Ground Water Conditions in the Bear River Ground Water Management Area

IDAHO DEPARTMENT OF
WATER RESOURCES

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The Idaho Department of Water Resources designates Critical Ground Water Areas (CGWAs) and Ground Water Management Areas (GWMAs) under Idaho Code §42-233a and §42-233b, respectively. A CGWA is all or part of a groundwater basin that does not have sufficient ground water to provide a reasonably-safe supply for irrigation or other uses at the current or projected rates of withdrawal. A GWMA is all or part of a groundwater basin that may be approaching the conditions of a CGWA. The Bear River GWMA was designated on August 12, 2001, based on local concerns regarding declining water levels. This report describes the status of the ground water monitoring efforts and the trends of aquifer levels in the Bear River GWMA located in Bear Lake, Caribou, and Franklin Counties.

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Introduction

The Idaho Department of Water Resources (IDWR) maintains a ground water level monitoring network in the Bear River GWMA, located in Bear Lake, Caribou, and Franklin Counties in southeastern Idaho (Figure 1). The monitoring network currently consists of 11 actively monitored wells, and 22 wells with historic data.

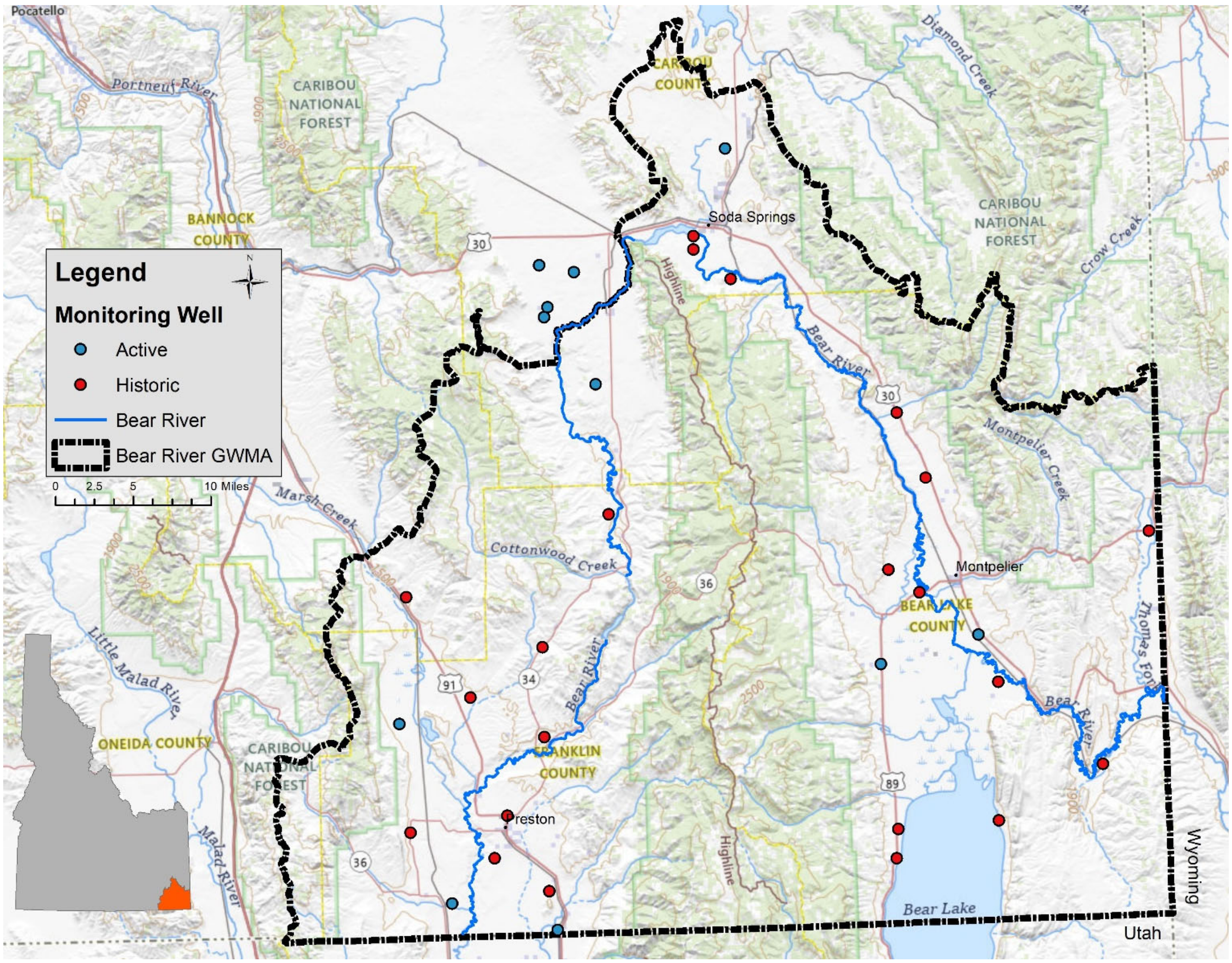

Figure 1. Map of Bear River Ground Water Management Area.

Hydrogeologic Setting

The geology and hydrogeology of the Bear River Basin has been described in previous studies (Mansfield, 1927, Dion, 1969, Seitz and Norvitch, 1979, Rehis and others, 2009). In general, the primary aquifers of the region are comprised of alluvial deposits within the Bear River Valley and its tributaries, basalt flows and metasedimentary rocks in the northern portion of the study area, and indurated sediments and volcanics in the southwestern portion of the study area (Graham and Campbell, 1981, Figure 2).

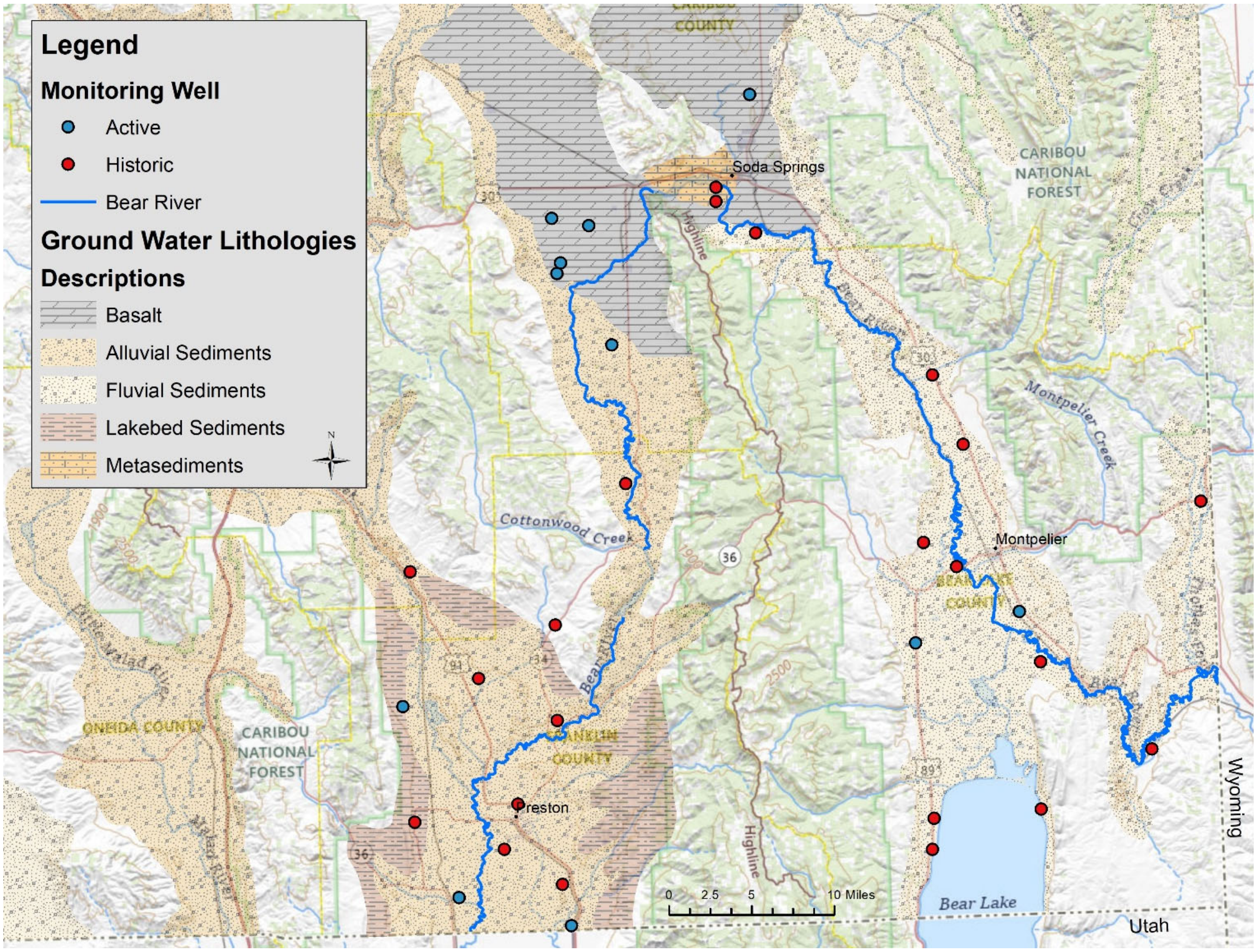

Figure 2. Generalized hydrogeologic map of the Bear River aquifer system.

Ground water flow generally coincides with the direction of the Bear River (Figure 3). Originating along the Thomas Fork near the Wyoming border and from Bear Lake, ground water flows west, then north through the sedimentary deposits that form the valley floor. Near Soda Springs, the aquifer transitions from alluvial sediments into basalt areas where the groundwater begins to flow to the west. West of Soda Springs, the aquifer transitions back into alluvial sediments and ground water follows the course of the Bear River south to where it discharges into Utah.

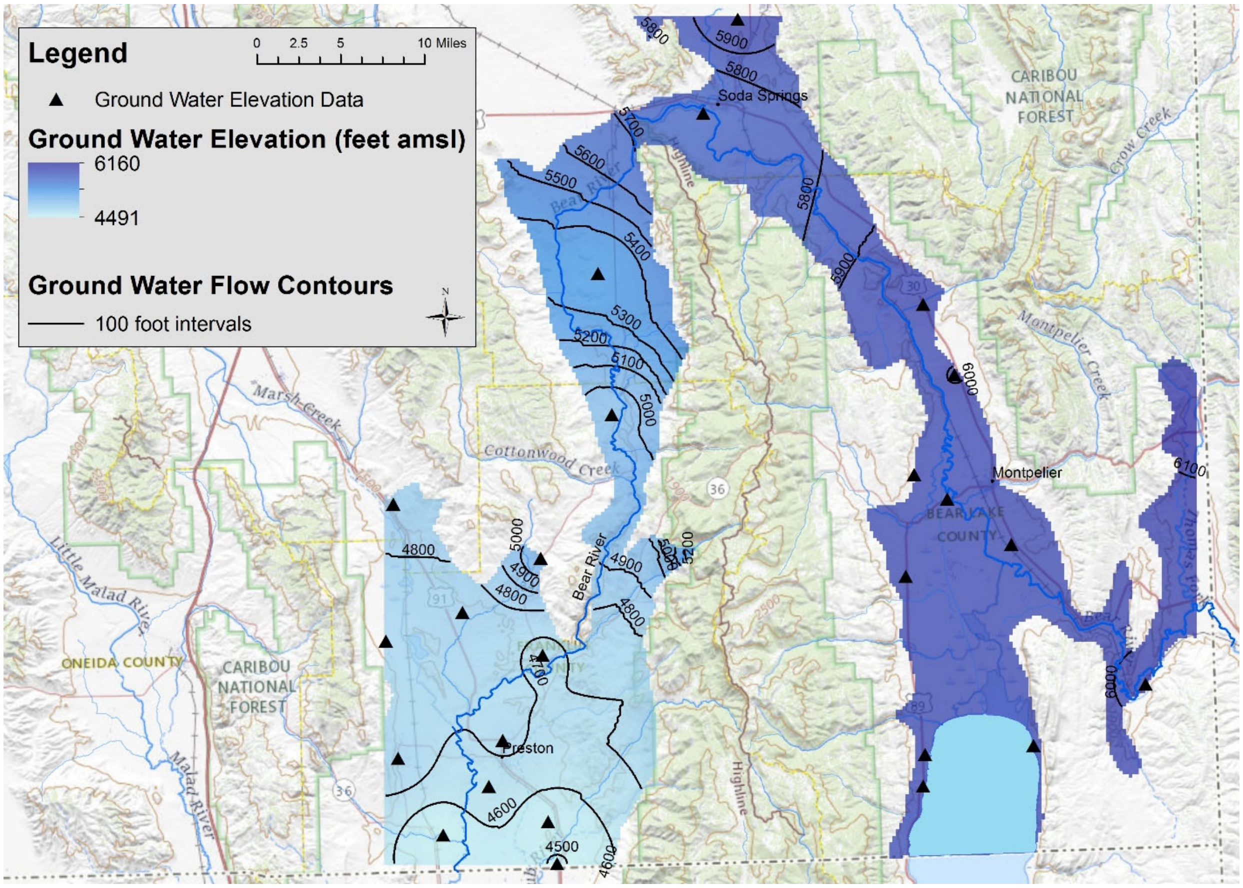

Figure 3. Ground water flow conditions of the Bear River aquifer system (figure based on 1967-1968 water level data).

The mountainous regions that surround the river valleys have not been extensively developed with respect to ground water use, although numerous springs have been mapped in such areas (Mansfield, 1927). The major sources of recharge are percolation of precipitation and snowmelt, leakage from surface streams, leakage from Bear Lake and associated swamps, and incidental leakage from irrigation practices.

Precipitation

Precipitation in the Bear River Basin averages around 30 inches per year (NRCS, 2023), occurring primarily in the form of winter snow. Annual valley snow accumulation is approximately two feet and the mountainous terrain averages over 30 inches. The Palmer Drought Severity Index (PDSI) is a measure of long-term regional drought conditions. The PDSI values usually range from -4 to 4, with -4 and lower indicating extreme drought conditions, and 4 and higher indicating extremely wet conditions. The PDSI for the eastern highlands indicates that drought conditions have existed 28% of the time between 1960 and 2003, (Figure 4, Table 1).

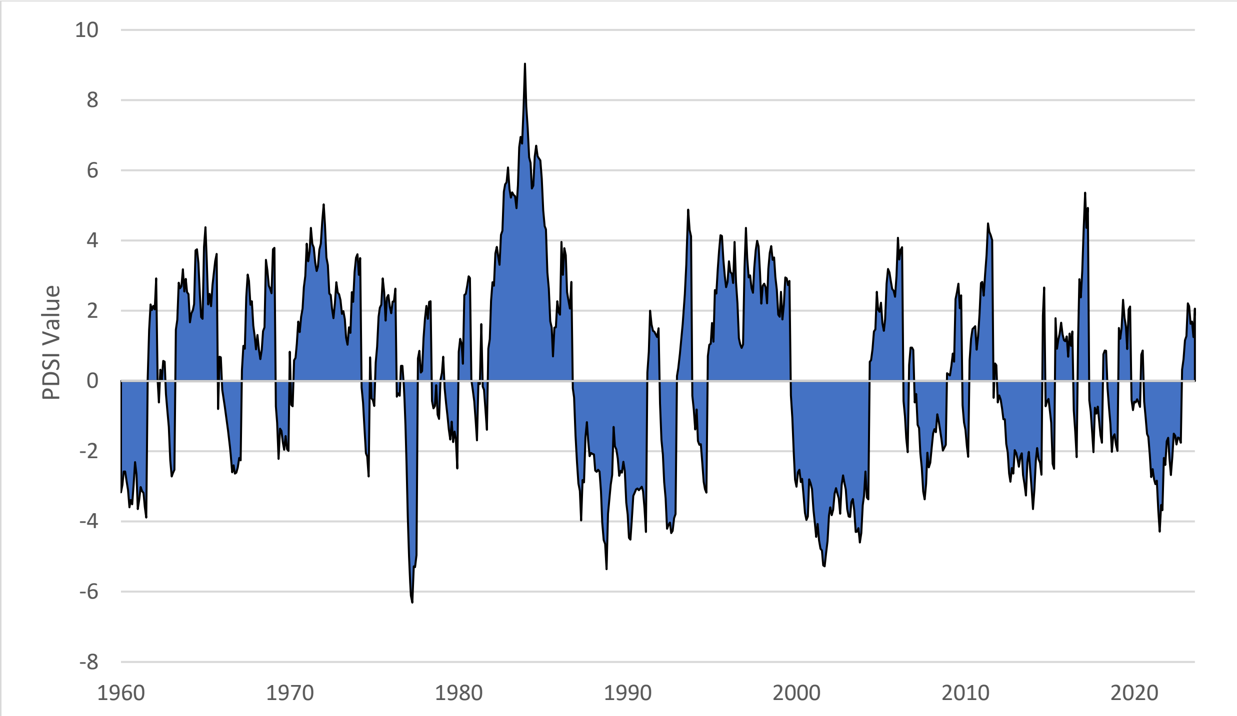

Figure 4. Palmer Drought Severity Index (PDSI) for the eastern highlands of the Bear River basin.

Similarly, drought conditions existed 28% of the time between 2003 and 2023. Near normal condition (PDSI values <2 and >-2) is the most prominent condition indicated, occurring 41% of the time between 1960 and 2023 and 55% of the time in the past 20 years.

Table 1. PDSI conditions since 1960.

PDSI Condition	PDSI Value	1960-2023	2003-2023
Extreme Drought	x ≤ -4	4.45%	2.42%
Severe Drought	-4 < x ≤ -3	9.29%	7.66%
Moderate Drought	-3 < x ≤ -2	13.74%	17.74%
Near Normal	-2 > x < 2	41.23%	54.84%
Unusually Moist	2 ≥ x < 3	15.58%	10.48%
Very Moist	3 ≥ x < 4	9.03%	3.23%
Extremely Moist	x ≥ 4	6.81%	3.63%

Water Level Analysis

Water level data in the Bear River Aquifer system are limited with respect to how many long records of historic water levels exist. Thirty-three wells with a minimum of five or more measurements exist in the IDWR ground water level database (IDWR, 2023). Eleven wells are currently being monitored and have data current through 2023 (Table 2).

Hydrographs for active monitoring wells are presented in Figures 4 and 5, and hydrographs for the inactive monitoring wells are in Appendix A. Due to the short duration or minimal number of measurements available, analysis of water level data for many of the wells can not be performed with any statistical confidence. In addition, the lack of spatial density and distribution of the current datasets limits the ability to map the water level data. Therefore, simple metrics (water level differences, linear trends, and seasonal fluctuations) for the period of record of each well were calculated. Twenty-four of the 33 wells have declining water levels based on a linear trendline applied to the period of record (Table 3).

Table 2. Summary of Bear River aquifer monitoring wells with five or more measurements.

Well Number	**Monitoring Status**	**Period of Record**	**Total Depth (feet)**	**Completion Date**	**Altitude (feet amsl)**	**XIDTM (meter)**	**YIDTM (meter)**	**Water Use**
08S 42E 17CAB1	Active	1967-2023	119	8/9/1967	6096	2698219.08	1283643.20	Stock
09S 40E 20CBC1	Active	1978-2023	525	7/5/1977	5564	2678946.76	1271567.93	Irrigation
09S 40E 27BCD1	Active	1980-2023	370	10/12/1974	5610	2682544.75	1270850.49	Irrigation
09S 41E 13BBB1	Inactive	1967-2000	77	11/1/1966	5740	2694918.77	1274596.10	Domestic
09S 41E 13CCC1	Inactive	1976-2010	138	4/23/1974	5810	2694923.65	1273207.02	Domestic
09S 42E 29CDC1	Inactive	1976-2007	100	9/2/1966	5850	2698803.99	1270141.34	Domestic
10S 40E 05BDD1	Active	1980-2023	208	2/21/1959	5500	2679816.75	1267215.61	Irrigation
10S 40E 08BBA1	Active	1967-2023	300	1/1/1960	5477	2679450.94	1266172.20	Irrigation
10S 40E 35BDD1	Active	1967-2023	90	*unknown*	5378	2684806.02	1259234.32	Irrigation
11S 43E 12DDB1	Inactive	1967-1971	*unknown*	*unknown*	6000	2716029.07	1256295.55	Irrigation
12S 40E 12CCB2	Inactive	1969-2009	103	4/16/1969	4960	2686132.06	1245711.77	Domestic
12S 43E 35DDC1	Inactive	1967-1977	224	1/1/1962	5980	2715160.07	1239966.37	Irrigation
12S 44E 05BAA1	Inactive	1967-1977	320	11/1/1953	6050	2719007.14	1249533.86	Irrigation
12S 46E 22DDC1	Inactive	1984-2010	60	4/24/1984	6170	2742164.93	1244018.63	Domestic
13S 38E 03DDB1	Inactive	1967-1978	400	1/1/1961	4853	2665161.03	1237127.29	Irrigation
13S 40E 30ACB1	Inactive	1967-1978	290	1/1/1963	5082	2679295.67	1231932.64	Irrigation
13S 43E 35CCD1	Active	1967-2023	500	1/1/1948	5955	2714359.16	1230185.46	Industrial
13S 44E 07ADC1	Inactive	1968-1971	*unknown*	*unknown*	5925	2718348.92	1237625.89	Stock
13S 44E 26BAD1	Active	1967-2023	170	1/1/1961	5968	2724486.86	1233263.65	Irrigation
14S 38E 15CDC1	Active	1967-2023	200	1/1/1937	4795	2664437.46	1223994.29	Irrigation
14S 39E 08ADA1	Inactive	1967-1978	206	9/1/1961	4870	2671806.07	1226731.93	Irrigation
14S 40E 30ABB1	Inactive	1967-1968	165	1/1/1962	4740	2679481.35	1222633.57	Domestic
14S 44E 12ACA1	Inactive	1991-2009	40	12/24/1980	5955	2726528	1228370.66	Domestic
15S 38E 22DDC1	Inactive	1967-1978	170	7/1/1966	4792	2665619.99	1212727.09	Irrigation
15S 39E 23BBB1	Inactive	1967-1984	11	1/1/1953	4725	2675644.23	1214481.55	Irrigation
15S 39E 34CBD1	Inactive	1967-1970	11	1/1/1940	4655	2674328.26	1210066.48	Stock
15S 43E 26DAA1	Inactive	1967-1978	*unknown*	1/1/1918	5948	2716190.27	1213106.61	Domestic
15S 44E 25BDA1	Inactive	1967-1968	303	1/1/1962	5975	2726603.81	1213988.96	Unused
15S 46E 06CCA1	Inactive	1967-2010	38	9/29/1964	6030	2737379.91	1219859.56	Stock
16S 39E 18CDA1	Active	1967-2023	462	3/1/1961	4543	2669936	1205381.88	Irrigation
16S 40E 18ABD1	Inactive	1967-1968	91	1/1/1960	4556	2680003.08	1206659.44	Unused
16S 40E 29CCB1	Active	1967-2023	84	1/1/1950	4505	2680865.09	1202638.32	Unused
16S 43E 02DDB1	Inactive	1967-2009	95	1/1/1967	5955	2716009.99	1210083.17	Domestic

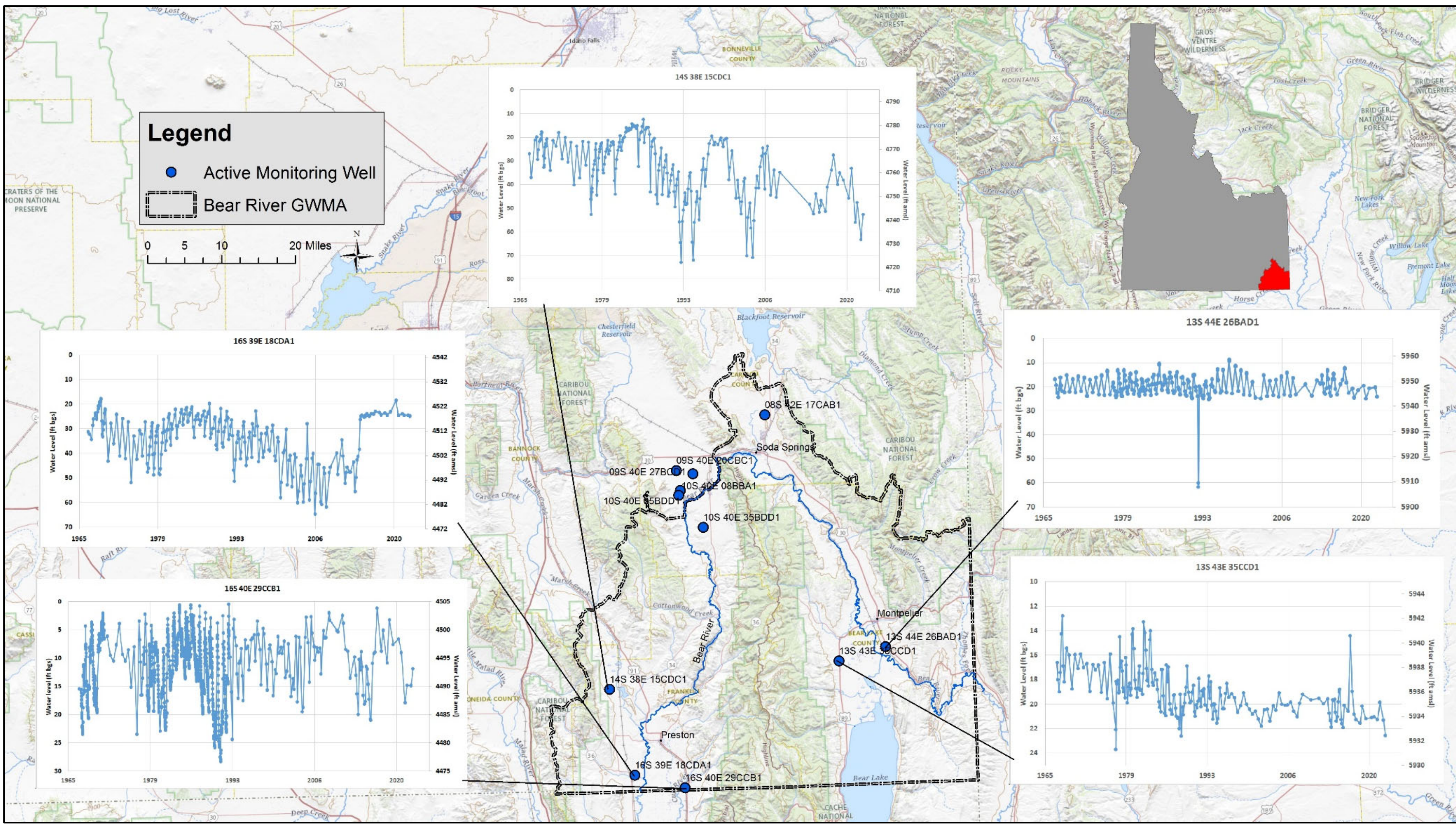

Figure 5. Hydrographs for the active monitoring wells in the southern portion of the Bear River GWMA.

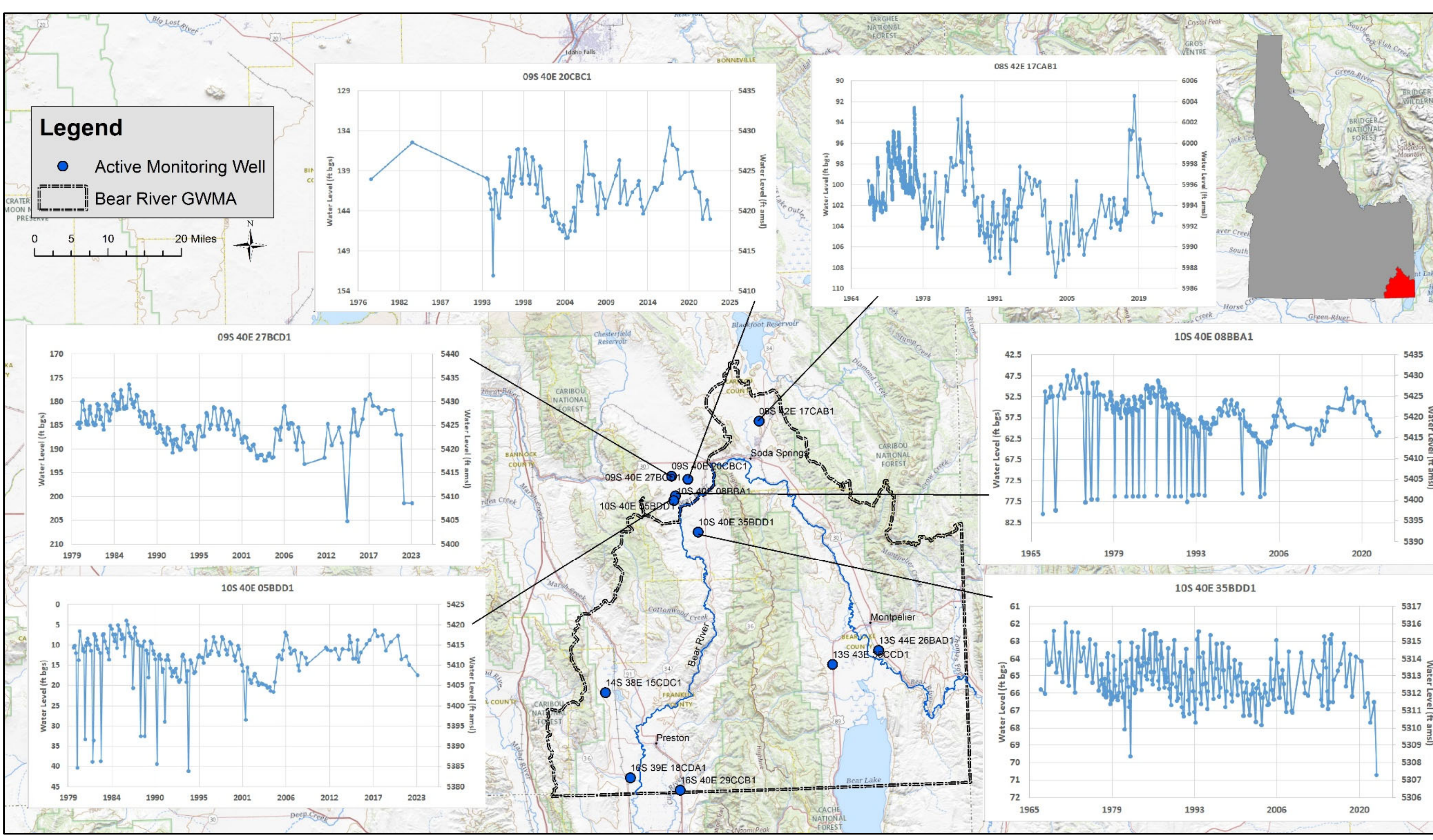

Figure 6. Hydrographs for the active monitoring wells in the northern portion of the Bear River GWMA.

Table 3. Bear River valley monitoring well water level changes for period of records.

Station Name	Period of Record	Number of Water Level Measurements	Period of Record Water Level Change (feet)*
08S 42E 17CAB1	1967-2023	685	-3.21
09S 40E 20CBC1	1978-2023	93	-5.01
09S 40E 27BCD1	1980-2023	175	-16.65
09S 41E 13BBB1	1967-2000	5	-0.11
09S 41E 13CCC1	1976-2010	15	-5.31
09S 42E 29CDC1	1976-2007	5	-3.29
10S 40E 05BDD1	1980-2023	178	-6.88
10S 40E 08BBA1	1968-2023	211	-9.73
10S 40E 35BDD1	1967-2023	222	-4.93
11S 43E 12DDB1	1967-1971	15	3.26
12S 40E 12CCB2	1969-2009	12	-0.40
12S 43E 35DDC1	1967-1977	5	3.74
12S 44E 05BAA1	1967-1977	153	-0.26
12S 46E 22DDC1	1984-2010	5	-5.04
13S 38E 03DDB1	1967-1978	10	2.00
13S 40E 30ACB1	1967-1978	23	9.43
13S 43E 35CCD1	1967-2023	203	-5.97
13S 44E 07ADC1	1968-1971	10	-0.16
13S 44E 26BAD1	1967-2023	198	-7.16
14S 38E 15CDC1	1967-2023	222	-25.67
14S 39E 08ADA1	1967-1978	24	12.31
14S 40E 30ABB1	1967-1968	8	-2.10
14S 44E 12ACA1	1991-2009	12	0.46
15S 38E 22DDC1	1967-1978	23	-6.10
15S 39E 23BBB1	1968-1984	91	-3.09
15S 39E 34CBD1	1967-1970	24	-0.39
15S 43E 26DAA1	1967-1978	12	-0.15
15S 44E 25BDA1	1967-1968	9	-0.69
15S 46E 06CCA1	1967-2010	16	2.16
16S 39E 18CDA1	1967-2023	245	6.52
16S 40E 18ABD1	1967-1968	5	-1.30
16S 40E 29CCB1	1967-2023	1291	3.56
16S 43E 02DDB1	1967-2009	8	-4.20

**Negative (-) values indicate water levels are lower than the original measurement*

Mann-Kendall Analysis

The Mann-Kendall test is a nonparametric test for trends that is commonly used to evaluate environmental data. The USGS KENDALL program by Helsel and others (2005), was used to perform Regional Kendall tests and Seasonal Kendall tests on the datasets of the active monitoring wells (these are the only wells with sufficient datasets to conduct such tests) to test for a consistent trend.

The Regional Mann-Kendall incorporates numerous wells in one analysis to determine the presence or absence of a long-term rising or falling trend. Tests were conducted on spring, fall, and the complete records for the 11 active monitoring wells, beginning in 1974. Data in Table 4 shows the results of the Regional Mann-Kendall analysis where:

Wells = number of wells included in the analysis.
Tau = a measure of correlation where 1.0 is perfectly correlated.
S = if S is positive, water levels are declining with time, if S is negative (-) water levels are rising with time.
z = if z is positive, the water levels are declining with time, if z is negative (-) the water levels are rising over time.
p-value = if less than 0.05, the data supports the trend at a 95% confidence interval.

Since the S and z statistics are positive and the p-value is less than 0.05 for all three datasets presented in Table 3, the trend since 1974 indicates declining water levels at a 95% confidence interval.

Table 4. Regional Kendall analysis for active monitoring wells in the Bear River aquifer.

Kendall Statistics	Spring	Fall	Annual
Wells	11	11	11
Tau	0.218	0.157	0.2
S	2001	1024	2365
z	6.602	4.311	6.507
p-value	0	0	0
Trend	0.05	0.046	0.052

The Seasonal Kendall test performs the Mann-Kendall trend test for individual seasons of the year, to account for serial correlation in the time series that could potentially skew the results. The Seasonal Kendall test was performed on the 11 datasets for the active monitoring wells. The p-value is significant in eight of the 11 wells analyzed, indicating a declining trend (positive S and z values) with a 95% confidence level (Table 5). Data for the other three wells does not support a consistent trend.

Table 5. Seasonal Kendall Analysis for Bear River active monitoring wells.

Well Number	Tau	S	z	p-value	Trend
08S 42E 17CAB1	**0.214**	**432**	**3.596**	**0.0338**	**0.89**
09S 40E 20CBC1	**0.097**	**64**	**1.154**	**0.4793**	**0.47**
09S 40E 27BCD1	**0.36**	**768**	**6.242**	**0.0018**	**0.20**
10S 40E 05BDD1	**0.284**	**582**	**4.764**	**0.0106**	**0.14**
10S 40E 08BBA1	**0.454**	**994**	**7.77**	**0**	**0.23**
10S 40E 35BDD1	**0.176**	**528**	**3.362**	**0.0198**	**0.21**
13S 43E 35CCD1	**0.45**	**992**	**7.711**	**0**	**0.70**
13S 44E 26BAD1	0.083	182	1.416	0.3364	0.14
14S 38E 15CDC1	**0.383**	**993**	**6.889**	**0.0003**	**0.58**
16S 39E 18CDA1	**0.19**	**613**	**3.676**	**0.0337**	**0.34**
16S 40E 29CCB1	-0.171	-209	-1.74	0.0819	-0.06

*Bold indicates wells with trends supported at the 95% confidence interval.

Conclusions and recommendations

Based on the establishment of the Bear River Ground Water Management Area in 2001 and the water level trends described within this report, it appears the ground water levels in the Bear River Aquifer system are in a declining pattern. Additional monitoring is required to further characterize the ground water conditions in the basin.

It is recommended that the current monitoring network be expanded to provide data in areas in the basin in which groundwater data is lacking. Wells with historic monitoring data should be prioritized to evaluate any long-term trends, with new well additions in areas where historic water level monitoring data is lacking.

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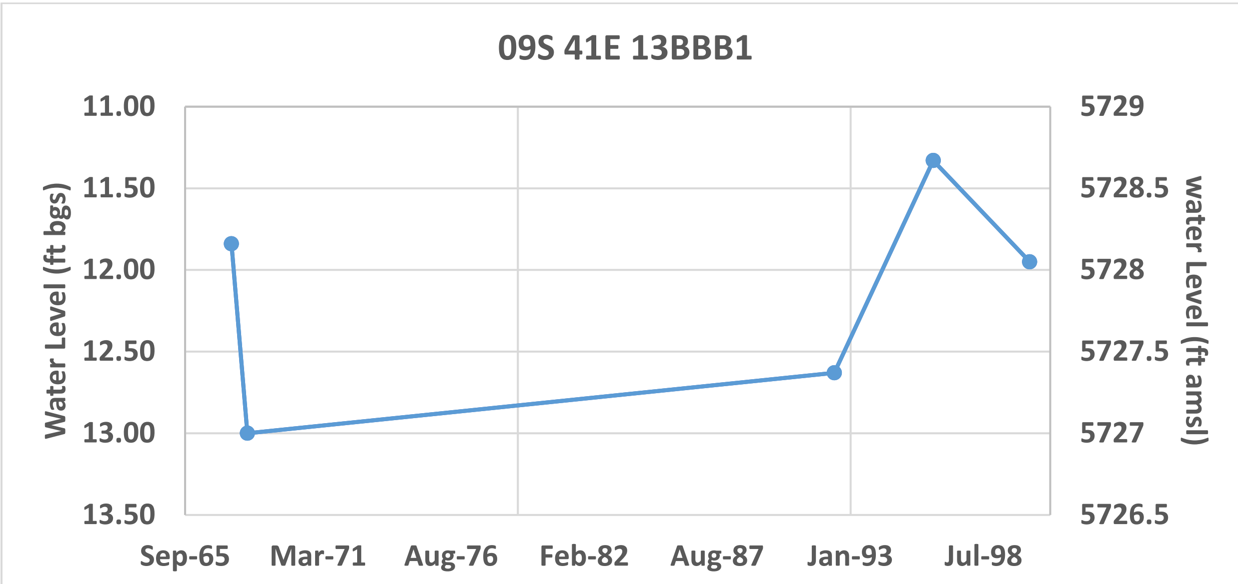
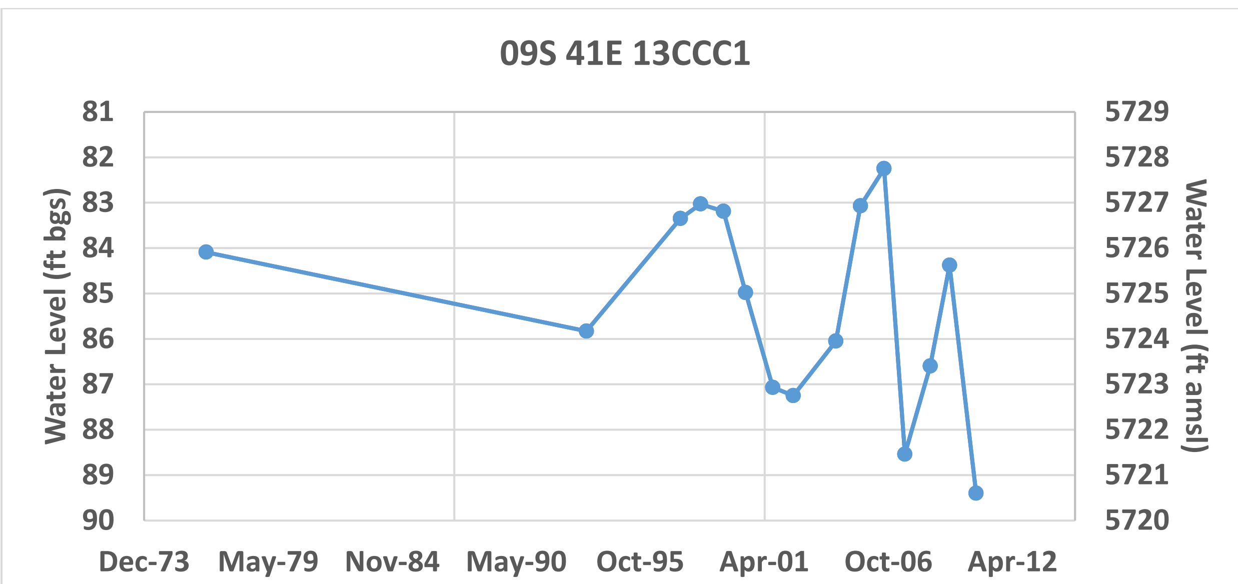
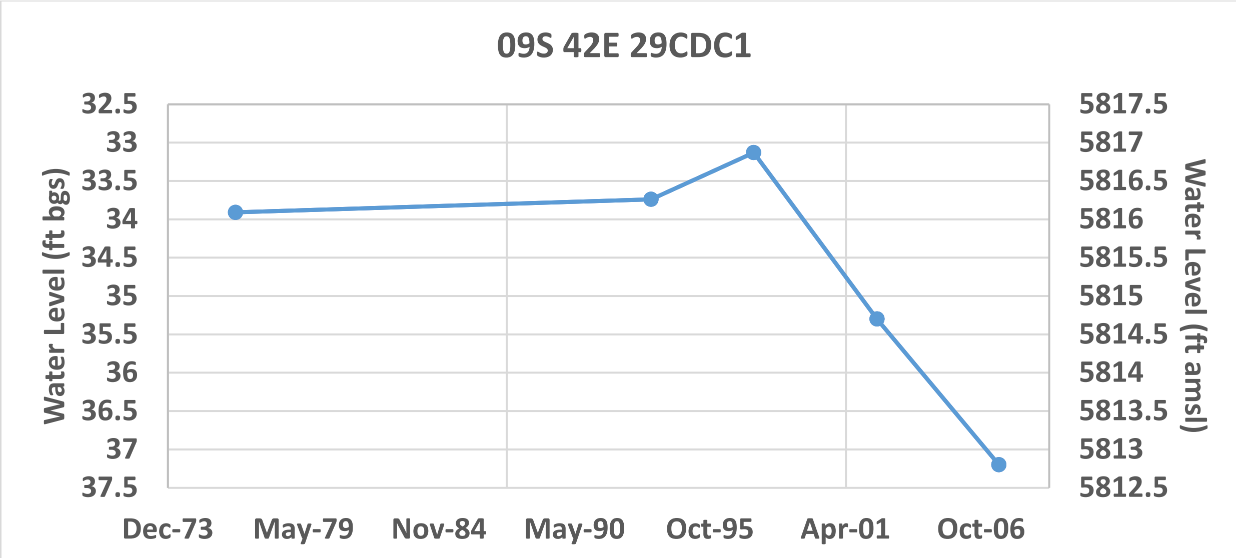
Appendix A

Hydrographs of inactive monitoring sites



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Water Level (ft amsl)
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33
33.5
34
34.5
35
35.5
36
36.5
37
37.5
5817.5
5817
5816.5
5816
5815.5
5815
5814.5
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Nov-84
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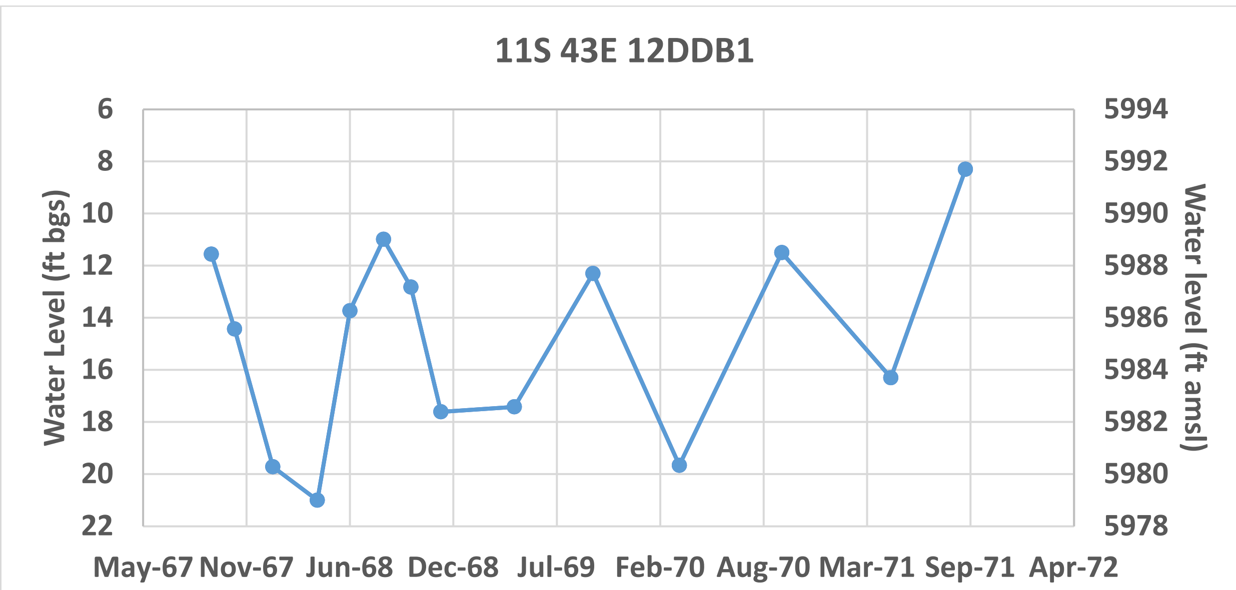
Oct-95
Apr-01
Oct-06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Water level (ft amsl)
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8
10
12
14
16
18
20
22
5994
5992
5990
5988
5986
5984
5982
5980
5978
May-67
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Dec-68
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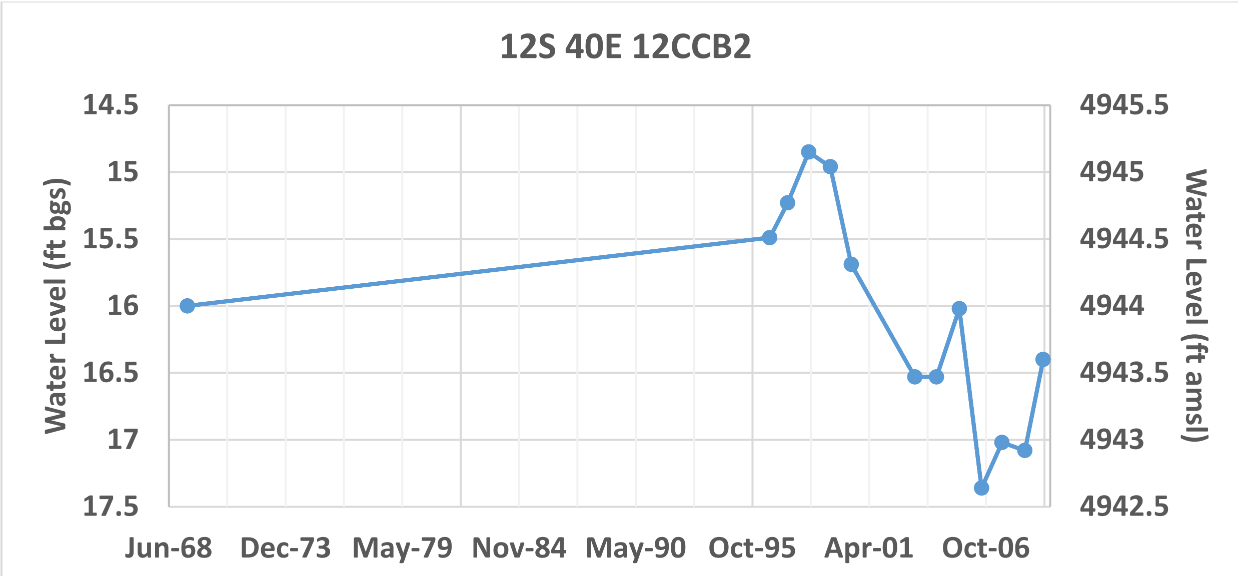
Feb-70
Aug-70
Mar-71
Sep-71
Apr-72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Water Level (ft amsl)
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15
15.5
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16.5
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17.5
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4945
4944.5
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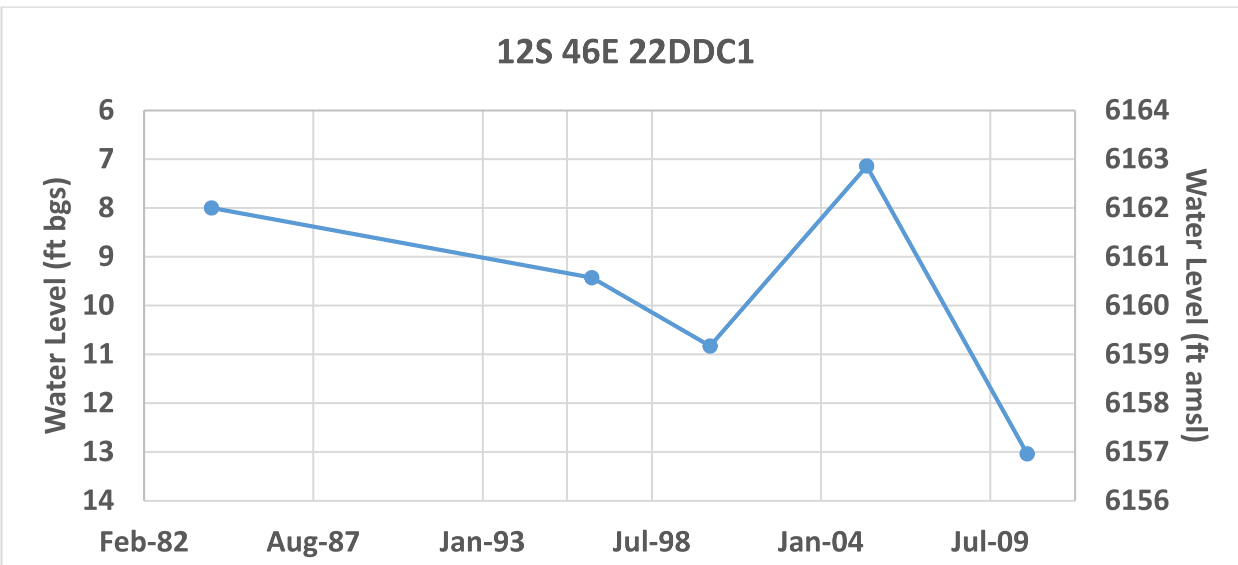
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Water Level (ft amsl)
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7
8
9
10
11
12
13
14
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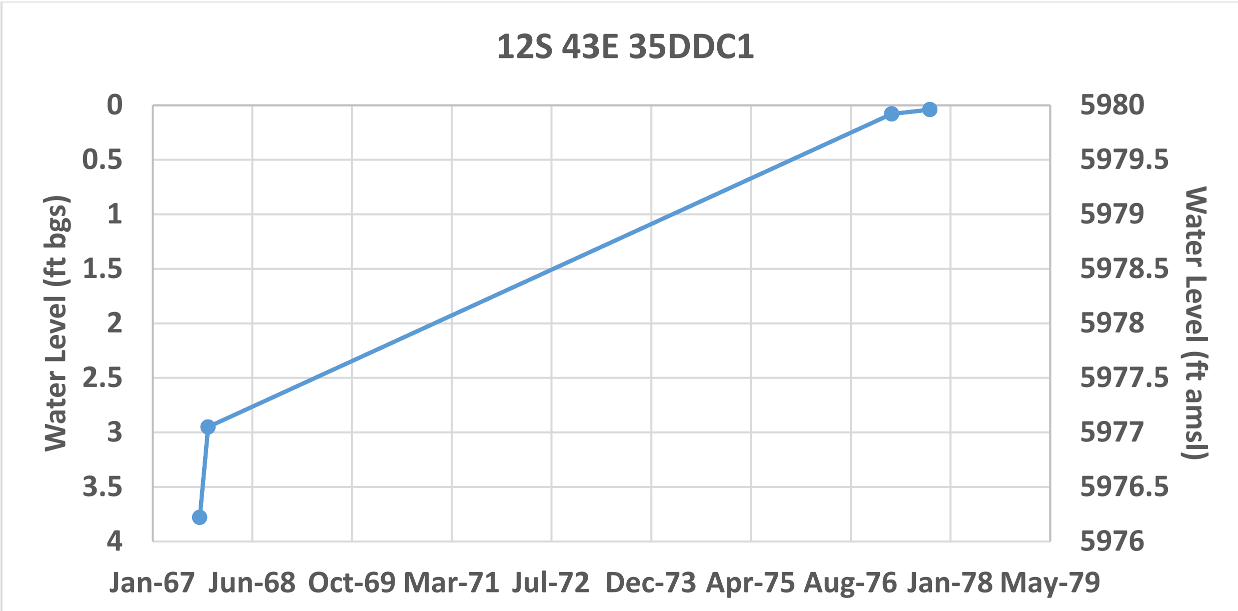
Jul-09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1.5
2
2.5
3
3.5
4
Water Level (ft amsl)
5980
5979.5
5979
5978.5
5978
5977.5
5977
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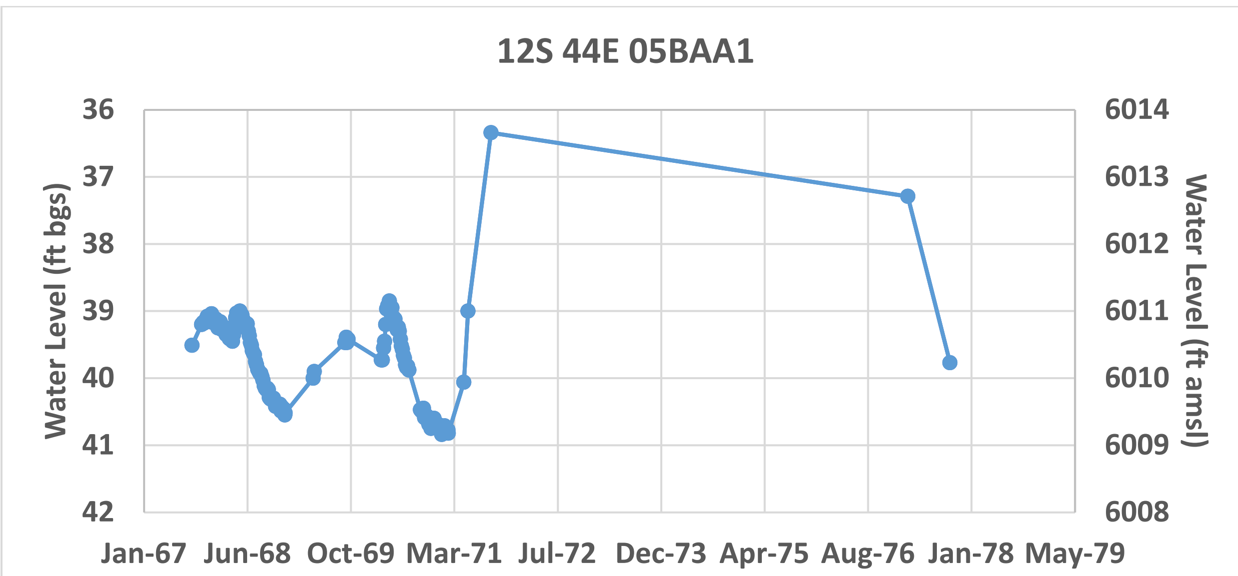
5976
Jan-67 Jun-68 Oct-69 Mar-71 Jul-72 Dec-73 Apr-75 Aug-76 Jan-78 May-79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Water Level (ft bgs)
36
37
38
39
40
41
42
Water Level (ft amsl)
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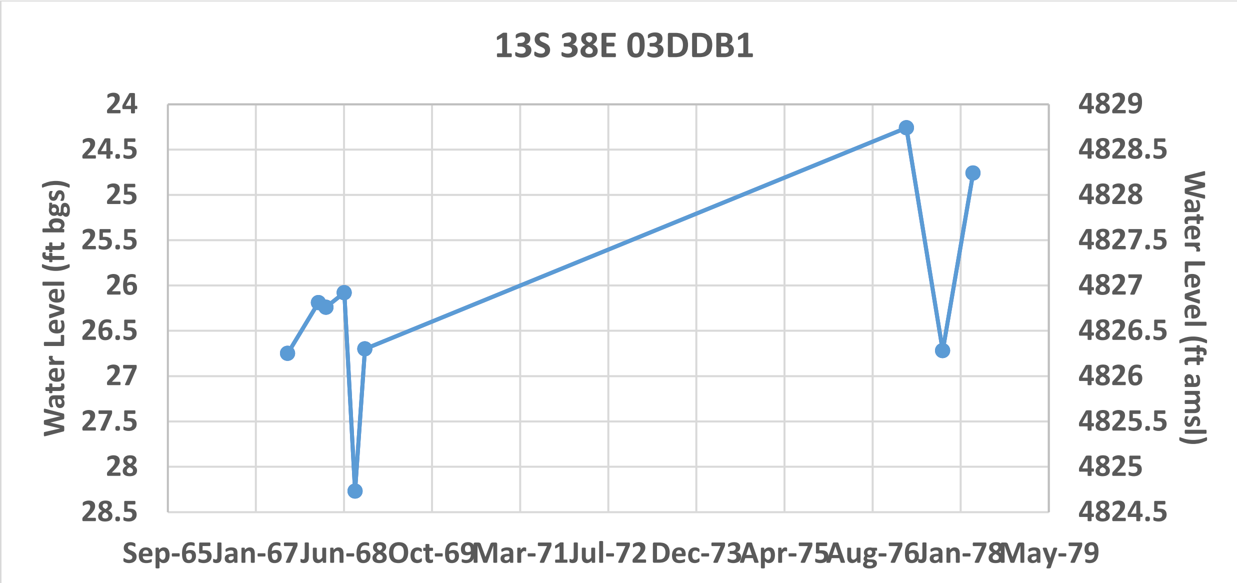
6013
6012
6011
6010
6009
6008
Jan-67 Jun-68 Oct-69 Mar-71 Jul-72 Dec-73 Apr-75 Aug-76 Jan-78 May-79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27.5
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28.5
Water Level (ft amsl)
4829
4828.5
4828
4827.5
4827
4826.5
4826
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4825
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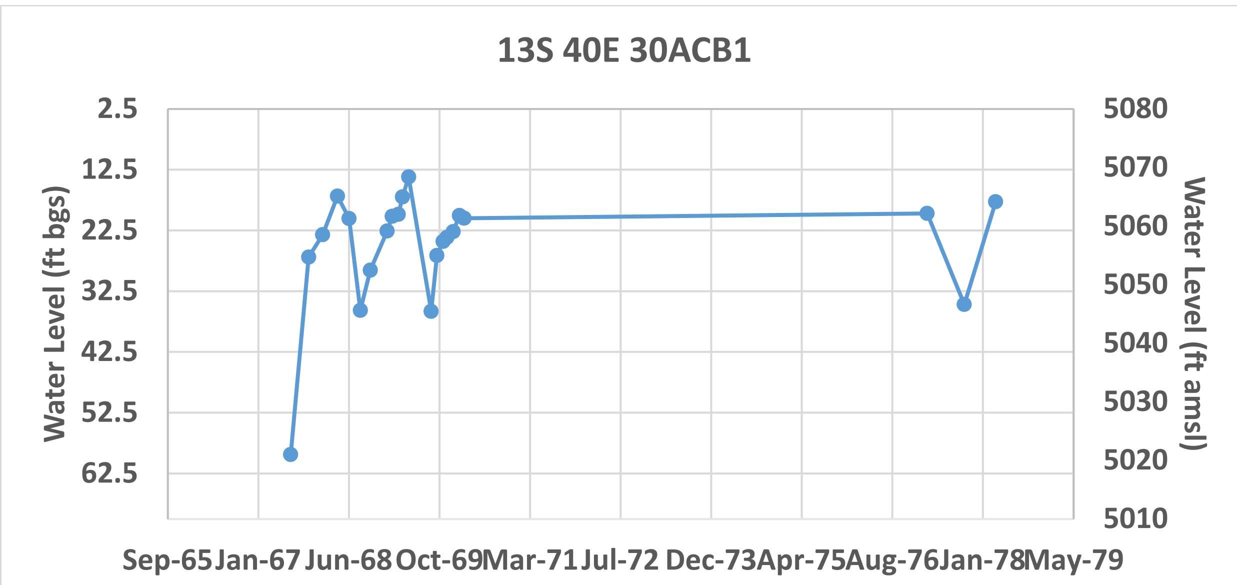
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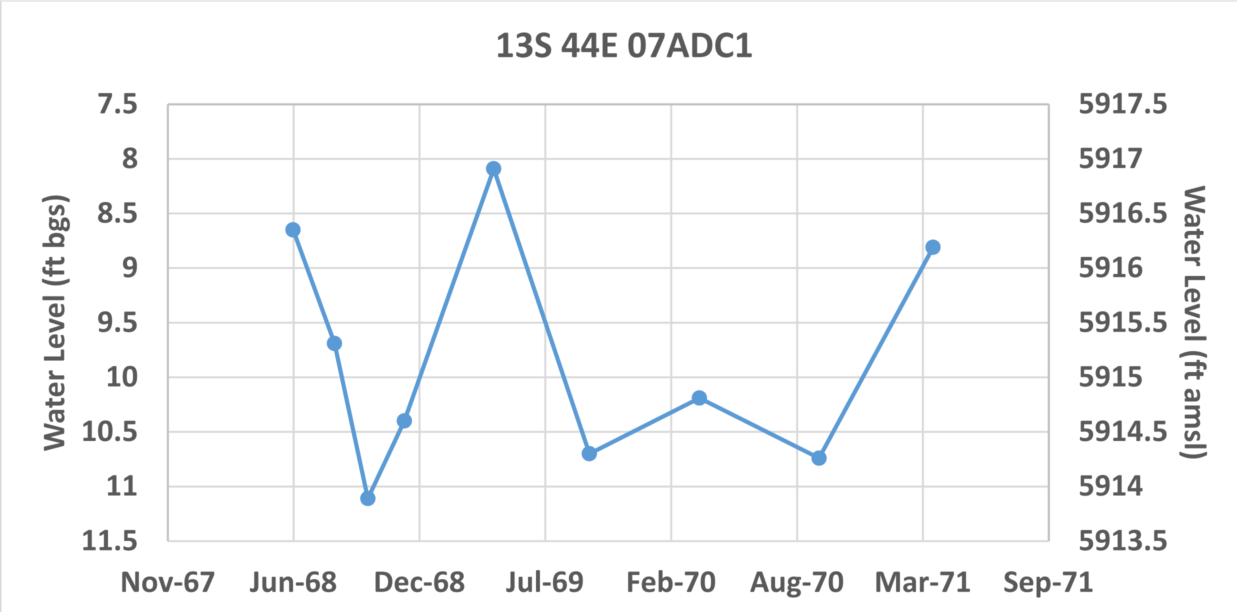
62.5
Water Level (ft amsl)
5080
5070
5060
5050
5040
5030
5020
5010
Sep-65 Jan-67 Jun-68 Oct-69 Mar-71 Jul-72 Dec-73 Apr-75 Aug-76 Jan-78 May-79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Water Level (ft bgs)
Water Level (ft amsl)
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8
8.5
9
9.5
10
10.5
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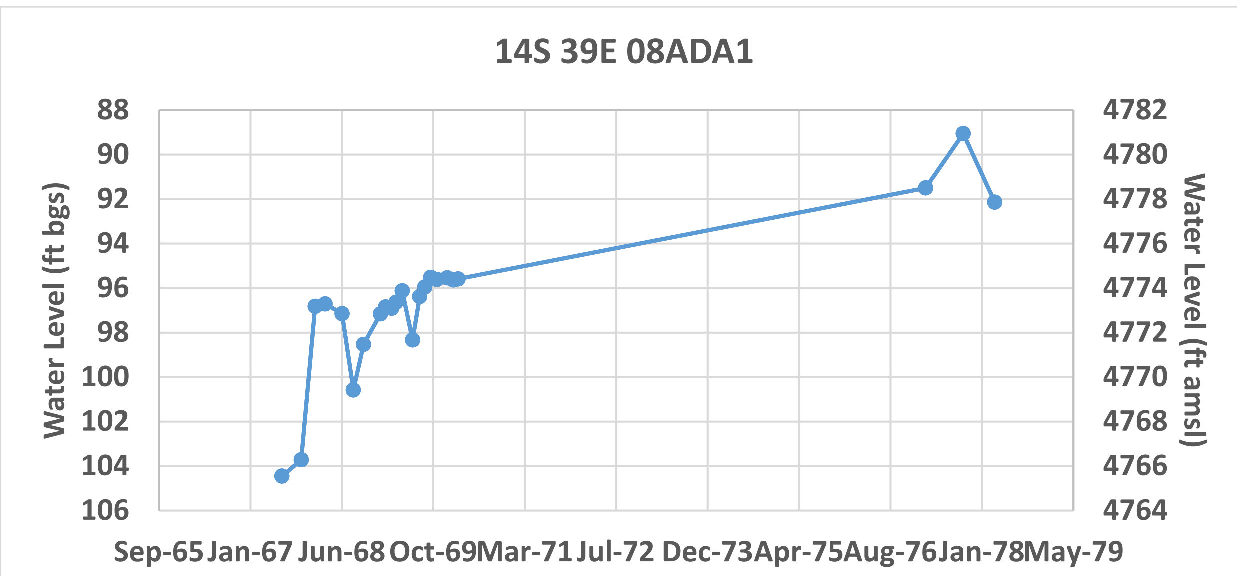
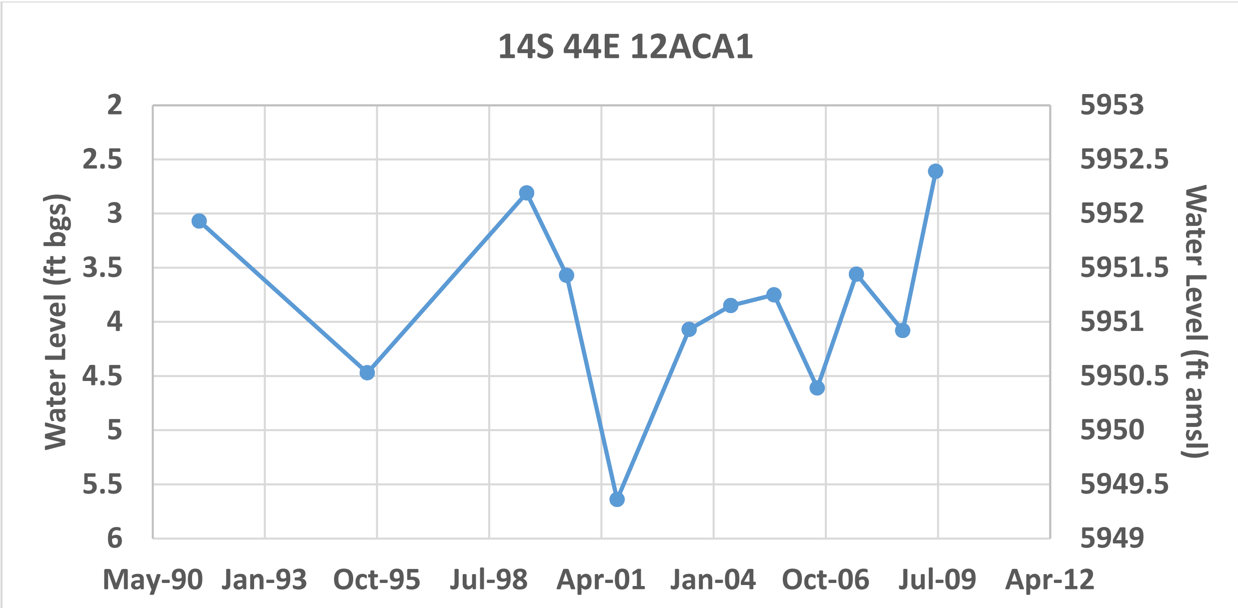
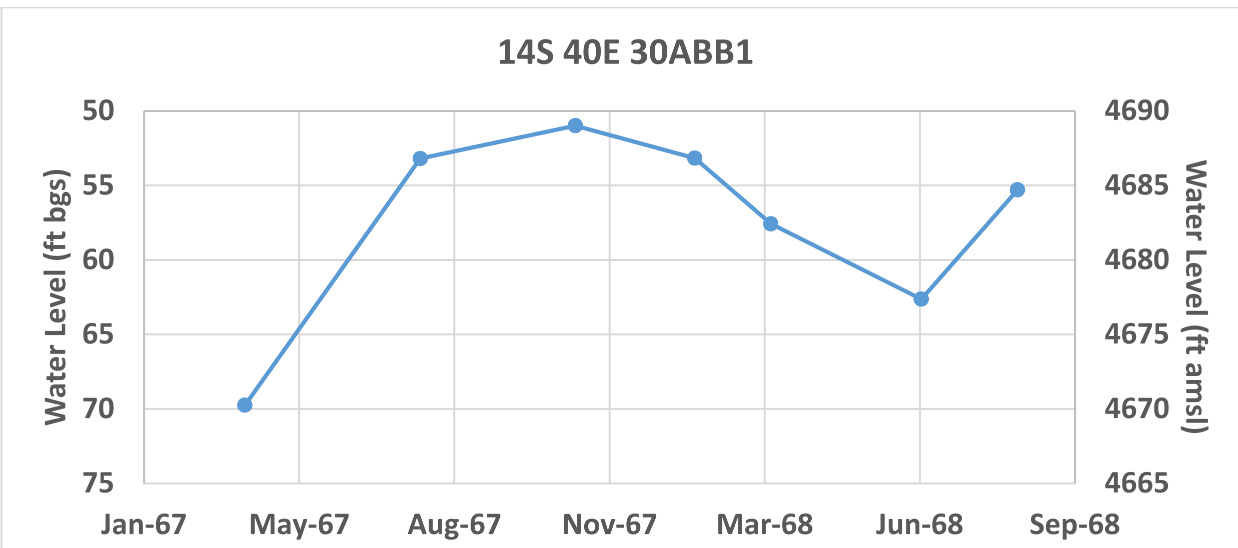
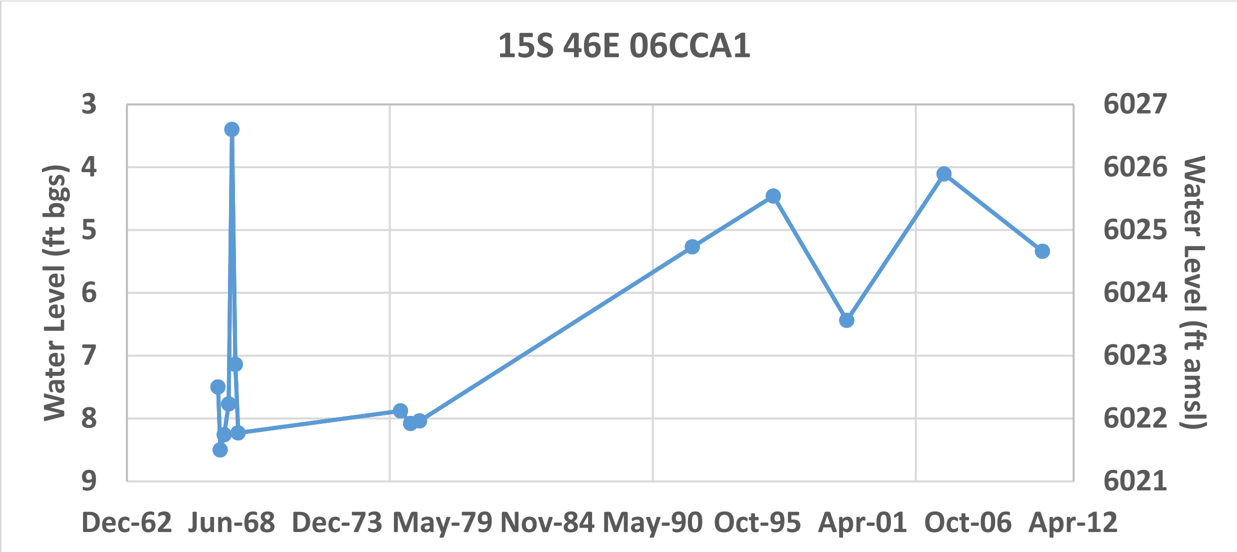
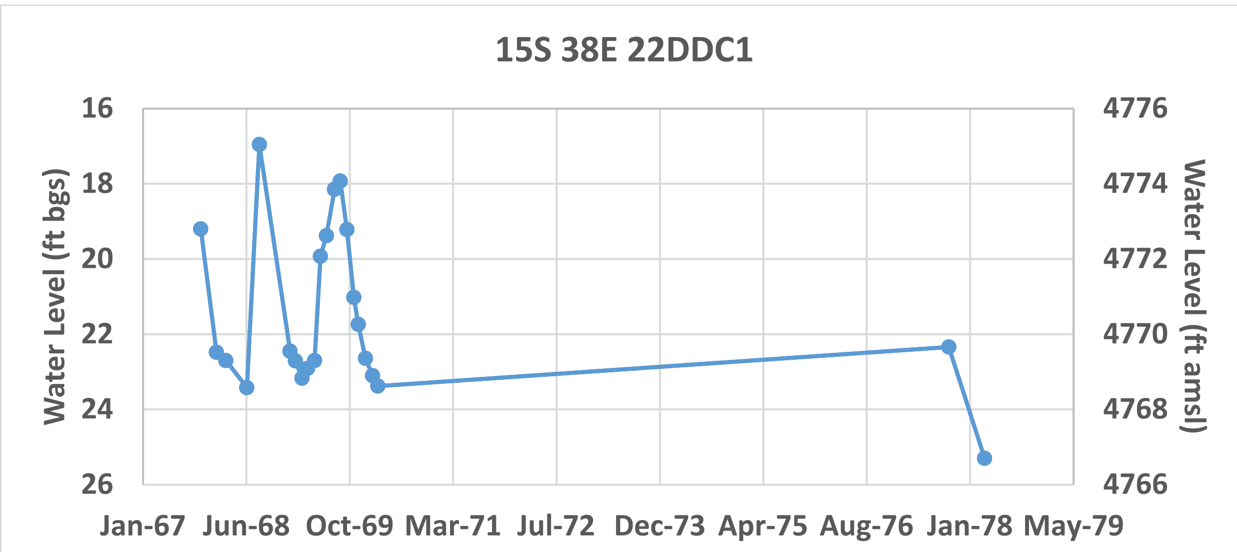
5915
5914.5
5914
5913.5
Nov-67
Jun-68
Dec-68
Jul-69
Feb-70
Aug-70
Mar-71
Sep-71

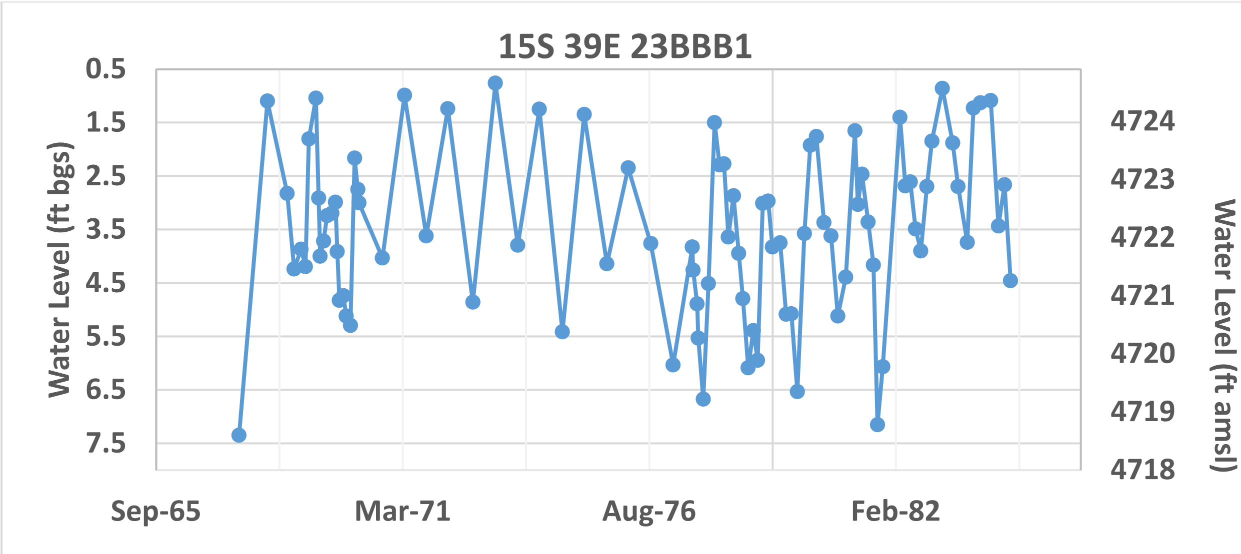

14S 39E 08ADA1
Water Level (ft bgs)
Water Level (ft amsl)
88
90
92
94
96
98
100
102
104
106
4782
4780
4778
4776
4774
4772
4770
4768
4766
4764
Sep-65
Jan-67
Jun-68
Oct-69
Mar-71
Jul-72
Dec-73
Apr-75
Aug-76
Jan-78
May-79

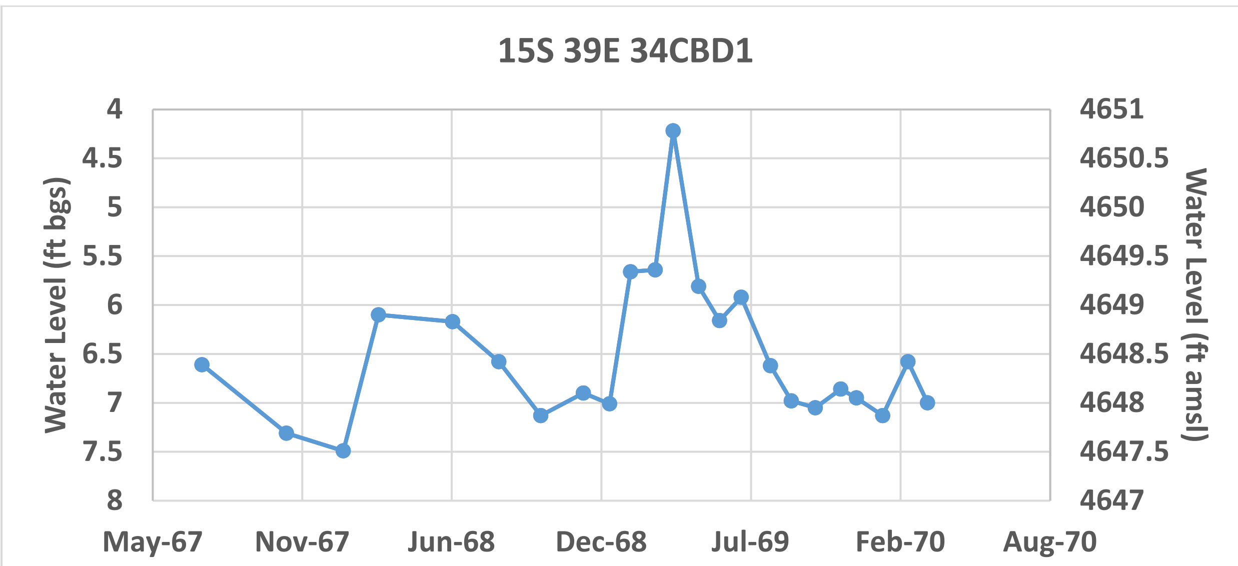

14S 44E 12ACA1
Water Level (ft bgs)
Water Level (ft amsl)
2
2.5
3
3.5
4
4.5
5
5.5
6
5953
5952.5
5952
5951.5
5951
5950.5
5950
5949.5
5949
May-90
Jan-93
Oct-95
Jul-98
Apr-01
Jan-04
Oct-06
Jul-09
Apr-12

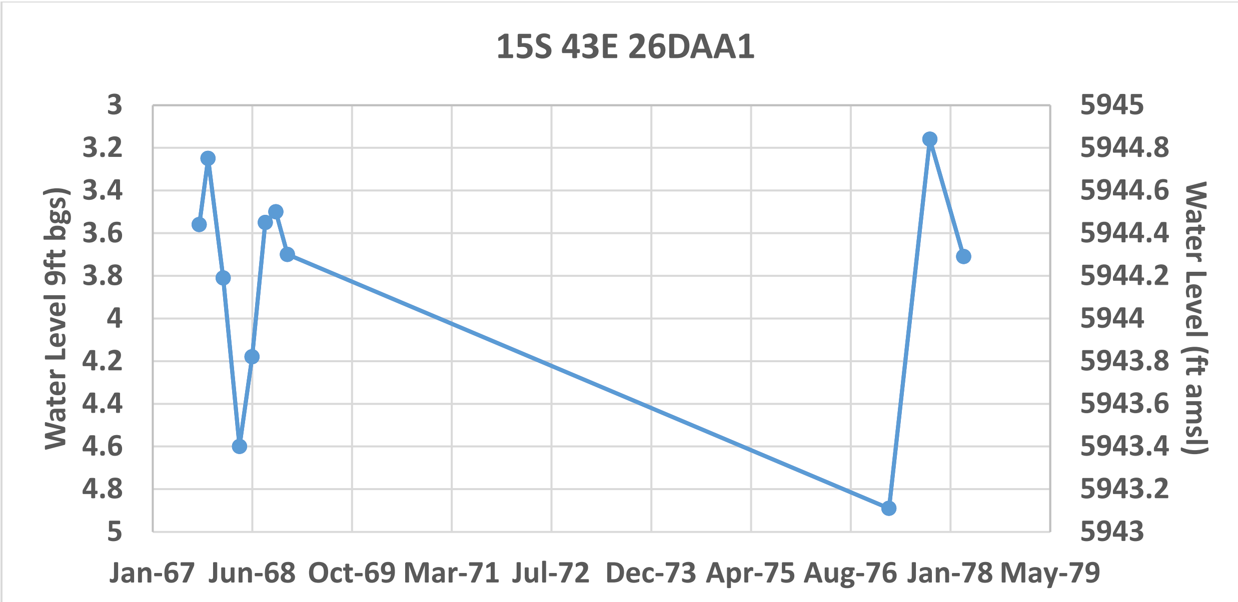

14S 40E 30ABB1
Water Level (ft bgs)
Water Level (ft amsl)
50
55
60
65
70
75
4690
4685
4680
4675
4670
4665
Jan-67
May-67
Aug-67
Nov-67
Mar-68
Jun-68
Sep-68

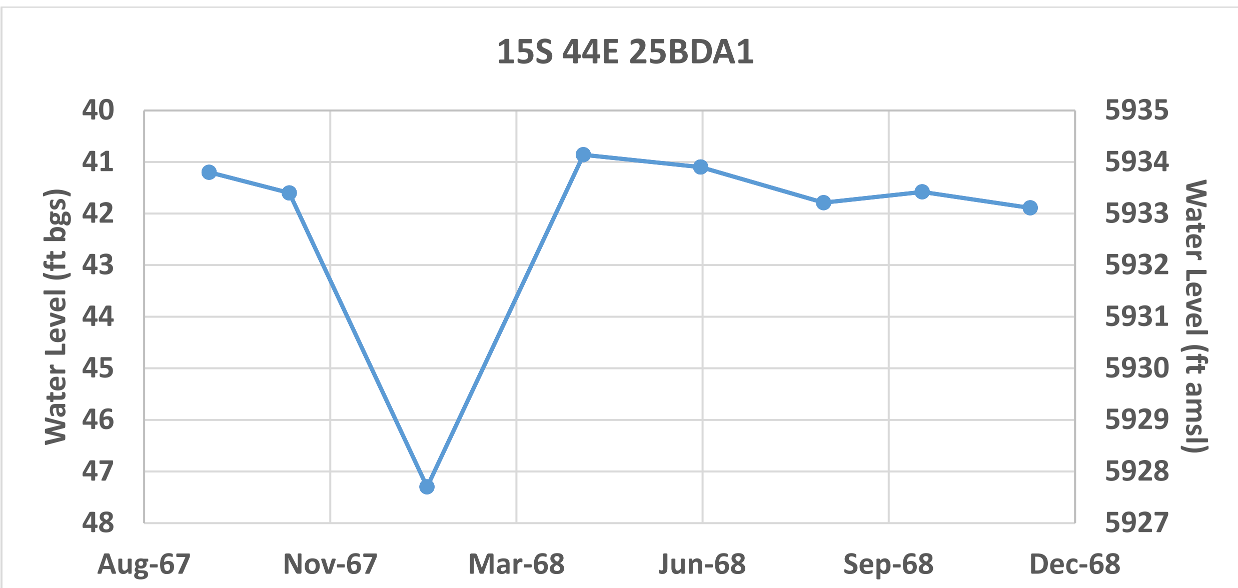

15S 46E 06CCA1
Water Level (ft bgs)
Water Level (ft amsl)
3
4
5
6
7
8
9
6027
6026
6025
6024
6023
6022
6021
Dec-62 Jun-68 Dec-73 May-79 Nov-84 May-90 Oct-95 Apr-01 Oct-06 Apr-12

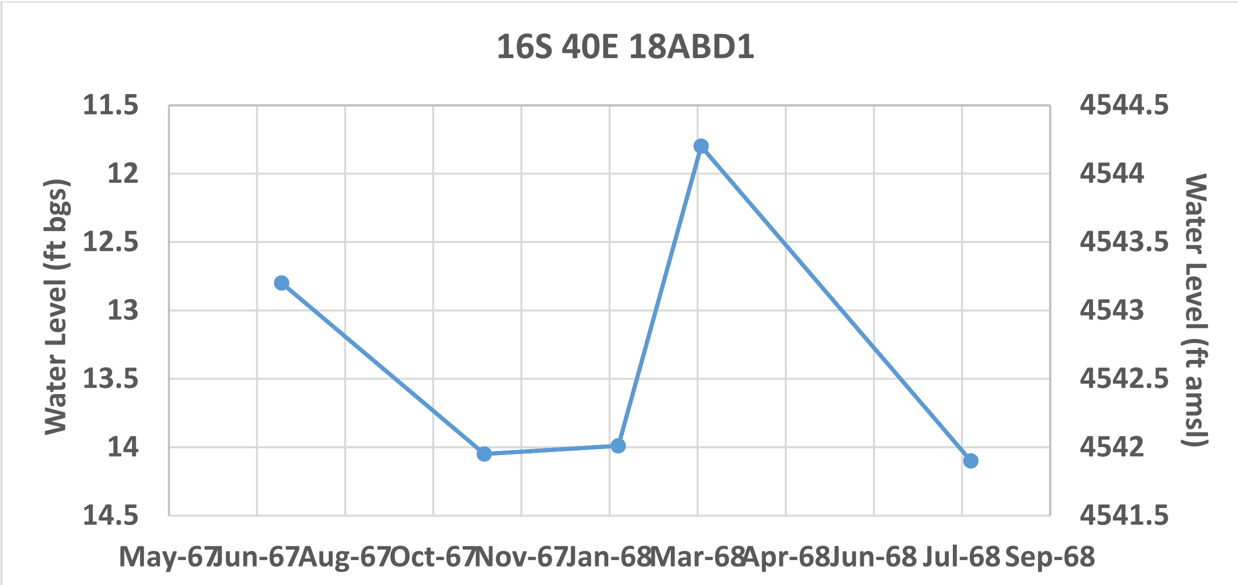

15S 38E 22DDC1
Water Level (ft bgs)
Water Level (ft amsl)
16
18
20
22
24
26
4776
4774
4772
4770
4768
4766
Jan-67 Jun-68 Oct-69 Mar-71 Jul-72 Dec-73 Apr-75 Aug-76 Jan-78 May-79


15S 39E 23BBB1
Water Level (ft bgs)
0.5
1.5
2.5
3.5
4.5
5.5
6.5
7.5
Water Level (ft amsl)
4724
4723
4722
4721
4720
4719
4718
Sep-65
Mar-71
Aug-76
Feb-82

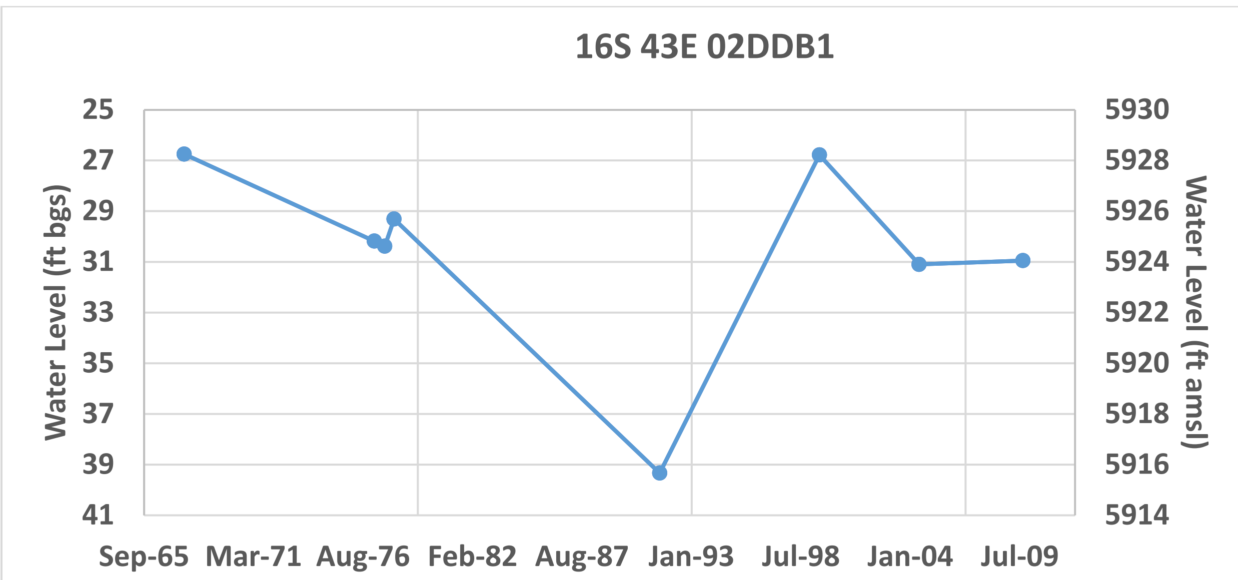

15S 39E 34CBD1
Water Level (ft bgs)
4
4.5
5
5.5
6
6.5
7
7.5
8
Water Level (ft amsl)
4651
4650.5
4650
4649.5
4649
4648.5
4648
4647.5
4647
May-67
Nov-67
Jun-68
Dec-68
Jul-69
Feb-70
Aug-70


15S 43E 26DAA1
Water Level 9ft bgs)
Water Level (ft amsl)
3
3.2
3.4
3.6
3.8
4
4.2
4.4
4.6
4.8
5
5945
5944.8
5944.6
5944.4
5944.2
5944
5943.8
5943.6
5943.4
5943.2
5943
Jan-67
Jun-68
Oct-69
Mar-71
Jul-72
Dec-73
Apr-75
Aug-76
Jan-78
May-79


15S 44E 25BDA1
Water Level (ft bgs)
Water Level (ft amsl)
40
41
42
43
44
45
46
47
48
5935
5934
5933
5932
5931
5930
5929
5928
5927
Aug-67
Nov-67
Mar-68
Jun-68
Sep-68
Dec-68



16S 40E 18ABD1
Water Level (ft bgs)
11.5
12
12.5
13
13.5
14
14.5
Water Level (ft amsl)
4544.5
4544
4543.5
4543
4542.5
4542
4541.5
May-67
Jun-67
Aug-67
Oct-67
Nov-67
Jan-68
Mar-68
Apr-68
Jun-68
Jul-68
Sep-68



16S 43E 02DDB1
Water Level (ft bgs)
25
27
29
31
33
35
37
39
41
Water Level (ft amsl)
5930
5928
5926
5924
5922
5920
5918
5916
5914
Sep-65
Mar-71
Aug-76
Feb-82
Aug-87
Jan-93
Jul-98
Jan-04
Jul-09