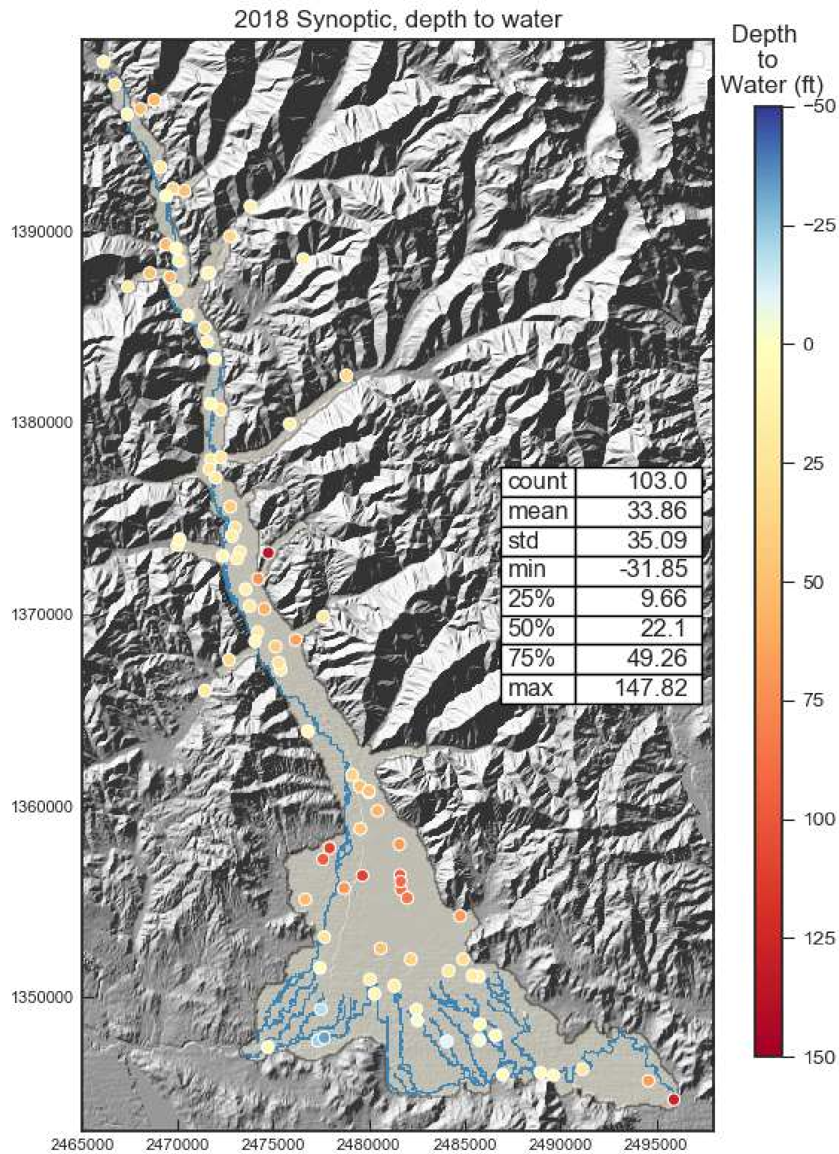


Figure 2: Map of depth to water measurements in 103 wells measured during the 2018 synoptic. Coordinates are in IDTM83.

Contours of the water table altitude are presented in figures A.1 through A.4. Results are similar to Bartolino (2014)'s water table maps in that there is a uniform gradient in the upper valley and a groundwater divide in the southern extent of the valley that forms diverging flow paths; one that flows west towards the Big Wood River at Stanton Crossing and another that flows east towards Silver Creek and Picabo.

Despite broad regional similaries, there are noticeable differences among the interpolation techniques used. Figure A.2 was splined using the IDWR monitoring network and shows the effects of using a smaller sampling size with a different spatial distribution. Contours based on the smaller IDWR network generally resolve the same features of the water table that the synoptic network defines, though there is a noticeable loss of detail and a shallower gradient towards Stanton Crossing. In A.3, a weighted average of both splined water table elevations and depth-to-water subtracted from a modified DEM produces water table elevation contours that point upstream in gaining reaches of the Big Wood River and that flatten out in losing reaches. Ordinary kriging (figure A.4) also produces steeper contours pointing up-gradient above Bellevue that flatten and exhibit a smaller gradient near the dry bed.

The standard error of predicted values from kriging maps uncertainty estimates of the contouring of water table elevation. In general, standard error is below 20 feet north of bypass canal diversion and south of well 99. South of the bypass canal diversion, standard error reaches above 40 feet away from wells.

Water Table Change

IDWR's monitoring network has been measured at least semi-annually since 2016 with measurements occurring near the end of the irrigation season at the end of October or early November, prior to irrigation season in April, and in the summer when possible. Well-to-well comparisons of subsequent years may provide the direction of short term trends in the water table. Figure 3 shows the differences in water levels between the years. Positive values indicate that the later year had a higher water level.

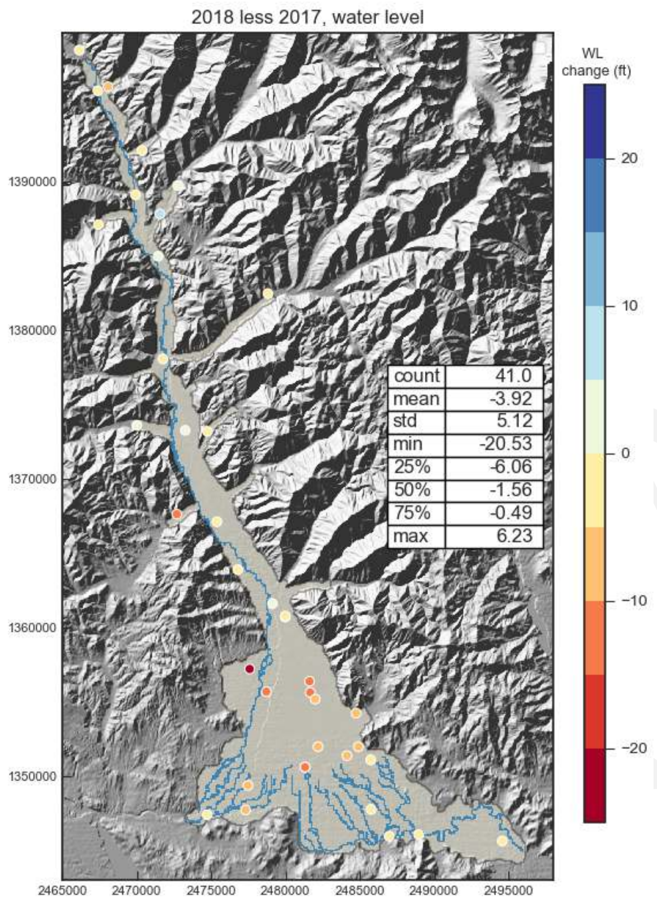
2018 and 2017 Water levels were down an average of 3.8 feet in fall 2018 relative to fall 2017. The largest drop was 20 feet at well 33 (01N 18E 14DBC1) in the Bellevue triangle area and 50% of water level decreases were between 0.5 and 6.1 feet. Figure A.7 shows an estimate of the water table change surface between 2017 and 2018 based on measurements shown in figure 3a. Declines are most prominent in the lower valley where the dry bed begins. Changes in the tributary valleys are mixed; Trail Creek water levels increased while other tributary valleys show little or no declines. Croy Creek near Hailey is the only tributary exhibiting water level declines.

2017 and 2016 The aquifer rose 5.5 feet on average in fall 2017 relative to fall 2016. The largest increase was 25 feet at well 33 (01N 18E 14DBC1). Contours in figure A.8 show the estimated water table surface change for unconfined wells. As in 2017 to 2018, the largest magnitude of change was in the lower portion of the valley. The water table in Trail Creek declined up to 4 feet while the other valleys showed little change. Water levels in Croy Creek and Deer Creek increased slightly.

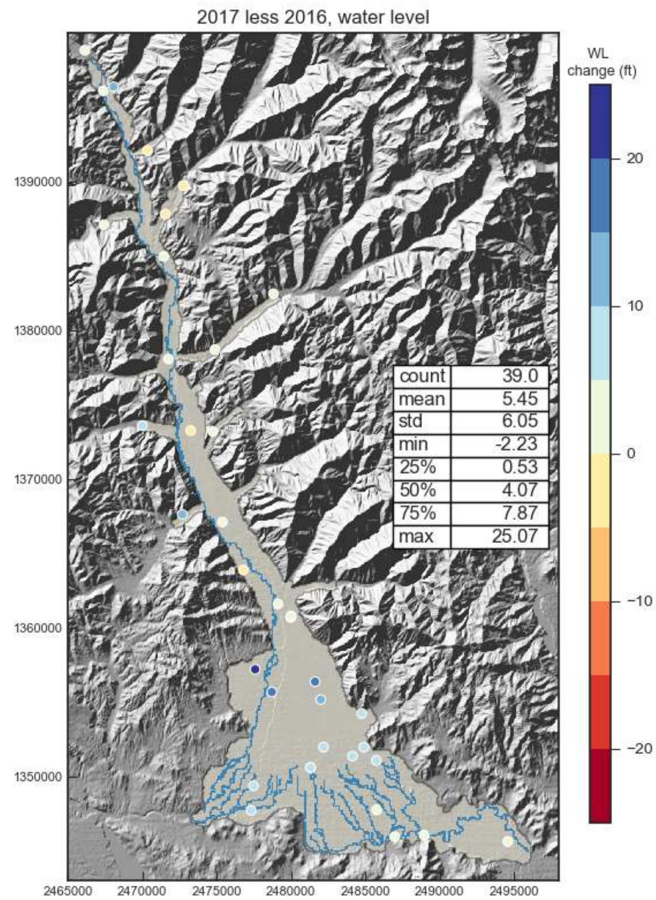
Discussion

Contouring The ArcGIS "Spline With Barriers" tool produces regional groundwater elevation contours that show a surface that we would expect in an unconfined alluvial aquifer. This allows for a quick assessment water levels in the aquifer using broadly distributed measurements taken during USGS synoptics of IDWR semi-annual measurements.

Ordinary kriging with a power model produced realistic results similar to spline methods and provided an estimate of error. The results suggest adding wells to the networks where the standard error is above 20 feet. Two locations exhibited high standard error: 1) Higher elevations of tributary valleys and 2) south of the bypass canal diversion. Of the tributary valleys, Croy Creek was especially high in error and shows contours that are artifacts of the isotropic kriging model selected. When considering a regional water table surface, more measurements are probably not necessary in Croy Creek. The higher standard error in the southern portion of the valley could be reduced by added measurements. This would improve definition of the divergence in water table towards the Big Wood River and Silver Creek.



(a) 2018 less 2017



(b) 2017 less 2016

Figure 3: Inter-annual difference for all wells completed in the confined or unconfined aquifer between subsequent fall measurements. Positive values indicate higher water levels in the most recent year. Each map contains a table of summary statistics for the differences between the two years.

Inter-annual water table change Inter-annual change from 2016 to 2018 is approximately equal in magnitude but differs in direction. The 2018 synoptic results show an aquifer that was lower than 2017 by 3.78 feet on average, while the water table was higher in fall 2017 than in fall 2016 by 5.45 feet on average.

Bartolino (2014) cites three probable causes of water level change in the Wood River Valley: precipitation prior to the measurement period, variability in surface-water supply, and groundwater pumping. Because irrigation in the Wood River Valley is mixed-source and surface-water supply is controlled by antecedent precipitation in the tributary valleys, all three drivers are correlated to a degree and have compounding effects as factors in the magnitude and direction aquifer water level change.

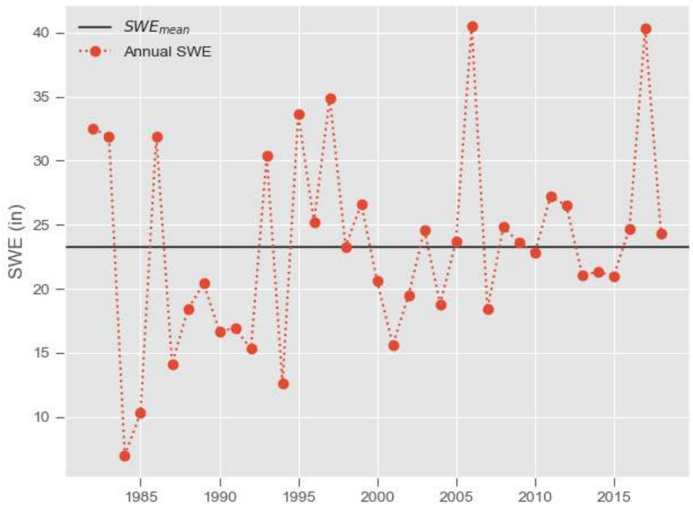


Figure 4: Galena Summit SNOTEL Station, snow water equivalent

A majority of areal recharge occurs outside of the aquifer boundary - 170,000 ac-ft/yr in tributary valleys versus 20,000 ac-ft/yr within the aquifer boundary (Bartolino, 2009) - and most of the precipitation in the catchments discharging to the tributary valleys occurs as snowfall. Average snow-water equivalent as recorded at the Galena Summit SNOTEL station (43° 52' N, 114° 43' W) is 24 inches on average, though annual depths have a large inter-annual variance. From 2016 to 2017, total snow pack increased by about 15 inches causing the overall water table rise in the Wood River Valley aquifer. Conversely, aquifer levels declined following a decrease in total snow pack in water year 2018.

The increased surface water supply during high runoff years reduces the demand for groundwater pumping, which could buffer aquifer declines through decreased groundwater withdrawals from the unconfined aquifer. There may also be more flow in the Big Wood River that does not divert into the Bypass Canal. If there is flow in the Big Wood River past the Bypass Canal, surface water will likely seep into the aquifer over the dry bed area which is typically a losing reach. The current synoptic datasets; however, do not allow for the partitioning of the effects of precipitation and groundwater pumping on water table level trends.

Long term groundwater level trends Trend analyses of five wells analyzed in Bartolino and Skinner et al. were updated to reflect data collected since 2012. Two wells not analyzed in these previous studies were added and the same approach using the non-parametric Mann-Kendall test on mean annual water levels was taken (Hirsch et al., 1982). Trends were significant at a p-value of less than 0.05 (table B.2). Locations of these wells are marked in figure 1 and the well IDs can be referenced in table B.1.

We found that five of the wells had downward trend (wells 1, 19, 40, C102, and C105; figure B.1), one well on Warm Springs Creek had an increasing trend (well 80) and one near Picabo had no significant trend (well 4). Well 80 is a geothermal well and is partially completed in granitic basement. Hydrologic connection to the upper alluvial aquifer is unlikely and we do not suspect the trend in well 80 is indicative of unconfined water levels. The trend direction is similar to prior studies.

Summary

103 wells were measured across the Wood River Valley; 97 in the confined and 6 in the unconfined. Between 2017 to 2018 and 2016 to 2017, the aquifer declined an average of 3.8 feet and rose an average of 5.5 feet, respectively. The greatest variability of aquifer levels occurs south of Bellevue and north of Gannett.

The smaller IDWR semi-annual monitoring network is able to produce contours in the upper and south-eastern extents of the valley that resemble the USGS synoptic contours. Definition in the water table is lost between Bypass Canal and Stanton crossing, suggesting the need for additional wells in the IDWR network. A dataset allowing for longer term trend analysis of the entire water table may be possible with continued semi-annual sampling and the periodic USGS synoptic measurement. Maintaining these measurements also provides valuable calibration data for updating the Wood River Valley Aquifer model.

References

Bartolino, J. R. (2009). *Ground-Water Budgets for the Wood River Valley Aquifer System, South-Central Idaho, 1995-2004*. Technical report, U. S. Geological Survey. https://pubs.usgs.gov/sir/2009/5016/.

Bartolino, J. R. (2014). Stream seepage and groundwater levels, wood river valley, south-central idaho, 2012–13. *US Geological Survey Scientific Investigations Report*, 5151(34), 2328–0328. https://pubs.usgs.gov/sir/2014/5151/.

Hirsch, R. M., Slack, J. R., & Smith, R. A. (1982). Techniques of trend analysis for monthly water quality data. *Water resources research*, 18(1), 107–121.

PyKrige (2017). Kriging toolkit for python. https://github.com/bsmurphy/PyKrige.

Skinner, K. D., Bartolino, J. R., & Tranmer, A. W. (2007). *Water-Resource Trends and Comparisons Between Partial-Development and October 2006 Hydrologic Conditions, Wood River Valley, South-Central Idaho*. US Department of the Interior, US Geological Survey. https://pubs.usgs.gov/sir/2007/5258/.

Appendices

Appendix A Water table contour maps

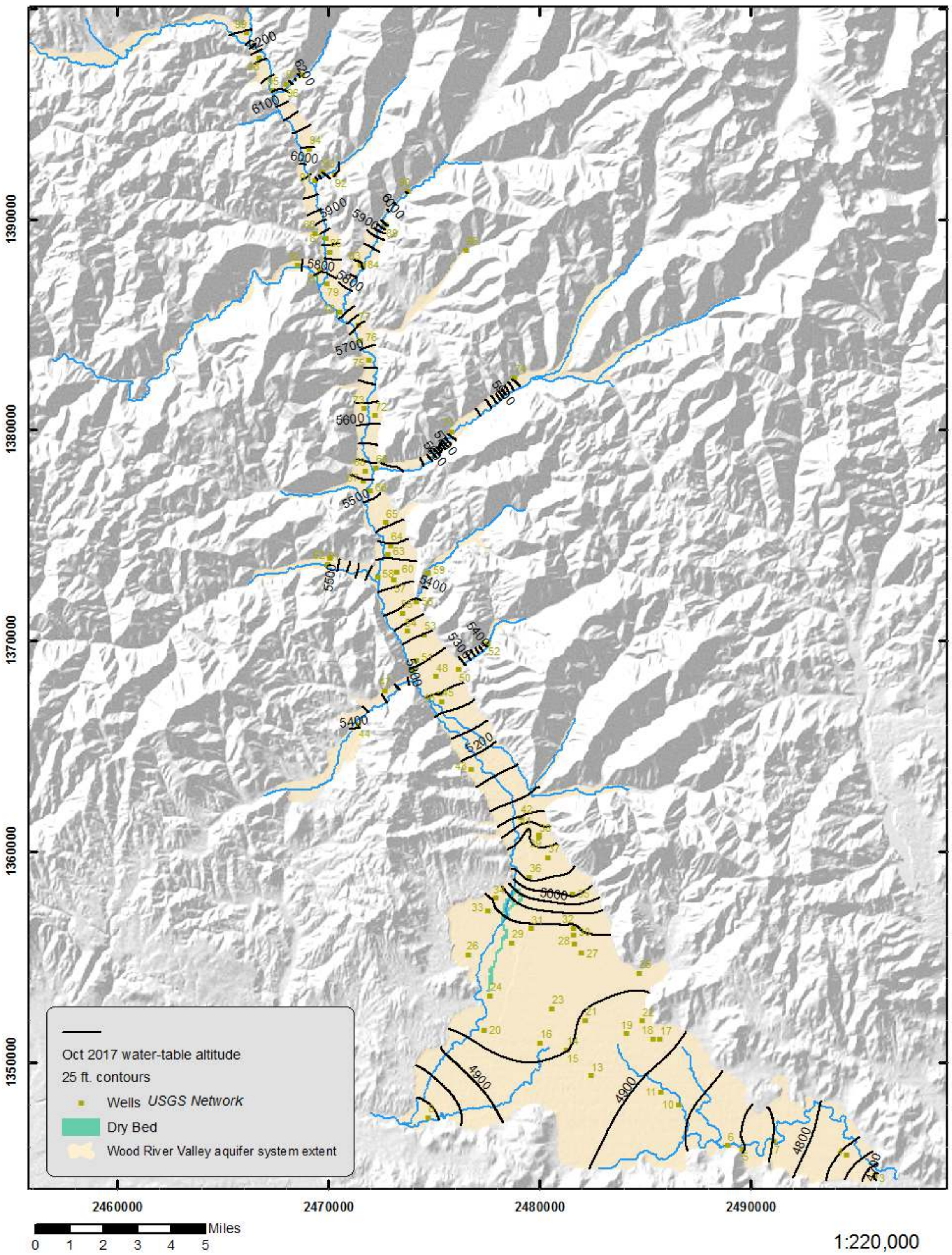


Figure A.1: Water table contours for the 2018 USGS Synoptic.

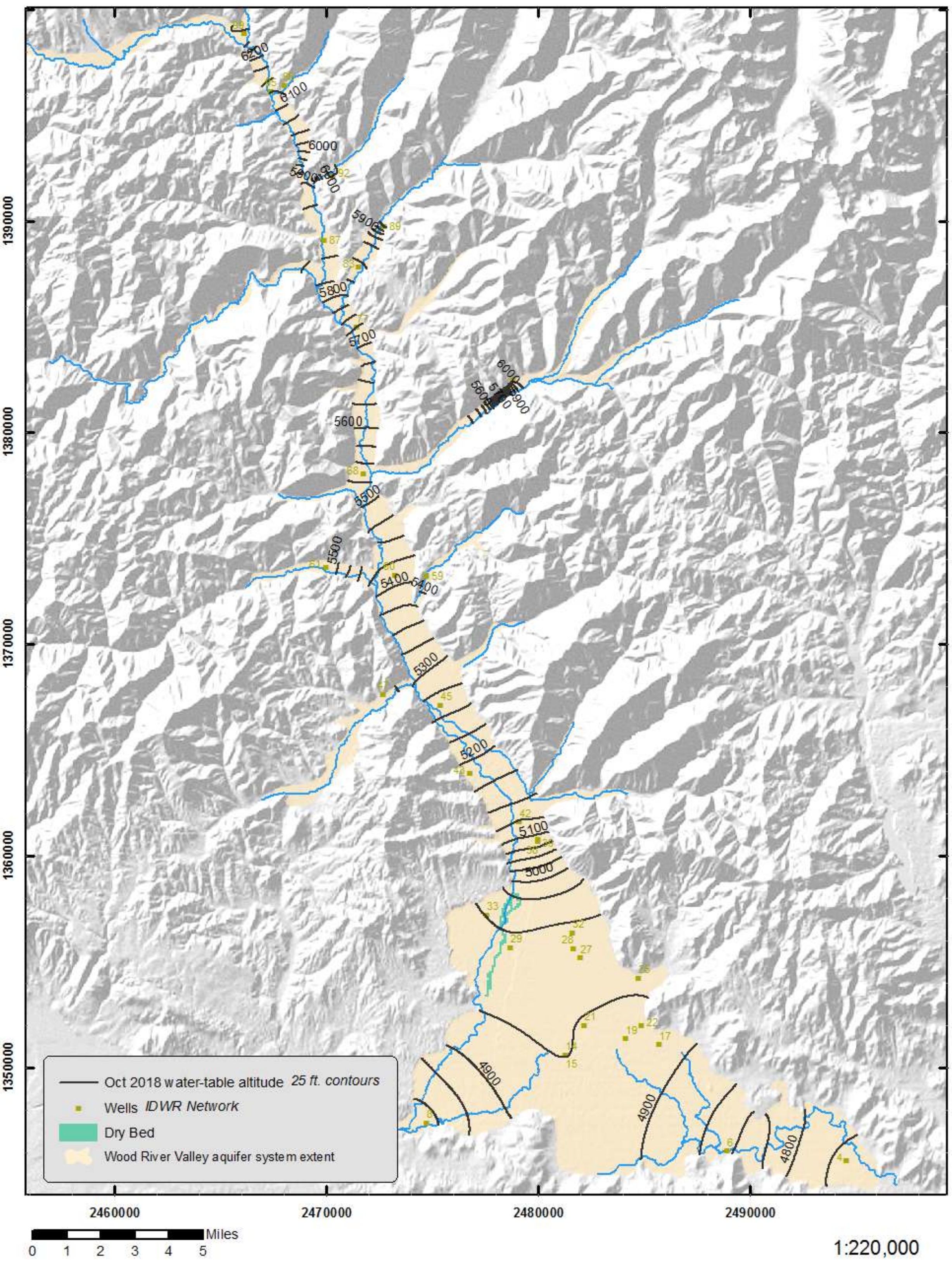


Figure A.2: Water table contours for the 2018 IDWR Fall Measurement. Detail is poor in the south western part of the valley relative to the USGS network.

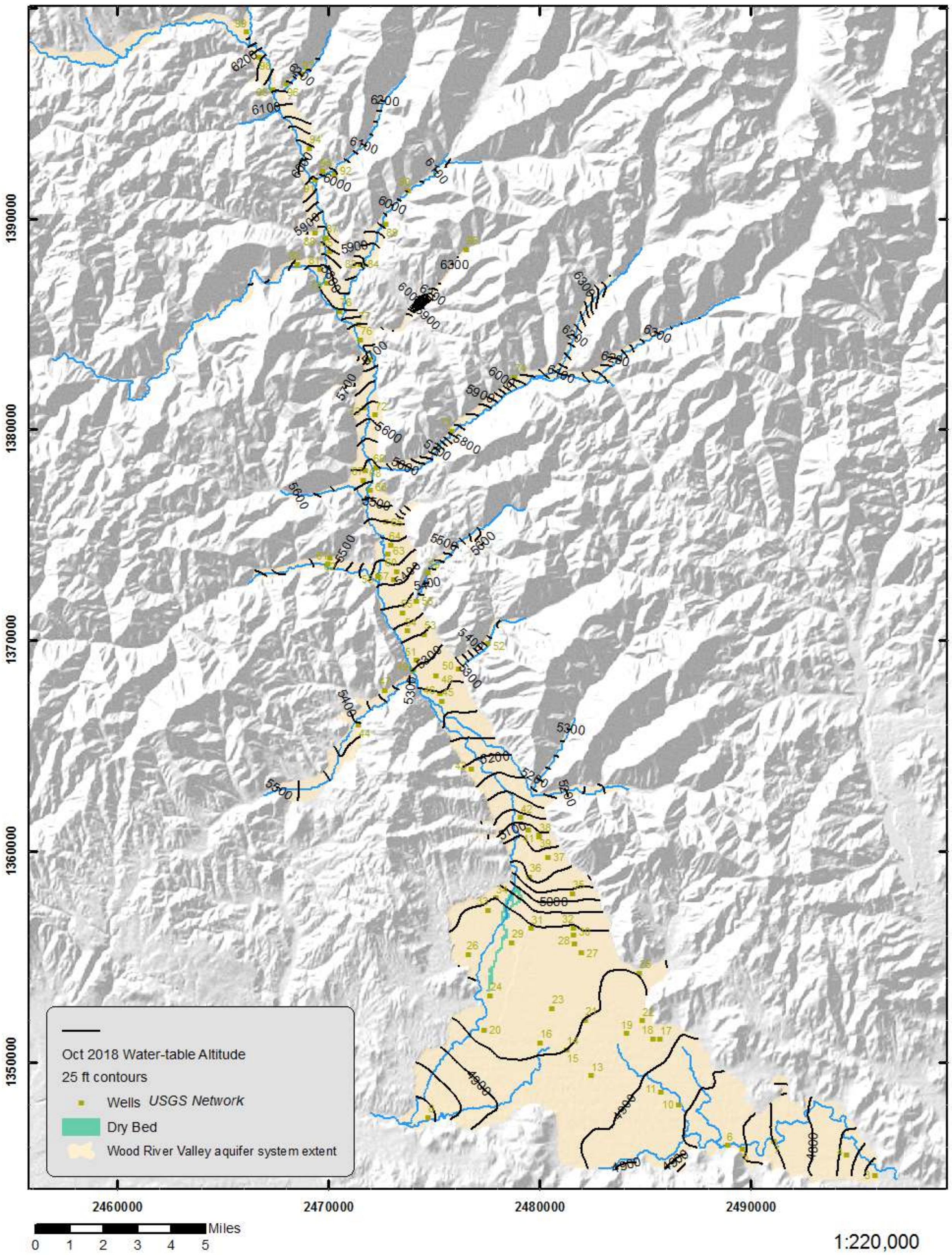


Figure A.3: Water table contours for the 2018 USGS Synoptic using the average of the altitude and DEM minus depth to water values.

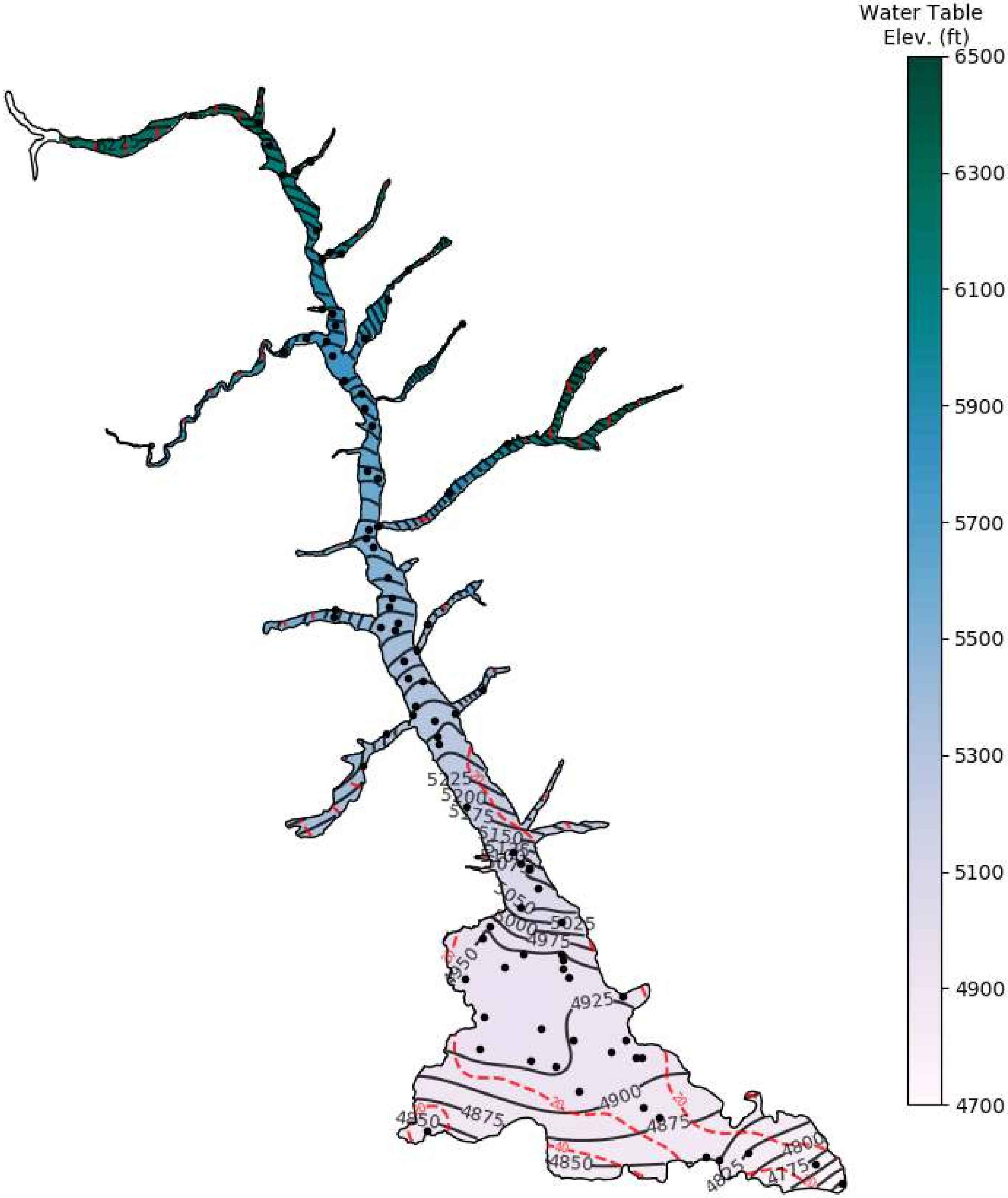


Figure A.4: Water table contours for the 2018 USGS Synoptic as estimated by ordinary kriging. The variogram model used is a power model with a parameters of scale=.0016, exponent=1.8479, and nugget=10. Black lines are the contours at an interval of 25 feet and dashed red lines represent 20 foot contours ofthe standard error of the predicted values.

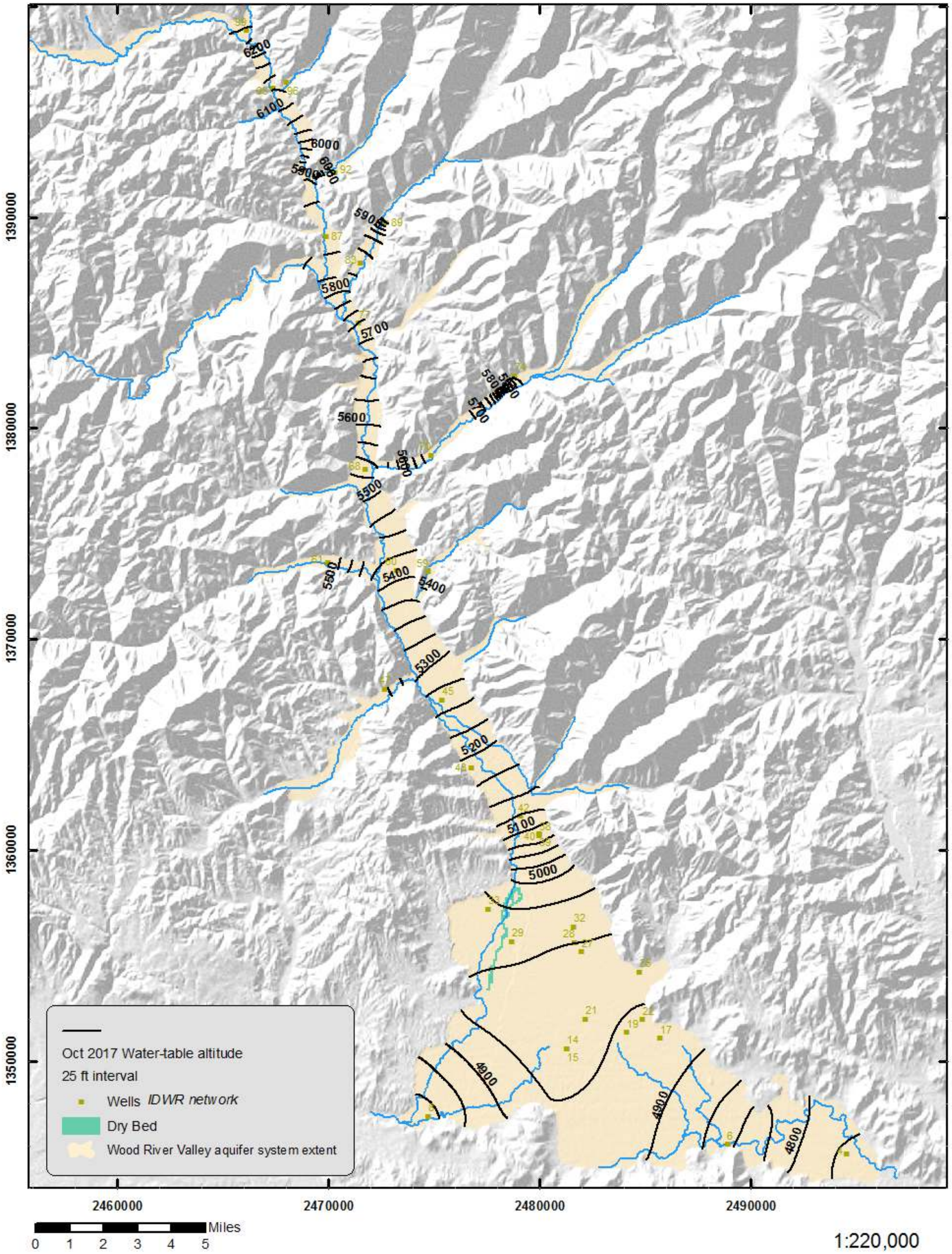


Figure A.5: Water table contours for the 2017 IDWR Fall Measurement.

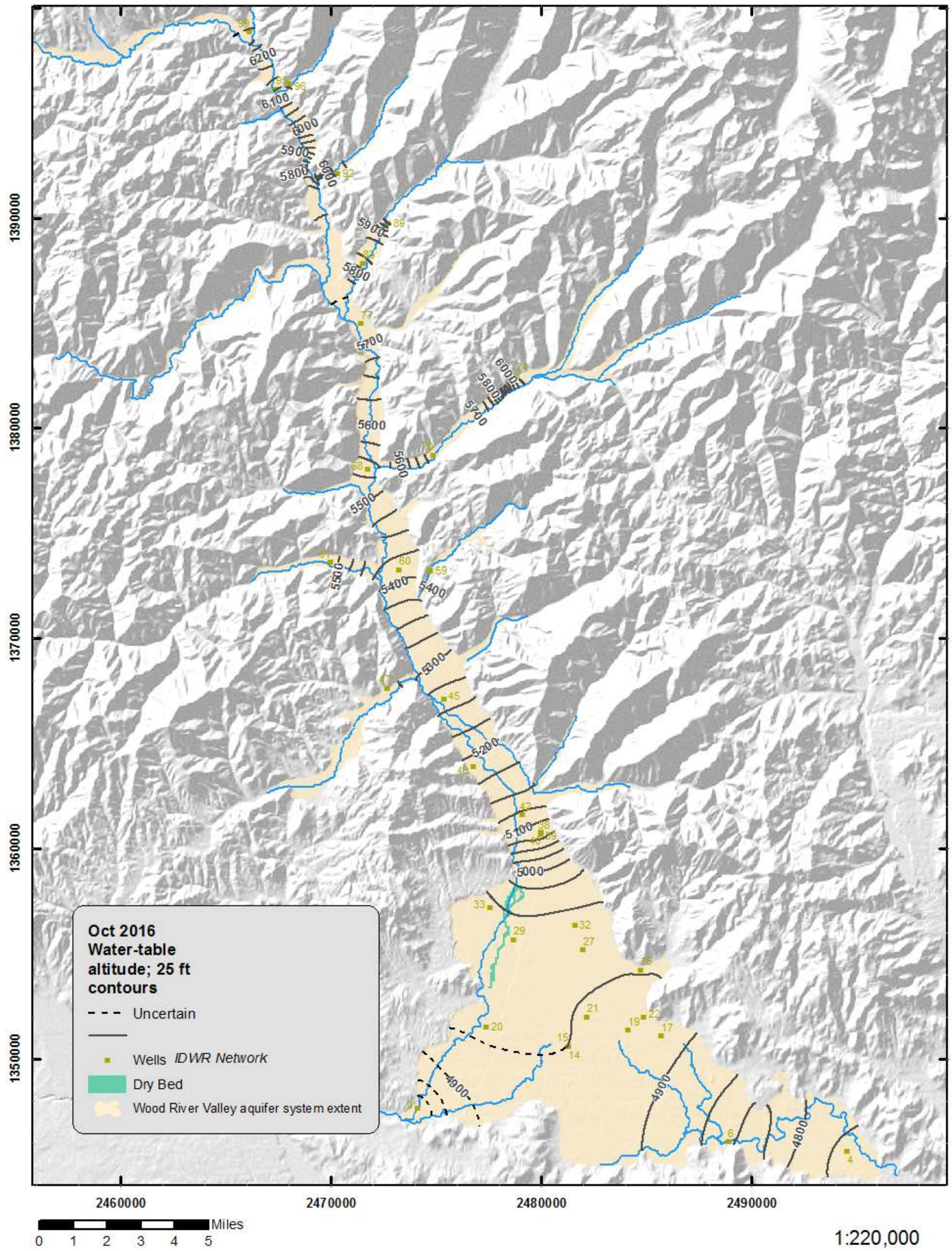


Figure A.6: Water table contours for the 2016 IDWR Fall Measurement.

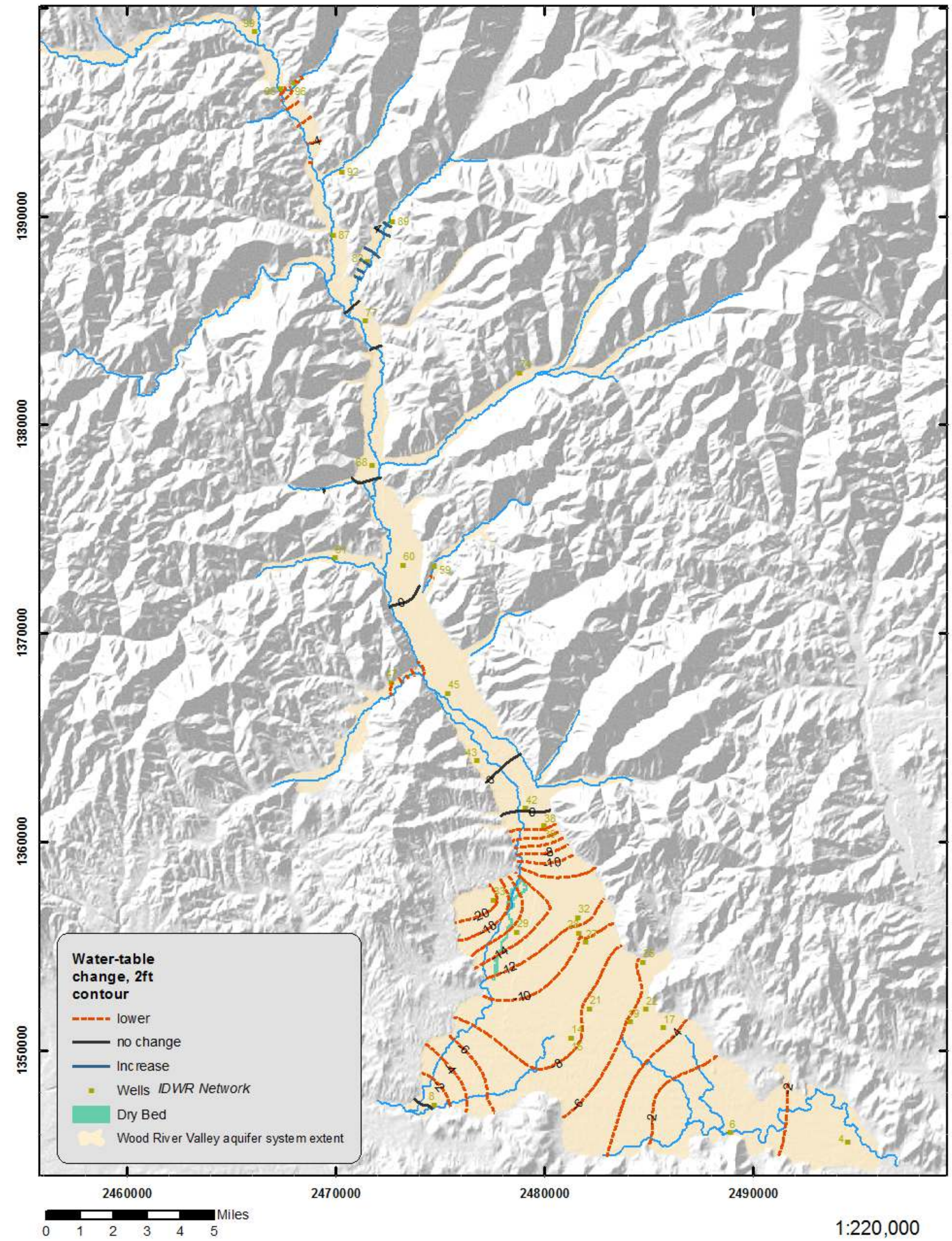


Figure A.7: Change in water level between 2018 and 2017. Blue (positive) contours indicate a increase in the water table. Contours are 2 feet.

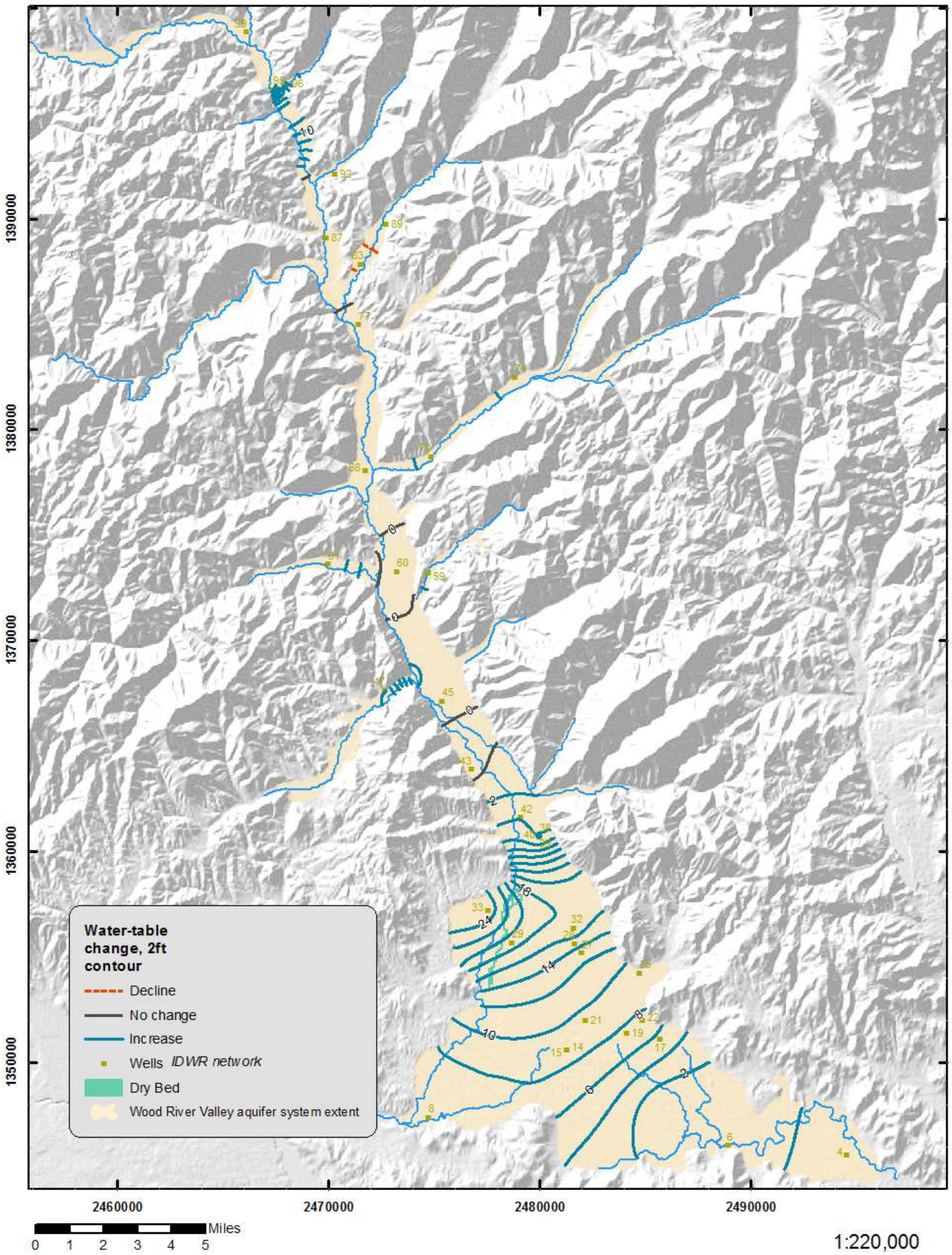


Figure A.8: Change in water level between 2017 and 2016. Blue (positive) contours indicate a increase in the water table. Contours are 2 feet.

Appendix B Groundwater Data

Table B.1: Well information and water levels for selected wells in the Wood River Valley, 2018 USGS Synoptic and 2016-2017 IDWR Fall Measurements. A "C" has been added to the well number if completed in the confined aquifer. Depth of water below land surface: A negative value indicates a water level above land surface for wells completed in the confined aquifer. NAD 83, North American Datum of 1983; NAVD 88, North American Vertical Datum of 1988. -, unknown or not measured

Well No.	USGS NWIS ID No.	Site name	Latitude NAD83 (decimal degrees)	Longitude NAD83 (decimal degrees)	Altitude NAVD88 (ft)	Well depth (ft)	2016		2017		2018	
							Depth of water below land surface (ft)	Altitude of water level (ft)	Depth of water below land surface (ft)	Altitude of water level (ft)	Depth of water below land surface (ft)	Altitude of water level (ft)
1	431642114013002	02S 20E 01ACC2	43.2796	-114.0250	4790.10	209.00	149.39	4640.71	143.76	4646.34	147.82	4642.28
2	431649114012601	02S 20E 01ACC1	43.2802	-114.0248	4789.60	250.00	-	-	142.25	4647.35	146.33	4643.27
3	431810114025901	01S 20E 26CDC1	43.3026	-114.0503	4825.10	180.00	-	-	-	-	127.58	4697.52
4	431836114040101	01S 20E 27BDA1	43.3115	-114.0667	4832.50	140.00	66.23	4766.27	63.11	4769.39	66.31	4766.19
5	431850114073601	01S 20E 30BAD1	43.3139	-114.1278	4856.80	51.00	-	-	-	-	4.91	4851.89
6	431855114081001	01S 19E 25AAA1	43.3152	-114.1361	4856.49	28.00	2.28	4854.21	1.86	4854.63	2.35	4854.14
7	431900114063001	01S 20E 20CDD1	43.3170	-114.1092	4849.50	180.00	-	-	-	-	25.66	4823.84
8	431937114184401	01S 18E 22BBD1	43.3269	-114.3117	4843.52	-	-	-	3.22	4840.30	3.47	4840.05
9	431952114164601	01S 18E 23AAB1	43.3299	-114.2798	4883.48	118.00	-21.77	4905.25	-27.90	4911.38	-21.84	4905.32
10	431958114095101	01S 19E 14DCC1	43.3327	-114.1652	4883.10	47.00	-	-	-	-	3.17	4879.93
11	432017114102801	01S 19E 14CBB1	43.3380	-114.1752	4894.60	166.20	-	-	-	-	4.07	4890.53
12	432022114125301	01S 19E 16BCC1	43.3396	-114.2154	4915.44	371.00	-0.98	4916.42	-	-	-2.82	4918.26
13	432041114125801	01S 19E 17AAA2	43.3448	-114.2162	4923.90	67.00	-	-	-	-	9.57	4914.33
14	432122114135002	01S 19E 08BBD1	43.3561	-114.2306	4938.05	35.00	16.31	4921.74	8.53	4929.52	15.23	4922.82
15	432122114135001	01S 19E 08BBD2	43.3561	-114.2306	4943.00	40.00	15.13	4927.87	5.21	4937.79	15.30	4927.70
16	432133114144302	01S 19E 07BAA2	43.3590	-114.2463	4945.30	47.00	-	-	-	-	17.25	4928.05
17	432138114103401	01S 19E 03DDD4	43.3605	-114.1760	4921.64	63.00	14.24	4907.40	8.69	4912.95	13.45	4908.19
18	432139114104501	01S 19E 03DDC3	43.3608	-114.1802	4927.00	68.00	-	-	-	-	17.23	4909.77
19	432143114114301	01S 19E 03CCB2	43.3630	-114.1956	4937.10	51.67	23.61	4913.49	16.28	4920.82	22.03	4915.07
20	432155114164701	01S 18E 02DAB1	43.3642	-114.2787	4934.81	120.00	4.04	4930.77	-	-	1.98	4932.83
21	432201114130901	01S 19E 05ADC1	43.3684	-114.2198	4962.04	80.00	40.16	4921.88	30.76	4931.28	38.34	4923.70
22	432207114110701	01S 19E 03BDD1	43.3684	-114.1862	4946.39	49.00	34.51	4911.88	27.09	4919.30	32.70	4913.69
23	432224114141901	01N 19E 31CAD1	43.3735	-114.2395	4979.50	87.00	-	-	-	-	48.86	4930.64
24	432244114163201	01N 18E 35ACB1	43.3789	-114.2756	4962.30	131.00	-	-	-	-	26.02	4936.28
25	432321114111501	01N 19E 28DAA1	43.3889	-114.1882	4998.49	174.00	72.57	4925.92	63.46	4935.03	69.02	4929.47
26	432347114171301	01N 18E 27AAA2	43.3964	-114.2881	4999.10	124.00	-	-	-	-	52.67	4946.43
27	432351114131701	01N 19E 29BAB1	43.3972	-114.2222	5021.36	130.00	87.90	4933.46	75.03	4946.33	84.93	4936.43
28	432406114133501	01N 19E 20CBC1	43.4013	-114.2264	5030.29	143.00	-	-	79.85	4950.44	90.09	4940.20
29	432410114154601	01N 18E 24CBD1	43.4017	-114.2629	5016.06	170.00	74.71	4941.35	55.95	4960.11	70.95	4945.11
30	432415114133401	01N 19E 20CBB1	43.4051	-114.2266	5040.30	200.00	-	-	-	-	91.18	4949.12
31	432428114150202	01N 18E 24ADB2	43.4078	-114.2513	5055.30	147.00	-	-	-	-	110.22	4945.08
32	432432114133301	01N 19E 20BBC1	43.4081	-114.2270	5043.97	172.00	102.64	4941.33	85.30	4958.67	98.95	4945.02
33	432456114163701	01N 18E 14DBC1	43.4154	-114.2768	5047.76	120.00	101.70	4946.06	76.63	4971.13	97.16	4950.60
34	432514114162101	01N 18E 14ACD1	43.4207	-114.2725	5061.00	132.00	-	-	-	-	109.36	4951.64
35	432521114133601	01N 19E 18ADA1	43.4225	-114.2275	5101.00	200.00	-	-	-	-	69.06	5031.94
36	432547114151001	01N 18E 12DCA2	43.4298	-114.2527	5104.90	-	-	-	-	-	47.99	5056.91
37	432616114143801	01N 19E 07BAC1	43.4382	-114.2418	5118.40	103.00	-	-	-	-	56.76	5061.64
38	432650114144701	01N 18E 01DAA2	43.4469	-114.2473	5138.41	81.00	51.02	5087.39	47.21	5091.20	48.77	5089.64
39	432653114144701	01N 19E 06CBB1	43.4476	-114.2473	5140.06	117.00	51.25	5088.81	47.18	5092.88	48.68	5091.38

Table B.1 – **Continued**

Well No.	USGS NWIS ID No.	Site name	Latitude NAD83 (decimal degrees)	Longitude NAD83 (decimal degrees)	Altitude NAVD88 (ft)	Well depth (ft)	2016		2017		2018	
							Depth of water below land surface (ft)	Altitude of water level (ft)	Depth of water below land surface (ft)	Altitude of water level (ft)	Depth of water below land surface (ft)	Altitude of water level (ft)
40	432657114144801	01N 18E 01DAA1	43.4478	-114.2470	5136.60	86.25	51.25	5085.35	47.18	5089.42	-	-
41	432659114151201	01N 18E 01ACA2	43.4498	-114.2532	5123.00	143.00	-	-	-	-	49.59	5073.41
42	432717114152601	01N 18E 01BAA1	43.4551	-114.2581	5161.90	97.00	42.62	5119.28	38.77	5123.13	38.61	5123.29
43	432832114171001	02N 18E 26CBB1	43.4756	-114.2870	5194.00	46.00	5.46	5188.54	6.05	5187.95	6.69	5187.31
44	432939114211201	02N 18E 19ACA1	43.4943	-114.3532	5421.00	98.00	-	-	-	-	22.10	5398.90
45	433017114181601	02N 18E 15CBB1	43.5046	-114.3044	5280.80	80.00	19.48	5261.32	19.13	5261.67	19.82	5260.98
46	433028114182101	02N 18E 15BCC1	43.5078	-114.3057	5301.80	-	-	-	-	-	26.98	5274.82
47	433033114201701	02N 18E 17BDA1	43.5091	-114.3379	5380.50	110.00	39.65	5340.85	25.59	5354.91	35.69	5344.81
48	433055114182201	02N 18E 09DDA1	43.5153	-114.3078	5324.00	198.00	-	-	-	-	41.55	5282.45
49	433103114191201	02N 18E 09CAC1	43.5178	-114.3212	5306.00	50.00	-	-	-	-	9.05	5296.95
50	433107114174201	02N 18E 10DBC1	43.5185	-114.2949	5351.20	174.00	-	-	-	-	65.31	5285.89
51	433117114190301	02N 18E 09BDC1	43.5220	-114.3194	5327.50	150.00	-	-	-	-	21.70	5305.80
52	-	02N 18E 02CDA1	43.5296	-114.2773	5461.27	38.00	-	-	-	-	20.46	5440.81
53	433159114185401	02N 18E 04DBB1	43.5331	-114.3151	5383.30	105.00	-	-	-	-	59.52	5323.78
54	433204114192701	02N 18E 04CBB1	43.5345	-114.3248	5360.00	37.00	-	-	-	-	21.30	5338.70
55	433232114193402	02N 18E 05AAA3	43.5423	-114.3274	5381.00	101.00	-	-	-	-	13.31	5367.69
56	433254114191001	03N 18E 33CAB1	43.5472	-114.3193	5443.90	122.00	-	-	-	-	73.47	5370.43
57	433322114195701	03N 18E 32ABA1	43.5566	-114.3330	5421.30	61.00	-	-	-	-	13.18	5408.12
58	433328114203201	03N 18E 29CCD1	43.5578	-114.3422	5420.80	49.00	-	-	-	-	9.29	5411.51
59	433334114184601	03N 18E 28DCA1	43.5594	-114.3127	5553.30	240.00	136.66	5416.64	133.58	5419.72	135.98	5417.32
60	433336114195201	03N 18E 29DDB1	43.5599	-114.3312	5433.81	-	20.75	5413.06	21.24	5412.57	20.70	5413.11
61	433348114221901	03N 17E 25DAB1	43.5629	-114.3716	5522.50	40.00	15.92	5506.58	9.96	5512.54	9.75	5512.75
62	433357114221001	03N 17E 25ADC1	43.5658	-114.3703	5520.40	95.00	-	-	-	-	8.03	5512.37
63	433359114200901	03N 18E 29BDA1	43.5673	-114.3364	5447.40	77.00	-	-	-	-	16.84	5430.56
64	433415114200201	03N 18E 20DCC1	43.5711	-114.3344	5478.80	-	-	-	-	-	31.37	5447.43
65	433451114201101	03N 18E 20BDA1	43.5811	-114.3374	5521.80	180.00	-	-	-	-	42.31	5479.49
66	433536114205701	03N 18E 18ADD1	43.5947	-114.3469	5530.70	-	-	-	-	-	21.03	5509.67
67	433556114210301	03N 18E 18AAB1	43.5989	-114.3511	5548.10	113.00	-	-	-	-	24.80	5523.30
68	433609114205801	03N 18E 07DDB1	43.6032	-114.3499	5565.30	48.00	25.06	5540.24	25.04	5540.26	25.21	5540.09
69	433616114203301	03N 18E 08CBC4	43.6044	-114.3438	5567.80	103.00	-	-	-	-	23.49	5544.31
70	433633114184101	03N 18E 09ADB1	43.6091	-114.3113	5748.00	115.00	57.17	5690.83	54.38	5693.62	-	-
71	433712114175701	03N 18E 03CAB1	43.6201	-114.2992	5828.60	380.00	-	-	-	-	15.31	5813.29
72	433734114203501	03N 18E 05BBC1	43.6268	-114.3442	5630.70	66.00	-	-	-	-	23.72	5606.98
73	433748114205701	04N 18E 31DDC1	43.6296	-114.3504	5626.90	35.00	-	-	-	-	7.10	5619.80
74	433838114155501	04N 18E 25CCC1	43.6430	-114.2626	6071.77	45.00	33.60	6038.17	32.81	6038.96	33.53	6038.24
75	433914114205401	04N 18E 30ADB3	43.6505	-114.3477	5691.80	37.00	-	-	-	-	6.65	5685.15
76	433936114210701	04N 18E 19DCDC1	43.6587	-114.3528	5722.00	55.50	-	-	-	-	13.47	5708.53
77	433955114211301	04N 18E 19DBB1	43.6653	-114.3543	5754.90	-	31.34	5723.56	30.36	5724.54	30.23	5724.67
78	434015114215201	04N 18E 19BBC1	43.6710	-114.3654	5790.50	48.50	-	-	-	-	7.76	5782.74
79	434059114222001	04N 17E 13ACA1	43.6829	-114.3731	5802.80	91.00	-	-	-	-	14.16	5788.64
80 [1]	434104114241301	04N 17E 14BBC1	43.6844	-114.4045	5904.00	50.00	20.06	5883.94	15.93	5888.07	16.61	5887.39

[1]Geothermal well open to bedrock aquifer. Not used in interpolation

Table B.1 – **Continued**

Well No.	USGS NWIS ID No.	Site name	Latitude NAD83 (decimal degrees)	Longitude NAD83 (decimal degrees)	Altitude NAVD88 (ft)	Well depth (ft)	2016		2017		2018	
							Depth of water below land surface (ft)	Altitude of water level (ft)	Depth of water below land surface (ft)	Altitude of water level (ft)	Depth of water below land surface (ft)	Altitude of water level (ft)
81	434122114223701	04N 17E 12CDD1	43.6891	-114.3772	5855.80	110.00	-	-	-	-	52.94	5802.86
82	434127114232301	04N 17E 11DAC1	43.6908	-114.3902	5876.60	80.00	-	-	-	-	48.93	5827.67
83	434129114210701	04N 18E 07DCA3	43.6910	-114.3530	5892.00	161.00	51.63	5840.37	53.86	5838.14	47.64	5844.36
84	434128114210202	04N 18E 07DCA2	43.6910	-114.3516	5871.30	54.00	-	-	-	-	9.05	5862.25
85	434150114221201	04N 17E 12ADB1	43.6966	-114.3713	5854.20	42.00	-	-	-	-	13.01	5841.19
86	434152114172701	04N 18E 10AAC1	43.6977	-114.2909	6380.00	80.00	-	-	-	-	13.50	6366.50
87	434212114222001	04N 17E 01DCD1	43.7024	-114.3735	5869.00	-	-	-	5.35	5863.65	5.45	5863.55
88	434216114224801	04N 17E 01CCA1	43.7043	-114.3801	5929.80	280.00	-	-	-	-	52.47	5877.33
89	434230114201801	04N 18E 05CAA1	43.7083	-114.3383	6013.60	-	36.64	5976.96	37.13	5976.47	36.60	5977.00
90	434321114193001	05N 18E 33CBB1	43.7226	-114.3253	6066.50	47.00	-	-	-	-	13.89	6052.61
91	434338114224801	05N 17E 36BDB1	43.7272	-114.3799	5969.00	-	-	-	-	-	2.79	5966.21
92	434346114220601	05N 17E 36AAA1	43.7295	-114.3682	6074.10	-	49.25	6024.85	49.59	6024.51	49.65	6024.45
93	434350114223201	05N 17E 36ABB1	43.7306	-114.3756	6064.40	480.00	-	-	-	-	37.36	6027.04
94	434426114225801	05N 17E 25BCA1	43.7405	-114.3837	6043.70	60.00	-	-	-	-	21.09	6022.61
95	434554114241701	05N 17E 14CBC1	43.7655	-114.4053	6132.70	39.00	7.01	6125.69	5.52	6127.18	6.39	6126.31
96	434605114234901	05N 17E 14ADD1	43.7680	-114.3969	6195.00	190.00	59.80	6135.20	47.51	6147.49	53.40	6141.60
97	434620114231601	05N 17E 14AAA1	43.7722	-114.3879	6269.90	160.00	-	-	-	-	56.03	6213.87
98	434646114244901	05N 17E 10DBD1	43.7794	-114.4135	6204.20	-	-	-	-	-	24.67	6179.53
99	434724114251601	05N 17E 03CDC1	43.7900	-114.4210	6283.42	20.00	10.85	6272.57	10.67	6272.75	11.21	6272.21
C100	431852114093501	01S 19E 26AAC1	43.3143	-114.1606	4867.20	267.00	1.32	4865.88	0.73	4866.47	1.25	4865.95
C101	431948114114401	01S 19E 21AAA1	43.3299	-114.1966	4892.60	192.00	-	-	-	-	-9.09	4901.69
C102	431950114102901	01S 19E 22AAA1	43.3305	-114.1756	4889.50	150.00	-4.49	4893.99	-4.96	4894.46	-3.42	4892.92
C103	431954114181001	01S 18E 15DCC2	43.3306	-114.3033	4858.10	72.00	-4.11	4862.21	-	-	-	-
C104	431955114162901	01S 18E 13CCC1	43.3314	-114.2756	4885.10	126.00	-	-	-	-	-31.85	4916.95
C105	432042114163801	01S 18E 14AAB1	43.3448	-114.2779	4907.10	126.00	-17.70	4924.80	-25.67	4932.77	-18.72	4925.82
C106	432108114143301	01S 19E 07DBB2	43.3522	-114.2434	4933.90	250.00	-	-	-	-	7.26	4926.64

Table B.2: Results of trend testing water year mean water levels with the Mann-Kendall test. Datasets are presented in figure B.1

Well No.	Site Name	trend	p-value
1	02S 20E 01ACC2	decreasing	2.09e-07
4	01S 20E 27BDA1	no trend	9.00e-3
19	01S 19E 03CCB2	decreasing	3.92e-12
40	01N 18E 01DAA1	decreasing	2.13e-12
80	04N 17E 14BBC1	increasing	1.00e-3
C102	01S 19E 22AAA1	decreasing	5.28e-06
C105	01S 18E 14AAB1	decreasing	7.32e-12

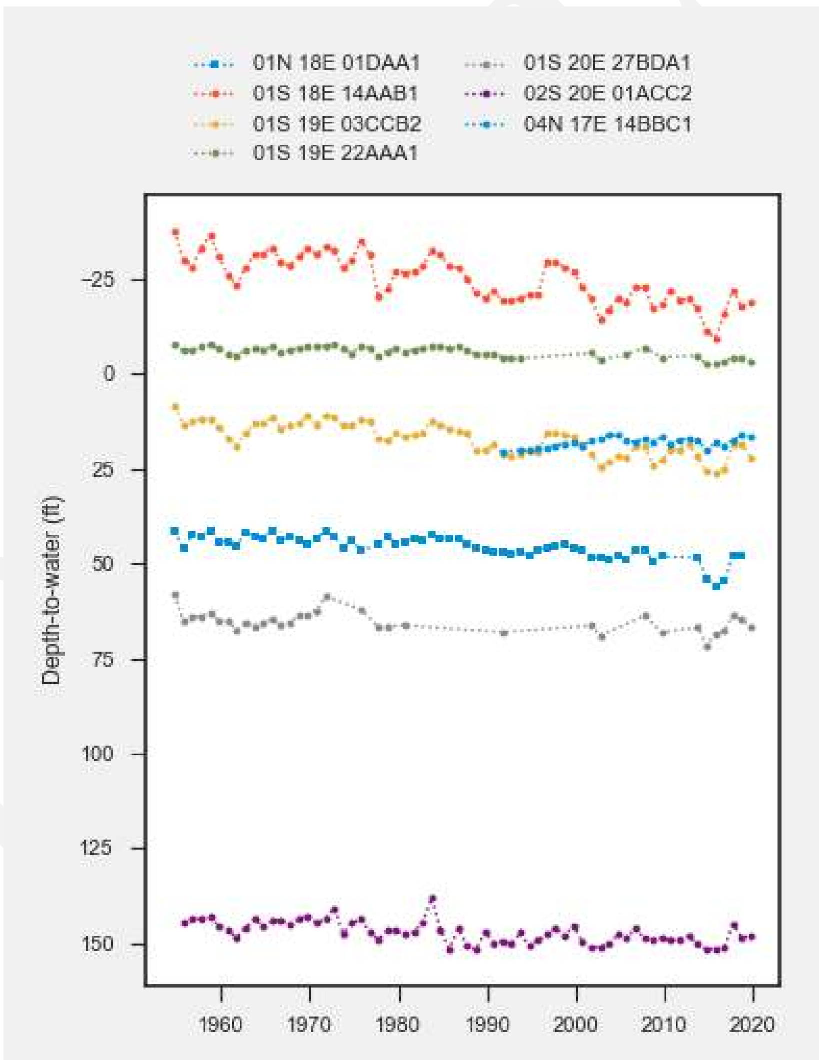


Figure B.1: Hydrographs for selected wells. Wells were analyzed for trends using the Mann-Kendall test on water year means.